SNOW COVERED MOUNTAINS, ANCHORAGE, AK

Risk Report: A Risk Assessment Database Summary

FEMA Region X – Municipality of Anchorage, Alaska

For the unincorporated areas within the Municipality of Anchorage, the communities of Anchorage, Chugiak, Eagle River, Girdwood, and Indian; the Alaska Bureau of Land Management; Chugach State Park; Chugach National Forest; Elmendorf Air Force Base; and Fort Richardson Military Reservation.

FEMA

DEPARTMENT OF COMMERCE, COMMUNITY AND ECONOMIC DEVELOPMENT

ALASKA GEOLOGICAL AND GEOPHYSICAL SURVEYS

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Executive Summary

Due to its variety of natural hazards, its at-risk population, and recent events, the Municipality of Anchorage has been identified as a priority community by the State of Alaska to receive specialized risk data and other information to help community leaders and decision makers increase their resiliency. The Federal Emergency Management Agency (FEMA) partnered with the Municipality of Anchorage and the State of Alaska to deploy a Risk Mapping, Assessment, and Planning (Risk MAP) project with the goal of accurately and comprehensively depicting the risk in the community.

This **Risk Report** outlines the results from the natural hazard risk and exposure assessments captured in the **Risk Assessment Database.** The report includes information on best practices to integrate natural hazard mitigation into local planning and highlights potential mitigation actions throughout the municipality. The data summarized in the report may be used to support day-to-day decision making and longer-term planning efforts, such as updates to comprehensive plans and other regulatory tools that inform land use decisions. The report has been created in concert with the **Anchorage Story Map** and the **Risk Assessment Database.** Together, these materials have the following aims:

- provide additional data to communities on local hazards;
- connect and integrate this data to pre-existing community planning mechanisms; and
- provide risk and vulnerability assessment results.

More specifically the **Risk Assessment Database** aggregates the natural hazard data developed by various local, State, and partner organizations and quantifies the risks from those natural hazards using community assessor data to determine local risk. The **Anchorage Story Map** showcases the results of a data collaboration between FEMA, the State of Alaska, and the Municipality of Anchorage.

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1. Introduction

This **Risk Report** outlines the risk assessment results and findings for FEMA's Risk MAP program study of King County, Washington. All results, databases, and maps used to generate this **Risk Report** are provided in the **Risk Assessment Database** included with this report. This risk assessment information can support the following local efforts:

- Updating local All Hazards Mitigation Plans (AHMPs) and community comprehensive plans;
- Updating emergency operations and response plans;
- Increasing and improving risk communication;
- Informing the modification of development standards; and
- Identifying mitigation projects.

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

- Elected officials;
- Tribal leaders;
- Floodplain administrators, engineers, community developers, planners, emergency managers, first responders, and Geographic Information System (GIS) technicians;
- Federal, State, regional, academic, and non-profit organizations interested in hazards or land use; and
- Other stakeholders.

2. Risk Assessment and Exposure Assessment

A **risk assessment** analyzes, in detail, how flooding and earthquake hazards affect the built environment, population, and local economy, and their likelihood of occurrence. In hazard mitigation planning, risk assessments are the basis for identifying resilience strategies and actions; they define the hazard and enhance the decision-making process. The earthquake risk assessment prepared for the Municipality of Anchorage was prepared using a free FEMA risk assessment tool, Hazus, which estimates losses due to earthquakes for specific buildings. The appendix provides detailed information on the risk assessment methodology.

An **exposure assessment** identifies areas that would be affected by a hazard. This provides an opportunity for State and local officials to prioritize mitigation actions in these areas. For the purposes of exposure assessments, 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 Risk Report as "improved parcels." Additionally, total values and economic losses consider the replacement value of the building and its contents.

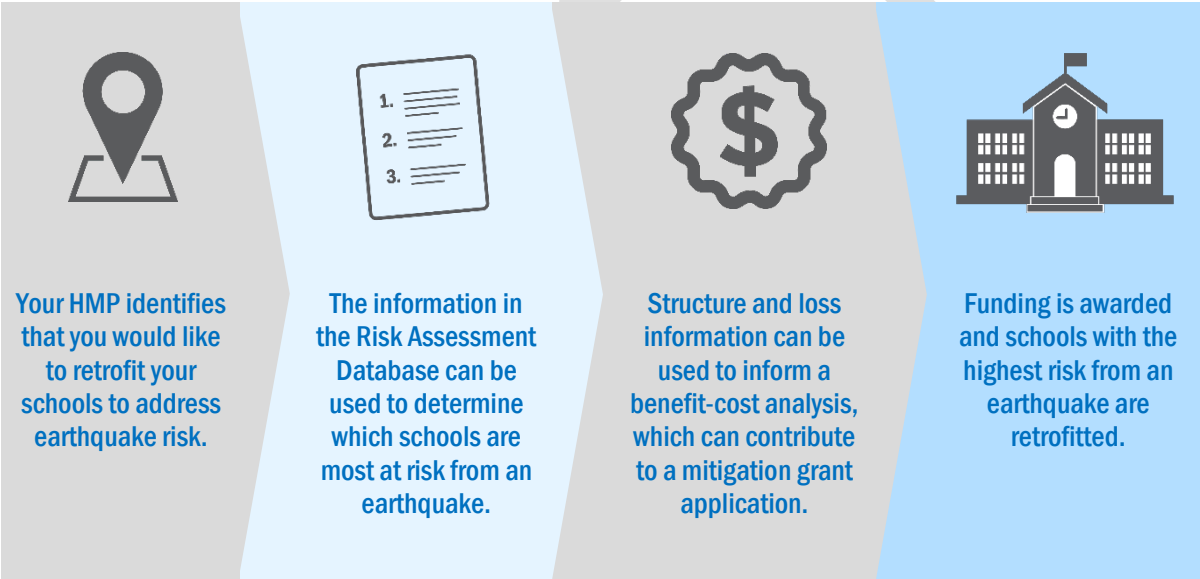
Exposure assessments were conducted for the following hazards at the jurisdictional levels:

- Flood Exposure Assessment

- Avalanche Exposure Assessment
- Dam Failure Exposure Assessment
- Landslide Exposure Assessment
- Wind Exposure Assessment
- Wildfire Exposure Assessment

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 the risk to those natural hazards using community assessor data, this dataset can determine local risk to hazards for each structure in a 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



3. Municipality of Anchorage Risk MAP Overview

FEMA and the State of Alaska have funded a Risk MAP Project to assess the risk posed by a variety of natural hazards. The FEMA Production and Technical Services provider (Strategic Alliance for Risk Reduction II, or STARR II); the FEMA Community Engagement and Risk Communication provider, *Resilience Action Partners*; and the Alaska Department of Community and Regional Affairs are contributors to this project. The projects summarized below were scoped for this risk assessment.

