SEWARD HARBOR, AK

Risk Report

FEMA Region X – Kenai Peninsula Borough, Alaska

Kenai Peninsula Borough and the Incorporated Cities of Homer, Kachemak, Kenai, Seldovia, Seward, and Soldotna

FEMA

DEPARTMENT OF COMMERCE, COMMUNITY AND ECONOMIC DEVELOPMENT

ALASKA GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Executive Summary

This report discusses risk for Kenai Peninsula Borough and its incorporated cities, including Homer, Kachemak, Kenai, Seldovia, Seward, and Soldotna. This report will inform communities of their risks related to natural hazards and enable them 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 act to reduce risk.

This Risk Report showcases the results of an in-depth risk assessment for flood, earthquake, erosion, tsunami, and dam failure hazards in Kenai Peninsula Borough. 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 (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 Kenai Peninsula Borough is incorporated into the Hazus model. Other hazards, including erosion and tsunami, were assessed through an exposure assessment, and a hazard profile summary was completed for failure. The information collected to assess potential community losses included 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.

This report provides a summary of the Risk Assessment Database. The Risk Assessment Database aggregates natural hazard data developed by various Federal and State partners and quantifies risk to those natural hazards using community assessor data to determine local risk. While this report summarizes the risk assessment results, the most detailed information is found in the database itself. State and local officials can use the data and analysis provided to update a variety of local plans, communicate risk, inform the modification of development standards, identify mitigation projects, and, ultimately, act to reduce risk.

Access to the Risk Assessment Database can be obtained by contacting the following individuals:

Chris Clough
Kenai Peninsula Borough GIS Manager
gisweb@kpb.us
(907) 714-2200

Or

Sally Russel Cox
Alaska Risk MAP Coordinator
sally.cox@alaska.gov
(907) 269-4588

Flood Risk Assessment

In Kenai Peninsula Borough, flood losses were modeled at $5.8 million. At 13.3 percent, the unincorporated areas of Kenai Peninsula Borough have the highest economic loss ratio of structures in the Special Flood Hazard Area (SFHA), the area subject to inundation by the 1-percent-annual-chance flood. The City of Homer has the largest total estimated building and content losses at over $2 million. As a result of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) project, these communities have new Flood Insurance Rate Maps (FIRMs) and 1-percent-annual-chance depth grids.

Earthquake Risk Assessment

Earthquake assessments were based on the Magnitude (M) 7.1 earthquake event of January 24, 2016, (referred to as the Old Iliamna event) and a M9.2 Great Alaska Earthquake scenario created to simulate the 1964 Anchorage event. Building and content losses were modeled at $17 million for the M7.1 event and at over $400 million for the M9.2 scenario. For both simulations, the heaviest losses occurred in unincorporated areas of Kenai Peninsula Borough, with estimated building and content losses of $8.9 million and $216 million for the M7.1 and M9.2 events, respectively. The incorporated communities of Homer, Kenai, and Soldotna were projected to have losses of over $8.5 million for the M7.1 event and losses of near or over $185 million for the M9.2 scenario. Losses were also projected for transportation systems (including highways, railways, ferries, ports, and airports), utility systems (including potable water, wastewater, oil systems, natural gas, electric power, and communication facilities), and essential facilities (educational, fire, government, health care, and police).

Erosion Exposure Assessment (Cook Inlet)

The erosion assessment for Kenai Peninsula Borough divided the vulnerability area into three zones, based on location along Cook Inlet. The largest "hot spot" erosion rates occur near Nikiski, on the northern banks of the Kenai River. Some of these areas experience erosion at 4.0 to 5.7 feet per year. The Central Zone, which consists of areas from the Kenai River to the Kasilof River and to the Ninilchik River, has the highest number of parcels (with structures) along the eroding coastline, with 289 parcels accounting for $65,152,300 in building and content values.

Tsunami Exposure Assessment (Homer, Seldovia, and Seward)

Existing tsunami hazard data is available for Homer, Seldovia, and Seward within Kenai Peninsula Borough. The exposure assessment identifies 221 structures, worth over $87.6 million, that would be at risk from a maximum credible tsunami scenario modelled to mimic the 1964 tsunami event. The City of Seward has the properties with the highest values (over $62 million) that intersect the tsunami zone. The community with the largest percentage of structures within a tsunami zone is the City of Seldovia, with 13.8 percent of its structures at risk.

Dam Failure Hazard Profile

There are eleven dams on the Kenai Peninsula Borough, two of which are identified as High Hazard according to the USACE National Inventory of Dams (NID). The Lowell Creek and Bridge Creek dams are both classified as High Hazard according to the NID, and neither structure has an approved Emergency Action Plan (EAP). In July 2016, the City of Seward signed an agreement to develop an EAP with the Alaska Department of Natural Resources. As of January 2017, the EAP has not yet been completed.

The assessor and economic data used to develop this report has been shared with the U.S. Army Corps of Engineers (USACE) and is being used to enhance the Lowell Creek Hybrid Risk Assessment currently in development by the USACE.

Using the Risk Assessment and Exposure Assessment Results

The results of this risk assessment, including the loss data from Hazus, the exposure assessment, and the design code analyses, highlight the areas most affected by the hazards noted above. State and local officials should use this information to identify areas for mitigation projects, as well as for additional outreach efforts to educate residents on the hazards that affect the Borough. The areas of greatest hazard impact are identified in the *Areas of Mitigation Interest* section of this Risk Report, which can serve as a starting point for identifying and prioritizing actions communities can take to reduce risk.

1. Introduction

This report outlines the risk assessment results and findings for FEMA's 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 (HMPs), shoreline master plans, and community comprehensive plans** – Planners can use risk information when developing or updating HMPs, 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 Kenai Peninsula Borough was incorporated into the Hazus model. Other hazards were assessed through an exposure assessment; when information was limited, a hazard profile was conducted. 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. Erosion Risk Assessment: Exposure Assessment
4. Tsunami Risk Assessment: Exposure Assessment
5. Dam Failure Risk Assessment: 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 are referred to throughout this report as “improved parcels”. 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 appendix.

3. Kenai Peninsula Borough Risk MAP Overview

A flood study project updating coastal, riverine, and stillwater flood hazards in select portions of Kenai Peninsula Borough became effective on October 20, 2016. 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.

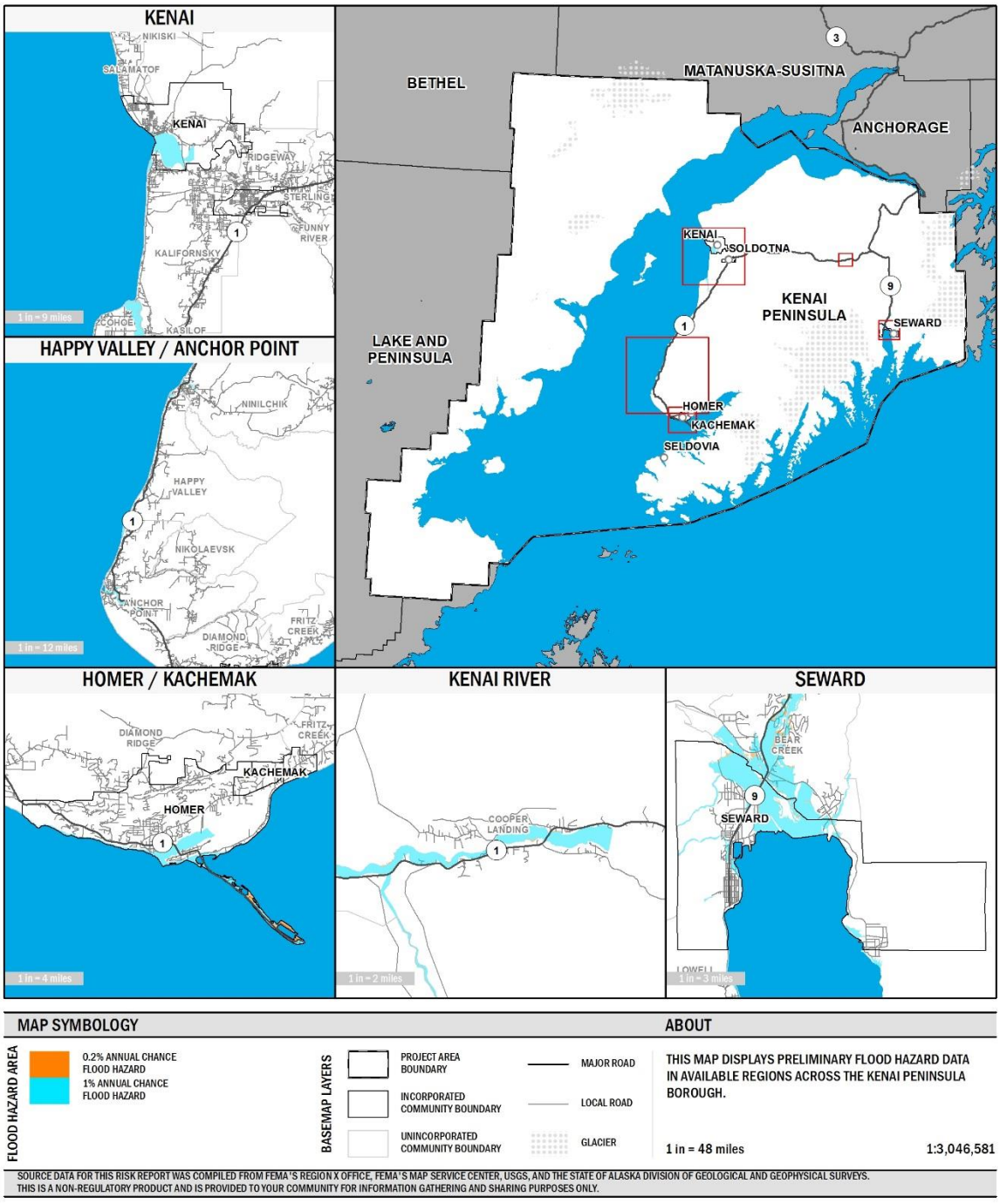
Project Milestones

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	KENAI PENINSULA BOROUGH RISK MAP TIMELINE
Risk MAP Discovery Meeting	March 2, 2011
Flood Study Kick-Off Meeting	July 23–26, 2012
Flood Risk Review Meeting (FRR) / Draft Mapping	August 27–28, 2013
Preliminary DFIRM and FIS Release	June 13, 2014
Consultation Coordination Officer (CCO) Meeting	September 9–11, 2014
Public Meeting / Workshop	September 9–11, 2014
Appeal Period(s)	(1st) January 28, 2015–April 28, 2015; (2nd) August 12, 2015–November 10, 2015
Letter of Final Determination	April 20, 2016
Resilience Meeting	August 22-24, 2017
FIRMs and FIS Effective Date	October 20, 2016

Map 1: Overview of Kenai Peninsula 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 were presented at the FRR meeting in August 2013. Preliminary results of the Flood Insurance Study (FIS) are reviewed and discussed with community officials at the CCO meeting, which was held in September 2014. At the request of the Borough, public meetings were also held in September 2014. Finally, Resilience meetings were held in August 2017. The purpose of Resilience meetings is to continue to build local capacity for implementing the most important mitigation activities within the watershed.

Project Scope

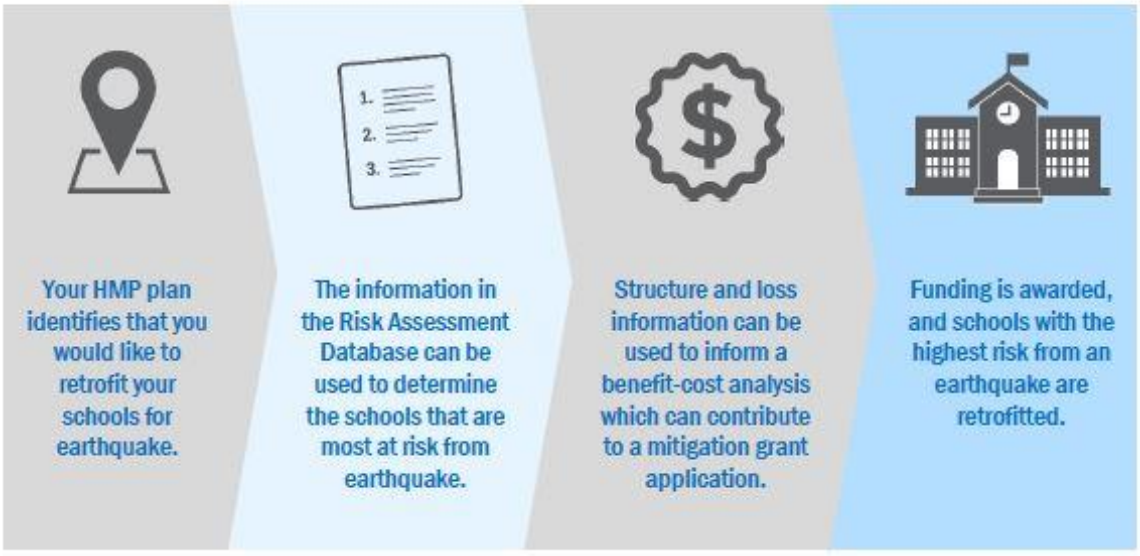
The Kenai Peninsula Borough Risk MAP flood study included the study of coastal flood hazards at select areas along Cook Inlet, Kachemak Bay, and Resurrection Bay. Riverine flood hazards were studied along portions of the Anchor River, the Kenai River, and the Ninilchik River, while Beluga Lake is the sole stillwater flood hazard studied.

Additional Project Deliverables

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

While this Risk Report provides a summary of the risk assessments, the Risk Assessment Database contains the data that is necessary to replicate and expand the results of the hazard analysis produced for the Risk Report. By aggregating natural hazard data and quantifying risk to those natural hazards using community assessor data, this dataset can determine local risk to hazards for every structure in the community. This information can be used for grant applications, local planning and emergency management efforts, identifying vulnerable populations, and communicating risk to various audiences. The risk database is a very powerful dataset that can be used for multiple projects and planning efforts.

Figure 1: Example of a Risk Assessment Database Application



4. Socioeconomic Vulnerability

Risk assessments are characterized by an analysis of the physical extent of hazards and their corresponding locations. However, it is important to highlight additional factors that play a role in a community's ability to be resilient after a natural disaster, and the feasibility of enacting mitigation actions. Socioeconomic factors can both amplify and dampen the community's susceptibility to loss, and understanding these factors can help communities allocate resources effectively and equitably to more vulnerable populations. Individuals' ability to prepare and respond to hazards will affect evacuation times and their ability to reach recovery centers and to afford hazard prevention techniques and repairs to their home and property.

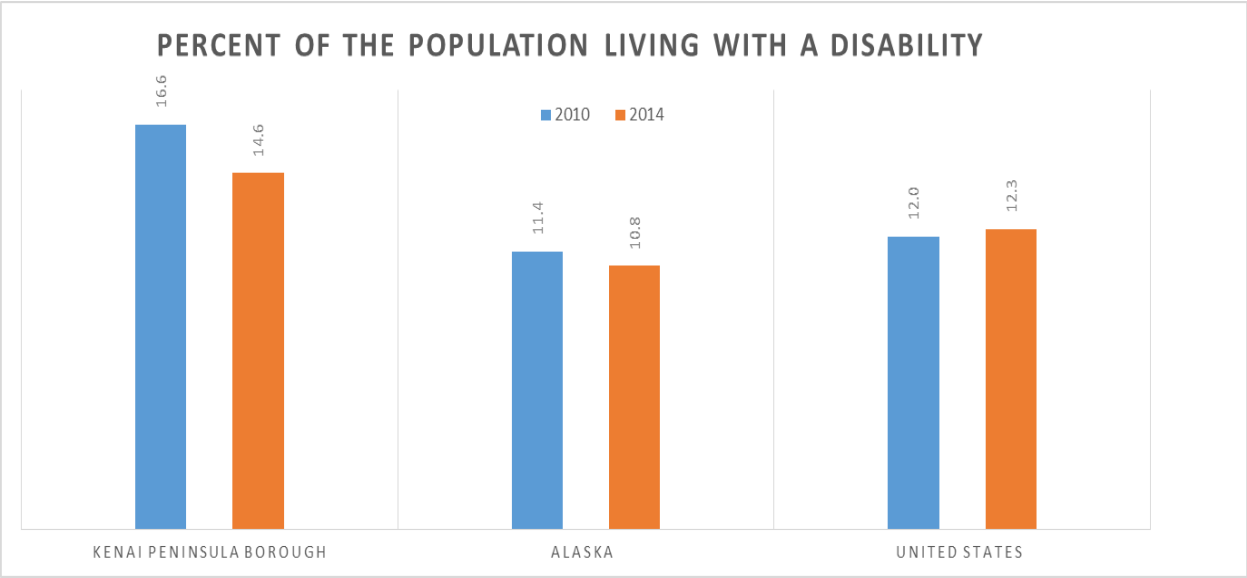
Understanding the population of the Kenai Peninsula Borough, relative to State and national populations, and how that population is changing over time, is necessary to effectively improve current communication programs that target individuals at risk from the natural hazards that affect the area. Demographic data, which is analyzed below, was obtained from the U.S. Census Bureau and is searchable through the American Fact Finder advanced search. Data from 2000 and 2010 data are provided through those years' census counts. Statistics provided in 2014 are from the American Community Survey, which is an ongoing statistical survey conducted by the U.S. Census Bureau.

Vulnerable Population Groups

People over the age of 65 or under the age of 18 are classified as vulnerable age groups. These individuals may be dependent on others or on assistive devices to fulfill the activities of daily living. Children rely on caregiving adults, while elderly populations may have transportation and mobility limitations. In the Kenai Peninsula Borough, 23.4 percent of residents were under the age of 18 in 2014, compared to 25.8 percent in Alaska and 23.5 percent nationwide. Elderly residents accounted for 12 percent of the Peninsula's population, compared to 8.5 percent in Alaska and 13.7 percent nationwide. Between 2000 and 2014, the size of the population under the age of 18 decreased, while the number of individuals over the age of 65 increased.

Additionally, individuals characterized as living with a disability may require more equitable services regarding hazard presentation, preparation, mitigation, and repairs. The percentage of residents living with a disability in the Kenai Peninsula Borough exceeds both the Alaska and national percentages (Figure 2). Of the jurisdictions within the Borough, Kachemak and Seldovia report that over 20 percent of their 2014 population includes people who live with a disability.

Figure 2: Percentage of the Population Living with a Disability

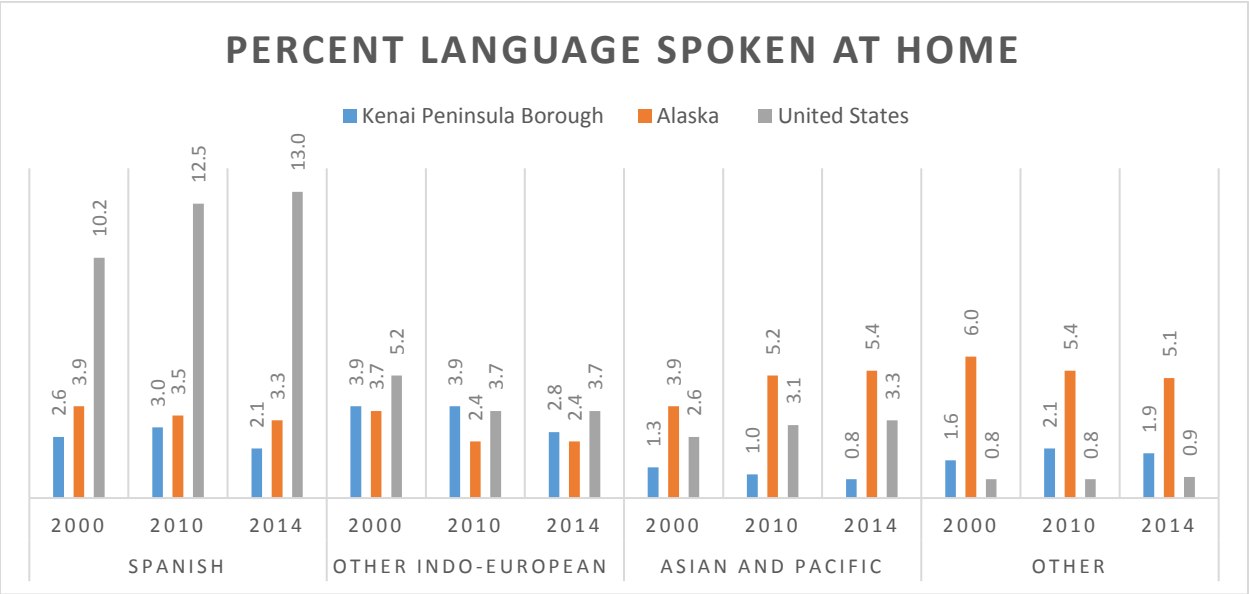


Culture and Language

The U.S. Census Bureau categorizes the language spoken at home in five main categories: English, Spanish, other Indo-European languages, Asian and Pacific languages, and other languages. Cultural and linguistic differences can have a negative impact on natural hazard communication and outreach efforts. Approaching hazard mitigation and response efforts with a comprehensive understanding of cultural behaviors, attitudes, and language barriers will increase the success rates of hazard prevention, preparation, and response in culturally diverse communities.

Within the Kenai Peninsula Borough, most of the population speaks English. When compared to the total population of the United States, both the Kenai Peninsula Borough and Alaska have fewer Spanish speakers and Indo-European language speakers. Alaska has a higher percentage of residents who speak an Asian and Pacific language or languages categorized as "other." However, the percentage of individuals speaking those languages is not as high in the Kenai Peninsula Borough. In the Borough, the largest percentage of non-English-speaking residents speak other Indo-European languages at home, which can include (but is not limited to) languages spoken in Europe and Western and Southern Asia. Because most residents living in the Kenai Peninsula Borough speak English and the percentage of non-English speakers is lower than the national average, communicating risk to communities may not present many language barriers. Ideally, all jurisdictions should approach community engagement and risk communication with cultural competency to ensure that outreach and education reaches all communities equitably.

Figure 3: Percentage of Non-English Languages Spoken



Economic Vulnerability

Knowing the economic characteristics of a community can assist in analyzing the community's ability to prepare, respond, and rebuild after a natural hazard. Categorizing economic vulnerability can encompass many factors, including median household income, poverty rates, employment and unemployment rates, housing tenure, and community building inventory.

Median household income and poverty rates measure individual economic stability. Communities with a larger portion of their population living paycheck to paycheck may have more individuals finding it difficult to rebuild after a disaster. Alternatively, wealthier communities may be less affected by a disaster because they have the financial means to prepare, prevent, and rebuild stronger after a disaster. In 2014, Kenai Peninsula Borough's median household income was roughly $10,000 higher than that of the United States as a whole (Figure 4), and poverty rates were roughly 6 percent lower than the national rate (Figure 5).