Seismic Hazus Run and Analysis

FEMA, the Municipality of Anchorage, and the Alaska Division of Geological and Geophysical Survey (DGGS) have worked together to complete the Hazus risk assessment for the three earthquake scenarios listed below.

- M7.5 Castle Mountain Scenario
- M7.2 Intraplate Scenario
- M7.1 Border Ranges Scenario

Avalanche, Dam Failure, Flood, Landslide, Wildfire, Wind Vulnerability Exposure Assessment

FEMA has completed an exposure assessment using Municipality of Anchorage, State, and Federal data and will recommend mitigation strategies based on the results. FEMA has identified vulnerable infrastructure and essential facilities based on results from the GIS-based assessment. FEMA has developed Areas of Mitigation Interest (AOMIs) in coordination with the Municipality of Anchorage.

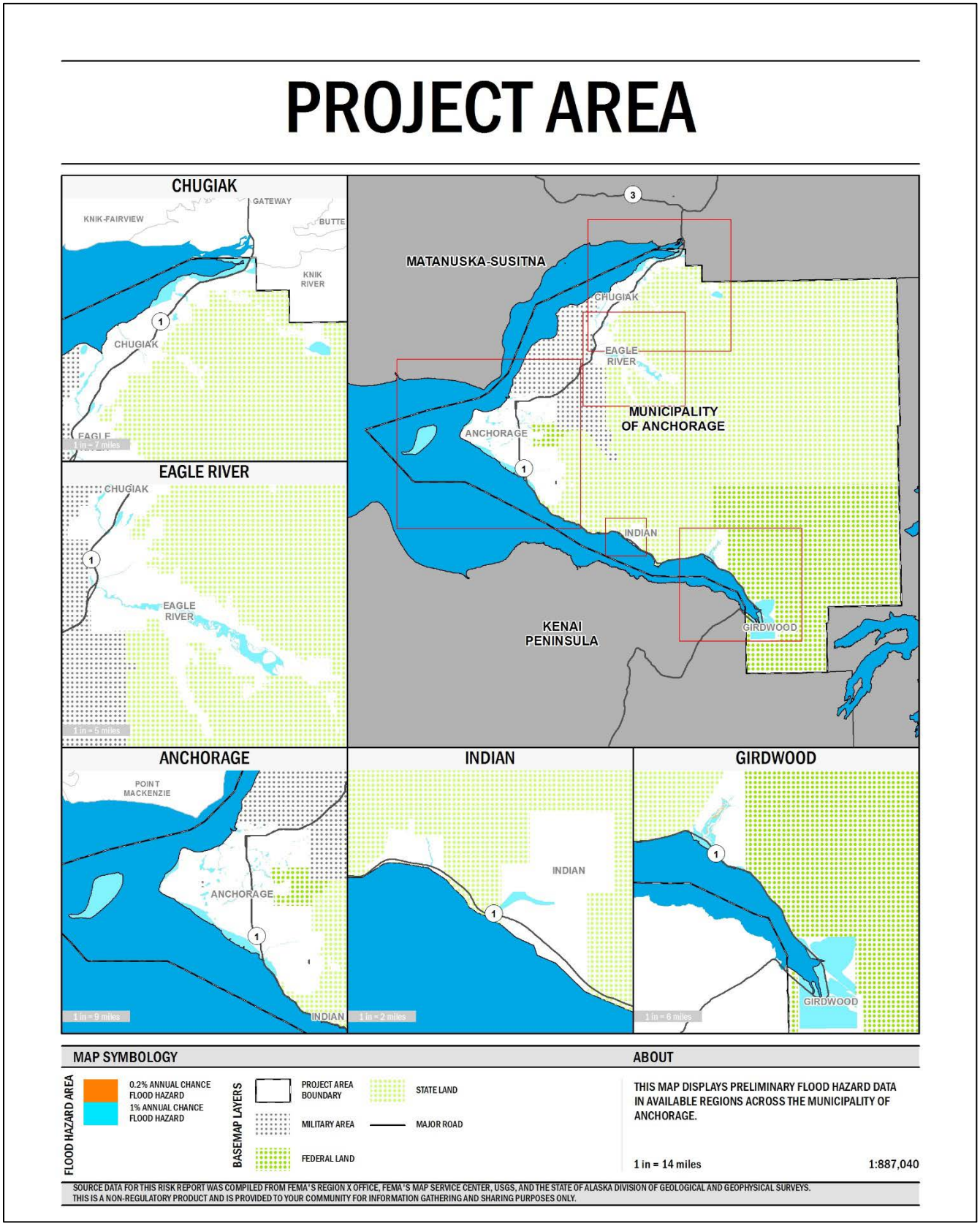
Project Milestones

Table 1: Project Milestones and Deliverables

March 2, 2011	Risk MAP Discovery Meeting
July 23-26, 2012	Flood Study Kickoff Meeting
August 27-28, 2013	Flood Risk Review Meeting/Draft Maps
June 13, 2014	Preliminary DFIRM/Flood Insurance Study (FIS Release
September 9-11, 2014	Consultation Coordination Officers Meeting
September 9-11, 2014	Public Meeting/Workshop
1st Start: January 28, 2015 2nd Start: August 12, 2015	Appeal Period Starts
1st End: April 28, 2015 2nd End: November 10, 2015	Appeal Period Ends
April 20, 2016	Letter of Final Determination
October 6, 2016	Draft Multi-Hazard Risk Report
October 20, 2016	Maps and FIS become Effective
Spring 2019*	Resilience Meeting will be scheduled to identify and review resilience strategies and steps toward implementation

*Dates are shown as projected

Map 1: Overview of the Municipality of Anchorage



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 homes and properties.

An understanding of the population of the Municipality of Anchorage, relative to State and national populations, and how that population is changing over time is necessary to effectively improve existing communication programs that target individuals at risk from the natural hazards that affect the area. Demographic data, which are analyzed below, were obtained from the U.S. Census Bureau and are searchable through the American Fact Finder advanced search. Data from 2000 and 2010 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. While most data are available for the years listed above, some socioeconomic statistic data was limited and not included in every discussion.

Vulnerable Population Groups

People over the age of 65 or under the age of 18 are classified as vulnerable age groups. These individuals may depend 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 Municipality of Anchorage, 25.4 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 8.1 percent of the Municipality population, compared to 8.5 percent in Alaska, and 13.7 percent nationwide. Between 2000 and 2014, 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 with regard to hazard presentation, preparation, mitigation, and repairs. The percentage of residents living with a disability in the Municipality of Anchorage was below both the State and national percentages (Figure 2) and decreased between 2010 and 2014.

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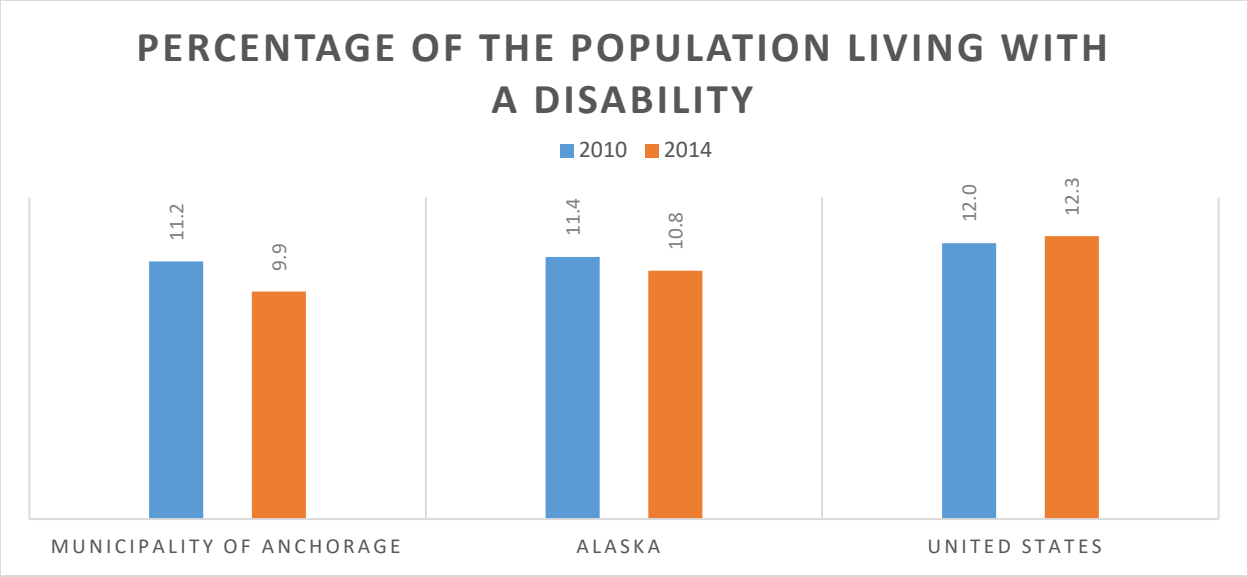

Figure 2: Percentage of the Population Living with a Disability

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 Municipality of Anchorage, the majority of the population speaks English. When compared to the total population of the United States, both the Municipality of Anchorage and Alaska have fewer Spanish speakers than the United States; however, the percentage of Spanish speakers in Anchorage is higher than the percentage of Spanish speakers statewide. In the Municipality, the largest percentage of non-English-speaking residents speak Asian and Pacific languages at home, which can be attributed to the larger populations of Filipino, Korean, and Hmong residents. While the majority of residents living in the Municipality of Anchorage speak English, the percentage of Asian and Pacific language-speaking residents is higher than both the State and national averages.

Communicating risk to communities may present some language barriers. Ideally, all jurisdictions should approach community engagement and risk communication with cultural competency to ensure that outreach and education efforts reach all communities equitably.

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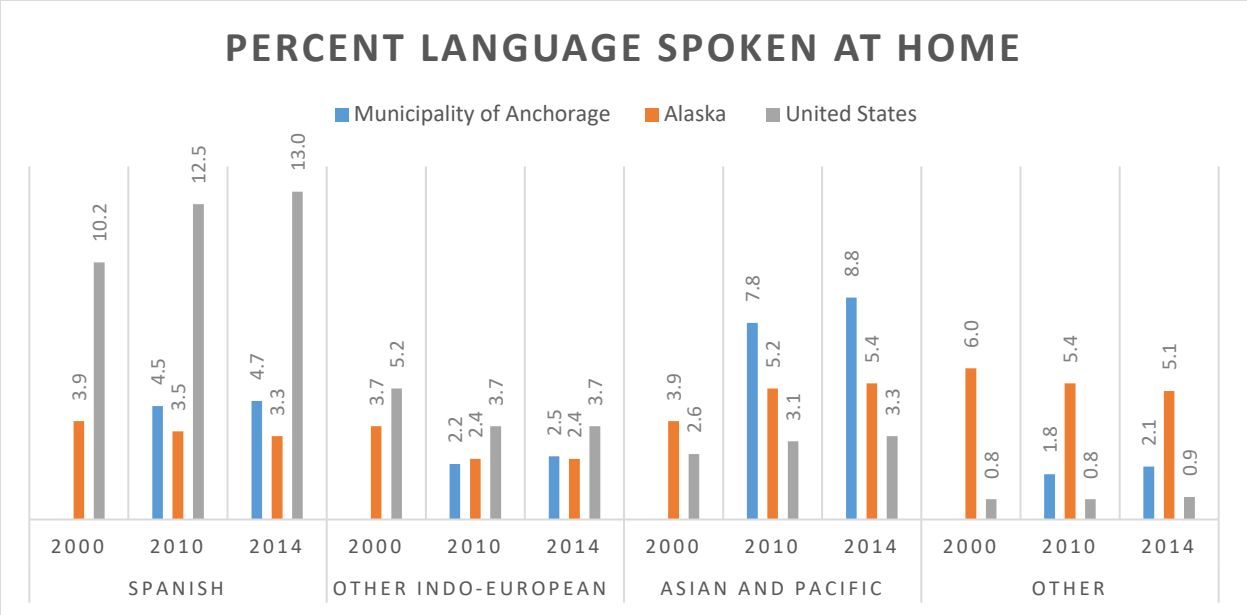

Figure 3: Percentage of Non-English Languages Spoken

Economic Vulnerability

Knowing the economic characteristics of a community can assist in the analysis of 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 from 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, the Municipality of Anchorage median household income was approximately $24,500 higher than the median household income nationwide (Figure 4), and the poverty rate for the Municipality was over 7 percent lower than the national rate (Figure 5).