Figure 4: Median Household Income Between 2000 and 2014

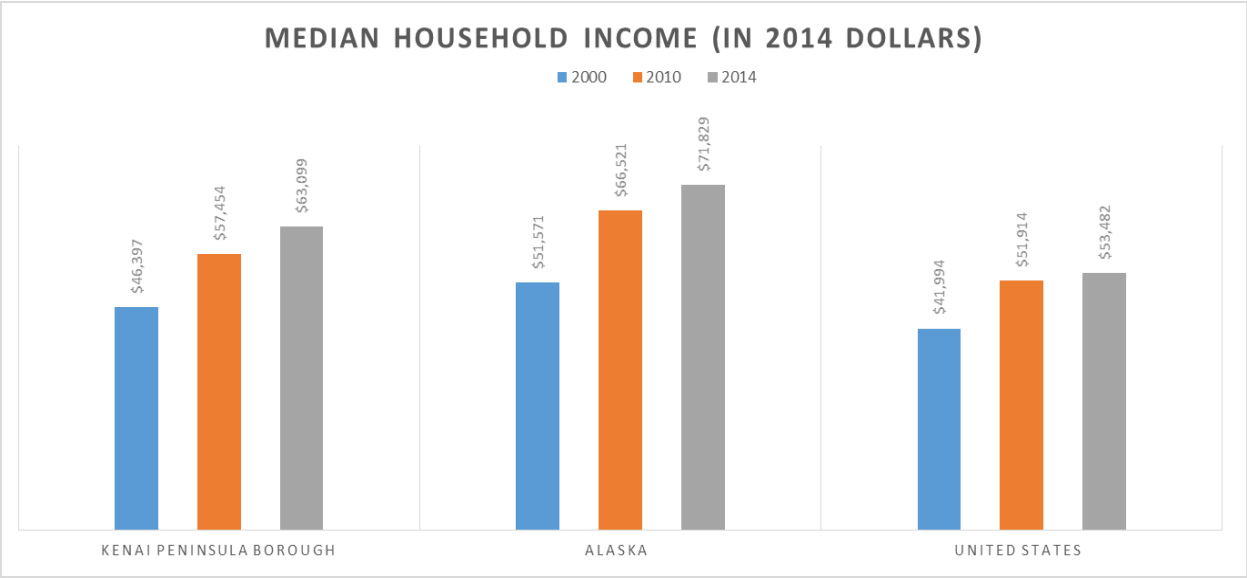
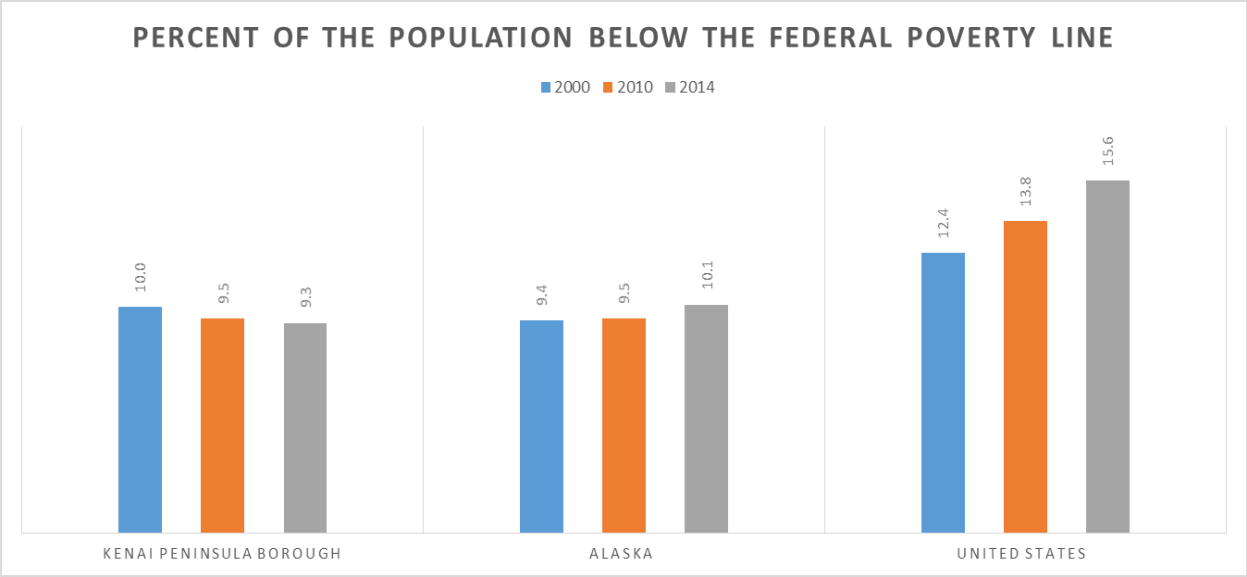
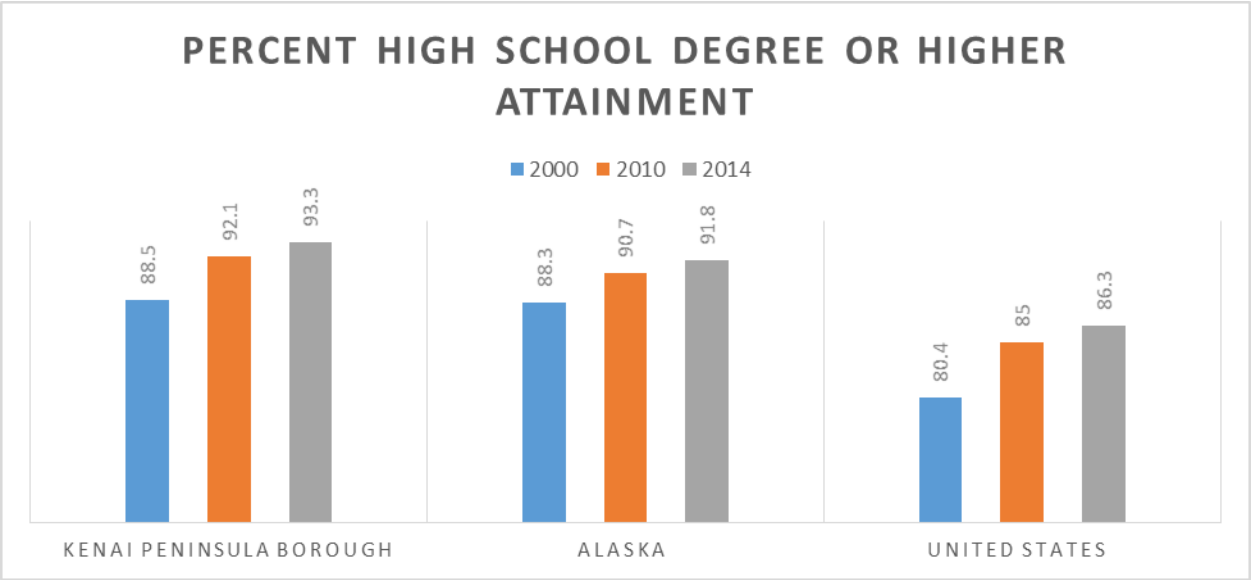


Figure 5: Percentage of Population Living below the Poverty Line Between 2000 and 2014



Educational attainment is a measure of how many individuals have received a high school degree or higher, or a bachelor's degree or higher. Obtaining a higher education may result in higher wages and more financial stability. When compared to the nationwide percentage of the population obtaining a high school degree or higher, the Kenai Peninsula Borough has remained 8 percent higher since 2000 (Figure 6). The percentage of people with a bachelor's degree or higher has consistently been higher nationwide than in the Kenai Peninsula Borough; however, the percentages of educational attainment in Kenai Peninsula Borough, Alaska, and the United States have all increased between 2000 and 2014.

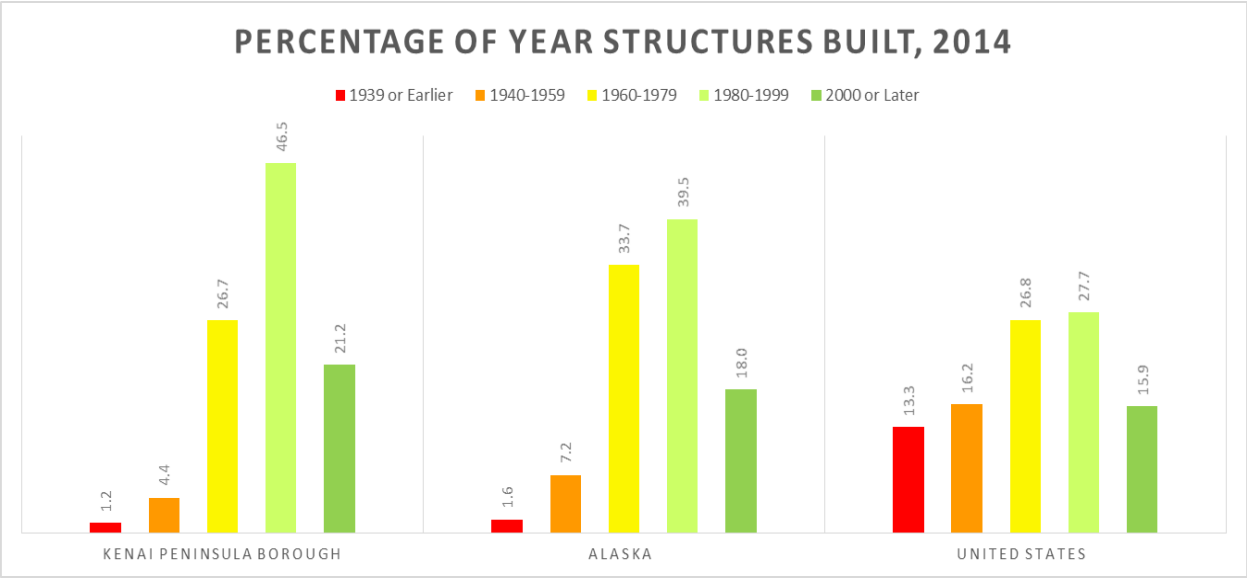
Figure 6: Percentage of Population with High School Degree or Higher Between 2000 and 2014



With most of the population living above the poverty line, more individuals are homeowners. Homeownership allows individuals to make structural alterations to their homes to prepare for disasters and prevent potential damage. In 2014, 73.1 percent of Kenai Peninsula Borough residents owned their home, while 26.9 percent were renters. Of the renters, 34.3 percent of individuals were spending more than 35 percent of their income on rent. Spending more of their income on rent may prevent these individuals from having the financial ability to prepare for natural disasters, access reliable transportation, and rebuild stronger after a hazard event.

Economic sustainability is encouraged through employment and job security. The higher the employment rate, the more financial stability is accomplished on an individual level. In addition, a healthy job market brings economic growth to communities. In 2014, the employment rates and unemployment rates for the Kenai Peninsula Borough were equal to the national rates—roughly 57 percent and 9 percent, respectively. Communities with more economic growth can invest in new development and retrofitting projects to increase the resilience of their buildings and infrastructure. In 2014, the Kenai Peninsula Borough reported that a higher percentage of its buildings had been built after 1980. Additionally, when compared with Alaska and the Nation, the Kenai Peninsula Borough had the lowest percentage of buildings built before 1960 (Figure 7). The economic growth in the Borough has resulted in building stock that may be more resilient to natural hazards.

Figure 7: Building Stock by Time Period



Socioeconomic Conclusion

Learning more about how to provide and effectively communicate multi-hazard risk information to residents is crucial when implementing hazard mitigation strategies. With the available demographic information, FEMA can assist community representatives in establishing better connections and delivery methods to keep the public informed, engaged, and aware of the risks presented by multiple hazards in the area, while understanding the audience the Agency wishes to reach.

5. Flood Risk Assessment

Flood Hazard Overview

The Kenai Peninsula Borough identified 12 sources of flooding that could occur independently or together. 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, coastal storm surges, and tsunamis.

The varying sources of local flooding make this hazard a regular occurrence in the region. The Kenai Peninsula Borough HMP tracks flood events back to the late 1940s and highlights several flood events along the Resurrection River, Salmon Creek, the Kenai River, and the Anchor River. The three flood events that received Presidential Disaster Declarations, with the most recent occurrence in 2014, are highlighted in the following paragraphs.

Table 2: Presidentially Declared Flood Disaster History for the Kenai Peninsula Borough

DISASTER NUMBER	DECLARATION DATE	DISASTER TYPE	INCIDENT TYPE	TITLE	INCIDENT BEGIN DATE	INCIDENT END DATE
4161	1/16/2014	DR	Flood	FLOODING	10/27/2013	10/28/2013
1072	10/13/1995	DR	Flood	FLOODING	9/18/1995	10/10/1995
782	10/27/1986	DR	Flood	SEVERE STORMS AND FLOODING	10/10/1986	10/13/1986

DR-4161

On January 16, 2014, Federal disaster aid was made available to the State of Alaska to support State, Tribal, and local recovery efforts in the Kenai Peninsula Borough areas affected by flooding on October 27-28, 2013. Heavy rain and elevated ground water resulted in flooding that damaged homes, properties, and roads. It was estimated that 6,000 acres of housing subdivisions were affected. Standing water was abundant over roads, culverts, and ditches, and vehicle use was limited to four-wheel-drive or all-terrain vehicles.

Table 3: DR-4161 Public Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$1,220,379.90	$304,225.40	$916,154.50

DR-1072

Heavy rains from a series of seasonal storms in September and October 1995 resulted in damages to public facilities, commercial and private properties and homes, fisheries, recreational facilities, well and septic infrastructure, trails, and roads. It was assessed that out of the approximately 2,000 parcels of land in the Kenai River's 100-year floodplain, 1,248 were affected by the flooding in 1995. Over $7 million in damages were estimated. Federal disaster aid was made available on October 13, 1995.

DR-782

On October 27, 1986, Federal disaster aid was made available to the Kenai Peninsula Borough following a series of rain storms. Flooding resulted in damaged culverts, erosion, bank sloughing, massive landslides,

debris dams, and “surge-release” flooding. Between October 9 and 11, 15 inches of rain fell across broad areas of the lower Resurrection River and Salmon Creek watershed. Borough-wide damages to roads, bridges, and other public facilities were estimated at around $2 million.

Studying Flood Hazards with the Risk MAP Program

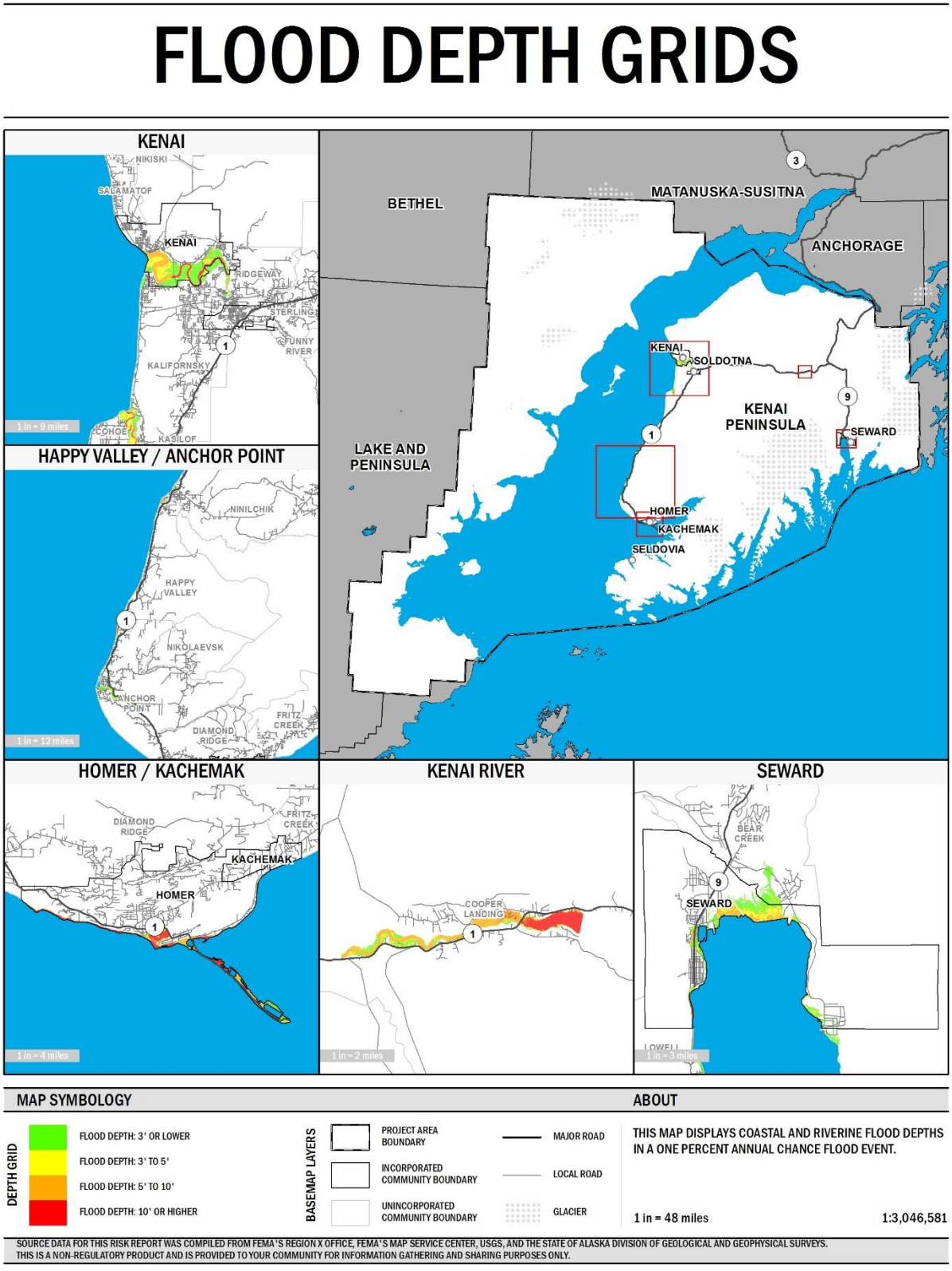
In 2016, FEMA created a new FIRM for the Kenai Peninsula Borough, which included updated flood modeling for portions of the coastline along the Cities of Homer, Kenai, Seward, and the unincorporated areas of Kenai Peninsula Borough. New flood modeling was performed for the unincorporated areas (riverine) and the City of Homer (stillwater). Areas subject to inundation by the 1-percent-annual-chance flood, or SFHAs, based on existing modeling were mapped for the Cities of Kenai and Seward. No modeled SFHAs have been identified in the Cities of Kachemak, Seldovia, and Soldotna, but future determination of SFHAs could be necessitated by changed conditions affecting these communities (i.e., annexation of new lands) or the availability of new scientific or technical flood hazard data.

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 were created for select coastal and riverine areas. Depth grids, which display the flood depth in feet, were used in this risk assessment to determine which properties would be affected by flooding. The 1-percent-annual-chance depth grid for the project area is shown in Map 2.

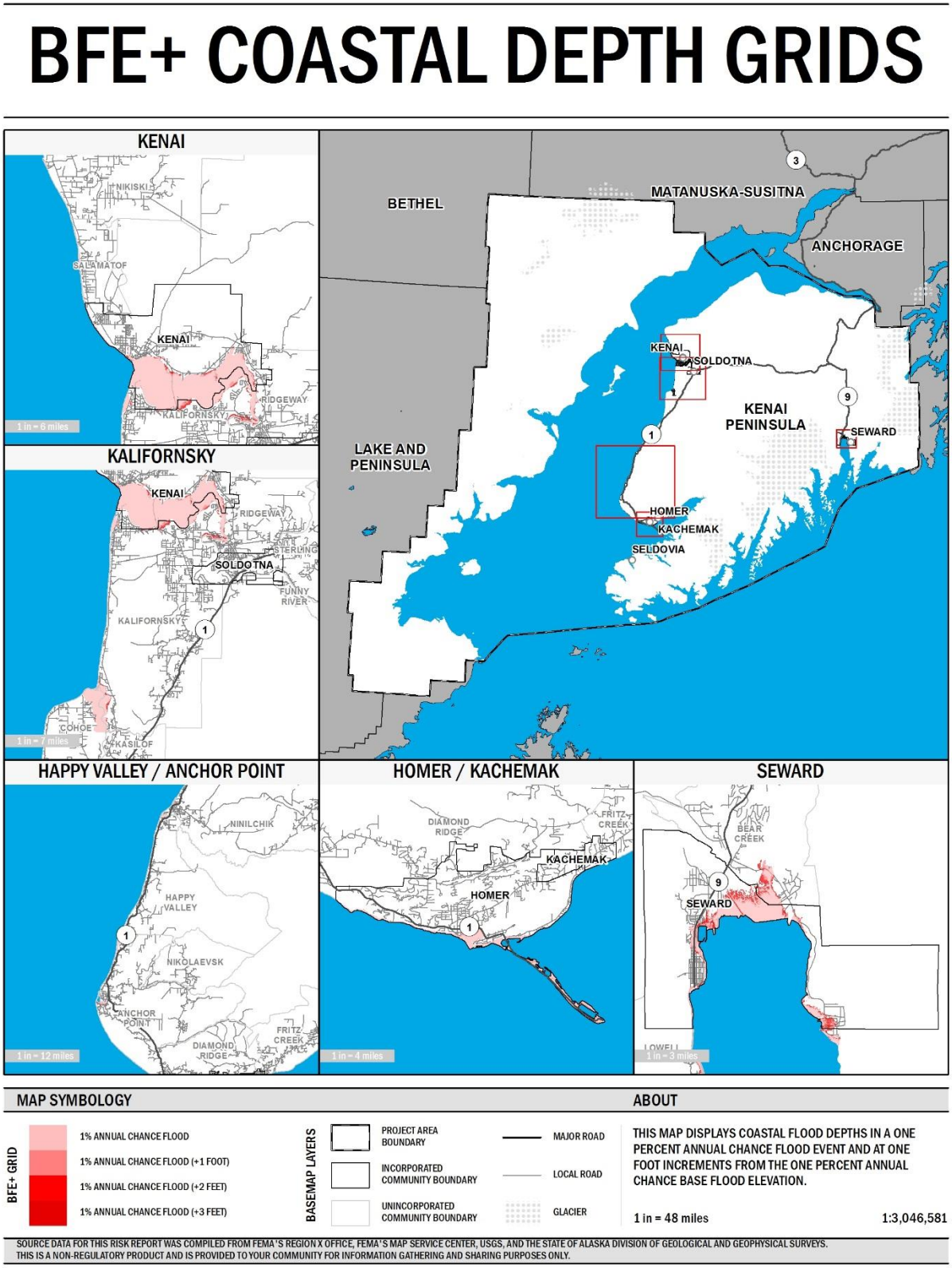
A depth grid can also be used as an outreach tool to show the hazards of flooding. Properties shown to be affected by the 1-percent-annual-chance flood would be excellent locations for mitigation projects. Some of these potential mitigation projects are highlighted in the section of this report for each community.

In addition to the 1-percent-annual-chance depth grid, a BFE+ grid was created. This tool shows flood depth increases of 1, 2, and 3 feet above the Base (1-percent-annual-chance) Flood Elevation (BFE), which can be used to represent higher flood events. The BFE+ grid can identify areas that could be affected by increased storm surge, storms greater than the 1-percent-annual-chance flood event, and areas potentially affected by sea-level rise. The BFE+ grid for the project area is shown in Map 3. The depth grid dataset can be used for future land use and comprehensive planning. This product is meant to guide local communities on future risk and is not a substitute for detailed sea-level rise modeling.

Map 2: 1-Percent-Annual-Chance Depth Grid (in feet) for the Kenai Peninsula Borough



Map 3: BFE+ 1-, 2-, and 3-Foot Depth Grids for the Kenai Peninsula Borough



Flood Risk Assessment Overview

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

Table 4: Community Characteristics in Kenai Peninsula Borough

COMMUNITY NAME	TOTAL POPULATION	CRS COMMUNITY	FLOOD CLAIMS	REPETITIVE LOSS PROPERTIES	TOTAL POLICIES	TOTAL INSURANCE COVERAGE
Homer, City of	5,003	NO	0	0	34	$6,393,100
Kachemak, City of**	472	NO	---	---	---	---
Kenai, City of*	7,112	NO	---	---	---	---
Kenai Peninsula, Borough of (Unincorporated Areas)	35,702	YES - 8	51	4	289	$76,255,400
Seldovia, City of**	255	NO	---	---	---	---
Seward, City of	2,693	YES - 7	0	0	15	$4,319,600
Soldotna, City of*	4,163	NO	---	---	---	---
TOTAL	**55,400**	**---**	**51**	**4**	**338**	**$86,968,100**

Note: Data obtained from the 2010 U.S. Census and FEMA Community Information System (CIS)
*Not participating in the National Flood Insurance Program (NFIP)
**Participating in the NFIP in tandem with Kenai Peninsula Borough

The information in Table 4 can be used to highlight communities 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.

FEMA completed the flood risk assessment using Hazus-MH 2.2, its loss estimation software, with individual parcel data provided by the Borough. Only properties with buildings (improvements) were incorporated into the analysis; therefore, FEMA did not assess impacts to vacant land. Coastal and riverine depth grids derived from the Risk MAP project were also used for this analysis. For this assessment, coastal and riverine depth grids were used where available, as shown in Map 2. Parcels in areas where depth grids were available were incorporated into Hazus, which provided building, content, and/or inventory loss values. Please refer to the appendix for a detailed methodology on incorporating local data into Hazus.

FEMA analyzed parcels outside of the coastal and riverine depth grid study extents to show whether they intersected an SFHA. Those parcels 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 community. Parcels with buildings intersecting any SFHA are also summarized by community, where the flood hazard data was available.

Table 5: SFHA Assessments in Kenai Peninsula Borough

COMMUNITY NAME	IMPROVED BUILDINGS IN HAZUS FLOOD ANALYSIS	ZONE A, AE, AH, AO	ZONE VE	BUILDING DOLLAR LOSS FOR A 1%-ANNUAL-CHANCE FLOOD EVENT	LOSS RATIO (DOLLAR LOSSES / TOTAL BUILDING VALUE)
Homer, City of	36	21	15	$2,318,107	11.93%
Kachemak, City of*	---	---	---	---	---
Kenai, City of	1	1	0	$31,077	9.00%
Seldovia, City of*	---	---	---	---	---
Seward, City of	25	21	4	$1,952,753	9.66%
Soldotna, City of*	---	---	---	---	---
Unincorporated Areas					
Anchor Point	9	9	0	$7,378	1.43%
Cooper Landing	15	15	0	$316,952	11.32%
Happy Valley	5	0	5	$23,542	2.44%
Kalifornsky	1	1	0	$309	0.90%
Lowell Point	41	41	0	$1,033,131	16.40%
Ninilchik	13	13	0	$162,914	15.23%
Salamatof	1	0	1	$12,282	46.00%
Unincorp. Total	85	79	6	$1,556,508	13.29%
TOTAL	**147**	**122**	**25**	**$5,858,445**	**11.33%**

Note: Dollar losses are reported, as well as a loss ratio, which is calculated as the total building losses/total building value. Also included is a count of parcels in Zone VE, which is the 1-percent-annual-chance coastal high hazard flood zone, as well as the buildings in Zones A, AE, AO, and AH, which are riverine and/or coastal 1-percent-annual-chance floodplains. The loss values are for buildings only; additional damages to infrastructure are not captured in this table.

*No flood hazard analysis available

The preliminary flood hazard data available for select locations throughout the Kenai Peninsula Borough allowed a partial flood risk assessment. No flood hazard areas have been studied for Kachemak, Seldovia, and Soldotna, but limited flood hazard data is available for unincorporated areas of the Borough and the remaining incorporated communities. The Hazus flood analysis was based on the 147 structures identified within a coastal or riverine hazard area. Most of those buildings are in the unincorporated areas of the Borough. Lowell Point, located south of Seward, has 41 improved parcels available for analysis. The incorporated communities have 62 buildings available for analysis, with one identified structure in Kenai, 25 in Seward, and 36 in Homer. A large portion of the flood risk assessment analyzes flood losses due to riverine flooding: of the 147 buildings, 122 are in Zones A, AE, AH, or AO. The remaining 25 are subject to coastal flooding (Zone VE). The highest projected building losses are in Homer, which accounts for almost

40 percent of the losses in the Borough. An estimated $2.32 million of at-risk facilities could be lost in a coastal and/or riverine flooding event. A $2.32-million-loss accounts for a 12 percent loss ratio of the studied buildings in Homer. Other vulnerable areas include Seward, with a projected $1.95 million loss, and its unincorporated neighbor to the south, Lowell Point, with a projected $1.03 million loss. In communities with more than one structure at risk, loss ratios of 16.40 percent in Lowell Point and 15.23 percent in Ninilchik were the highest in the Borough.

When comparing structures at risk in Table 5 to insurance policies in Table 4, the number of flood insurance policies in the Borough (338) is higher than the number of properties in the floodplain (147). Communities look to have a comparable level of insurance for their risk. Additional outreach promoting flood insurance is essential, as it not only covers riverine and coastal flooding, but tsunami as well.