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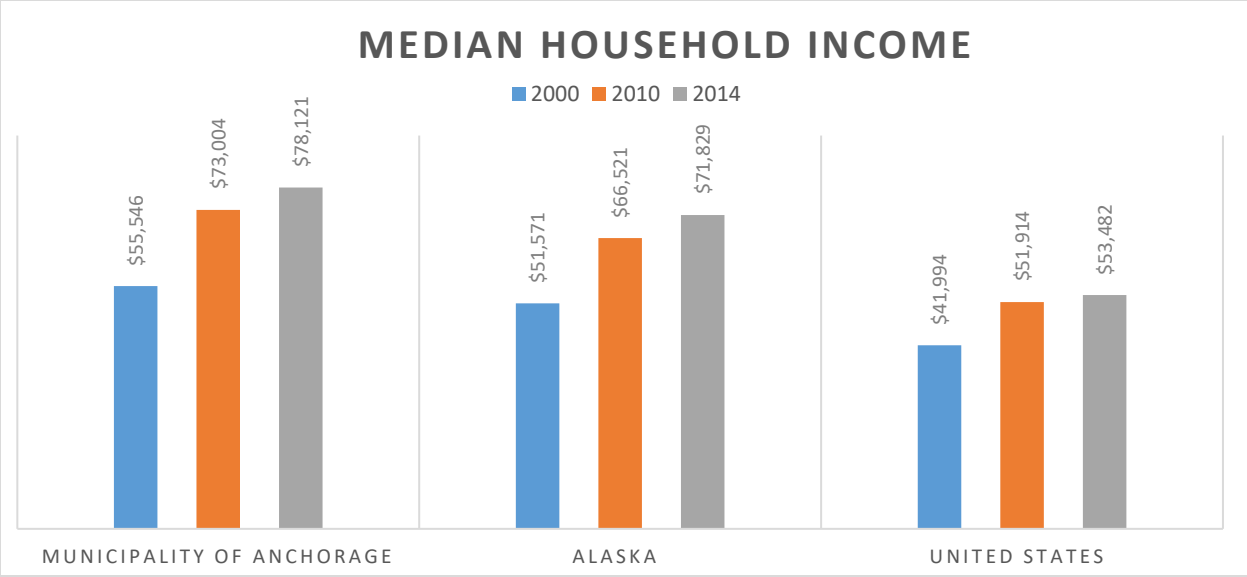

Figure 4: Median Household Income between 2000 and 2014 (in 2014 Dollars)

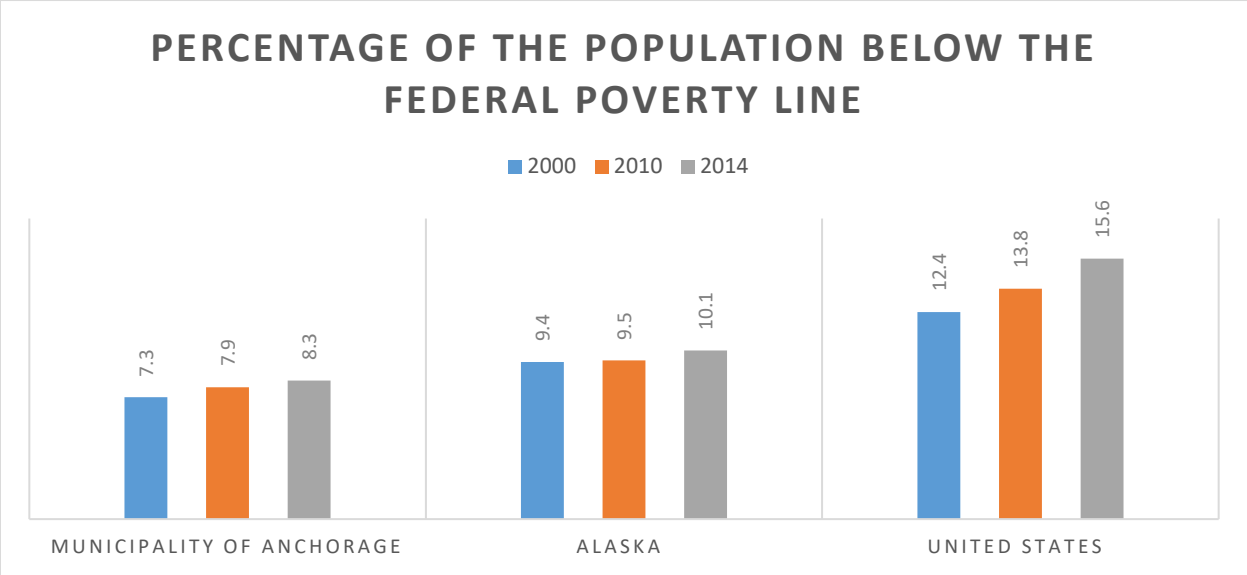

Figure 5: Percentage of Population Living below the Federal Poverty Line between 2000 and 2014

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 Municipality of Anchorage consistently had a higher percentage of individuals who had obtained a high school degree and a bachelor's degree when compared to both Alaska and the United States (Figure 6). Additionally, the percentage of educational attainment steadily increased between 2000 and 2014 within the Municipality of Anchorage.

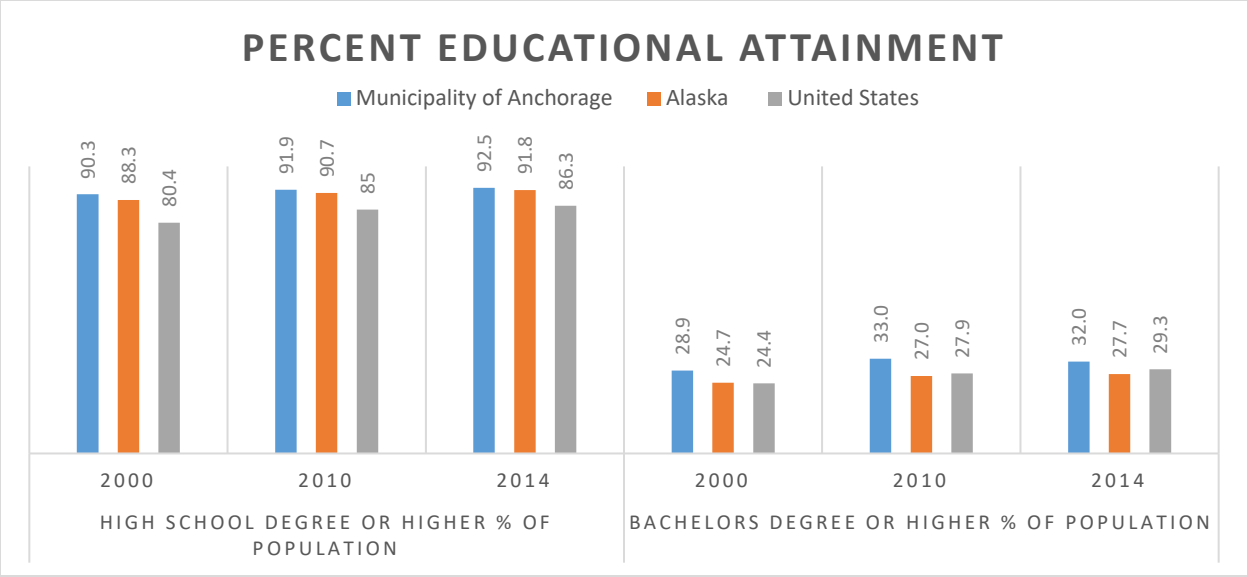

Figure 6: Percentage of Population with High School Degree or Higher Between 2000 and 2014

With the majority 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, only 59.8 percent of Municipality of Anchorage residents owned their home, while 40.2 percent were renters. Of the renters, 36.2 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 rate in the Municipality of Anchorage was almost 8 percent higher than the national employment rate. Additionally, the unemployment rate for the Municipality of Anchorage was 6.9 percent in 2014, lower than statewide rate of 8.4 percent and the nationwide rate of 9.2 percent.