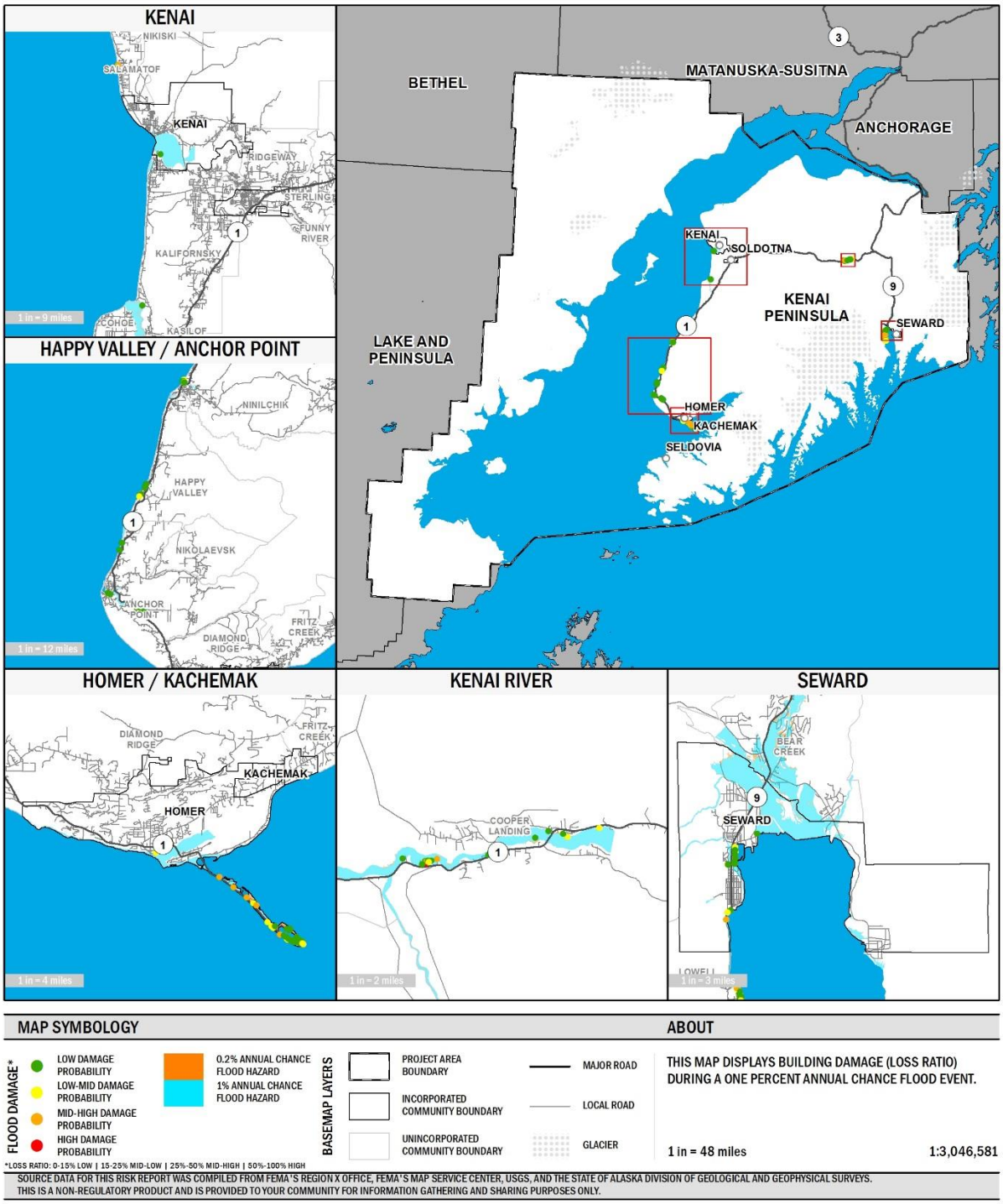
The buildings within Zone VE are highlighted specifically because they are subject to 3 feet or more of wave inundation and are in a high-hazard area due to the effects of the wave velocity. For properties along the coast, the risk assessment only takes the depth of water into account when calculating damages; therefore, the properties in Zone VE should use the loss information as a minimum since velocity impacts are not accounted for. Furthermore, due to the limited flood study area, unmapped areas represent an additional unknown risk that needs to be communicated to residents.

The community results shown above give an idea of where the largest flooding concerns are. This risk assessment includes information for every parcel in each community within studied flooding zones, so it can be used to determine which parcels in a community have the highest flood risk. Map 4 shows the potential losses during a 1-percent-annual-chance event for the coastal and riverine areas of Kenai Peninsula Borough. Parcels shown in red and orange have the potential to be significantly damaged during a 1-percent-annual-chance flood event, based on the depth of flooding at their location and the height of the building.

The loss data from Hazus and the exposure analysis, which highlight the areas affected by flooding, can be used to identify properties for mitigation projects as well as areas to target for additional outreach. These areas of greatest impacts and potential mitigation actions will be highlighted in the community sections of this report. All results, databases, and maps are provided in the Risk Assessment Database included with this report.

Map 4: Building Damage Percentage (Loss Ratio) in Kenai Peninsula Borough

FLOOD DAMAGE



6. Earthquake Risk Assessment

Earthquake Hazard Overview

The Kenai Peninsula Borough is subject to numerous earthquake events of varying magnitudes. Several fault lines traverse the borough, including the Lake Clark Fault, Bruin Bay Fault, Sterling Fault, Border Ranges Fault, and Eagle River Fault. The region's tectonic activity, documented back to 1933, includes 258 earthquakes centered within the borough that registered over 4.5 in Magnitude (M) (USGS, 2016).

The most recent large earthquake and one of the largest such events in the region occurred on January 24, 2016. The M7.1 earthquake, referred to as the 2016 Old Iliamna earthquake, occurred 123.4 kilometers below ground, approximately 54 miles west of Anchor Point, across the Cook Inlet. It was reported that the shaking could be felt from Fairbanks to Juneau. The earthquake caused immediate regionwide power outages, gas leaks, and fires, which destroyed four homes. Additionally, businesses reported damaged merchandise, and the Kalifornsky Beach Road dropped down a foot, creating a 150-foot-long crack. The Red Cross provided shelters for those whose homes were damaged, and for residents unable to return home due to closed roads. No fatalities were reported, and the structural damage was minimal.

The largest earthquake in the region and the second largest earthquake event ever recorded on Earth occurred just outside the borough limits on March 27, 1964. It is known as the Great Alaska Earthquake. This M9.2 earthquake, centered in the northern part of Prince William Sound, created landslides, avalanches, and tsunamis, and instituted radical landscape changes with extreme subsidence and uplift. According to the Kenai Peninsula All-Hazard Mitigation Plan, two local slide-generated tsunamis were triggered at Seward and Kachemak Bay, with the Seward tsunami resulting in 11 to 13 fatalities. Land subsidence occurred in Seward, Homer Spit, the town of Hope, and Seldovia, where some of the most drastic subsidence dropped land 6 feet.

ShakeMaps

Maps depicting the 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 U.S. Geological Survey (USGS). These ShakeMaps can be used for response, land use, and emergency planning purposes. For this analysis, ShakeMaps were used for the M7.1 Old Iliamna event (Map 5) and M9.2 Great Alaska scenario (Map 6).

The heaviest shaking during the M7.1 event was in areas surrounding Soldotna, including the unincorporated communities of Ridgeway and Kalifornsky, where instrumental intensity reached 6.6, defined as *strong* shaking. Likewise, the heaviest shaking modeled for a M9.2 scenario would also be felt in areas outside of Soldotna. Ridgeway is projected to have an instrumental intensity reaching 8.0 (defined as *severe* shaking). Unlike the M7.1 event, a M9.2 scenario would have more consistent shaking across the borough. Seward (7.8 instrumental intensity), Homer (7.4 instrumental intensity), and Kenai (7.4 instrumental intensity) would experience similar results.

Earthquake Risk Assessment Overview

Two earthquake risk assessments were performed using Hazus for this Risk Report. The first assessment uses a USGS ShakeMap created from the January 2016 M7.1 Old Iliamna earthquake event and provides an estimate of expected earthquake losses. The second assessment simulates the M9.2 Great Alaska Earthquake (using a USGS-developed shaking scenario) to predict losses if the event were to happen

today. The earthquake risk assessment for the M7.1 Old Iliamna event and M9.2 Great Alaska scenario was completed using local parcel data from the Kenai Peninsula Borough and the USGS ShakeMaps as shown in Maps 7 and 8. For this study, individual parcel data from the 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. Please refer to the appendix 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 7 and 8.

Table 6: Hazus Earthquake Results for M7.1 and M9.2 Earthquakes in Kenai Peninsula Borough

COMMUNITY NAME	TOTAL ESTIMATED VALUE OF IMPROVED PARCELS	TOTAL NUMBER OF IMPROVED PARCELS	M7.1 EVENT		M9.2 SCENARIO	
			TOTAL DOLLAR LOSS	LOSS RATIO (DOLLAR LOSSES/ TOTAL VALUE)	TOTAL DOLLAR LOSS	LOSS RATIO (DOLLAR LOSSES/ TOTAL VALUE)
Homer, City of	$1,238,970,427	3,683	$3,303,266	0.27%	$56,997,792	4.60%
Kachemak, City of	$87,057,763	476	$141,658	0.16%	$3,739,163	4.30%
Kenai, City of	$1,525,005,650	3,652	$2,482,040	0.16%	$52,539,885	3.45%
Seldovia, City of	$89,984,700	335	$310,314	0.34%	$4,632,983	5.15%
Seward, City of	$586,613,603	1,205	$58,612	0.01%	$17,820,544	3.04%
Soldotna, City of	$1,402,717,346	2,243	$2,250,671	0.16%	$49,540,560	3.53%
Unincorporated Areas						
Anchor Point	$240,439,432	2,296	$570,875	0.24%	$9,790,972	4.07%
Bear Creek	$214,418,041	1,742	$21,583	0.01%	$10,691,606	4.99%
Beluga	$6,646,963	146	$646	0.01%	$128,435	1.93%
Clam Gulch	$21,482,326	253	$47,360	0.22%	$761,480	3.54%
Cohoe	$191,720,391	1,667	$419,365	0.22%	$7,516,350	3.92%
Cooper Landing	$103,647,714	889	$37,303	0.04%	$3,644,352	3.52%
Crown Point	$17,417,650	101	$246	0.00%	$738,513	4.24%
Diamond Ridge	$158,480,954	1,027	$385,248	0.24%	$6,930,417	4.37%
Fox River	$40,815,890	547	$32,172	0.08%	$1,813,432	4.44%
Fritz Creek	$248,802,660	1,776	$247,681	0.10%	$10,425,929	4.19%
Funny River	$181,606,141	1,670	$241,411	0.13%	$7,383,686	4.07%
Halibut Cove	$22,741,663	347	$24,214	0.11%	$1,122,328	4.94%
Happy Valley	$78,845,363	1,028	$271,612	0.34%	$2,785,475	3.53%
Hope	$29,398,339	429	$8,140	0.03%	$1,156,537	3.93%
Kalifornsky	$1,182,578,155	6,100	$2,268,031	0.19%	$42,620,010	3.60%
Kasilof	$64,485,015	521	$151,524	0.23%	$2,466,019	3.82%
Lowell Point	$11,819,500	150	$1,162	0.01%	$371,231	3.14%
Moose Pass	$36,814,576	273	$572	0.00%	$1,073,026	2.91%
Nanwalek	$17,548,800	75	$52,605	0.30%	$703,301	4.01%
Nikiski	$1,366,286,338	3,893	$1,188,767	0.09%	$39,252,912	2.87%
Nikolaevsk	$39,255,865	301	$83,138	0.21%	$1,557,553	3.97%
Ninilchik	$170,896,708	1,812	$509,926	0.30%	$6,241,777	3.65%

COMMUNITY NAME	TOTAL ESTIMATED VALUE OF IMPROVED PARCELS	TOTAL NUMBER OF IMPROVED PARCELS	M7.1 Event		M9.2 Scenario	
			TOTAL DOLLAR LOSS	LOSS RATIO (DOLLAR LOSSES/ TOTAL VALUE)	TOTAL DOLLAR LOSS	LOSS RATIO (DOLLAR LOSSES/ TOTAL VALUE)
Point Possession	$3,176,863	215	$646	0.02%	$92,322	2.91%
Port Graham	$22,841,728	126	$56,996	0.25%	$583,937	2.56%
Primrose	$9,157,813	104	$373	0.00%	$462,263	5.05%
Ridgeway	$303,552,858	2,327	$637,165	0.21%	$11,272,571	3.71%
Salamatof	$130,977,126	779	$141,083	0.11%	$3,770,968	2.88%
Seldovia Village	$30,861,602	361	$72,129	0.23%	$1,326,419	4.30%
Sterling	$854,290,246	5,954	$1,287,621	0.15%	$34,938,271	4.09%
Sunrise	$3,569,800	55	$374	0.01%	$131,547	3.68%
Tyonek	$24,753,739	118	$7,224	0.03%	$467,636	1.89%
Other Areas	$90,167,717	1,231	$147,698	0.16%	$3,329,848	3.69%
Unincorporated Total	$5,919,497,976	38,313	$8,914,890	0.15%	$1,073,026	2.91%
TOTAL	**$10,849,847,465**	**49,907**	**$17,461,451**	0.16%	**$400,822,052**	3.69%

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 M7.1 event and M9.2 scenario.

The Kenai Peninsula Borough's improved parcel building and content values total $10.8 billion and are highest in the unincorporated areas ($5.9 billion). The Cities of Kenai ($1.5 billion), Soldotna ($89.9 million), and Homer ($1.2 billion), followed by the unincorporated communities of Kalifornsky ($1.1 billion) and Sterling ($854.2 million), have the five highest total building and content values.

Losses estimated from the M7.1 Old Iliamna event were low across all jurisdictions and communities. The total building and content dollar loss was estimated as close to $17.4 million, with a borough-wide loss ratio of 0.16 percent. The City of Seldovia (0.34 percent) and unincorporated communities of Nanwalek (0.30 percent) and Port Graham (0.24 percent) have the highest loss ratios. The largest total loss values are projected for the Cities of Homer ($3.3 million), Kenai ($2.5 million), and Soldotna ($2.3 million), and the unincorporated community of Kalifornsky ($2.7 million).

The impacts of the M9.2 Great Alaska Earthquake scenario are much greater than those of the M7.1 Old Iliamna event. Total losses are estimated to be over $400 million, with a borough-wide loss ratio of 3.69 percent. Loss ratios are highest in Seldovia (5.15 percent), Primrose (5.05 percent), Bear Creek (4.99 percent), and Halibut Cove (4.94 percent). Homer, Fox River, Diamond Ridge, Seldovia Village, Kachemak, Crown Park, Fritz Creek, Sterling, Anchor Point, Funny River, and Nanwalek average a loss ratio around 4 percent with building values losses ranging from $700 thousand to $56 million. Of the $400 million in projected losses, the City of Seward has a loss ratio just over 3 percent, with nearly $17.8 million in building and contents damage. Regarding the total estimated value of improved parcels, the City of Kenai has the largest amount—over $1.5 billion—with more than $52 million in total dollar losses, resulting in a loss ratio over 3.45 percent. The City of Soldotna has almost $1.4 billion in total inventory, with almost $50 million in projected losses, also resulting in a loss ratio of more than 3.53 percent. In the unincorporated area of the peninsula, Kalifornsky has the highest number of improved parcels (6,100), and Sterling has 5,954 improved parcels; both communities have a loss ratio of around 4 percent. Across the entire

borough, a projected 3.68 percent loss ratio with losses totaling more than $400 million is projected for an earthquake similar to the 1964 Great Alaska Earthquake.

Essential Facilities

Essential facilities identified by Kenai Peninsula Borough were extracted from the building analysis and shown in Table 7 and Map 8 to determine the level of earthquake vulnerability after a M9.2 event.

Table 7: Essential Facility Damage due to a M9.2 Great Alaska Earthquake Scenario in Kenai Peninsula Borough

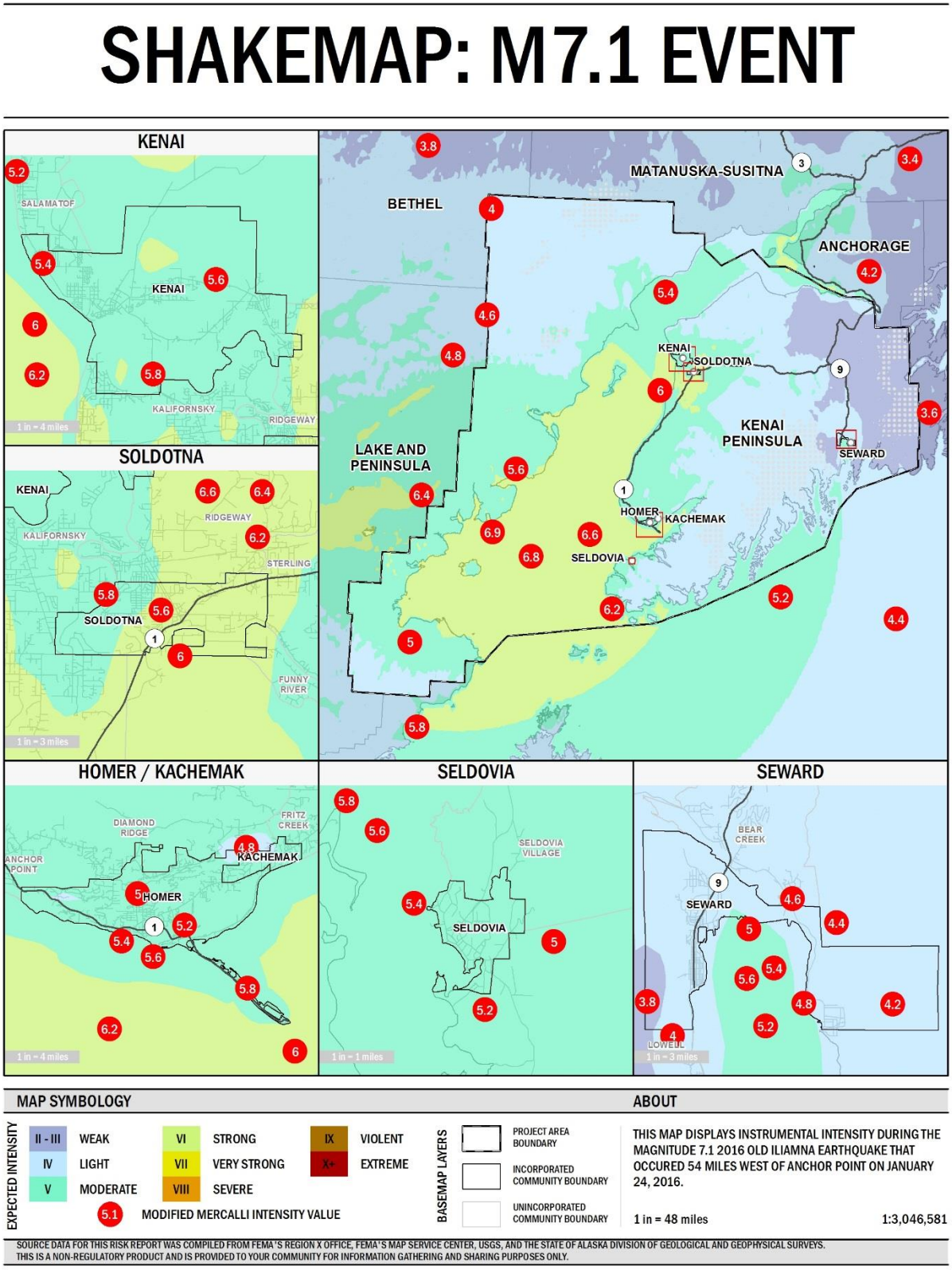
ESSENTIAL FACILITY	TOTAL FACILITIES	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL FACILITIES VALUE	TOTAL LOSS	LOSS RATIO
AIRPORT	4	1	25.00%	$43,644,600	$1,813,802	4.16%
AIRSTRIP	2	1	50.00%	$489,000	$21,387	4.37%
BOAT DOCK	4	3	75.00%	$61,638,300	$3,015,125	4.89%
BOAT HARBOR	1	0	0.00%	$594,750	$23,466	3.95%
BOAT LAUNCH	11	0	0.00%	$3,369,350	$107,726	3.20%
BOROUGH FACILITY	1	0	0.00%	$6,729,000	$180,866	2.69%
BOROUGH OFFICE	8	0	0.00%	$55,229,600	$2,056,947	3.72%
BRIDGE	1	0	0.00%	$20,400	$541	2.65%
CAMPGROUND	9	0	0.00%	$45,057,526	$1,445,203	3.21%
CITY OFFICE	11	2	18.18%	$21,708,900	$846,543	3.90%
COLLEGE	2	0	0.00%	$88,112,800	$3,268,142	3.71%
COMMUNITY CENTER	4	0	0.00%	$799,600	$28,450	3.56%
EMERGENCY RESOURCE	2	0	0.00%	$415,200	$16,611	4.00%
EMERGENCY SHELTER	41	5	12.20%	$138,300,001	$4,622,833	3.34%
FAIR GROUNDS	1	0	0.00%	$361,600	$13,687	3.79%
FEDERAL OFFICE	4	0	0.00%	$6,030,200	$225,376	3.74%
FERRY TERMINAL	1	0	0.00%	$1,500,400	$65,721	4.38%
FIRE STATION	17	1	5.88%	$33,718,600	$1,238,797	3.67%
HELIPORT	1	0	0.00%	$4,076,000	$93,015	2.28%
HOSPITAL	3	0	0.00%	$355,903,808	$12,600,651	3.54%
LANDFILL / TRANSFER FACILITY	6	0	0.00%	$24,275,400	$907,571	3.74%
LEARNING CENTER	2	0	0.00%	$28,486,400	$1,117,179	3.92%
LIBRARY	7	0	0.00%	$30,364,450	$1,317,307	4.34%
MALL	1	0	0.00%	$2,204,800	$70,782	3.21%
MEDICAL	1	0	0.00%	$558,050	$24,444	4.38%

ESSENTIAL FACILITY	TOTAL FACILITIES	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL FACILITIES VALUE	TOTAL LOSS	LOSS RATIO
MUSEUM	3	1	33.33%	$2,183,600	$103,336	4.73%
OIL AND GAS	2	0	0.00%	$467,110,000	$13,861,162	2.97%
PARK	4	0	0.00%	$1,004,000	$33,054	3.29%
POLICE STATION	5	1	20.00%	$11,945,700	$467,409	3.91%
POST OFFICE	13	1	7.69%	$19,271,200	$717,929	3.73%
PRISON	1	0	0.00%	$5,000,000	$175,914	3.52%
RECREATION	7	0	0.00%	$43,458,500	$1,191,815	2.74%
SCHOOL	41	5	12.20%	$1,140,142,200	$42,989,103	3.77%
SENIOR CENTER	10	0	0.00%	$30,870,250	$1,038,973	3.37%
STATE FACILITY	7	0	0.00%	$42,924,600	$1,320,607	3.08%
STATE OFFICE	9	1	11.11%	$16,253,200	$609,037	3.75%
VISITOR CENTER	3	0	0.00%	$3,773,000	$119,964	3.18%
WATER TREATMENT FACILITY	3	0	0.00%	$32,610,400	$1,142,172	3.50%
WILDLIFE REFUGE	1	0	0.00%	$16,335,200	$715,517	4.38%
TOTAL	**254**	**22**	**8.66%**	**$2,786,470,584**	**$99,608,160**	**3.57%**

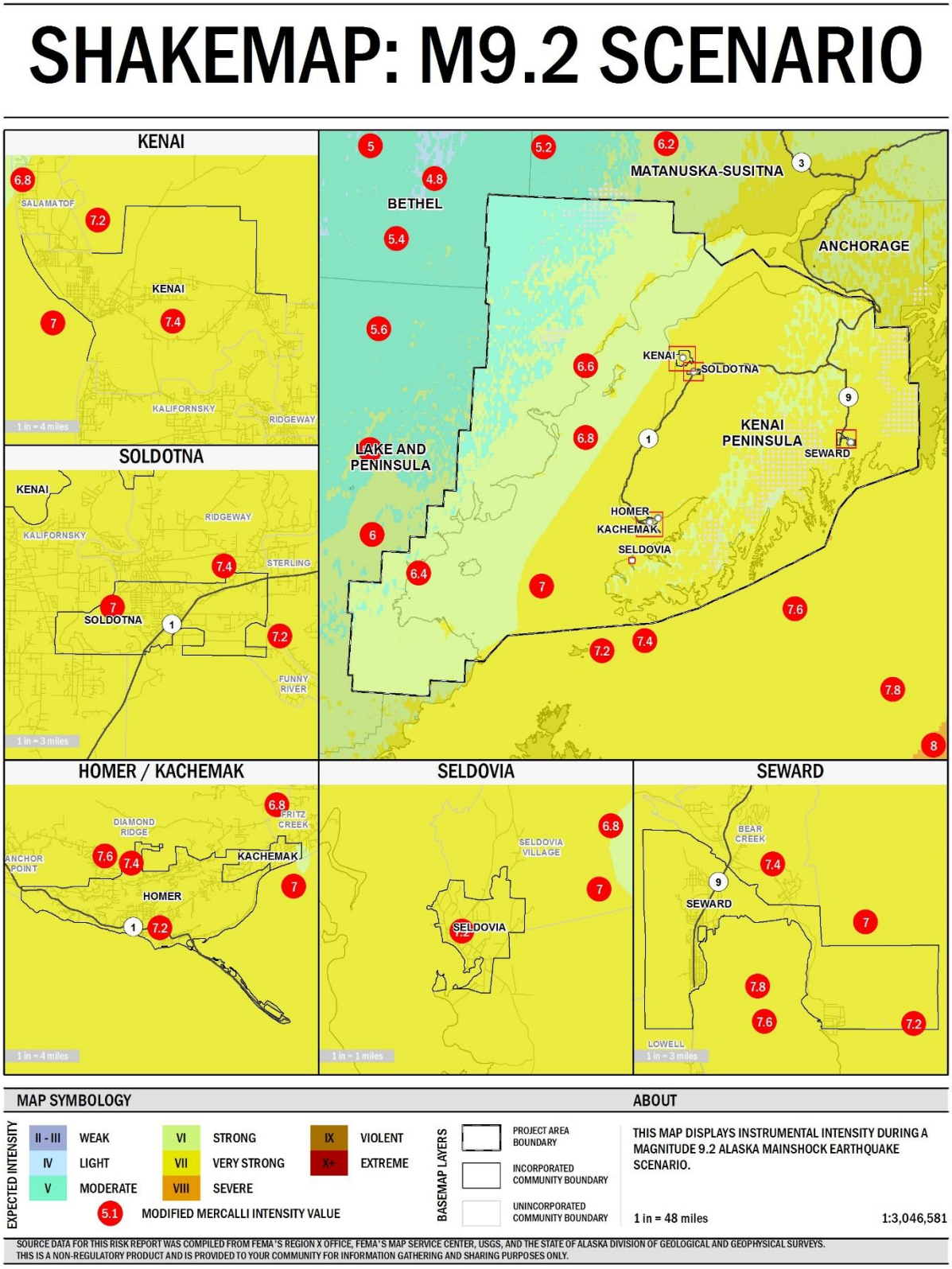
The total estimated facilities value is the total building and content value on that parcel divided equally by the number of facilities on an improved parcel. Content value was estimated based on a percentage of the building value, as defined in the Hazus model. Dollar losses are reported as well as a loss ratio, which is calculated as the total losses (including building and contents loss)/total building and contents value. Estimated loss values are for a M9.2 scenario.