Communities with more economic growth are able to invest in new development and retrofitting projects to increase the resilience of their buildings and infrastructure. In 2014, the Municipality of Anchorage reported that a higher percentage of its buildings had been built after 1960. Additionally, when compared with Alaska and the Nation, the Kenai Peninsula Borough had the lowest percentage of buildings built between 1940 and 1959, and the lowest percentage of buildings built before 1940 (Figure 7). The economic growth in the Municipality of Anchorage has resulted in building stock that may be more resilient to natural hazards.

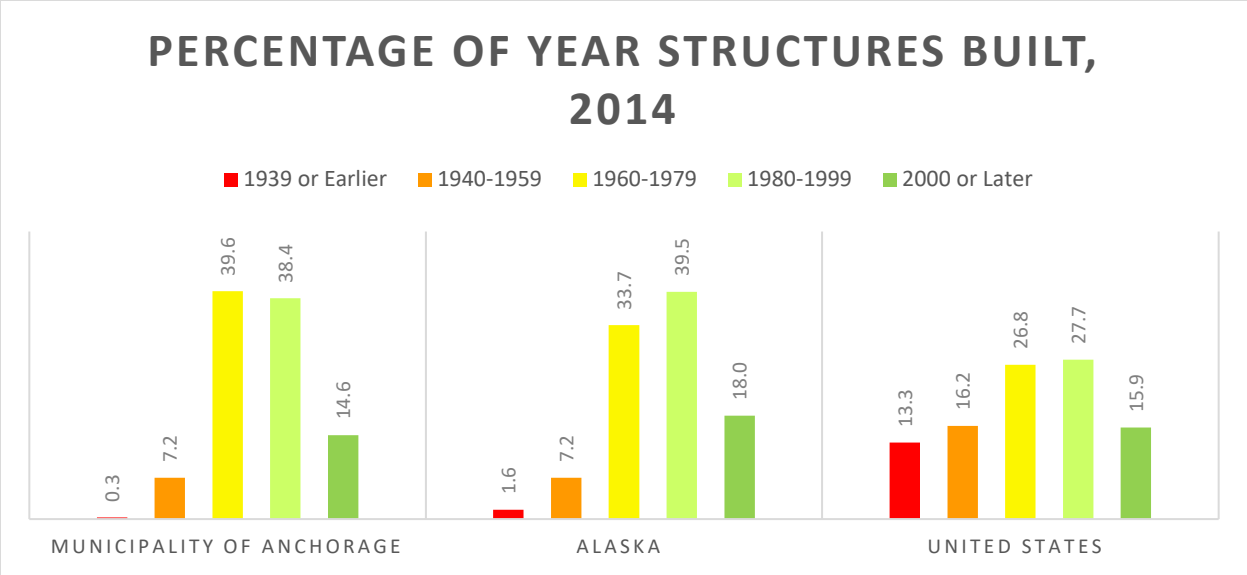

Figure 7: Building Stock by Time Period

Socioeconomic Conclusion

Learning more about how to communicate multi-hazard risk information effectively 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 FEMA would like to reach.

5. Flood Exposure Assessment

Flood Hazard Overview

The Municipality of Anchorage is susceptible to flooding from multiple sources including, but not limited to, heavy rainfall, rapid snowmelt, rising groundwater, ice jamming, alluvial fan flooding, coastal storm surges, and tsunamis. Flooding is a regular occurrence in the municipality. Figure 8 depicts the history of Presidential Disaster Declarations for floods in Anchorage and summarizes funding sources for hazard assistance.

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Note: Information on the timeline has been pulled from the FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having a food disaster type.

Figure 8: Anchorage Recent Flood Disasters

Studying Flood Hazards

FEMA created a digital Flood Insurance Rate Map for the Municipality of Anchorage in 2009, using existing U.S. Army Corps of Engineers work maps, to regulate and manage flood hazards in Anchorage, Chugiak, Eagle River, Girdwood, Indian, and other regions within the Municipality of Anchorage. Special Flood Hazard Areas (SFHAs) based on existing modeling were mapped for the Cities of Anchorage, Chugiak, Eagle River, and Girdwood. Portions of the Municipality of Anchorage are mapped as Zone D. The Zone D designation is used for areas where there are possible but undetermined flood hazards, as no assessment of flood hazards has been conducted.

Flood Frequencies and National Flood Insurance Program Participation Information

While the flood risk assessments in the Municipality of Anchorage were conducted for the 1-percent-annual-chance flood event, it is important to note that flood frequencies can also be defined as other percent chances of occurrence such as the 0.2-percent-annual-chance event or 10-percent-annual-chance event. These frequencies are referred to in multiple ways, but all refer to the same rate of annual occurrence. The table below summarizes the terms used to categorize flood frequencies.

Table 2: Estimated Probability of a Flood Event

EVENT	ANNUAL-CHANCE OF OCCURRENCE	ADDITIONAL WAYS TO REFERENCE THE OCCURRENCE
10-year flood	10-percent	• During the span of a 30-year mortgage, a home has a 96-percent chance of being flooded at least once.
25-year flood	4-percent	• During the span of a 30-year mortgage, a home has a 71-percent chance of being flooded at least once.
50-year flood	2-percent	• During the span of a 30-year mortgage, a home has a 45-percent chance of being flooded at least once.
100-year flood	1-percent	• SFHA • During the span of a 30-year mortgage, a home has a 26 percent chance of being flooded at least once.
500-year flood	0.2-percent	• During the span of a 30-year mortgage, a home has a 6-percent chance of being flooded at least once.

Note: It is important to note that each flood has its respective chance of occurrence each year. For example, if a 100-year flood occurred last year, there is a 1-percent chance that is will occur this year as well.

The National Flood Insurance Program (NFIP) requires flood insurance for property owners with structures that are in the SHFA and carry a federally insured mortgage. The Municipality of Anchorage participates in the NFIP. Table 3 provides a brief overview of program participants, past flood claims, total policies, and total insurance coverage.

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

Table 3: Community Characteristics in the Municipality of Anchorage

COMMUNITY NAME	TOTAL POPULATION (2015 EST.)	CRS COMMUNITY	FLOOD CLAIMS	REPETITIVE LOSS PROPERTIES	TOTAL POLICIES	TOTAL INSURANCE COVERAGE
Municipality of Anchorage	298,695	YES-6	63	2	457	$127,149,800

Special Flood Hazard Area Overview

The project team completed a flood risk exposure assessment with individual parcel data provided by the Municipality of Anchorage. The project team incorporated only properties with buildings (improvements) into the analysis; therefore, no impacts to vacant land were assessed. For this assessment, buildings that intersected a mapped SFHA (Zones A, AE, AH, or AO) are summarized.

Table 4 highlights the building value and loss ratios of parcels within the floodplain, by region.

Table 4: Special Flood Hazard Area Assessments in the Municipality of Anchorage

COMMUNITY/AGENCY NAME	BUILDINGS IN FLOOD ANALYSIS*	BUILDINGS IN ZONE A, AE, AH, AO	PERCENT BUILDINGS IN ZONE A, AE, AH, AO	BUILDING VALUE (BUILDING AND CONTENTS) IN FLOOD ANALYSIS	BUILDING VALUE EXPOSURE IN ZONE A, AE, AH, AO	PERCENT BUILDING VALUE EXPOSURE IN ZONE A, AE, AH, AO
Anchorage	71,430	328	0.46%	$57.5B	$329.2M	0.57%
Chugiak	2,896	3	0.10%	$1.7B	$1.0M	0.06%
Eagle River	9,038	30	0.33%	$4.8B	$10.3M	0.21%
Girdwood	1,388	71	5.12%	$513.7M	$35.7M	6.94%
Indian	130	---	---	$69.0M	---	---
AK Bureau of Land Management	496	---	---	$417.4M	---	---
Chugach State Park	---	---	---	---	---	---
Chugach National Forest	---	---	---	---	---	---
Elmendorf Air Force Base	---	---	---	---	---	---
Fort Richardson Military Reservation	---	---	---	---	---	---
TOTAL	**85,378**	**432**	**0.51%**	**$65.1B**	**$376.2M**	**0.58%**

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 damage to infrastructure is not captured in this table.

*Structures residing in Zone D were not included for this assessment

The preliminary flood hazard data available for select locations throughout the Municipality of Anchorage allowed for a partial flood risk analysis. No flood hazard areas have been mapped for Chugach State Park,

Chugach National Forest, Elmendorf Air Force Base, or Fort Richardson Military Reservation, but flood hazard data are available for many inhabited regions of the Municipality of Anchorage. The exposure flood analysis was based on the 432 structures identified within a mapped flood hazard area. Most of those buildings are in the Anchorage Bowl (referred to as Anchorage throughout this Risk Report). Located in the eastern area of the Municipality of Anchorage, Anchorage has 71,430 improved parcels available for analysis and 328 of those parcels were identified in the mapped SFHA. In Girdwood, 71 identified structures are within the mapped SFHA. In Eagle River, 30 structures are within the mapped SFHA.

A large portion of the flood risk exposure assessment focused on flood losses due to riverine flooding. Of the 85,378 buildings, 432 are in Zones A, AE, AH, or AO. The highest projected building losses are in Anchorage, which accounts for almost 75 percent of the losses in the Municipality. An estimated $376 million worth of at-risk facilities could be lost in a riverine flooding event. A $376-million loss accounts for a 0.58-percent loss ratio of the studied buildings. Other vulnerable areas include Girdwood with a projected $35 million loss, and Eagle River with a projected $10 million loss. In communities with more than one structure at risk, loss ratios of 6.94 percent in Girdwood and 0.58 percent in Anchorage were the highest in the Municipality of Anchorage.

When comparing the structures at risk listed in Table 4 to insurance policies listed in Table 3, the number of flood insurance policies in the Municipality of Anchorage (457) is higher than the number of properties in the mapped SFHA (432). Communities look to have a comparable level of insurance for their risk.

The community results shown above give an idea of where the largest flooding concerns are. This exposure assessment includes information for every parcel in each community within a studied flood-prone area, so local officials can use the results to determine which parcels in a community have the highest flood risk. Map 2 shows the potential losses during a 1-percent-annual-chance flood event for the coastal and riverine areas of the Municipality of Anchorage. 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.

Local officials can use the loss data from the exposure assessment, which highlights the areas affected by flooding, to identify properties for mitigation projects as well as areas to target for additional outreach. These areas of greatest impacts and potential mitigation actions are highlighted in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