Of the essential facilities with a Hazus earthquake output for a M9.2 Great Alaska Earthquake scenario, 22 have loss ratios greater than 5 percent. This accounts for nearly 9 percent of all defined borough facilities, and nearly $100 million in projected losses are tied to essential facilities alone. Facilities designated solely as emergency shelters (12.20 percent) and schools (12.20 percent) each have five structures with loss ratios over 5 percent. Schools also have the highest total loss values of all defined facilities. A projected loss of $43 million for schools is more than triple the loss of the second highest loss category, Oil and Gas, with a projected loss of $13.9 million). A detailed breakout of facilities is available in the Area of Mitigation Interest tables located in Section 11. Additional information is also available in the Risk Database.

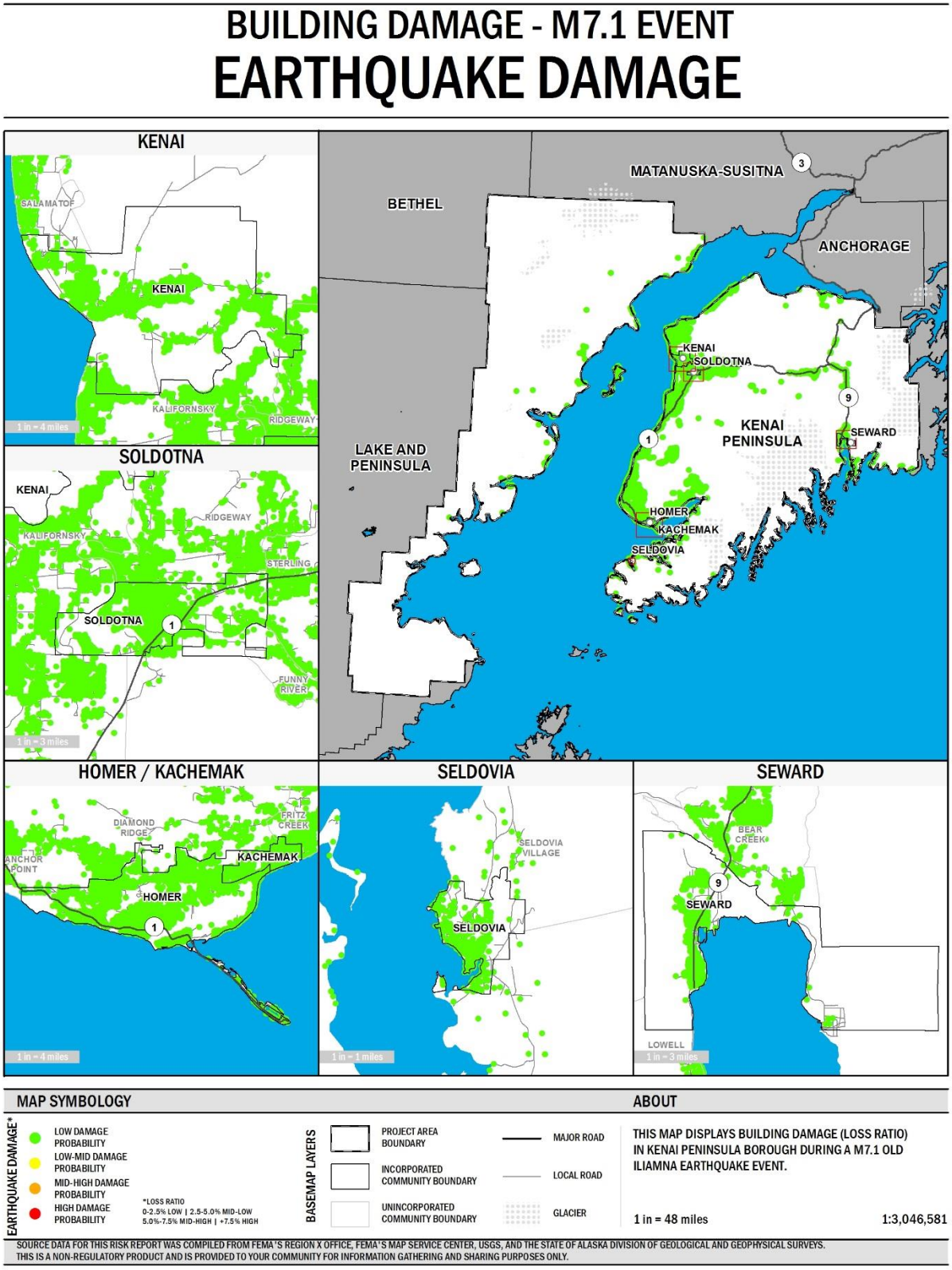
Map 5: USGS ShakeMap of M7.1 Old Iliamna Earthquake Event



Map 6: USGS ShakeMap of M9.2 Alaska Mainshock Earthquake Scenario

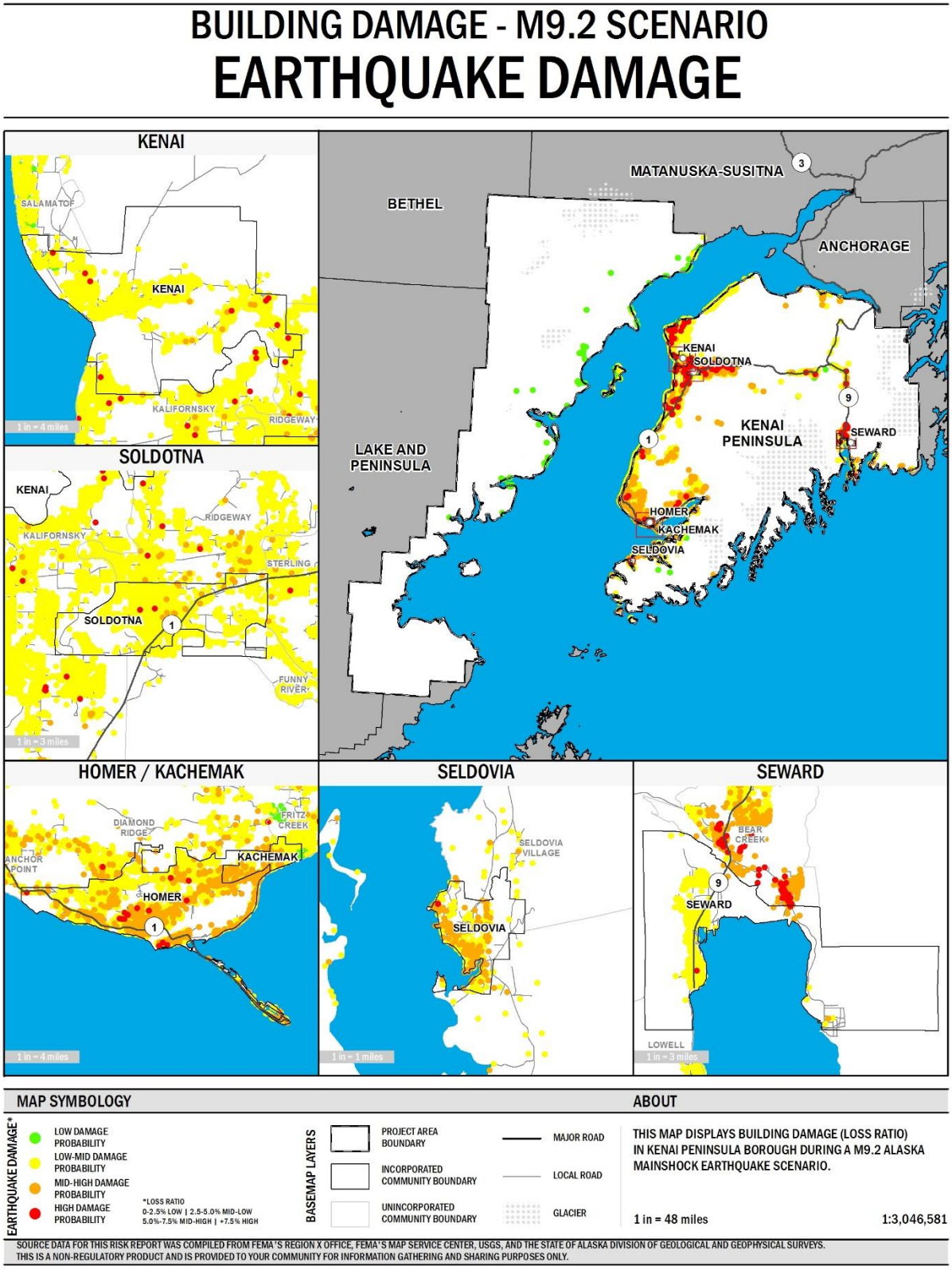


Map 7: M7.1 Earthquake Event - Damage Referenced as Loss Ratio in Kenai Peninsula Borough*



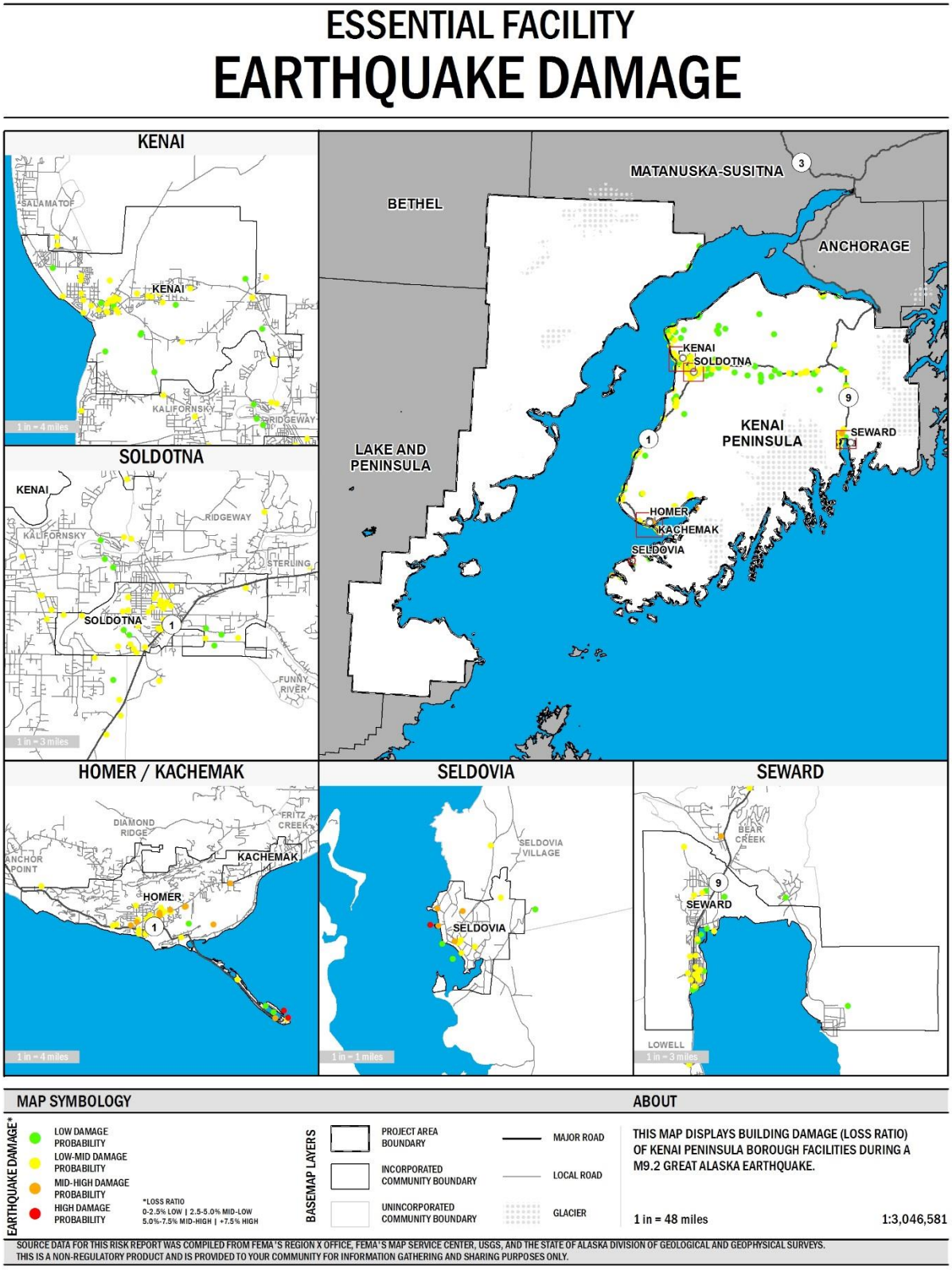
**damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami*

Map 8: M9.2 Earthquake Scenario – Damage Referenced as Loss Ratio in Kenai Peninsula Borough*



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

Map 9: Essential Facility Damage in Kenai Peninsula Borough*



**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 M7.1 earthquake, summarized at the borough level. Table 9 provides an overview of potential damage to transportation systems in the event of a M9.2. Table 10 provides an overview of the utility systems in the event of a M7.1 earthquake, summarized at the Borough level. Table 11 provides an overview of the utility systems in the event of a M9.2 earthquake.

Table 8: Transportation System Impacts for a M7.1 Old Iliamna Earthquake Event in Kenai Peninsula Borough

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS/ SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY AFTER DAY 1	FUNCTIONALITY AFTER DAY 7	INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
Highway	Segments	17	---	---	---	$1,155,850,000	---	---
	Bridges	62	0	100%	100%	$924,813,000	$610,000	0.0%
	Tunnels	---	---	---	---	---	---	---
Railway	Segments	58	---	---	---	$72,087,000	---	---
	Bridges	---	---	---	---	---	---	---
	Facilities	7	0	98%	100%	$18,770,000	$501,000	2.7%
Light Rail	Segments	---	---	---	---	---	---	---
	Facilities	---	---	---	---	---	---	---
	Facilities	---	---	---	---	---	---	---
Bus	Facilities	---	---	---	---	---	---	---
Ferry	Facilities	42	0	99%	100%	$112,619,000	$5,023,000	4.5%
Port	Facilities	43	0	98%	99%	$288,251,000	15,308,000	5.3%
Airport	Runways	42	---	---	---	$1,605,593,000	---	---
	TOTAL	**271**	**---**	**---**	**---**	**$4,177,983,000**	**$21,442,000**	**0.5%**

Table 9: Transportation System Impacts for a M9.2 Great Alaska Earthquake Event in Kenai Peninsula Borough

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS/ SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY AFTER DAY 1	FUNCTIONALITY AFTER DAY 7	INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
Highway	Segments	17	---	---	---	$1,155,850,000	---	---
	Bridges	62	13	79%	85%	$924,813,000	$74,419,000	8.1%
	Tunnels	---	---	---	---	---	---	---
Railway	Segments	58	---	---	---	$72,087,000	---	---
	Bridges	---	---	---	---	---	---	---
	Facilities	7	3	66%	87%	$18,770,000	$5,634,000	0.0%

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS/ SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY AFTER DAY 1	FUNCTIONALITY AFTER DAY 7	INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
Light Rail	Segments	---	---	---	---	---	------	---
	Facilities	---	---	---	---	---	---	---
	Facilities	---	---	---	---	---	---	---
Bus	Facilities	---	---	---	---	---	---	---
Ferry	Facilities	42	18	70%	86%	$112,619,000	$33,212,000	30.0%
Port	Facilities	43	16	73%	88%	$288,251,000	$78,229,000	34.3%
Airport	Runways	42	---	---	---	$1,605,593,000	---	---
	TOTAL	**271**	**---**	**---**	**---**	**$4,177,983,000**	**$191,494,000**	**4.6%**

Minimal economic losses for transportation systems are projected for the M7.1 Old Iliamna Earthquake scenario. There are, however, varying degrees of economic loss to these systems under the M9.2 Great Alaska Earthquake Event scenario. At the greatest risk are highway bridges and port and airport facilities. Port and airport facilities have estimated loss ratios around 30 percent. However, all modeled transportation systems are roughly 72 percent functional after day 1, and most systems are near 90 percent functional by day 7. In total dollars, highway bridges are the most affected. Over $70 million would be lost during a M9.2 earthquake. Collectively, transportation systems are estimated to lose more than $191 million, which represents a loss ratio of 4.6 percent.

Table 10: Utility System Impacts for a M7.1 Old Iliamna Earthquake Event in Kenai Peninsula Borough

UTILITY SYSTEM	COMPONENT	FACILITIES/ SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY AFTER DAY 1	FUNCTIONALITY AFTER DAY 7	INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
Potable Water	Facilities	7	0	90%	100%	$126,639,000	$2,210,000	1.7%
	Pipelines	2,204	---	---	---	$44,088,000	---	---
Waste Water	Facilities	9	---	---	---	$409,590,000	---	---
	Pipelines	1,323	---	---	---	$26,453,000	---	---
Oil Systems	Facilities	5	---	---	---	$615,000	---	---
	Pipelines	---	---	---	---	---	---	---
Natural Gas	Facilities	---	---	---	---	---	---	---
	Pipelines	882	---	---	---	$17,635,000	---	---
Electric Power	Facilities	3	---	---	---	$405,900,000	---	---
Communication	Facilities	15	---	---	---	$1,845,000	---	---
	TOTAL	**39/4,409**	**0**	**---**	**---**	**$1,032,765,000**	**---**	**---**

Table 11: Utility System Impacts for a M9.2 Great Alaska Earthquake Event in Kenai Peninsula Borough

UTILITY SYSTEM	COMPONENT	FACILITIES/ SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY AFTER DAY 1	FUNCTIONALITY AFTER DAY 7	INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
Potable Water	Facilities	7	4	48%	89%	$126,639,000	$20,531,000	16.2%
	Pipelines	2,204	---	---	---	$44,088,000	---	---
Waste Water	Facilities	9	---	---	---	$409,590,000	---	---
	Pipelines	1,323	---	---	---	$26,453,000	---	---
Oil Systems	Facilities	5	---	---	---	$615,000	---	---
	Pipelines	-	---	---	---	---	---	---
Natural Gas	Facilities	-	---	---	---	---	---	---
	Pipelines	882	---	---	---	$17,635,000	---	---
Electric Power	Facilities	3	---	---	---	$405,900,000	---	---
Communication	Facilities	15	---	---	---	$1,845,000	---	---
	TOTAL	**39/4,409**	**4**	**---**	**---**	**$1,032,765,000**	**---**	**---**

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.

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 11).

An additional analysis identified how many buildings were constructed to a specific building code. Hazus identifies key changes in earthquake building codes, based on year. Homes built prior to 1941 that are not constructed with a wood frame are considered pre-code; they were constructed before earthquake building codes were put in place. Homes constructed after 1941 or built prior to 1941 but with a wood frame are considered moderate code and may include some earthquake building components. Buildings built after 1975 are considered high code. 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. The results of each code type are summarized in Table 12.

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 would not perform as well in an earthquake. Contrarily, high-code buildings will fare much better in the event of an earthquake. The Borough has no pre-code buildings (built before 1941, without a wood frames), and just over 17 percent of all facilities are moderate code. The remaining 83 percent were built after 1975. The areas with the highest percentage of moderate-code buildings are the Cities of Seward (46 percent) and Seldovia (40 percent). The City of Kenai (1,077) and the unincorporated areas of Nikiski (822), Sterling (779), and Kalifornsky (702) have the largest number of moderate-code buildings. Areas with the highest percentage of high-code buildings include the City of Kachemak (85 percent) and the unincorporated areas of Fox River, Funny River, and Point Possession, where over 90 percent of the buildings are high code. By volume,

the communities with the most high-code buildings are the City of Homer (2,984) and the unincorporated areas of Kalifornsky (5,432) and Sterling (5,161).

Table 12: Pre-Code and Moderate Code Buildings in Kenai Peninsula Borough

COMMUNITY NAME	TOTAL MODERATE-CODE BUILDINGS	PERCENT MODERATE-CODE BUILDINGS	TOTAL HIGH-CODE BUILDINGS	PERCENT HIGH-CODE BUILDINGS	TOTAL NUMBER OF BUILDINGS
Homer, City of	688	18.69%	2,993	81.31%	3,681
Kachemak, City of	72	15.13%	404	84.87%	476
Kenai, City of	1,077	29.49%	2,575	70.51%	3,652
Seldovia, City of	129	39.33%	199	60.67%	328
Seward, City of	555	46.06%	650	53.94%	1,205
Soldotna, City of	438	19.53%	1,805	80.47%	2,243
Unincorporated Areas					
Anchor Point	284	12.38%	2,012	87.71%	2,294
Bear Creek	259	14.87%	1,483	85.13%	1,742
Beluga	37	25.34%	109	74.66%	146
Clam Gulch	39	15.42%	214	84.58%	253
Cohoe	203	12.18%	1,464	87.82%	1,667
Cooper Landing	227	25.53%	662	74.47%	889
Crown Point	29	28.71%	72	71.29%	101
Diamond Ridge	104	10.13%	923	89.87%	1,027
Fox River	41	7.50%	506	92.50%	547
Fritz Creek	188	10.59%	1588	89.41%	1,776
Funny River	164	9.82%	1506	90.18%	1,670
Halibut Cove	56	16.14%	291	83.86%	347
Happy Valley	112	10.89%	916	89.11%	1,028
Hope	105	24.48%	324	75.52%	429
Kalifornsky	700	11.48%	5,400	88.52%	6,100
Kasilof	92	17.66%	429	82.34%	521
Lowell Point	15	10.00%	135	90.00%	150
Moose Pass	67	24.54%	206	75.46%	273
Nanwalek	10	13.33%	65	86.67%	75
Nikiski	823	21.15%	3,070	78.90%	3,891
Nikolaevsk	65	21.59%	236	78.41%	301

COMMUNITY NAME	TOTAL MODERATE-CODE BUILDINGS	PERCENT MODERATE-CODE BUILDINGS	TOTAL HIGH-CODE BUILDINGS	PERCENT HIGH-CODE BUILDINGS	TOTAL NUMBER OF BUILDINGS
Ninilchik	250	13.80%	1,562	86.20%	1,812
Point Possession	8	3.85%	200	96.15%	208
Port Graham	44	34.92%	82	65.08%	126
Primrose	42	40.38%	62	59.62%	104
Ridgeway	396	17.02%	1,931	82.98%	2,327
Salamatof	199	25.55%	580	74.45%	779
Seldovia Village	46	12.74%	315	87.26%	361
Sterling	780	13.10%	5,174	86.90%	5,954
Sunrise	18	32.73%	37	67.27%	55
Tyonek	25	21.19%	93	78.81%	118
Other Areas	216	17.55%	1,015	82.45%	1,231
Unincorporated Total	5,644	14.73%	32,662	85.27%	38,306
TOTAL	**8,603**	17.24%	**41,288**	82.76%	**49,891**

Note: Kenai Peninsula Borough is in Zone 4 (UBC Seismic Zone NEHRP Map Area). No buildings were built prior to 1941 without a wood frame. As a result, no pre-code facilities exist.

7. Erosion Exposure Assessment

Erosion Hazard Overview

The 2011 FEMA Risk MAP Discovery effort and 2014 Kenai Peninsula Borough All-Hazard Mitigation Plan identified erosion as a primary concern. Coastal erosion severely impacts the communities of Nanwalek, Port Graham, Homer, Ninilchik, Anchor Point, Hope, Seward, and Seldovia along the Cook Inlet. Erosion rates along the coastline vary from a few inches to several feet a year. These varying rates are heavily dependent on weather events. A landscape that appears to be virtually untouched for years can succumb to several feet of erosion in a matter of days. Erosion from riverine flooding is also problematic for the Borough and has been identified along the Resurrection River, Salmon Creek, and the Anchor River, and near the mouth of the Kenai River during historic flooding events.

While erosion is a natural cycle, property and infrastructure built within floodplains and along coastlines can become threatened by changing banks, coastlines, and bluffs. The earliest flood records for the peninsula date back to the 1940s. Since then, flood and erosion impact and risk potential has increased as more development occurs along waterfront locations. In 2002, Federal aid was available to provide assistance for recovery, community outreach, and mitigation efforts.

Table 13: Presidentially Declared Erosion and Severe Storm Disaster History for the Kenai Peninsula Borough

DISASTER NUMBER	DECLARATION DATE	DISASTER TYPE	INCIDENT TYPE	TITLE	INCIDENT BEGIN DATE	INCIDENT END DATE
1445	12/4/2002	DR	Severe Storm(s)	SEVERE WINTER STORMS, FLOODING, COASTAL EROSION AND TIDAL SURGE	10/23/2002	12/20/2002

DR-1445

From October 23 to December 20, 2002, unseasonably warm temperatures and heavy rain contributed to flooding and coastal flood surge on the Kenai Peninsula. Federal disaster aid was declared on December 4, 2002. The declaration covered damages to both public and private property in the Kenai Peninsula Borough, the Kodiak Island Borough, and the Chignik Bay area. Disaster emergency centers were opened in Seward, Ninilchik, and Homer.

Table 14: DR-1445 Public Assistance - Dollars Approved

	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*	EMERGENCY WORK (CATEGORIES A-B) - DOLLARS OBLIGATED*	PERMANENT WORK (CATEGORIES C-G) - DOLLARS OBLIGATED*
Total Amount	$8,721,045.16	$441,657.36	$8,028,649.40

Table 15: DR-1445 Individual Assistance - Dollars Approved

	TOTAL INDIVIDUAL ASSISTANCE (IA) - APPLICATIONS APPROVED:	TOTAL INDIVIDUAL AND HOUSEHOLDS PROGRAM - DOLLARS APPROVED*	TOTAL HOUSING ASSISTANCE - DOLLARS APPROVED*	TOTAL OTHER NEEDS ASSISTANCE - DOLLARS APPROVED*
Total Amount	199	$509,173.67	$461,070.95	$48,102.72

In addition to public and individual assistance, FEMA issued a series of Hazard Mitigation Grant Program (HMGP) funds to the Kenai Peninsula following DR-1445. These grants supported multiple hazard-specific projects including HMP updates, shoreline stabilization projects, stormwater management projects, infrastructure improvements, and utility system improvements. Table 16 lists the HMGP grants that were issued to Kenai Peninsula Borough communities. In total, almost $740,000 in grant assistance was awarded to the Borough.