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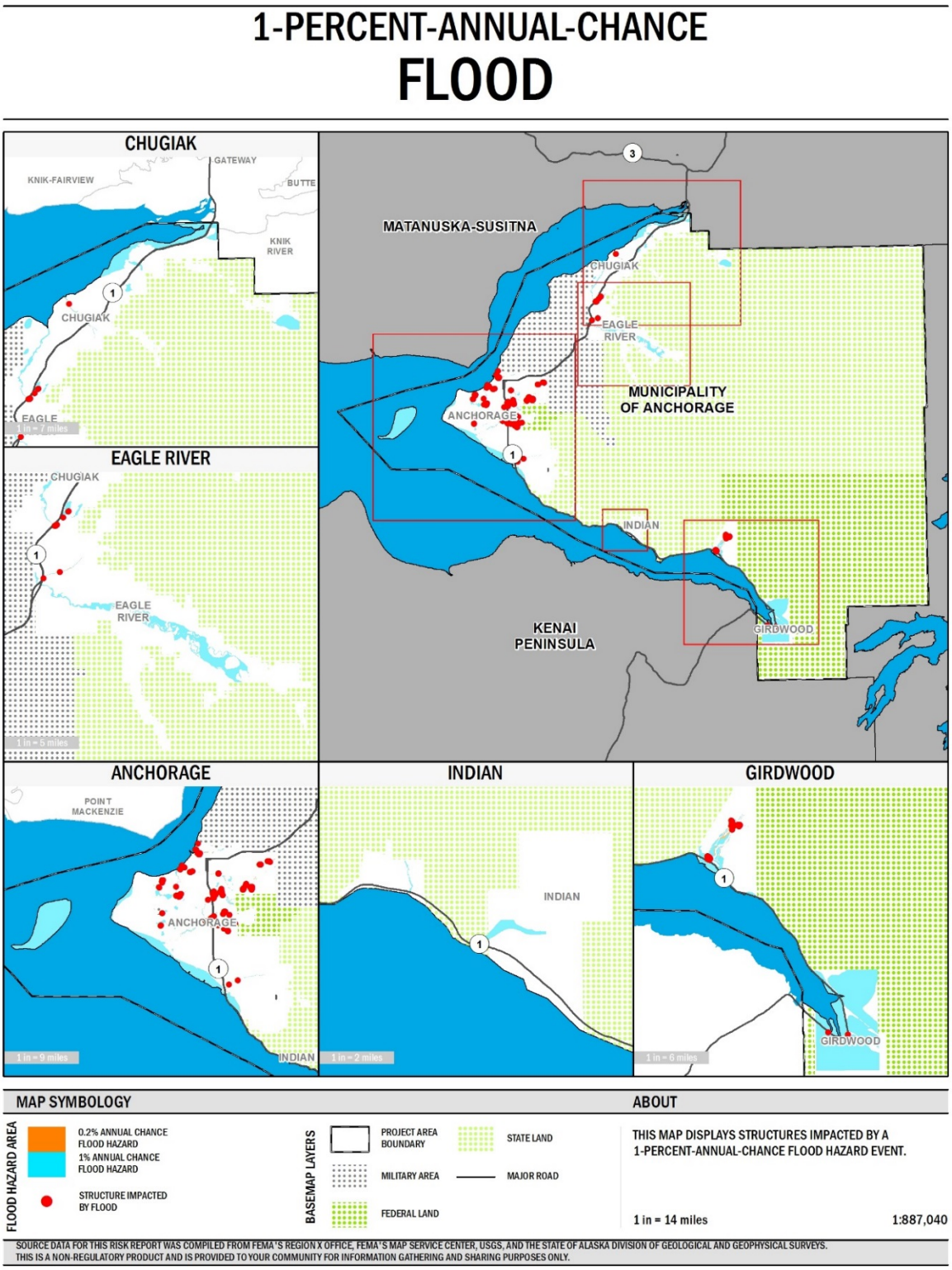
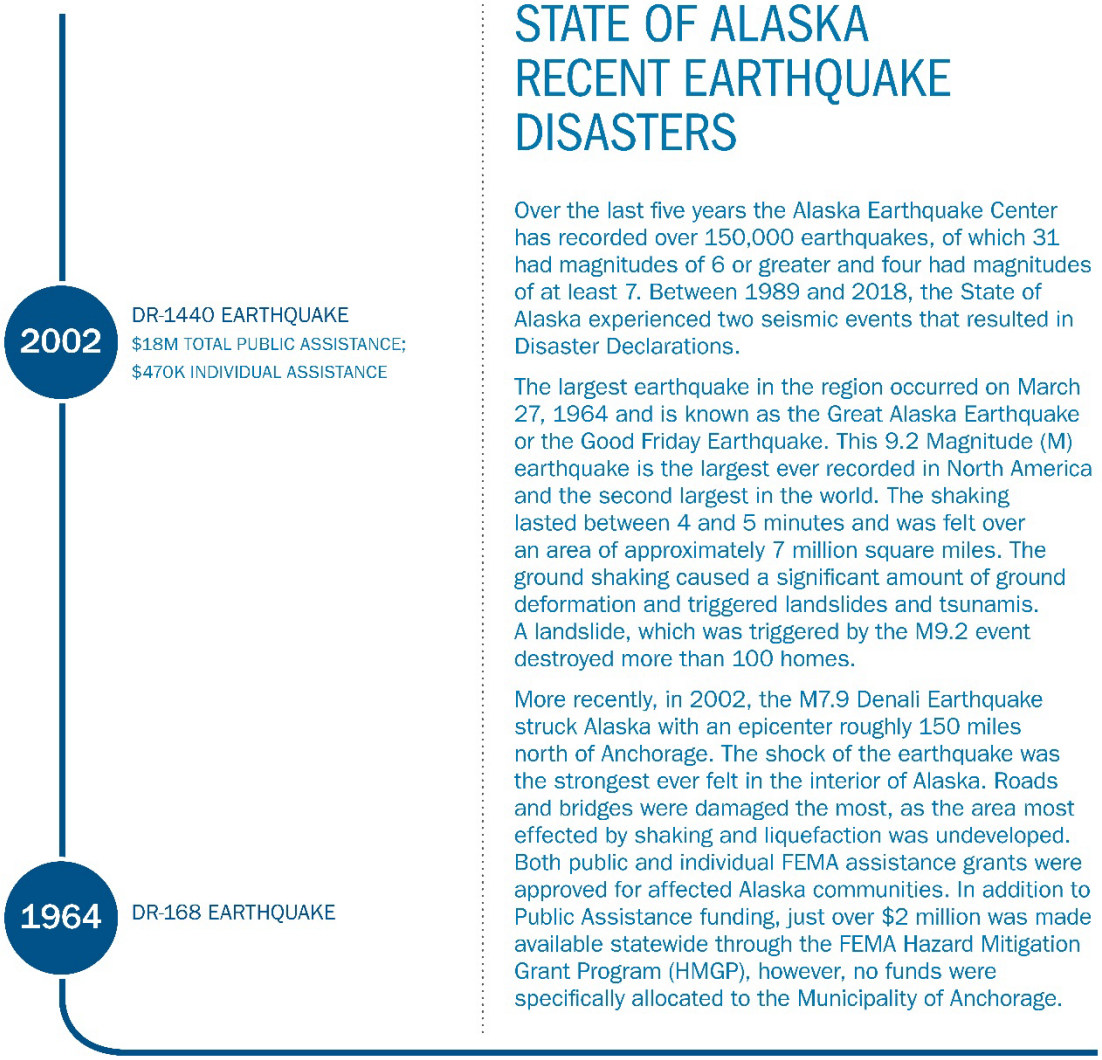
Map 2: Buildings Impacted by a 1-Percent-Annual-Chance Flood in the Municipality of Anchorage



6. Earthquake Risk Assessment

Earthquake Hazard Overview

Throughout history, the Municipality of Anchorage has experienced numerous earthquake events of varying magnitudes. The region is susceptible to earthquake events due to its location and proximity to the Pacific Plate subduction beneath the North American Plate. Since 1900, there have been 15 events having a magnitude greater than 4.0 that have had an epicenter within the Municipality of Anchorage boundary (Alaska Earthquake Information Center). The timeline below depicts the history of Presidential Disaster Declarations for earthquakes in the State of Alaska and summarizes funding sources for hazard assistance.



STATE OF ALASKA RECENT EARTHQUAKE DISASTERS

Over the last five years the Alaska Earthquake Center has recorded over 150,000 earthquakes, of which 31 had magnitudes of 6 or greater and four had magnitudes of at least 7. Between 1989 and 2018, the State of Alaska experienced two seismic events that resulted in Disaster Declarations.

The largest earthquake in the region occurred on March 27, 1964 and is known as the Great Alaska Earthquake or the Good Friday Earthquake. This 9.2 Magnitude (M) earthquake is the largest ever recorded in North America and the second largest in the world. The shaking lasted between 4 and 5 minutes and was felt over an area of approximately 7 million square miles. The ground shaking caused a significant amount of ground deformation and triggered landslides and tsunamis. A landslide, which was triggered by the M9.2 event destroyed more than 100 homes.

More recently, in 2002, the M7.9 Denali Earthquake struck Alaska with an epicenter roughly 150 miles north of Anchorage. The shock of the earthquake was the strongest ever felt in the interior of Alaska. Roads and bridges were damaged the most, as the area most effected by shaking and liquefaction was undeveloped. Both public and individual FEMA assistance grants were approved for affected Alaska communities. In addition to Public Assistance funding, just over $2 million was made available statewide through the FEMA Hazard Mitigation Grant Program (HMGP), however, no funds were specifically allocated to the Municipality of Anchorage.

Note: Information on the timeline has been pulled from FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having an earthquake disaster type.