Table 16: HMGP Funds Awarded to the Kenai Peninsula Borough Following DR-1445

PROJECT TYPE	PROJECT TITLE	PROJECT DESCRIPTION	PROJECT COUNTIES	SUB-GRANTEE	PROJECT AMOUNT
401.1: Water and Sanitary Sewer System Protective Measures	Bishop property install well and septic	---	Kenai Peninsula	Alaska Dept. of Community and Economic Development	$9,475
301.1: Shoreline Stabilization (Riprap, etc.)	Alaska Railroad MP 29	---	Kenai Peninsula	Alaska Railroad Corporation	$118,438
91.1: Local Multi-Hazard Mitigation Plan	City of Homer HMP	---	Kenai Peninsula	Homer	$2,573
301.1: Shoreline Stabilization (Riprap, etc.)	Alaska RR MP 19 to 23 - Embankment Rehab	---	Kenai Peninsula	Alaska Railroad Corporation	$235,211
403.2: Stormwater Management - Diversions	SO. Peninsula Hospital - Hillside runoff water diversion and drainage	Divert hillside water runoff by cutting back slope and re-routing run-off to natural drainage away from hospital offices and reception area.	Kenai Peninsula	South Peninsula Hospital	$96,360
402.1: Infrastructure Protective Measures (Roads and Bridges)	Kasilof River Road Relocation	Relocate existing road from top of river bank that is subject to erosion and washout.	Kenai Peninsula	Kenai Peninsula (Borough)	$187,406
402.1: Infrastructure Protective Measures (Roads and Bridges)	Kachemak Silo road elevation	Raise sole entrance road 3 feet to prevent isolation from flood event.	Kenai Peninsula	Kachemak Silo	$0
401.1: Water and Sanitary Sewer System Protective Measures	City of Seward lift station #1 control reconfiguration	Raise controls above 100-year flood level.	Kenai Peninsula	Seward City Manager	$90,000
				TOTAL	**$739,463**

In efforts to combat erosion near development and infrastructure, individual communities in Kenai Peninsula Borough are monitoring erosion sites and initiating improvement projects when necessary. The most recent is the Homer Rehabilitation Project, which began in 2015 to address erosion impacts along local critical transportation routes. Erosion rates of the roadside bluffs, measured at 1 to 5.7 feet per year in some areas, jeopardize the stability and safety of the roads. In total, the project is estimated to cost roughly $15.5 million.

Erosion Exposure Assessment Overview

Coastal erosion is well documented along the eastern side of the Cook Inlet in Kenai Peninsula Borough. Spatial data collected for the borough includes the coastlines from Nikiski south to Anchor Point, from three different time periods: 1952, 1996, and 2004. The borough identified “hot spots,” or areas with a high erosion rate, with an erosion rate of up to 5.7 feet per year in some places. Table 17 lists various locations along the Cook Inlet, their erosion rates, and the erosion “hot spot” values. Using coastlines from various periods, an assessment of improved parcels intersecting these lines provides the potential vulnerability by Borough zone and the location within the zone. The results of this exposure assessment are shown in Table 18.

Table 17: Erosion Rates along the Cook Inlet in Kenai Peninsula Borough

BOROUGH ZONE	LOCATION	EROSION RATE	"HOT SPOT" EROSION RATE
North Zone	Nikiski	0.8 feet per year	4.0-5.7 feet per year
North Zone	Nikiski to Kenai River	2.2 feet per year	4.0-5.7 feet per year
Central Zone	Kenai River to Kasilof River	1.6 feet per year	2.3–4.0 feet per year
Central Zone	Kasilof River to Ninilchik River	0.6 feet per year	2.3–4.0 feet per year
South Zone	Ninilchik River to Stariski Creek	0.6 feet per year	2.3–5.7 feet per year
South Zone	Stariski Creek to Anchor River	1.0 foot per year	2.3–5.7 feet per year
South Zone	Anchor Point to Homer	0.7 feet per year	2.3–5.7 feet per year

Note: Data obtained from the 2014 Kenai Peninsula Borough All-Hazard Mitigation Plan

Table 18: Parcel Improvement Exposure Associated with Coastal Erosion in Kenai Peninsula Borough

BOROUGH ZONE	LOCATION	IMPROVED PARCEL VALUE IN EROSION ZONE	IMPROVED PARCEL VALUE IN EROSION HOT SPOTS (2.3 - 5.7' PER YEAR)	TOTAL NUMBER OF IMPROVED PARCELS IN EROSION ZONE	TOTAL NUMBER OF IMPROVED PARCELS IN EROSION HOT SPOTS (2.3 - 5.7' PER YEAR)	PERCENTAGE OF IMPROVED PARCELS IN EROSION HOT SPOTS
North Zone	Nikiski	$23,365,500	$ 21,323,900	18	7	38.89%
North Zone	Nikiski to the Kenai River	$24,873,300	$ 15,978,200	87	77	88.51%
Central Zone	Kenai River to Kasilof River	$28,939,400	$ 7,302,500	123	29	23.58%
Central Zone	Kasilof River to Ninilchik River	$36,212,900	$830,400	166	5	3.01%
South Zone	Ninilchik River to Stariski Creek	$11,225,800	$1,842,800	88	5	5.68%
South Zone	Stariski Creek to Anchor River	$9,590,800	$1,279,000	70	9	12.86%
South Zone	Anchor Point to Homer	$3,823,500	$0	23	0	0.00%
TOTAL	---	**$138,031,200**	**$48,556,800**	**575**	**132**	**23.00%**

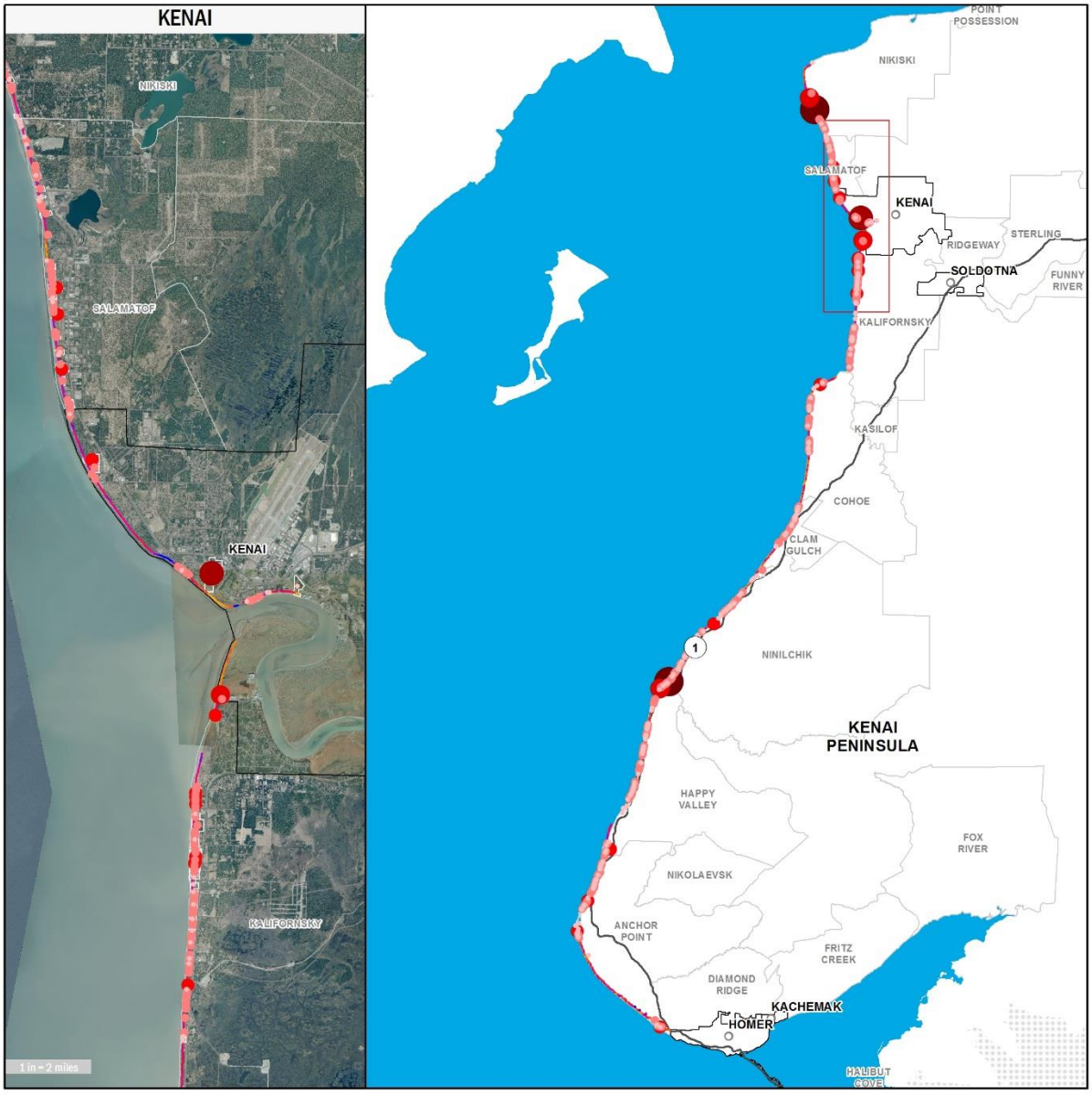
The highest erosion rates occur in the north and central zones of the borough, from the southern limits of Nikiski along Salamatof, Kenai, and Kalifornsky to the Kasilof River. Erosion rates are between 1.6 and 2.2 feet per year. The largest "hot spot" erosion rates occur in relatively the same vicinity, from Nikiski to the northern banks of the Kenai River. Some areas experience erosion at 4.0 to 5.7 feet per year. In total, 575 improved parcels are located along the studied coastline, with a total improvement value of just over $138 million. The central zone (from the southern bank of the Kenai River through Kalifornsky) has the largest improved value along the eroding coastline, as 289 parcels account for $65,152,300. The area has the lowest "hot spot" erosion variability (between 2.3 and 4.0 feet a year), but it has moderate erosion concerns, as yearly rates vary between 0.6 and 1.6 feet a year. The North Zone accounts for over $48 million in improved values along the coastline. Of the 105 parcels in this zone, 84 are susceptible to 2.7 to 5.7 feet in yearly erosion, totaling over $37.3 million in improved parcel vulnerability. The south zone, from the Ninilchik River south to Homer, has the lowest value of improved parcels along the

coastline at $24.6 million. Map 10 shows coastal erosion rates along Cook Inlet and highlights the shoreline around Kenai.

The erosion inventory assessment can be used to identify properties for mitigation projects and areas for additional outreach. Areas of greatest impact and potential mitigation actions are shown in the community sections of this report (Section 11). All results, databases, and maps are provided in the Risk Assessment Database included with this report.

Map 10: Coastal Erosion along Cook Inlet in Kenai Peninsula Borough

COASTAL EROSION



8. Tsunami Exposure Assessment

Tsunami Hazard Overview

Tsunamis are generated when geologic events, such as earthquakes or landslides, cause large, rapid movements in the sea floor that displace the water column above. That swift change 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.

Kenai Peninsula Borough is particularly vulnerable to tsunamis due to the seismic activity, volcanic activity, and landslides in the region. Notable historic tsunamis include the 1883 tsunami generated by the volcanic eruption of Augustine, which created 15- to 30-foot waves, and the 1964 tsunami generated by the M9.2 Great Alaska Earthquake and subsequent local landslides, which resulted in the death of 106 Alaskans.

More recent tsunamis have also been reported along the west coast of the continental United States. Presidential disasters were declared in 2011 (between late March and mid-April) following the 8.9-magnitude earthquake in Japan, when Oregon, California, and Hawaii coastal communities were hit by towering tsunami waves. The National Oceanic and Atmospheric Administration (NOAA) reported that waves in northern California reached a height of 8.1 feet, destroying six docks and 35 boats, and leaking gas and other debris into the harbor. In Hawaii, damages were estimated over $30.6 million as 7-foot waves crashed into hotel lobbies and up roads 30 feet inland. In Oregon, the waves were not as high; but the three 3-foot waves that came ashore damaged harbors and commercial ports. To aid in recovery, Federal funding was provided to support communities to provide extensive debris removal, emergency protective measures, and infrastructure and property repair.

Table 19: 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 Exposure Assessment

Tsunami models are available for select areas in Kenai Peninsula Borough in the Cities of Homer, Seldovia, and Seward, via the Alaska Division of Geological and Geophysical Surveys. Hypothetical composite lines, also referred to as “maximum credible scenarios,” generate a maximum extent of tsunami inundation based on all model simulations. The composite lines are generated by the following models:

- Homer and Seldovia: Modeled repetition of the 1964 earthquake event and Border Ranges fault rupture

- Seward: Modeled repetition of the 1964 earthquake event (and accompanying modifications), ruptures of the Pamplona Zone, underwater slides, and underwater slope failures (and accompanying modifications)

For this exposure assessment, the locations of improved parcels were compared to the geographic extent of the tsunami. The results of the exposure assessment are shown in Table 20.

Table 20: Parcel Improvement Exposure Associated with Maximum Credible Scenario Tsunamis in Kenai Peninsula Borough

COMMUNITY NAME	TOTAL ESTIMATED VALUE OF IMPROVED PARCELS	IMPROVED PARCEL VALUE IN TSUNAMI ZONE	TOTAL NUMBER OF IMPROVED PARCELS	TOTAL NUMBER OF IMPROVED PARCELS IN TSUNAMI ZONE	PERCENTAGE OF IMPROVED PARCELS IN TSUNAMI ZONE
Homer, City of	$709,435,100	$18,947,300	2,396	15	0.63%
Seldovia, City of*	$56,261,000	$6,541,900	319	44	13.79%
Seward, City of**	$472,711,500	$62,134,500	1,835	162	13.14%
TOTAL	**$1,238,407,600**	**$87,623,700**	**4,550**	**221**	**4.86%**

Note: No tsunami inundation modeling is available outside of these jurisdictions.
*Includes surrounding Seldovia RSA and KPB Road Maintenance Parcels.
**Includes surrounding Seward Special, Seward/Bear Creek Flood Service Area, and Bear Creek Fire Area Parcels.

Approximately $87 million (221 improved parcels) in the studied communities is at risk from a maximum tsunami inundation. Seward and surrounding areas have the largest number of improved parcels at risk—162—as well as the greatest value at just over $62 million. Seldovia and surrounding areas have the highest percentage of parcels at risk—close to 14 percent—but the lowest values at $6.5 million. Homer's primary tsunami risk is along the Homer Spit. Only 15 parcels were identified to be at risk, but their improvement value is close to $19 million. Maps 11, 12, and 13 display the tsunami extents and improved parcel values in areas at risk in Homer, Seldovia, and Seward.

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 11, Areas of Mitigation Interest). All results, databases, and maps are provided in the Risk Assessment Database included with this report.

Map 11: Maximum Inundation for a Tsunami in Homer

TSUNAMI: HOMER

MAP SYMBOLOGY

TSUNAMI — TSUNAMI EXTENT

LOSS VALUE
- $100K OR LESS
- $100K TO $500K
- $500K TO $1000K
- $1000K TO $5000K
- $5000K TO $10000K
- $10000K OR GREATER

ABOUT

THIS MAP DISPLAYS THE MAXIMUM TSUNAMI EXTENT FOR A REPEAT 1964 EVENT AND MODELED BORDER RANGES FAULT RUPTURE.

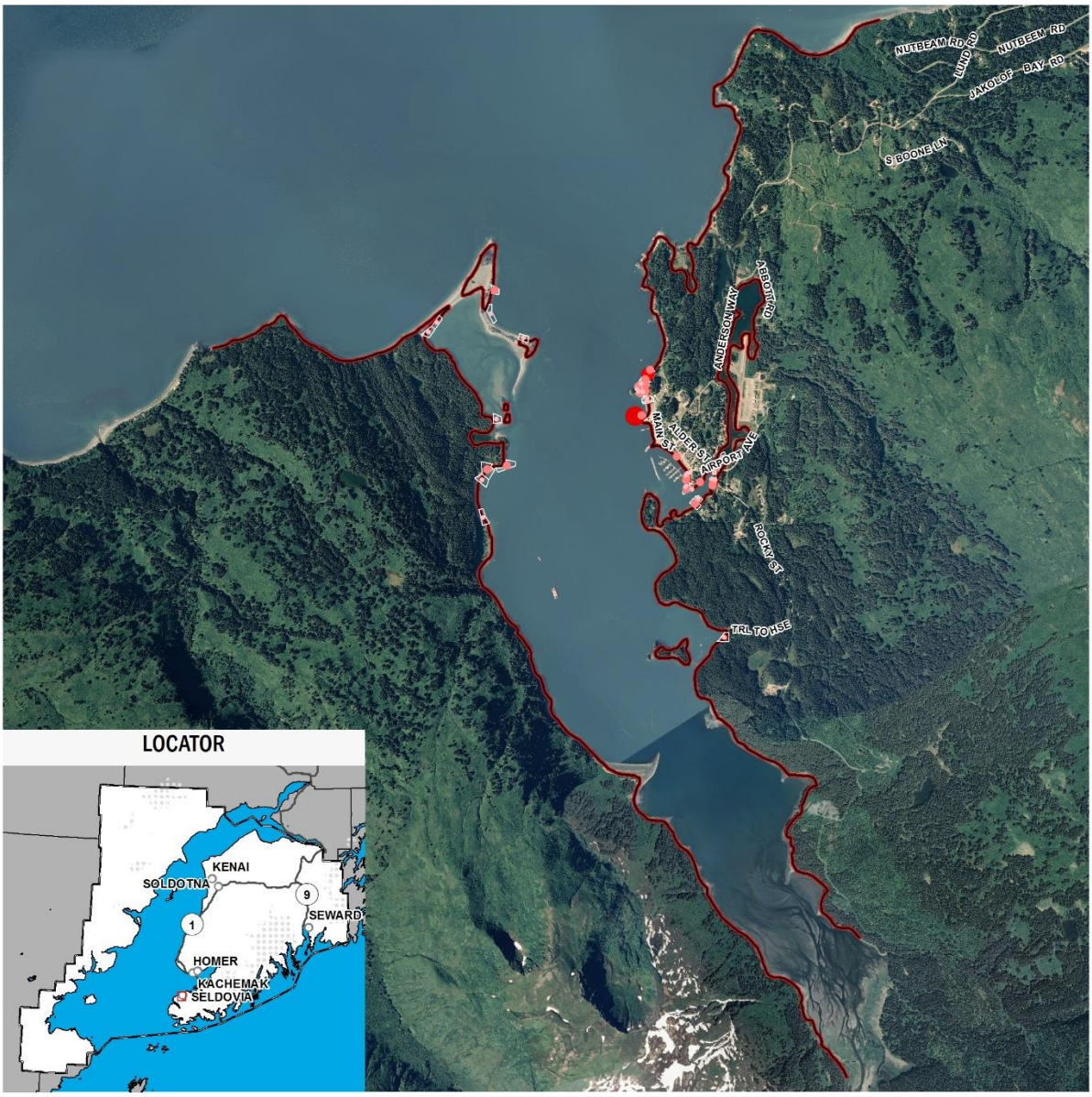
1 in = 4,000 feet

1:48,000

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.

Map 12: Maximum Inundation for a Tsunami in Seldovia

TSUNAMI: SELDOVIA



MAP SYMBOLOGY

TSUNAMI — TSUNAMI EXTENT

LOSS VALUE
- $100K OR LESS
- $100K TO $500K
- $500K TO $1000K
- $1000K TO $5000K
- $5000K TO $10000K
- $10000K OR GREATER

ABOUT

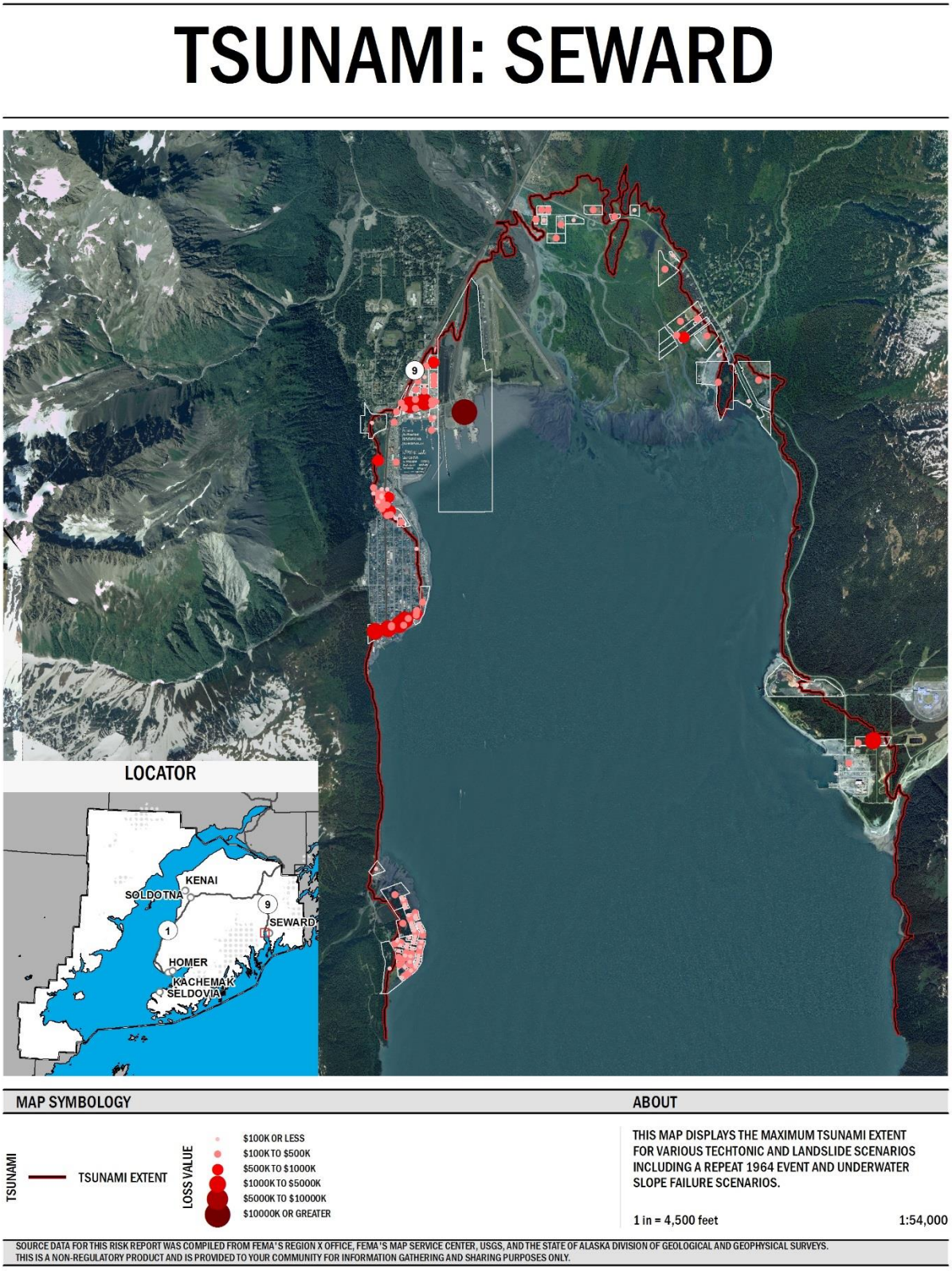
THIS MAP DISPLAYS THE MAXIMUM TSUNAMI EXTENT FOR A REPEAT 1964 EVENT AND MODELED BORDER RANGES FAULT RUPTURE.

1 in = 4,000 feet

1:48,000

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.

Map 13: Maximum Inundation for a Tsunami in Seward



9. Dam Failure Hazard Profile

Dam Failure Hazard Overview

There have been several dam failures in Alaska's history. The most recent event occurred in July 2000 when the City of Kake's main water supply dam failed. After the dam failed, the small reservoir drained quickly and the town became acutely aware of the importance of the dam. Significantly impacted, Kake was forced to find a temporary and long-term solution to provide water to the 800-person village. The water supply loss was the most apparent impact. The local processor lost production for the next two weeks at the peak of the fishing season. The hatchery experienced an increased egg and fry mortality rate due to water problems. The failure of the City of Kake's Dam had a truly significant impact on the entire community. The response included local residents and government entities, businesses, State agencies, and the Federal government. The initial economic impact to the community was estimated at approximately $2 million, not including replacement of the dam. The budget for a new, replacement dam planned by the USACE was approximately $10 million.

Only one dam failure in Alaska has resulted in a fatality. Anchorage's Lake O' the Hills Dam failed in 1972, allegedly resulting in the death of a child who was swept into a culvert.

Nationally, there have been few Presidentially declared disasters listing dam failure as the event type. However, there have been multiple Presidentially declared disasters that have caused dam breaches, resulting in a national significant dam failure event. No one knows precisely how many dam failures have occurred in the United States, but they have been documented in every State. From January 1, 2005, through June 2013, State dam safety programs reported 173 dam failures and 587 "incidents"- episodes that, without intervention, would likely have resulted in dam failure.

Table 21: Presidentially Declared Dam Failure Disaster History for the United States

DISASTER NUMBER	DECLARATION DATE	STATE	COUNTY	INCIDENT TYPE	TITLE	INCIDENT BEGIN/END DATE	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*
DR-665	7/22/1982	CO	Larimer	Flood	FLASH FLOOD DUE TO DAM FAILURE	7/22/1982	---
DR-541	11/7/1977	GA	Stephens	Flood	DAM COLLAPSE, FLOODING	11/7/1977	---
DR-505	6/6/1976	ID	Bingham	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Bonneville	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Fremont	Flood	DAM COLLAPSE, FLOODING	6/6/1976	---
DR-505	6/6/1976	ID	Jefferson	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-505	6/6/1976	ID	Madison	Flood	DAM COLLAPSE, FLOODING	6/6/1976	
DR-379	5/8/1973	CO	Weld	Dam/ Levee Break	DAM FAILURE	5/8/1973	---

DISASTER NUMBER	DECLARATION DATE	STATE	COUNTY	INCIDENT TYPE	TITLE	INCIDENT BEGIN/END DATE	TOTAL PUBLIC ASSISTANCE GRANTS - DOLLARS OBLIGATED*
DR-161	12/21/1963	CA		Dam/ Levee Break	FLOOD DUE TO BROKEN DAM	12/21/1963	---

To date, the Kenai Peninsula Borough has not had a presidentially declared disaster caused by dam failure. While the number of dams on the Kenai Peninsula are limited, sudden flooding hazards do exist. Failure of the Copper Lake Dam or the Lowell Creek Diversion Tunnel and Dam could cause damage to critical infrastructure, including hospitals, fire and police stations, city administration buildings, businesses, homes, and retirement centers.

Lowell Creek Diversion Tunnel and Dam Hazard Overview

The Lowell Creek Diversion Tunnel and Dam, completed in 1940, was the first USACE project in Alaska. Its creation diverted water from its original path down modern-day Jefferson Street to an uninhabited area south of the City of Seward and into Resurrection Bay. The dam is 400 feet long and 25 feet high, and the tunnel, which channels the creek underneath Bear Mountain, is just over 2,000 feet long and 10 feet in diameter. Current concerns with the Lowell Creek Diversion Tunnel and Dam include the rapid deterioration of the tunnel floor due to debris scouring and the near overtopping of the dam after major flood events that pose considerable risk to the City of Seward.

Dams on the Kenai Peninsula Borough

There are eleven dams on the Kenai Peninsula Borough, two of which are identified as High Hazard according to the USACE NID. The Lowell Creek and Bridge Creek dams are both classified as High Hazard according to the NID, and neither structure has an approved EAP. In July of 2016, the City of Seward signed an agreement to develop an EAP with the Alaska Department of Natural Resources. As of January 2017, the EAP has not yet been completed.

To date, the Kenai Peninsula Borough has not had a presidentially declared disaster caused by dam failure. While the number of dams on the Kenai Peninsula are limited, sudden flooding hazards do exist. Failure of the Copper Lake Dam or the Lowell Creek Diversion Tunnel and Dam could cause damage to critical infrastructure including hospitals, fire and police stations, city administration buildings, businesses, homes, and retirement centers.

Table 22: Dams located on the Kenai Peninsula Borough

DAM ID NUMBER	NAME	BOROUGH REAA	OWNER	NEARBY DEVELOPMENT	HAZARD POTENTIAL CLASSIFICATION	EMERGENCY ACTION PLAN
AK00060	Lowell Creek	Kenai Peninsula Borough	State	Seward	High	No
AK00101	Bridge Creek Dam	Kenai Peninsula Borough	State	Homer	High	No
AK00082	Roycroft Lake	Kenai Peninsula Borough	State	Moose Pass	Significant	Yes
AK00262	Beluga Lake Dam	Kenai Peninsula Borough	State	Homer	Significant	No
AK00024	Seldovia Upper Dam	Kenai Peninsula Borough	State	Seldovia	Low	Not Required
AK00079	Jerome Lake Dam	Kenai Peninsula Borough	Federal	None	Low	Not Required
AK83016	Bradley Lake Dam	Kenai Peninsula Borough	Federal	None	Low	Not Required

DAM ID NUMBER	NAME	BOROUGH REAA	OWNER	NEARBY DEVELOPMENT	HAZARD POTENTIAL CLASSIFICATION	EMERGENCY ACTION PLAN
AK00001	Cooper Lake Dam	Kenai Peninsula Borough	Federal	None	Low	Not Required
AK00096	Fish Creek Dam	Kenai Peninsula Borough	Non-Jurisdictional	Seldovia	Low	Not Required
AK00097	Port Graham Dam #2	Kenai Peninsula Borough	Non-Jurisdictional	Port Graham	Low	Not Required
AK00160	Port Graham Dam #1	Kenai Peninsula Borough	Non-Jurisdictional	Port Graham	Low	Not Required

Lowell Creek Diversion Dam Failure Hazard Profile

During the planning phase of this Risk Report, FEMA intended to conduct a risk assessment using Hazus for a dam failure hazard profile of the Lowell Creek Diversion Dam. During this time however, the USACE began planning their own, more in-depth, assessment of the structure. FEMA has since redirected its efforts from running their own hazard assessment of the dam to supporting USACE's efforts for their study. FEMA has provided all the obtained tax and economic data from this report to enhance USACE's risk assessment.

The USACE is conducting a Hybrid Risk Assessment of the Lowell Creek Dam. The risk assessment will determine the most credible failure modes. Once the most credible failure modes are determined, an Elicitation of Experts will be performed with full failure trees to determine the risk at Lowell Creek. Once alternatives in the final array are determined through the formulation process, another elicitation will take place to determine how much risk reduction and loss of life will occur with the implementation of the alternative. This will help inform the Project Delivery team in their selection process of a tentatively selected plan at Lowell Creek. The risk assessment will include the following:

- Potential failure mode analysis
- Existing condition of project with credible failure modes
- Risk reduction alternatives

The results of the risk assessment will contribute to the completion of a feasibility study that will act as a standalone report (FOUO). [The FOUO determination is due to consequence and failure information that could be used to harm the public.]

Table 23 shows the USACE's tentative milestone schedule.

Table 23: USACE Tentative Milestone Schedule

DATE	MILESTONE	DESCRIPTION
June 8, 2017	Alternatives Milestone Meeting	The Alternatives Milestone is the first decisional milestone of the study, in which the team presents their list of design alternatives to be evaluated in greater depth, and presents their intended direction/path forward for completing the study.
June 7, 2018	Tentatively Selected Plan	Between the Alternatives Milestone and the Tentatively Selected Plan (TSP) Milestone, the team collects data and models alternatives to analyze and evaluate effectiveness with the intent of identifying a TSP. When the District is prepared to release the draft report and draft NEPA documentation for concurrent public, technical, legal, and policy review, the TSP milestone meeting is held.
February 8, 2019	Agency Decision Milestone	This milestone occurs after completion of the concurrent reviews and marks corporate endorsement of the recommended plan and proposed way forward to complete feasibility-level design and the feasibility study report package.

DATE	MILESTONE	DESCRIPTION
June 14, 2019	Civil Works Review Board	After the final report package is submitted to USACE Headquarters, this board makes a determination as to whether the documents are ready to be released for State and Agency review and final NEPA review.
August 9, 2019	Chief's Report signed	After the final feasibility study report is submitted to USACE Headquarters, a "Chief's Report" is developed. This milestone marks the signing of the report by the Chief of Engineers, signifying approval of the project recommendation.

More information on the USACE study can be obtained by contacting the following individual:

George Kalli, P.E.
U.S. Army Corps of Engineers, Alaska District Project Management, Civil Planning (CEPOA-PM-C-PL)
george.a.kalli@usace.army.mil
(907) 753-2594

10. Plan Integration

The information in this Risk Report is intended to support the ongoing planning processes within the borough, including those for the comprehensive plan and the HMP. Because the cities with annexed HMPs regulate their own land-use planning, this Risk Report focuses primarily on resiliency strategies for the borough. However, the information is provided with the goal that it may be transferable to first class and/or home rule cities or flood service areas. Through a public perception survey, the borough knows that residents may support local zoning options, especially if the requirements are streamlined and easy to obtain.

The borough's comprehensive plan is unique in that natural hazards are already integrated into the plan and strategies are provided for addressing hazard risk through land-use planning. The information in the resilience strategies could support future updates to these sections in the comprehensive plan, as well as updates to HMPs. Further plan integration in HMP update is encouraged. HMP goals that align with integration are as follows:

- Modify impacts of hazard events by encouraging, assisting, and training individuals and communities to prepare for, respond to, and recover from hazard events;
- Reduce susceptibility to damage and disruption by avoiding hazardous, uneconomic, and unwise development in known hazard areas;
- Protect natural and beneficial values of floodplains, coastal areas, and water resources; and
- Reduce unnecessary economic losses and promote positive economic development by incorporating hazard mitigation into land use and development decisions.

The HMP goals complement the objectives of the borough's comprehensive plan, which are to ensure an adequate supply of land that is:

- Suitable for development
- In appropriate ownership status
- Appropriately zoned, with needed utilities and services
- For future private and public uses
- At desirable locations.

The information in this Risk Report is provided to support the borough's ongoing land-use planning and hazard mitigation efforts. The resiliency strategies included in Section 11, Areas of Mitigation Interest (AOMI), were developed to fit in with the goals and purpose of the HMP and the comprehensive plan. The information included in this Risk Report and suggested in the resiliency strategies are intended to support the borough's ongoing and future efforts to address natural hazards through both hazard mitigation and land-use planning. Page 3 of the comprehensive plan lists connections to other existing planning mechanisms. While hazards are clearly described later in the plan, this would be a strategic opportunity to write a stronger connection to the borough's HMP. The resiliency strategies also recognize the changes in population growth across the borough. The population increased more dramatically in the early 1980s than in the past decade; however, the largest change in demographics was the increase in people aged 45 or older. This change is relevant to mitigation strategies pertaining to evacuation routes, new structures for long-term care, access to utilities during and after an event, and siting or designing new structures. The resiliency strategies recognize overall low population growth and primarily apply to existing and substantially damaged structures. The strategies also recognize nuances in land ownership across the peninsula among the borough, Federal, municipal, Native, private, and State lands. Because the most effective resiliency strategies will be tailored specifically to small geographic areas, the strategies

provide information that could be used in many different ways. This information is intended to be integrated into the borough's ongoing hazard mitigation efforts, including updates to building codes, ordinances, or any other mechanism intended to reduce risks to life, infrastructure, and natural resources, or in whatever form will be most politically, economically, and socially feasible at the local level.

The borough's comprehensive plan describes existing planning mechanisms that help to manage development. As one of these, the HMP is listed under "Development Constraints and Natural Hazards" as a resource for specific hazard and mitigation information. The AOMI resilience strategies were developed through a lens of these land-use planning goals while incorporating primary components of the HMP, including stakeholder engagement, public participation, hazard profiles, and mitigation actions. The stakeholder engagement and public participation in the borough's HMP and each annexed plan is inclusive and strong. These relationships can be used to help disseminate the information found in this report for each community's plan update as it comes available. These relationships can also be the foundation for community outreach and hazard awareness campaigns that aim to increase preparedness for many types of natural hazards.

The same outlets used to gather public participation and provide comment (names, surveys, organizations, etc. are included in each city's and borough's HMP) are existing avenues to use for reaching out with this updated information. These contacts could be used to form Community Rating System (CRS) User Groups, to develop hazard outreach events that coincide with annual community events, and to use the same libraries or public spaces where existing hazard brochures have been circulated. These networks could also be used to identify local Community Emergency Response Teams (CERTs) and other local champions who are passionate about reducing risk in their communities, where they have unique knowledge about how to reach out to different audiences.

The following resiliency strategies were developed using the land-use and hazard mitigation information in the local plans. These strategies are designed to be as consistent as possible with the existing planning mechanism and with the goals and objectives of both plans. These strategies are also intentionally written to provide supportive information to help all communities update both plans.

11. Areas of Mitigation Interest

Kenai Peninsula Borough, Unincorporated Areas of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 24 highlights facilities in the unincorporated areas of Kenai Peninsula Borough that are most affected by these hazards.

Table 24: Unincorporated Areas of the Kenai Peninsula Borough Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
UNINCORPORATED	AIRSTRIP	BEAR COVE FARM AIRSTRIP – PRIVATE	$163,350	$10,213	6.25%	EARTHQUAKE
UNINCORPORATED - ANCHOR POINT	BOAT LAUNCH	TRACTOR BOAT LAUNCH	$163,250	$5,714	3.50%	FLOOD, EROSION
UNINCORPORATED - ANCHOR POINT	CAMPGROUND	STARISKI CAMPGROUND	$86,600	$2,750	3.18%	EROSION
UNINCORPORATED - BEAR CREEK	EMERGENCY SHELTER	LE BARN APPETIT	$637,800	$33,541	5.26%	EARTHQUAKE, FLOOD
UNINCORPORATED - BEAR CREEK	FIRE STATION	BEAR CREEK VOLUNTEER FIRE AND EMS*	$6,911,600	$235,129	3.40%	FLOOD
UNINCORPORATED - BEAR CREEK	EMERGENCY SHELTER	LDS CHAPEL - BEAR CREEK	$1,256,400	$36,869	2.93%	FLOOD
UNINCORPORATED - CLAM GULCH	POST OFFICE	CLAM GULCH POST OFFICE	$118,600	$5,021	4.23%	---
UNINCORPORATED - COHOE	SCHOOL	TUSTUMENA ELEMENTARY*	$26,555,200	$1,227,108	4.62%	---
UNINCORPORATED - COOPER LANDING	COMMUNITY CENTER	COOPER LANDING COMMUNITY CENTER	$544,400	$17,844	3.28%	FLOOD
UNINCORPORATED - CROWN POINT	CAMPGROUND	PTARMIGAN CREEK CAMPGROUND	$33,000	$1,377	4.17%	---
UNINCORPORATED - FOX RIVER	SCHOOL	KACHEMAK-SELO SCHOOL	$264,600	$11,967	4.52%	---
UNINCORPORATED - FOX RIVER	SCHOOL	RAZDOLNA SCHOOL	$493,200	$21,344	4.33%	---

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
UNINCORPORATED - FRITZ CREEK	POST OFFICE	FRITZ CREEK POST OFFICE	$299,800	$14,171	4.73%	---
UNINCORPORATED - FUNNY RIVER	FIRE STATION	CENTRAL EMERGENCY SERVICES STATION 5 (FUNNY RIVER)	$1,912,400	$71,900	3.76%	---
UNINCORPORATED - HAPPY VALLEY	BOAT LAUNCH	DEEP CREEK BOAT LAUNCH	$287,200	$9,036	3.15%	FLOOD
UNINCORPORATED - HOPE	POST OFFICE	HOPE POST OFFICE	$664,600	$29,111	4.38%	---
UNINCORPORATED - KALIFORNSKY	---	PROPOSED CES STATION - KALIFORNSKY	$55,800	$2,340	4.19%	EARTHQUAKE
UNINCORPORATED - KALIFORNSKY	BOAT HARBOR	KASILOF SMALL BOAT HARBOR	$594,750	$23,466	3.95%	FLOOD
UNINCORPORATED - KASILOF	COMMUNITY CENTER	MCLANE CENTER	$72,000	$3,048	4.23%	---
UNINCORPORATED - MOOSE PASS	EMERGENCY SHELTER	MOOSE PASS COMMUNITY CLUB	$430,000	$16,788	3.90%	---
UNINCORPORATED - NANWALEK	EMERGENCY SHELTER	NANWALEK COMMUNITY CENTER	$911,800	$47,563	5.22%	EARTHQUAKE
UNINCORPORATED - NIKISKI	OIL AND GAS	TESORO ALASKA COMPANY	$421,250,000	$12,858,151	3.05%	---
UNINCORPORATED - NIKISKI	FIRE STATION	NIKISKI FIRE STATION NO. 2	$1,378,000	$41,963	3.05%	---
UNINCORPORATED - NIKOLAEVSK	SCHOOL	NIKOLAEVSK SCHOOL*	$15,675,600	$581,400	3.71%	---
UNINCORPORATED - NINILCHIK	SCHOOL	NINILCHIK SCHOOL*	$31,415,200	$1,260,191	4.01%	EROSION
UNINCORPORATED - RIDGEWAY	FIRE STATION	CENTRAL EMERGENCY SERVICES STATION 2 (MACKEY LAKE)	$359,200	$12,873	3.58%	---
UNINCORPORATED - SALAMATOF	PRISON	WILDWOOD CORRECTIONAL CENTER	$5,000,000	$175,914	3.52%	---
UNINCORPORATED - SELDOVIA VILLAGE	EMERGENCY SHELTER	FIRST MISSIONARY BAPTIST CHURCH	$270,800	$11,426	4.22%	---

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
UNINCORPORATED - STERLING	SCHOOL	STERLING ELEMENTARY*	$15,973,000	$887,543	5.56%	EARTHQUAKE
UNINCORPORATED - STERLING	LANDFILL/TRANSFER FACILITY	STERLING TRANSFER FACILITY	$712,000	$35,276	4.95%	---

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter

Hazard Mitigation Plan and Comprehensive Plan Analysis

The Kenai Peninsula Borough All-Hazard Mitigation Plan, effective August 2014 through August 2019, and the 2005 Kenai Peninsula Borough Comprehensive Plan identify some of the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 25: Unincorporated Areas of the Kenai Peninsula Borough All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	Goal 6.7	To assess and help identify floodplains.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and AOMI section for areas most vulnerable to flooding.
Depth Grid: Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **BFE+ Grid:** Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	2.12 Strategy 2	Develop mechanisms to enhance floodplain permit compliance. Develop a project notification process to connect property owners with the appropriate floodplain, utility, and right-of-way construction permit information.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, NFIP enrollment, and educational outreach.
Hazus Flood Output: Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	Goal 6.7 Objective 2	To increase local participation in decisions regarding development in floodplains and wetlands areas	Promote new flood hazard data to the public through existing local events. Show flood hazard areas, the depth of flooding in select locations, and how development decisions are made based on hazard information.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario. **Hazus Earthquake Output:** Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	All Hazard Mitigation Plan	4.5 Strategy 1	Identify and prioritize studies and retrofit measures for KPB critical facilities and infrastructure that are seismically vulnerable.	Use Hazus earthquake output and AOMI section to review loss ratios to critical facilities for both earthquake scenarios.
Erosion Rate: Spatial data provides erosion rates along Cook Inlet. **Erosion Historic Rate:** Spatial data provides coastline extents in 1952, 1996, and 2004 along Cook Inlet.	All-Hazard Mitigation Plan	Goal 6.7	To assess and help identify erosion prone areas.	Utilize erosion rate and erosion historical rate dataset to find parcels exposed to greatest erosion along Cook Inlet and review coastline change over time.
Master Output: Spatial and tabular data indicates whether a building is impacted by coastal erosion along Cook Inlet.	All-Hazard Mitigation Plan	2.12 Strategy 2	Determine the areas of highest hazard and implement appropriate development standards in those areas	Use erosion exposure assessment to analyze zones with greatest threat to assets by Borough zone and location.
Tsunami Hazard Area: Spatial data shows maximum tsunami extents in coastal regions of Homer, Seldovia, and Seward. **Master Output:** Spatial and tabular data indicates whether a building is within a tsunami hazard area along coastal regions of Homer, Seldovia, and Seward.	All-Hazard Mitigation Plan	6.6 Strategy 1	Increase public awareness of tsunami and seiche mitigation activities and emergency response.	Use tsunami exposure assessment to identify the percentage of affected parcels in tsunami hazard areas. Using the master output, locate at-risk structures and prioritize non-development areas, structure relocation, and educational outreach. Work with local officials to organize a tsunami evacuation exercise.
The USACE is conducting a Hybrid Risk Assessment of the Lowell Creek Dam. The risk assessment will include: • Potential failure mode analysis • existing condition of project with credible failure modes • risk reduction alternatives The results of the risk assessment will contribute to the completion of a feasibility study which will act as a standalone report (FOUO).	All-Hazard Mitigation Plan	5.10.3 Goal 1	Improve information, data collection, and compliance for the Class I and Class II State Jurisdiction dams.	When available, utilize the results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam to identify at-risk structures and prioritize non-development areas, structure relocation, and educational outreach in Seward. Information provided in the study can support efforts to procure funding for ongoing maintenance of dam and diversion structures.
	Comprehensive Plan	Chapter 7-8	Oversee the permitting, construction, and operation of dams.	When available, utilize the results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam to identify at-risk structures and prioritize non-development areas, structure relocation, and educational outreach in Seward. Information provided in the study can support efforts to procure funding for ongoing maintenance of dam and diversion structures.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 26: Unincorporated Areas of the Kenai Peninsula Borough Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. Homeowners often lack the funds to take proactive steps to retrofit houses or take other steps to reduce risk. Tourism at Kenai Beach during the summer creates evacuation challenge. Home buyers are not informed about relevant hazards at the point of sale. There is a need to transfer local environmental knowledge to the public. There is no central location for dissemination of environmental information on the Kenai Peninsula. There is a lack of knowledge among individuals about the best ways to site and develop responsibly. There is limited authority of the government creates regulatory and enforcement issues; social norms against government intervention into private property rights. While mitigation projects have been identified, funding is always a challenge.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations, and after-event repairs. • Update evacuation plans to include tourism impacts and to address instances of large gatherings of people. • Develop a central clearinghouse for Kenai Peninsula hazard data and information. • Develop risk communication education materials for property owners, real estate agents, and others. • Consider developing outreach documents with comparisons between flood insurance rates and other utility bills to highlight the relative cost of flood insurance. • Disseminate outreach materials at Homeowners' Association meetings and Riverfest. • Gather information on grant opportunities (for flood mitigation economic development, and environmental protection), and eligibility requirements. Work with FEMA and State partners to develop successful grant applications to fund mitigation projects.
Flood	There are 79 buildings in Zones A, AE, AH, and AO, and 6 buildings in Zone VE. The building dollar loss ratio for a 1-percent-annual-chance flood event totals roughly $1.6M, or a 13.3% loss ratio. Additionally, of the 51 flood claims and 4 repetitive loss properties identified for the total project area, all were within the unincorporated areas of Kenai Peninsula Borough. Numerous homes in Kenai were constructed in high-hazard areas, some of which were built without permits (particularly some of the older homes in the area). Some bridges and other infrastructure could be threatened by severe flooding. Agricultural runoff during flood events could have negative impacts on wildlife.	• Consider limiting additional development in flood hazard zones. • Develop a priority list for essential facility flood capability enhancements. • Develop a buyout program for repetitive loss properties. • Provide outreach to homeowners and business owners regarding flood risk, and the importance of permitting when developing. • Provide outreach materials to community members to communicate flood risks. Consider developing an animation of historic flood events, flood frequencies, and BFE+ scenarios. • Conduct assessments of bridges and identify those most at risk to severe flooding events. Use this to prioritize project and available funding. • Consider natural habitat restoration projects that can reduce agricultural pollutants.

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Earthquake	Unincorporated areas of Kenai Peninsula Borough, in total, would experience loss ratios of 0.15% and 2.91% following the M7.1 event or M9.2 scenario, respectively. Of these areas, Happy Valley would experience the greatest building damage from the M7.1 event, and Primrose would be most affected by the M9.2 scenario. Additionally, 14.7% of the buildings in the unincorporated areas were built with moderate building codes. Primrose has the highest percentage of moderately coded buildings at 40%.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Erosion	**North Zone:** *Nikiski, Salamatof* The erosion rate in Nikiski is 0.8 feet per year, with "hot spot" rates of 4 to 5.7 feet per year. From Nikiski to the Kenai River, the erosion rate is 2.2 feet per year, with "hot spot" rates of 4 to 5.7 feet per year. In the North Zone, there are a total of 105 improved parcels in the erosion zone, of which, 84 are located within the erosion "hot spots". **Central Zone:** *Clam Gulch, Cohoe, Kalifornsky* The erosion rate from the Kenai River to the Kasilof River is 1.6 feet per year, with "hot spot" rates of 2.3 to 4 feet per year. From the Kasilof River to Ninilchik River, the erosion rate is 0.6 feet per year, with "hot spot" rates of 2.3 to 4 feet per year. In the Central Zone, there are a total of 289 improved parcels in the erosion zone, of which, 34 are located within the erosion "hot spots". **South Zone:** *Anchor Point, Diamond Ridge, Happy Valley, Ninilchik* The erosion rate from the Ninilchik River to the Stariski Creek is 0.6 feet per year, from the Stariski Creek to Anchor River the erosion rate is 1 foot per year, and from Anchor Point to Homer the erosion rate is 0.7 feet per year. Throughout all of the South Zone, the "hot spot" erosion rate is between 2.3 and 5.7 feet per year. In the South Zone, there are a total of 181 improved parcels in the erosion zone, of which, 14 are located within the erosion "hot spots".	• Manage development in erosion hazard areas by enforcing erosion control regulations, maintaining zoning districts, and prohibiting development in high-hazard areas. • Promote and regulate site and building design standards including foundation design and building placement. • Stabilize erosion hazard areas with proper bank stabilization techniques, and prevent vegetation removal. • Develop a buyout program for homes in high-risk areas. • Provide education and outreach materials to educate residents of risks.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Homer, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 27 highlights facilities in the City of Homer that are most affected by these hazards.

Table 27: City of Homer Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO (%)	IDENTIFIED HAZARDS
HOMER	BOAT DOCK	PIONEER DOCK	$12,000,000	$1,012,601	8.44%	EARTHQUAKE, FLOOD, TSUNAMI
HOMER	BOAT DOCK	HOMER DEEP WATER DOCK	$4,366,000	$512,981	11.75%	EARTHQUAKE, TSUNAMI
HOMER	CITY OFFICE	HOMER HARBORMASTER	$239,000	$12,850	5.38%	EARTHQUAKE, FLOOD
HOMER	AIRPORT	HOMER AIRPORT	$15,416,800	$905,695	5.87%	EARTHQUAKE
HOMER	SCHOOL	PAUL BANKS ELEMENTARY*	$19,231,600	$1,125,202	5.85%	EARTHQUAKE
HOMER	EMERGENCY SHELTER	LDS CHAPEL - HOMER	$2,481,000	$145,078	5.85%	EARTHQUAKE
HOMER	STATE OFFICE	DEPARTMENT OF MOTOR VEHICLES - HOMER	$2,271,800	$130,447	5.74%	EARTHQUAKE
HOMER	SCHOOL	HOMER MIDDLE SCHOOL*	$36,683,000	$2,038,298	5.56%	EARTHQUAKE
HOMER	POLICE STATION	HOMER POLICE STATION	$2,064,500	$112,256	5.44%	EARTHQUAKE
HOMER	FIRE STATION	HOMER VOLUNTEER FIRE DEPARTMENT*	$2,064,500	$112,256	5.44%	EARTHQUAKE
HOMER	EMERGENCY SHELTER	GLACIERVIEW BAPTIST CHURCH	$1,659,400	$84,571	5.10%	EARTHQUAKE
HOMER	MUSEUM	PRATT MUSEUM	$1,791,400	$90,469	5.05%	EARTHQUAKE
HOMER	FERRY TERMINAL	HOMER FERRY TERMINAL**	$1,500,400	$65,721	4.38%	FLOOD

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO (%)	IDENTIFIED HAZARDS
HOMER	RECREATION	HOMER HOCKEY RINK***	$488,200	$20,598	4.22%	FLOOD

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter
**Identified 1-percent-annual-chance-flood event loss ratio of 25.50%
***Identified 1-percent-annual-chance-flood event loss ratio of 22.75%

Hazard Mitigation Plan and Comprehensive Plan Analysis

The City of Homer All-Hazard Mitigation Plan, updated in 2016, and the 2010 City of Homer Comprehensive Plan identify some of the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 28: City of Homer All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	Land Use Goal 1 Objective C	Develop clear and well-defined land use regulations that address flooding hazards and update the zoning map in support of the desired pattern of growth.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and AOMI section for areas most vulnerable to flooding.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Depth Grid: Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **BFE+ Grid:** Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Hazus Flood Output:** Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	Objective 2.1	Update the Flood Hazard Maps and map the City's watershed and drainage patterns. Obtain updated flood plain maps to include all current city limits, the Bridge Creek Watershed, Beluga Slough and Beluga Lake.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, and NFIP enrollment. Promote new flood hazard data to public through existing local events. Show flood hazard areas, the depth of flooding in select locations, and how development decisions are made based on hazard information.
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	Land Use Goal 1 Objective C	Develop clear and well-defined land use regulations that address earthquake hazards and update the zoning map in support of the desired pattern of growth.	Use Hazus earthquake output and AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Regulate or restrict new construction in locations most affected by earthquake hazards.
Hazus Earthquake Output: Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	All-Hazard Mitigation Plan	Objective 1.1	Reduce the effects of earthquake hazards on existing critical buildings and infrastructure owned by the City of Homer.	Use Hazus earthquake output and AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Prioritize structure retrofits.
Erosion Rate: Spatial data provides erosion rates along Cook Inlet. **Erosion Historic Rate:** Spatial data provides coastline extents in 1952, 1996, and 2004 along Cook Inlet.	Comprehensive Plan	Land Use Goal 1 Objective C	Develop clear and well-defined land use regulations that address erosion hazards and update the zoning map in support of the desired pattern of growth.	Use erosion rate and erosion historical rate dataset to find parcels exposed to greatest erosion along Cook Inlet and review coastline change over time.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Master Output: Spatial and tabular data indicates whether a building is impacted by coastal erosion along Cook Inlet.	Comprehensive Plan	Goal 2 Objective B	Establish development standards and require development practices that protect environmental functions. Develop standards and guidelines to reduce bluff erosion and shoreline erosion.	Use erosion exposure assessment to analyze zones with greatest threat to assets by Borough zone and location.
Tsunami Hazard Area: Spatial data shows maximum tsunami extents in coastal regions of Homer, Seldovia, and Seward.	Comprehensive Plan	Land Use Goal 1 Objective C	Develop clear and well-defined land use regulations that address tsunami hazards and update the zoning map in support of the desired pattern of growth.	Use tsunami hazard area spatial data and tsunami master outputs to prioritize hazard outreach and education distribution, evacuation routes, and development regulations and restrictions.
Master Output: Spatial and tabular data indicates whether a building is within a tsunami hazard area along coastal regions of Homer, Seldovia, and Seward.	All-Hazard Mitigation Plan	Objective 2.1	Maintain evacuation route signs and Tsunami Warning System.	Use tsunami exposure assessment to identify the percentage of affected parcels in tsunami hazard areas. Using the master output, locate at-risk structures and prioritize non-development areas, structure relocation, and educational outreach.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 29: City of Homer Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Homer, 15.5% of residents live with a disability. The City lacks duplicative ingress and egress routes, making the resilience of the roads and bridges into the City extremely important. The local economy is highly dependent upon businesses along the Spit, which is vulnerable to multiple hazards. While mitigation projects have been identified, funding is always a challenge.	• Know where vulnerable populations are located, and assist with personal preparedness, appropriate evacuations, and after-event repairs. • Develop evacuation and response plans that address ingress/egress routes, and practice drills. • Host risk assessment data on local websites, including the KPB parcel viewer, to spread awareness of hazards. • Develop evacuation materials and provide at popular tourist locations. • Develop general and community-specific materials that can be used at public events, permitting offices, etc. to help inform community members about different natural hazards; possible deployment of flood table and/or Immersed! • Develop models for hazards under future conditions. • Coordinate training for city staff to improve knowledge of how to set up shelters during and after hazard events. • Identify funding for infrastructure protection projects; identify and apply for funding specific to burying power lines, and protecting critical infrastructure on the spit (including the fuel farm).
Flood	There are 21 buildings in Zones A, AE, AH, and AO, and 15 buildings in Zone VE. The building dollar loss ratio for a 1-percent-annual-chance flood event totals roughly $2.3M, or an 11.9% loss ratio. The Woodard Creek-Community recently developed a flood management plan for the creek, but there is much work remaining to reduce risk in the area. There have been previous issues with stormwater flooding in the city, which can lead to pollutant discharge into the bay.	• Consider limiting additional development in flood hazard zones. • Develop a priority list for essential facility flood capability enhancements. • Develop a buyout program for repetitive loss properties. • Provide outreach to homeowners and business owners regarding flood risk. • Continue work on the Woodard Creek-Community flood management plan. • Address storm water management issues by developing a risk assessment for storm water, and identifying projects to decrease risk.
Earthquake	The City of Homer would experience loss ratios of 0.27% ($3.3M) and 4.60% ($57M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 18.69% of the buildings were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Erosion	Erosion issues at Anchor Point (the tractor parking lots), Clam Gulch (the roads into the area), and the bluffs at Baycrest Hill and elsewhere; complicated by social norms against government intervention into private property rights.	• Coordinate with Silver Jackets to increase outreach to key stakeholders about erosion risks. • Populate outreach to land owners and real estate agents regarding erosion risks.

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Tsunami	In the City of Homer, 0.63% of improved parcels with an estimated value of almost $19M are within the tsunami zone.	• Adopt and enforce building codes and design standards for tsunami-resistant design. • Limit new development in tsunami run-up areas. • Elevate or relocate critical infrastructure. • Provide education and outreach materials to educate residents of risks and evacuation routes.
Dam Failure	The Bridge Creek Dam, which serves to prevent flooding and ensure the community has a supply of fresh water, requires regular maintenance which can be costly and time consuming.	• Map dam failure inundation areas. • Provide outreach to homeowners and business owners regarding risk. • Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. • Establish early warning capability downstream of listed high-hazard dams.
Landslide	The City of Homer is concerned about the landslide hazards within the currently unmapped floodplain.	• Complete a comprehensive landslide hazard risk assessment for the city • Implement monitoring mechanisms and procedures. • Conduct a geotechnical assessment of the transportation network to locate the highest risk areas and mitigation needs. • Conduct a transportation risk assessment to understand limited access risks.
Water	The city does not have an integrated water resource plan, and there are concerns with long-term water scarcity issues.	• Develop an integrated water resource plan with an analysis of future growth projections.
Wildfire	Increasing prevalence of nearby wildfires, could lead to additional problems with stormwater runoff and pollution into the bay.	• Maintain a community wildfire protection plan as a central repository for wildfire risk and mitigation actions. • Regularly update the Wildland Urban Interface (WUI) in the county to maintain current information on defensible space. • Conduct targeted public outreach to educate homeowners on wildfire risks and preventative measures. • Work cooperatively and sign mutual aid agreements with the incorporated areas, State, and Federal agencies.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Kachemak, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 30 highlights facilities in the City of Kachemak that are most affected by these hazards.

Table 30: City of Kachemak Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
KACHEMAK	RESIDENTIAL	CITYWIDE (46 STRUCTURES)	$5,333,162	$1,012,601	6.01%	EARTHQUAKE
KACHEMAK	COMMERCIAL	CITYWIDE (15 STRUCTURES)	$1,576,932	$89,704	5.69%	EARTHQUAKE

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

Hazard Mitigation Plan and Comprehensive Plan Analysis

The Kachemak HMP, updated in 2015, and the 2009 Kachemak City Comprehensive Plan identify some of the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 31: City of Kachemak Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Depth Grid:** Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	Land Use Plan	Kachemak has historically let landowners and subdivision covenants guide land usage, with no opinion from the city. There is no plan to change this policy at this time.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and AOMI section for areas most vulnerable to flooding. Provide this information to developers and landowners to inform development decisions.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
BFE+ Grid: Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Hazus Flood Output:** Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	HMP	Flood Mitigation Goal 1	Reduce and eliminate flood damage to roads, drainage and utilities by requiring that reconstruction be adequate for the anticipated flood events.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, and NFIP enrollment.
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario. **Hazus Earthquake Output:** Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	Land Use Plan	Kachemak has historically let landowners and subdivision covenants guide land usage, with no opinion from the city. There is no plan to change this policy at this time.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Provide this information to landowners and developers to inform development decisions.
	HMP	Earthquake Mitigation Goal 1	Reduce earthquake damage to structures, facilities, roads, and utilities by requiring that construction practices be adequate for the anticipated earthquake events.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Prioritize structure retrofits, and enforce building code regulations.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 32: City of Kachemak Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Kachemak, 21.9% of residents live with a disability.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations, and after-event repairs.
Earthquake	The City of Kachemak would experience loss ratios of 0.16% ($141K) and 4.30% ($3.7M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 15.13% of the buildings were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Kenai, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 33 highlights facilities in the City of Kenai that are most affected by these hazards.

Table 33: City of Kenai Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
KENAI	WATER TREATMENT FACILITY	KENAI WASTEWATER TREATMENT FACILITY	$14,625,200	$453,829	3.10%	EROSION
KENAI	SCHOOL	KENAI CENTRAL HIGH SCHOOL*	$115,594,200	$4,971,042	4.30%	---
KENAI	SCHOOL	KENAI MIDDLE SCHOOL*	$46,243,200	$1,988,654	4.30%	---
KENAI	CITY OFFICE	KENAI CITY HALL	$3,279,950	$123,822	3.78%	---
KENAI	FIRE STATION	KENAI FIRE DEPARTMENT	$3,279,950	$123,822	3.78%	---
KENAI	CITY OFFICE	KENAI HARBORMASTERS OFFICE	$3,279,950	$123,822	3.78%	---
KENAI	POLICE STATION	KENAI POLICE STATION	$3,279,950	$123,822	3.78%	---
KENAI	EMERGENCY SHELTER	LDS CHAPEL - KENAI	$3,459,400	$129,867	3.75%	---
KENAI	EMERGENCY SHELTER	SEARS ELEMENTARY	$20,886,600	$783,338	3.75%	---
KENAI	FEDERAL OFFICE	ARMY CORPS OF ENGINEERS KENAI FIELD OFFICE	$879,600	$32,401	3.68%	---
KENAI	PARK	BEAVER CREEK PARK	$15,800	$552	3.49%	---
KENAI	SCHOOL	MOUNTAIN VIEW ELEMENTARY*	$27,087,400	$942,826	3.48%	---

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 3.48 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter

Hazard Mitigation Plan and Comprehensive Plan Analysis

The City of Kenai ANNEX to the Kenai Borough Local All-Hazard Mitigation Plan, effective April 2010, and the 2016 City of Kenai Comprehensive Plan draft identify the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 34: City of Kenai All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Depth Grid:** Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	NH-2	Prohibit development in known flood hazard areas except where no feasible or prudent alternative can be identified.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and the AOMI section for areas most vulnerable to flooding. Regulate or restrict development in flood hazard areas.
BFE+ Grid: Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	PF-5	Continue mutual cooperation with the Kenai Peninsula Borough Division of Emergency Management for efficient delivery of public safety services (police, fire, EMS) to residents of the City of Kenai.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website so that it can be accessed by other agencies. Use data to prioritize development standards, code enforcement, NFIP enrollment, and educational outreach.
Hazus Flood Output: Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	A: Flood	Reduce or eliminate property damage and influx of debris into waterways due to floods by raising public awareness, and through zoning changes.	Use flood hazard data and Hazus flood outputs to update zoning maps. Promote new flood hazard data to the public through existing local events. Show flood hazard areas, the depth of flooding in select locations, and how development decisions are made based on hazard information. Provide information about NFIP enrollment.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	Q-12	Update Historic District design standards in the city's land use regulations.	Use Hazus earthquake outputs to identify building and content loss for properties affected by both earthquakes. Prioritize retrofit projects and building code enforcement.
Hazus Earthquake Output: Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event or M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	NH-2	Prohibit development in known earthquake hazard areas except where no feasible or prudent alternative can be identified.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios and regulate or restrict new development.
	Comprehensive Plan	PF-5	Continue mutual cooperation with the Kenai Peninsula Borough Division of Emergency Management for efficient delivery of public safety services (police, fire, EMS) to residents of the City of Kenai.	Host or link earthquake ShakeMap data and Hazus earthquake outputs on local permitting website so the data can be accessed by other agencies. Use data to prioritize development standards, code enforcement, and educational outreach.
	All-Hazard Mitigation Plan	E: Earthquake	Prepare citizens and the built environment to better survive the hazards associated with earthquakes.	Incorporate earthquake ShakeMap spatial data and Hazus earthquake outputs into educational outreach materials.
Erosion Rate: Spatial data provides erosion rates along Cook Inlet. **Erosion Historic Rate:** Spatial data provides coastline extents in 1952, 1996, and 2004 along Cook Inlet.	Comprehensive Plan	NH-2	Prohibit development in known erosion hazard areas except where no feasible or prudent alternative can be identified.	Use erosion exposure assessment to analyze zones with greatest threat to assets by Borough zone and location. Regulate or restrict development is high hazard areas.
Master Output: Spatial and tabular data indicates whether a building is impacted by coastal erosion along Cook Inlet.	Comprehensive Plan	PF-5	Continue mutual cooperation with the Kenai Peninsula Borough Division of Emergency Management for efficient delivery of public safety services (police, fire, EMS) to residents of the City of Kenai.	Host or link erosion rate spatial data, historic erosion rates, and erosion outputs on local permitting website so that the data can be accessed by other agencies. Use data to prioritize development standards, stabilization techniques, code enforcement, and educational outreach.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
	Comprehensive Plan	ER-2	Development Plans should include provisions to avoid or minimize impacts on environmental resources such as the dunes, bluffs, wetlands.	Use erosion rate and erosion historical rate dataset to find parcels exposed to greatest erosion along Cook Inlet, and review coastline change over time. Prioritize stabilization opportunities along dunes and bluffs.
	All-Hazard Mitigation Plan	C: Erosion	Reduce or eliminate the erosion of the bluff at the mouth of the Kenai River.	Use erosion exposure assessment to analyze zones with greatest threat to assets by Borough zone and location. Discuss stabilization techniques and bluff preservation opportunities.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 35: City of Kenai Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Kenai, 15.7% of residents live with a disability.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations and after-event repairs.
Flood	One building is in Zone A, AE, AH, or AO. The building dollar loss ratio for a 1% annual chance flood event totals roughly $31K, or a 9.00% loss ratio.	• Consider limiting additional development in flood hazard zones. • Develop a priority list for essential facility flood capability enhancements. • Develop a buyout program for repetitive loss properties. • Provide outreach to homeowners and business owners regarding flood risk
Earthquake	The City of Kenai would experience loss ratios of 0.16% ($2.4M) and 3.45% ($52.5M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 29.5% of the buildings were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Erosion	**North Zone:** *Kenai River and north* The erosion rate in Nikiski is 0.8 feet per year, with "hot spot" rates of 4 to 5.7 feet per year. From Nikiski to the Kenai River, the erosion rate is 2.2 feet per year, with "hot spot" rates of 4 to 5.7 feet per year. In the North Zone, there are a total of 105 improved parcels in the erosion zone, of which, 84 are located within the erosion "hot spots". **Central Zone:** *Kenai River and south* The erosion rate from the Kenai River to the Kasilof River is 1.6 feet per year, with "hot spot" rates of 2.3 to 4 feet per year. From the Kasilof	• Manage development in erosion hazard areas by enforcing erosion control regulations and zoning districts, and prohibiting development in high-hazard areas. • Promote and regulate site and building design standards including foundation design and building placement. • Stabilize erosion hazard areas with proper bank stabilization techniques, and prevent vegetation removal. • Develop a buyout program for homes in high-risk areas. • Provide education and outreach materials to educate residents of risks.

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
	River to Ninilchik River, the erosion rate is 0.6 feet per year, with "hot spot" rates of 2.3 to 4 feet per year. In the Central Zone, there are a total of 289 improved parcels in the erosion zone, of which, 34 are located within the erosion "hot spots".	

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Seldovia, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models, and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 36 highlights facilities in the City of Seldovia that are most affected by these hazards.

Table 36: City of Seldovia Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
SELDOVIA	BOAT DOCK	SELDOVIA CITY DOCK	$1,048,300	$123,170	11.75%	EARTHQUAKE, TSUNAMI
SELDOVIA	EMERGENCY SHELTER	SELDOVIA BIBLE CHAPEL	$571,400	$33,413	5.85%	EARTHQUAKE, TSUNAMI
SELDOVIA	POST OFFICE	SELDOVIA POST OFFICE	$392,200	$22,520	5.74%	EARTHQUAKE
SELDOVIA	CITY OFFICE	SELDOVIA CITY HALL	$719,000	$36,789	5.12%	EARTHQUAKE
SELDOVIA	SCHOOL	SUSAN B. ENGLISH SCHOOL*	$34,055,800	$1,733,161	5.09%	EARTHQUAKE

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter

Hazard Mitigation Plan and Comprehensive Plan Analysis

The City of Seldovia All-Hazard Mitigation Plan, effective January 2012, and the 2014 City of Seldovia draft Comprehensive Plan identify some of the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 37: City of Seldovia All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Depth Grid:** Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **BFE+ Grid:** Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Hazus Flood Output:** Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	P-4	Actively offer prospective developers and property owners flood hazard handouts, maps, and pre-application meetings to convey how best to work with the community to meet code and improve outcomes.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and the AOMI section for areas most vulnerable to flooding. Host or link new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, and NFIP enrollment. Promote new flood hazard data through existing local events and provide educational outreach materials.
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	P-4	Actively offer prospective developers and property owners earthquake hazard handouts, maps, and pre-application meetings to convey how best to work with the community to meet code and improve outcomes.	Host or link earthquake ShakeMap data and Hazus earthquake outputs on local permitting website so the data can be accessed by other agencies. Use data to prioritize development standards, code enforcement, and educational outreach.
Hazus Earthquake Output: Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event or M9.2 Great Alaska earthquake scenario.	All-Hazard Mitigation Plan	E2	Assess seismic engineering of critical infrastructure-particularly school/shelter and other important city buildings.	Use Hazus earthquake outputs and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios and to prioritize retrofits.
Erosion Rate: Spatial data provides erosion rates along Cook Inlet. **Erosion Historic Rate:** Spatial data provides coastline extents in 1952, 1996, and 2004 along Cook Inlet. **Master Output:** Spatial and tabular data indicates whether a building is impacted by coastal erosion along Cook Inlet.	Comprehensive Plan	P-4	Actively offer prospective developers and property owners erosion hazard handouts, maps, and pre-application meetings to convey how best to work with the community to meet code and improve outcomes.	Host or link erosion rate spatial data, historic erosion rates, and erosion outputs on local permitting website so the data can be accessed by other agencies. Use data to prioritize development standards, stabilization techniques, code enforcement, and educational outreach.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
	All-Hazard Mitigation Plan	W-4	Include a discussion of weather-related [including erosion hazards] emergencies on public outreach/emergency information.	Use spatial and tabular data from erosion rate analysis, and the erosion output to prioritize communities and structures most at risk of erosion hazards following a severe weather or flooding event. Incorporate data into community outreach materials.
Tsunami Hazard Area: Spatial data shows maximum tsunami extents in coastal regions of Homer, Seldovia, and Seward. **Master Output:** Spatial and tabular data indicates whether a building is within a tsunami hazard area along coastal regions of Homer, Seldovia, and Seward.	Comprehensive Plan	P-4	Actively offer prospective developers and property owners tsunami hazard handouts, maps, and pre-application meetings to convey how best to work with the community to meet code and improve outcomes.	Utilize tsunami hazard area spatial data and tsunami master outputs to prioritize hazard outreach and education distribution, evacuation routes, and development regulations and restrictions.
	All-Hazard Mitigation Plan	T1	Revise tsunami inundation mapping for Seldovia, as current maps are not accurate.	Review existing tsunami hazard area and compare to areas of concern. Develop a scope of study that would include areas not captured by existing data.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 38: City of Seldovia Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Seldovia, 25% of residents live with a disability.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations and after-event repairs.
Earthquake	The City of Seldovia would experience loss ratios of 0.34% ($310K) and 5.15% ($4.6M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 39.33% of the buildings were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Tsunami	In the City of Seldovia, 13.79% of improved parcels are within the tsunami zone, with an estimated value of $6.5M.	• Adopt and enforce building codes and design standards for tsunami-resistant design. • Limit new development in tsunami run-up areas. • Elevate or relocate critical infrastructure. • Provide education and outreach materials to educate residents of risks and evacuation routes.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Seward, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 39 highlights facilities in the City of Seward that are most affected by these hazards.

Table 39: City of Seward Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
SEWARD	BOROUGH OFFICE	KPB SEWARD ANNEX	$2,850,000	$101,056	3.55%	DAM FAILURE, TSUNAMI
SEWARD	BOAT DOCK	CRUISE SHIP AND STATE FERRY DOCK	$44,224,000	$1,366,373	3.09%	FLOOD, TSUNAMI
SEWARD	LIBRARY	SEWARD PUBLIC LIBRARY	$1,252,800	$45,954	3.67%	DAM FAILURE
SEWARD	SENIOR CENTER	SEWARD SENIOR CENTER*	$2,529,600	$92,788	3.67%	DAM FAILURE
SEWARD	CITY OFFICE	SEWARD CITY HALL	$1,643,000	$60,267	3.67%	DAM FAILURE
SEWARD	POLICE STATION	SEWARD POLICE STATION/DMV	$1,643,000	$60,267	3.67%	DAM FAILURE
SEWARD	EMERGENCY SHELTER	ST PETERS EPISCOPAL CHURCH	$415,400	$15,095	3.63%	DAM FAILURE
SEWARD	EMERGENCY SHELTER	SACRED HEART CATHOLIC CHURCH	$1,095,200	$39,797	3.63%	DAM FAILURE
SEWARD	FIRE STATION	SEWARD VOLUNTEER FIRE DEPARTMENT*	$808,000	$25,899	3.21%	DAM FAILURE
SEWARD	HOSPITAL	PROVIDENCE SEWARD MEDICAL CENTER	$6,869,800	$188,411	2.74%	DAM FAILURE
SEWARD	CITY OFFICE	SEWARD HARBORMASTER	$321,400	$8,815	2.74%	TSUNAMI

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
SEWARD	POST OFFICE	SEWARD POST OFFICE	$2,590,800	$71,055	2.74%	DAM FAILURE
SEWARD	EMERGENCY SHELTER	MEMORIAL UNITED METHODIST CHURCH	$952,000	$25,832	2.71%	DAM FAILURE

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter

** Identified 1-percent-annual-chance-flood event loss ratio of 10.75%

Hazard Mitigation Plan and Comprehensive Plan Analysis

The City of Seward All-Hazard Mitigation Plan, effective April 2010, and the City of Seward 2020 Comprehensive Plan identify the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 40: City of Seward All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	3.8.1	Promote community safety from natural disasters through mitigation measures and preparedness training.	Incorporate data from new flood hazard area, depth, and BFE+ grid analysis into educational outreach, education materials, and training. Host risk assessment data results on the State Parks parcel viewer.
Depth Grid: Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **BFE+ Grid:** Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	3.8.1.4	Control development on lands subject to risks from floods.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments. Use Hazus Flood Output and the AOMI section for areas most vulnerable to flooding. Host or link new flood hazard data and Hazus flood outputs on local permitting website and the State Parks parcel viewer. Use data to prioritize development standards, code enforcement, and NFIP enrollment.
Hazus Flood Output: Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	Flood Mitigation Measure; Goal 1	Identify flood hazard areas and mitigation measures that will better protect individual and commercial property owners.	Incorporate new flood hazard area, depth, and BFE+ grids for local assessments, zoning maps, and development regulations or restrictions. Use Hazus Flood Output and AOMI to identify areas most vulnerable to flooding.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
	Comprehensive Plan	3.8.1.3	Mitigate flood hazards: source funding to implement the comprehensive flood mitigation plan; maintain dike systems; cooperate with the Bear Creek/Seward Flood Service area. Seek solution and funding to address concerns with the Lowell Creek Diversion Tunnel and Dam complex.	Use new flood hazard area, depth, and BFE+ grid analysis to prioritize mitigation projects, and incorporate Risk Report data into grant applications to various funding sources.
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario. **Hazus Earthquake Output:** Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event or M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	3.8.1	Promote community safety from natural disasters through mitigation measures and preparedness training.	Incorporate data from the earthquake ShakeMap and Hazus earthquake output into community education outreach and training materials. Host risk assessment data results on the State Parks parcel viewer. Present data analysis, outreach materials, and training at local events.
	Comprehensive Plan	3.8.1.4	Control development on lands subject to risks from earthquakes.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Regulate or restrict new construction in locations most affected by earthquake hazards.
	All-Hazard Mitigation Plan	Earthquake Mitigation Measure; Goal 1	Identify hazard areas and select mitigation measures for those areas, including updating building codes, zoning maps, evacuation routes, and retrofitting critical infrastructure.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Regulate or restrict new construction in locations most affected by earthquake hazards. Host or link earthquake spatial data on local permitting sites, like the State Parks parcel viewer, so the data can be accessed by outside agencies, including the Department of Transportation.
Erosion Rate: Spatial data provides erosion rates along Cook Inlet. **Erosion Historic Rate:** Spatial data provides coastline extents in 1952, 1996, and 2004 along Cook Inlet. **Master Output:** Spatial and tabular data indicates whether a building is impacted by coastal erosion along Cook Inlet.	Comprehensive Plan	3.8.1	Promote community safety from natural disasters through mitigation measures and preparedness training.	Incorporate data from erosion rate spatial data, historical erosion rates, and analysis of erosion outputs into community education outreach and training materials. Present data analysis, outreach materials, and training at local events. Host risk assessment data results on the State Parks parcel viewer.
	Comprehensive Plan	3.8.1.4	Control development on lands subject to risks from erosion.	Use erosion rate spatial data, erosion outputs, and the AOMI section to review loss ratios to critical facilities. Regulate or

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
				restrict new construction in locations most affected by erosion hazards.
	All-Hazard Mitigation Plan	Coastal Erosion Mitigation Measure; Goal 1	Reduce the amount of shoreline erosion within allowable practices and monetary constraints.	Use the erosion rate spatial data to prioritize areas of coastal erosion hazards. Incorporate Risk Report data into grant applications to various funding sources.
Tsunami Hazard Area: Spatial data shows maximum tsunami extents in coastal regions of Homer, Seldovia, and Seward. **Master Output:** Spatial and tabular data indicates whether a building is within a tsunami hazard area along coastal regions of Homer, Seldovia, and Seward.	Comprehensive Plan	3.8.1	Promote community safety from natural disasters through mitigation measures and preparedness training.	Incorporate spatial data from the tsunami hazard area and tsunami output assessments into community education and outreach materials. Present data analysis, outreach materials, and training at local events. Host risk assessment data results on the State Parks parcel viewer.
	Comprehensive Plan	3.8.1.4	Control development on lands subject to risks from tsunami.	Use spatial data from the tsunami hazard area and tsunami output assessments to identify areas most impacted by tsunami wave and, where possible, regulate or restrict development.
	All-Hazard Mitigation Plan	Tsunami Mitigation Measure; Goal 2	Protect lives and properties in the event of a tsunami through public education and emergency response exercises.	Use spatial data from the tsunami hazard area and tsunami output assessments to locate landowners within the tsunami hazard zone. Provide educational outreach to community members, highlighting evacuation routes and drills. Host risk assessment data results on the State Parks parcel viewer.
	Comprehensive Plan	3.5.1	Create a thriving port of Seward through harbor improvements, infrastructure expansion, and implementation of management plans.	Use the tsunami output data to identify buildings located within the tsunami hazard zone. Determine total losses within the port and plan future port development accordingly.
The USACE is conducting a Hybrid Risk Assessment of the Lowell Creek Dam. The risk assessment will include: • Potential failure mode analysis • existing condition of project with credible failure modes • risk reduction alternatives The results of the risk assessment will contribute to the completion of a feasibility study which will act as a standalone report (FOUO).	Comprehensive Plan	3.8.1	Promote community safety from natural disasters through mitigation measures and preparedness training.	Use results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam to identify at-risk structures and prioritize non-development areas, structure relocations, and educational outreach in Seward.
	Comprehensive Plan	3.8.1.4	Control development on lands subject to risks from tsunami.	Use results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam to identify areas that would be flooded during a dam failure and enforce building standards that would withstand flooding.

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
				Educate landowners of their risk and provide information about NFIP enrollment. Host risk assessment data results on the State Parks parcel viewer.
	All-Hazard Mitigation Plan	Flood Mitigation Measure; Goal 1	Coordinate and advise the USACE of conditions concerning the Lowell Creek Tunnel Project including renovating the tunnel and developing a new outfall, or tunnel replacement or alternative.	Support efforts to procure funding for ongoing maintenance of dam and diversion structures by using the results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam.
	Comprehensive Plan	3.8.1.3	Seek solution and funding to address concerns with the Lowell Creek Diversion Tunnel and Dam complex.	Support efforts to procure funding for ongoing maintenance of dam and diversion structures by using the results from the USACE Hybrid Risk Assessment of the Lowell Creek Dam.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing the FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 41: City of Seward Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Seward, 16.3% of residents live with a disability. There is a need for internal capacity building in terms of community connectivity and ability to address the needs of vulnerable populations.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations and after-event repairs. • Work with FEMA and partners to develop engagement resources. • Stage emergency evacuation events. • Develop a Community Engagement Plan for the CRS.
Flood	There are 21 buildings in Zones A, AE, AH, and AO, and 4 buildings in Zone VE. The building dollar loss ratio for a 1-percent-annual-chance flood event totals roughly $1.9M, or a 9.66% loss ratio.	• Consider limiting additional development in flood hazard zones. • Develop a priority list for essential facility flood capability enhancements. • Develop a buyout program for repetitive loss properties. • Provide outreach to homeowners and business owners regarding flood risk. • Peruse floodplain management and training for local staff. • Develop CRS outreach and engagement materials and support to help raise awareness about the value of participating in the CRS in terms of saving money and reducing flood risk.
Flood: Gravel and Sediment	Several million cubic yards of silt comes from glacial melting each year, resulting in increased flooding in multiple areas. This issue will only get worse as more silt builds up. Identified floodplains are based on historic flood levels and may not adequately account for changes associated with rising stream floors.	• Develop a Sediment Management Plan. • Identify sources for change direction maps, sediment detection, and the identification of locations where sediment can be deposited. • Reframe sediment removal as more than a maintenance issue. Emphasize that action is necessary because the build-up of sediment exacerbates the intensity of flood events

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
	There is limited developable land in Seward and much of what appears to be appropriate for development is at risk to flooding due to sediment issues and related channel migration.	• Consider beach nourishment projects using removed gravel.
Earthquake	The City of Seward would experience loss ratios of 0.01% ($58K) and 3.04% ($17M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 46.06% of the buildings in Seward were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.
Tsunami	In the City of Seward, 13.14% of improved parcels are within the tsunami zone, with an estimated value of almost $62M.	• Adopt and enforce building codes and design standards for tsunami-resistant design. • Limit new development in tsunami run-up areas. • Elevate or relocate critical infrastructure. • Provide education and outreach materials to educate residents about risks and evacuation routes.
Dam Failure	The USACE is conducting a Hybrid Risk Assessment of the Lowell Creek Dam. The risk assessment will include: • Potential failure mode analysis • existing condition of project with credible failure modes • risk reduction alternatives The tentative schedule of this study is between June 2017 and August 2019.	• Map dam failure inundation areas. • Provide outreach to homeowners and business owners regarding risk. • Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. • Establish early warning capability downstream of listed high-hazard dams.
Levees	Numerous levees (many of which are essentially just gravel banks), constructed at different times in and around the city to protect different areas, are well beyond their original intended useful life and could be at risk to breaching. Multiple levees have eroded during flood events in recent years. Some have been restored, but future breaches of these levees could lead to major damage to schools, residences, and businesses.	• Conduct regular maintenance for drainage systems and flood control structures. • Map levee failure inundation areas. • Provide outreach to residents and businesses in levee failure inundation areas. • Work with landowners, businesses, and levee partners to gather information about levee stability and maintenance.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

Soldotna, City of

Areas of Mitigation Interest and Recommended Resilience Strategies

An assessment of the Kenai Peninsula Borough was completed based on Hazus earthquake and flood risk models, and vulnerability assessments in 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, coastal erosion areas, dam failure areas, and tsunami inundation areas. Table 42 highlights facilities in the City of Soldotna that are most affected by these hazards.

Table 42: City of Soldotna Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M9.2 EARTHQUAKE	M9.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
SOLDOTNA	LIBRARY	SOLDOTNA PUBLIC LIBRARY	$11,297,600	$522,565	4.63%	---
SOLDOTNA	SCHOOL	KPBSD CONNECTIONS PROGRAM	$9,500,000	$439,418	4.63%	---
SOLDOTNA	SCHOOL	SOLDOTNA ELEMENTARY* **	$9,500,000	$439,418	4.63%	---
SOLDOTNA	SCHOOL	SOLDOTNA MONTESSORI SCHOOL**	$9,500,000	$439,418	4.63%	---
SOLDOTNA	RECREATION	SOLDOTNA RODEO GROUNDS	$400,000	$17,356	4.34%	---
SOLDOTNA	STATE FACILITY	DIVISION OF FORESTRY	$1,334,000	$56,058	4.20%	---
SOLDOTNA	RECREATION	SOLDOTNA BALL FIELDS	$600,000	$24,484	4.08%	---
SOLDOTNA	EMERGENCY SHELTER	LDS CHAPEL - SOLDOTNA	$2,980,800	$120,247	4.03%	---

Note: Hazards are considered identified if the following applies

1. Earthquake: Subject has a M9.2 Earthquake Loss Ratio greater than 5 percent
2. Flood: Subject is identified in a 0.2-percent or 1-percent-annual-chance flood hazard area
3. Erosion: Subject is within a parcel along an identified Cook Inlet erosion zone
4. Dam Failure: Subject is within a Lowell Creek Diversion Dam Failure hazard area based on a USACE 2,000cfs failure scenario
5. Tsunami: Subject is within a Homer, Seldovia, or Seward tsunami hazard area

*Facility is also a designated Emergency Shelter

**While Soldotna Elementary and Soldotna Montessori School are one facility, their combined value is split in two within the risk database.

Hazard Mitigation Plan and Comprehensive Plan Analysis

The Soldotna All-Hazard Mitigation Plan, effective in 2010, and the Envision Soldotna 2030 Comprehensive Plan identify the following hazard mitigation projects that can be aided by information in this Risk Report.

Table 43: City of Soldotna All-Hazard Mitigation Plan and Comprehensive Plan Analysis and Risk MAP Support

RISK REPORT DATA	PLAN TYPE	PLAN LINK	PROJECTS	RISK REPORT LINK
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent and 0.2-percent-annual-chance events (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Depth Grid:** Spatial data identifies flood depth for 1-percent-annual chance event (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	Comprehensive Plan	General Land Use Goal 1	Use the Generalized Future Land Use Map to guide land use decisions and infrastructure development.	• Incorporate new flood hazard area, depth, and BFE+ grid assessments, the Hazus Flood Output, and the AOMI section into the Generalized Future Land Use Map and future city planning. Provide this information to developers and landowners to inform development decisions. Develop flood risk data for areas not mapped in FIRMs.
BFE+ Grid: Spatial data identifies 1-foot increases in Base Flood Elevations (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only). **Hazus Flood Output:** Spatial and tabular data provides specific building and content loss data for properties affected by coastal flooding (select areas of Cook Inlet, Kenai River-Cooper Landing, and Seward only).	All-Hazard Mitigation Plan	Goal 1	Reduce the vulnerability of property and infrastructure along the Kenai River to flooding and ice damage. Continue to regulate development within the 100-foot overlay, and investigate NFIP participation benefits.	Host or link to new flood hazard data and Hazus flood outputs on local permitting website. Use data to prioritize development standards, code enforcement, NFIP enrollment, and community outreach.
Earthquake ShakeMap: Spatial data provides shaking intensity and ground motion following an earthquake. Data provided for M7.1 Old Iliamna event and M9.2 Great Alaska earthquake scenario. **Hazus Earthquake Output:** Spatial and tabular data provides specific building and content loss data for properties affected by a M7.1 Old Iliamna event or M9.2 Great Alaska earthquake scenario.	Comprehensive Plan	General Land Use Goal 1	Use the Generalized Future Land Use Map to guide land use decisions and infrastructure development.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Provide this information to landowners and developers to inform development decisions. Prioritize structure and infrastructure retrofits.
	All-Hazard Mitigation Plan	Goal 3	Reduce the city's vulnerability to damage from earthquakes by identifying retrofit measures, and strengthening response capacities.	Use Hazus earthquake output and the AOMI section to review loss ratios to critical facilities for both earthquake scenarios. Prioritize structure retrofits, and enforce building code regulations. Incorporate earthquake risk analysis into community education and outreach materials.

Recommended Resilience Strategies

Based on the assessment above, the following strategies are recommended. Additional strategies can be found by referencing FEMA's *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards* or by clicking here.

Table 44: City of Soldotna Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	Compared to Alaska and the Nation, the Kenai Peninsula Borough has a higher percentage of residents living with a disability. In Soldotna, 11.9% of residents live with a disability.	• Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations and after-event repairs.
Earthquake	The City of Soldotna would experience loss ratios of 0.16% ($2.25M) and 3.53% ($49.5M) following the M7.1 event or M9.2 scenario, respectively. Additionally, 19.53% of the buildings in Soldotna were built with moderate building codes.	• Adopt and enforce updated building code provisions that reduce earthquake risk. • Develop a priority list for essential facility earthquake retrofits. • Develop an outreach program about earthquake risk and mitigation activities for homes, schools, and businesses.

While Federal funding for these projects is limited, FEMA recommends incorporating them into your Natural Hazards Mitigation Plan in case disaster funds become available. Additional funding may be available through your community's capital improvement planning process, bond authority, or other local, State, or private funding source. More information on how to mitigate the effects of natural hazards can be found in FEMA's *Local Mitigation Planning Handbook*:

http://www.fema.gov/media-library/assets/documents/31598?id=7209

Additional information on integrating your HMP with the local planning process can be found here:

http://www.fema.gov/media-library/assets/documents/19261?id=4267

12. Additional Resources

The Economic Benefits of Investing in Water Infrastructure

http://thevalueofwater.org/sites/default/files/Fact%20Sheet_Economic%20Impact%20of%20Investing%20in%20Water%20Infrastructure%20FINAL.pdf

The Value of Water Campaign commissioned a new report, "The Economic Benefits of Investing in Water Infrastructure" to assess how investments in the Nation's water infrastructure can affect economic growth and employment. This fact sheet outlines the key findings of the study, and the full report can be found at www.thevalueofwater.org/resources.

Imagine a Day Without Water

https://www.linkedin.com/pulse/imagine-day-without-water-hal-shepherd/

An article, published on October 11, 2017, that discusses the importance of investing in water infrastructure, and making it a top priority of decision makers.

Four Ways Water Utilities Can Weather a Hurricane

http://efc.web.unc.edu/2017/09/18/four-ways-water-utilities-might-weather-hurricane/?+Blog&utm_term=0_a946d249ba-fb01cc5994-212733337

A blog post, published on September 18, 2017, that provides four ways water and wastewater utilities can be more resilient during a natural disaster.

US Water Alliance: Water Equality Clearinghouse

http://uswateralliance.org/wec

An online database showcasing the promising practices that are being developed around the country to make our water systems more equitable and inclusive.

13. Appendix

Earthquake Hazus Analysis

For this analysis, the Hazus Advanced Engineering Building Module (AEBM) was applied. The underlying approach to the AEBM procedure is a combination of the nonlinear static (pushover) analysis method of the National Earthquake Hazards Reduction Program (NEHRP) Guidelines and other sources, (namely the ATC 40 document: Seismic Evaluation and Retrofit of Concrete Buildings, CSSC, 1996) with Hazus loss estimation methods. Seismic/structural engineers, having performed detailed pushover analysis of a specific building, are expected to have a much better understanding of the building's potential failure modes, overall response characteristics, structural and nonstructural system performance, and the cost required to repair damaged components.

The software architecture of the AEBM has two main components (or databases), AEBM Inventory and AEBM Profiles. AEBM Inventory is structured to accept a "portfolio" of individual buildings, each uniquely defined by latitude/longitude location, number of occupants, size, replacement cost, and other building-specific financial data. The AEBM Profiles describe an extensive set of building performance characteristics, including damage and loss function parameters. To run the AEBM, each building in the AEBM Inventory must be linked to one of the AEBM Profiles, but an AEBM Profile can be used for more than one building of the AEBM Inventory. Applications of the AEBM include evaluating individual buildings or a group of buildings of a similar type.

Earthquake Analysis Omissions

If no improvement values are available in the provided assessor's database, earthquake risk assessments may be omitted. The following table lists the Kenai Peninsula Borough facilities that were not captured in the earthquake risk assessments:

PARCEL ID	CATEGORY	NAME
		PROPOSED CES STATION
14502401	AIRPORT	SEWARD AIRPORT
11912411	AIRSTRIP	COOPER LANDING AIRSTRIP
17940001	AIRSTRIP	HOMER-BELUGA LAKE SEAPLANE BASE
03503028	AIRSTRIP	HOPE AIRSTRIP
19101061	AIRSTRIP	JAKOLOF BAY AIRSTRIP
13308106	AIRSTRIP	KASILOF AIRSTRIP
12513026	AIRSTRIP	LAWING AIRSTRIP
18519052	AIRSTRIP	NINILCHIK AIRSTRIP
06388089	AIRSTRIP	SCOOTERS LANDING AIRSTRIP
06034018	AIRSTRIP	SOLDOTNA AIRSTRIP
02513001	AIRSTRIP	SOUTH GASLINE AIRSTRIP
06304341	AIRSTRIP	STERLING AIR PARK AIR STRIP
04945002	BOAT DOCK	CITY OF KENAI DOCK
19109121	BOAT DOCK	JAKOLOF BAY BOAT DOCK
18103214	BOAT HARBOR	HOMER SMALL BOAT HARBOR
00000000	BOAT HARBOR	SELDOVIA SMALL BOAT HARBOR

PARCEL ID	CATEGORY	NAME
00000000	BOAT HARBOR	SEWARD SMALL BOAT HARBOR
00000000	BOAT LAUNCH	BARBARA LAKE BOAT LAUNCH
01418027	BOAT LAUNCH	BERNICE LAKE BOAT LAUNCH
13526401	BOAT LAUNCH	BOAT LAUNCH
00000000	BOAT LAUNCH	CABIN LAKE BOAT LAUNCH
06001126	BOAT LAUNCH	CENTENNIAL PARK BOAT LAUNCH
18103216	BOAT LAUNCH	CITY OF HOMER BOAT LAUNCH
04945002	BOAT LAUNCH	CITY OF KENAI BOAT LAUNCH
	BOAT LAUNCH	CITY OF SELDOVIA BOAT LAUNCH
00000000	BOAT LAUNCH	CITY OF SEWARD BOAT LAUNCH
13307225	BOAT LAUNCH	COHOE COVE BOAT LAUNCH
11909017	BOAT LAUNCH	COOPER LANDING STATE REC SITE BOAT LAUNCH
00000000	BOAT LAUNCH	DOTS KENAI RIVER CAMP BOAT LAUNCH
00000000	BOAT LAUNCH	DOUGLAS LAKE BOAT LAUNCH
04906007	BOAT LAUNCH	EAGLE ROCK BOAT LAUNCH
13506007	BOAT LAUNCH	HIDDEN LAKE BOAT LAUNCH
02518002	BOAT LAUNCH	JIM'S LANDING
04910106	BOAT LAUNCH	KENAI LANDING BOAT LAUNCH
00000000	BOAT LAUNCH	LONGMERE LAKE BOAT LAUNCH
13502002	BOAT LAUNCH	LOWER SKILAK LAKE BOAT LAUNCH
00000000	BOAT LAUNCH	POACHERS COVE BOAT LAUNCH
00000000	BOAT LAUNCH	PORTERS BOAT LAUNCH
12533002	BOAT LAUNCH	PRIMROSE BOAT LAUNCH
00000000	BOAT LAUNCH	RIVERSIDE BOAT LAUNCH
00000000	BOAT LAUNCH	SEWARD EAST SIDE BOAT LAUNCH
	BOAT LAUNCH	SMILING ROCK BOAT LAUNCH
02519004	BOAT LAUNCH	STORMY LAKE BOAT LAUNCH
06033010	BOAT LAUNCH	SWIFTWATER BOAT LAUNCH
00000000	BOAT LAUNCH	THETIS LAKE BOAT LAUNCH
13510002	BOAT LAUNCH	TUSTUMENA LAKE BOAT LAUNCH
13506007	BOAT LAUNCH	UPPER SKILAK LAKE BOAT LAUNCH
	BRIDGE	WARREN AMES BRIDGE
01418027	CAMPGROUND	BERNICE LAKE CAMPGROUND
06001126	CAMPGROUND	CENTENNIAL PARK CAMPGROUND
02508101	CAMPGROUND	DISCOVERY CAMPGROUND
02511002	CAMPGROUND	DOLLY VARDEN LAKE CAMPGROUND
02518002	CAMPGROUND	ENGINEER LAKE CAMPGROUND
02512001	CAMPGROUND	FISH LAKE CAMPGROUND
13506007	CAMPGROUND	HIDDEN LAKE CAMPGROUND
02518002	CAMPGROUND	JEAN LAKE CAMPGROUND
02518002	CAMPGROUND	KELLY LAKE CAMPGROUND
02510002	CAMPGROUND	KING LAKE CAMPGROUND

PARCEL ID	CATEGORY	NAME
13506007	CAMPGROUND	LOWER OHMER CAMPGROUND
13502002	CAMPGROUND	LOWER SKILAK LAKE CAMPGROUND
02518002	CAMPGROUND	PETERSEN LAKE CAMPGROUND
02511002	CAMPGROUND	RAINBOW LAKE CAMPGROUND
00000000	CAMPGROUND	RESURRECTION CAMPING AREA
11901026	CAMPGROUND	RUSSIAN RIVER CAMPGROUND
02508005	CAMPGROUND	SWANSON RIVER CAMPGROUND
06033016	CAMPGROUND	SWIFTWATER CAMPGROUND
03525005	CAMPGROUND	TENDERFOOT CAMPGROUND
13506007	CAMPGROUND	UPPER SKILAK LAKE CAMPGROUND
02517001	CAMPGROUND	WATSON LAKE CAMPGROUND
14920015	COLLEGE	UNIVERSITY OF ALASKA INSTITUTE OF MARINE SCIENCE
	EMERGENCY RESOURCE	FIREFIGHTING WATER RESOURCE
03512112	EMERGENCY RESOURCE	FIREFIGHTING WATER RESOURCE
03503028	EMERGENCY RESOURCE	FOREST SERVICE FIRE CACHE
14514107	EMERGENCY SHELTER	SEWARD CHAPEL
14502604	EMERGENCY SHELTER	SEWARD MILITARY RESORT
20129031	FIRE STATION	BELUGA FIRE STATION
13312202	FIRE STATION	CENTRAL EMERGENCY SERVICES STATION 6 (KASILOF)
16564044	FIRE STATION	FUTURE NIKOLAEVSK FIRE STATION
16905071	LANDFILL/TRANSFER FACILITY	ANCHOR POINT TRANSFER SITE
11912419	LANDFILL/TRANSFER FACILITY	COOPER LANDING TRANSFER SITE
12532412	LANDFILL/TRANSFER FACILITY	CROWN POINT TRANSFER SITE
06601021	LANDFILL/TRANSFER FACILITY	FUNNY RIVER TRANSFER SITE
03529021	LANDFILL/TRANSFER FACILITY	HOPE TRANSFER SITE
13312203	LANDFILL/TRANSFER FACILITY	KASILOF TRANSFER SITE
17231114	LANDFILL/TRANSFER FACILITY	MCNEIL CANYON TRANSFER SITE
15901089	LANDFILL/TRANSFER FACILITY	NINILCHIK TRANSFER SITE
19113030	LANDFILL/TRANSFER FACILITY	ROCKY RIDGE LANDFILL
14920012	LEARNING CENTER	ALASKA SEALIFE CENTER
01401004	OIL AND GAS	AGRIUM-KENAI NITROGEN OPERATIONS
01401002	OIL AND GAS	CONOCOPHILLIPS COMPANY
04327036	PARK	KENAI CITY PARK AND BALLFIELDS
06024032	PARK	SOLDOTNA CREEK PARK
04331016	POST OFFICE	KENAI POST OFFICE
01209002	POST OFFICE	NIKISKI POST OFFICE
14532008	PRISON	SPRING CREEK CORRECTIONAL FACILITY
04938216	RECREATION	KENAI GOLF COURSE
04337002	RECREATION	KENAI RECREATION CENTER
13104361	RECREATION	TSALTESHI TRAILS
04103035	RECREATION	TWIN CITIES RACEWAY
16562006	RECREATION	WHISKEY GULCH BEACH ACCESS SITE

PARCEL ID	CATEGORY	NAME
19112215	RESERVOIR	CITY OF SELDOVIA RESERVOIR
11901101	STATE FACILITY	POWER HOUSE
14502611	VISITOR CENTER	SEWARD CHAMBER OF COMMERCE AND VISITOR CENTER

Duplicate Essential Facilities

Some essential facilities, if they were also categorized as emergency shelters, were duplicated in the facility dataset. For parcels with more than one facility (one being an emergency shelter), the emergency shelter was removed:

PARCEL ID	CATEGORY	NAME
01202017	EMERGENCY SHELTER	NIKISKI MIDDLE/HIGH SCHOOL
01217006	EMERGENCY SHELTER	NIKISKI SENIOR CENTER
01524050	EMERGENCY SHELTER	NORTH STAR ELEMENTARY SCHOOL
04521061	EMERGENCY SHELTER	MOUNTAIN VIEW ELEMENTARY
04501008	EMERGENCY SHELTER	KENAI CENTRAL HIGH SCHOOL
04501009	EMERGENCY SHELTER	KENAI MIDDLE SCHOOL
04705510	EMERGENCY SHELTER	KENAI SENIOR CENTER
03531031	EMERGENCY SHELTER	HOPE SCHOOL
06306303	EMERGENCY SHELTER	STERLING SENIOR CENTER
05930101	EMERGENCY SHELTER	SOLDOTNA HIGH SCHOOL
05913021	EMERGENCY SHELTER	SOLDOTNA ELEMENTARY
05930202	EMERGENCY SHELTER	REDOUBT ELEMENTARY
05929067	EMERGENCY SHELTER	SOLDOTNA SENIOR CENTER
06001308	EMERGENCY SHELTER	KENAI PENINSULA COLLEGE
06001301	EMERGENCY SHELTER	K-BEACH ELEMENTARY
12521054	EMERGENCY SHELTER	MOOSE PASS ELEMENTARY
06001103	EMERGENCY SHELTER	SOLDOTNA SPORTS CENTER
13104525	EMERGENCY SHELTER	SKYVIEW HIGH SCHOOL
13312102	EMERGENCY SHELTER	TUSTUMENA ELEMENTARY
14401102	EMERGENCY SHELTER	BEAR CREEK VOLUNTEER FIRE AND EMS
14502621	EMERGENCY SHELTER	SEWARD ELEMENTARY
14909019	EMERGENCY SHELTER	SEWARD SENIOR CENTER
14912006	EMERGENCY SHELTER	SEWARD VOLUNTEER FIRE DEPARTMENT
15715028	EMERGENCY SHELTER	NINILCHIK SCHOOL
15718055	EMERGENCY SHELTER	NINILCHIK SENIOR CENTER
15905040	EMERGENCY SHELTER	NINILCHIK FAIR GROUNDS
15710023	EMERGENCY SHELTER	NINILCHIK VOLUNTEER FIRE DEPARTMENT
16565063	EMERGENCY SHELTER	NIKOLAEVSK SCHOOL
16517025	EMERGENCY SHELTER	ANCHOR POINT VOLUNTEER FIRE DEPT AND RESCUE
16905004	EMERGENCY SHELTER	CHAPMAN SCHOOL
17231166	EMERGENCY SHELTER	MCNEIL CANYON ELEMENTARY
17903018	EMERGENCY SHELTER	PAUL BANKS ELEMENTARY

PARCEL ID	CATEGORY	NAME
17702074	EMERGENCY SHELTER	HOMER HIGH SCHOOL
17702057	EMERGENCY SHELTER	HOMER VOLUNTEER FIRE DEPARTMENT
17732038	EMERGENCY SHELTER	HOMER SENIOR CENTER
17510069	EMERGENCY SHELTER	HOMER MIDDLE SCHOOL
17510211	EMERGENCY SHELTER	WEST HOMER ELEMENTARY
19213015	EMERGENCY SHELTER	SUSAN B. ENGLISH SCHOOL
19119022	EMERGENCY SHELTER	NANWALEK SCHOOL
06368022	EMERGENCY SHELTER	STERLING ELEMENTARY
11910003	EMERGENCY SHELTER	COOPER LANDING ELEMENTARY
19102003	EMERGENCY SHELTER	PORT GRAHAM SCHOOL
14502134	EMERGENCY SHELTER	SEWARD MIDDLE SCHOOL
21115152	EMERGENCY SHELTER	TEBUGHNA SCHOOL

For a full list of Kenai Peninsula Borough facilities, please visit http://www.kpb.us/gis-dept/kpb-data-downloads/administrative