Figure 9: State of Alaska Earthquake Presidentially Declared Disasters

ShakeMaps

Maps depicting the shaking intensity and ground motion produced by an earthquake, called ShakeMaps, can be produced in near-real time for events or created for specific scenarios by regional seismic network operators in cooperation with the U.S. Geological Survey. ShakeMaps can be used for response, land use, and emergency planning purposes. In this case, FEMA, the Municipality of Anchorage, and the DGGS worked together to choose ShakeMaps for three earthquake scenarios:

1. M7.1 Border Ranges Scenario
2. M7.2 Intraplate Scenario
3. M7.5 Castle Mountain Scenario

The heaviest shaking and economic losses occurred during the M7.1 Border Ranges Scenario in areas northeast of the Municipality of Anchorage, including Eagle River and Chugiak. Instrumental intensity in this area reached M7.8, defined as *strong* shaking. Instrumental intensity observed during the M7.2 Intraplate Scenario was highest to the east of Anchorage in the Cook Inlet, measuring M6.5. The M7.5 Castle Mountain Scenario produced shaking intensities of M6.6 to the west of Anchorage in the Cook Inlet.

Earthquake Risk Assessment Overview

The project team performed three earthquake risk assessments using Hazus for this Risk Report. The first assessment used a ShakeMap created for the M7.1 Border Ranges Scenario. The second assessment used a ShakeMap created for the M7.2 Intraplate Scenario. The third assessment used a ShakeMap created for the M7.5 Castle Mountain Scenario. The team completed all three earthquake risk assessments using local parcel data from the Municipality of Anchorage and the ShakeMaps shown in Maps 3, 4, and 5.

For this study, the team incorporated individual parcel data from the Municipality of Anchorage into Hazus to allow losses to be reported at the parcel level. The team incorporated only properties with buildings (improvements) into the analysis; therefore, the team did not assess impacts to vacant land. Please refer to the appendix for a detailed methodology on incorporating local data into Hazus. The building loss from the earthquake assessments is summarized in Table 5 and displayed in Maps 6, 7, and 8.

Table 5: Hazus Earthquake Results for M7.1 and M9.2 Earthquakes in the Municipality of Anchorage

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS	M7.1 BORDER RANGES SCENARIO		M7.2 INTRAPLATE SCENARIO		M7.5 CASTLE MOUNTAIN SCENARIO	
			TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
Anchorage	$57.5B	71,430	$618.6M	1.07%	$423.3M	0.74%	$336.5M	0.58%
Chugiak	$1.7B	2,896	$86.1M	4.96%	$9.4M	0.54%	$15.0M	0.86%
Eagle River	$4.8B	9,038	$222.4M	4.59%	$25.0M	0.52%	$23.8M	0.49%
Girdwood	$513.7M	1,388	$424,586	0.08%	$510,324	0.10%	$169,483	0.03%

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COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS	M7.1 BORDER RANGES SCENARIO		M7.2 INTRAPLATE SCENARIO		M7.5 CASTLE MOUNTAIN SCENARIO	
Indian	$69.0M	130	$140,384	0.20%	$175,874	0.25%	$22,438	0.03%
AK Bureau of Land Management	$417.4M	496	$3.9M	0.93%	$2.5M	0.59%	$1.4M	0.35%
Chugach State Park	$52.8M	16	$2.5M	4.67%	$378,359	0.72%	$670,307	1.27%
Chugach National Forest	$111.0M	16	$102,990	0.09%	$111,122	0.10%	$69,422	0.06%
Elmendorf Air Force Base	$281.3M	29	$8.0M	2.86%	$3.0M	1.08%	$2.6M	0.92%
Fort Richardson Military Reservation	$331.4M	25	$11.1M	3.36%	$3.8M	1.15%	$3.3M	0.99%
TOTAL	**$66.0B**	**85,464**	**$953.2M**	**1.45%**	**$468.2M**	**0.71%**	**$383.6M**	**0.58%**

Note: This table shows the total estimated parcel value by community. The total estimated value of improved parcels only includes 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, M7.2, and M7.5 scenarios.

Building and content values in the Municipality of Anchorage total $66 billion and are highest in Anchorage ($57.5 billion). Eagle River ($4.8 billion) and Chugiak ($1.7 billion) have the second and third highest total building and content values.

Losses estimated from the M7.1 Border Ranges Scenario were high across all communities. The team estimated total building and content dollar losses at close to $953 million, with a municipality-wide loss ratio of 1.45 percent. The team projected that Chugiak (4.96 percent), Chugach State Park (4.67 percent), and Eagle River (4.59 percent) will have the highest loss ratios. The largest total loss values are projected for Anchorage ($618.6 million) and Eagle River ($222.4 million).

The impacts of the M7.2 Intraplate Scenario are less than those of the M7.1 Border Ranges Scenario. The team estimated total losses to be over $468 million, with a municipality-wide loss ratio of 0.71 percent. Loss ratios are highest for the Fort Richardson Military Reservation (1.15 percent) and Elmendorf Air Force Base (1.08 percent). Of the $468 million in projected losses, Anchorage had the largest losses at $423 million with a loss ratio of 0.74 percent. Eagle River had $25 million in total projected losses resulting in a loss ratio of 0.52 percent.

The M7.5 Castle Mountain Scenario resulted in loss estimates for all jurisdictions and communities within the Municipality of Anchorage. The team projected total losses for the Municipality of Anchorage from the M7.5 Castle Mountain Scenario to be $383.6 million with a loss ratio of 0.58 percent. The team projected that Anchorage would have the largest loss in total estimated value of improved parcels, $336.5 million, resulting in a loss ratio of 0.58 percent. The team projected that Chugach State Park would have the highest loss ratio at 1.27 percent, with a total loss amount of $670,307.

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Essential Facilities

The project team extracted essential facilities identified by the Municipality of Anchorage from the building analysis as shown in Table 6, Table 7, and

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Table 8 to determine the level of earthquake vulnerability after the identified earthquake event scenarios.

Table 6: Essential Facility Damage due to a M7.1 Border Ranges Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$2.0M	2.85%
FIRE	19	$374.2M	4	21.05%	$6.3M	1.68%
HEALTH CARE	7	$2.2B	0	0.00%	$42.6M	1.98%
POLICE	2	$56.8M	1	50.00%	$1.6M	2.81%
SCHOOL	91	$3.9B	5	5.49%	$63.6M	1.64%
TOTAL	**120**	**$6.5B**	**10**	**8.33%**	**$116.1M**	**1.78%**

Table 7: Essential Facility Damage due to a M7.2 Intraplate Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$1.4M	2.04%
FIRE	19	$374.2M	0	0.00%	$3.7M	0.98%
HEALTH CARE	7	$2.2B	0	0.00%	$20.1M	0.94%
POLICE	2	$56.8M	0	0.00%	$783,571	1.38%
SCHOOL	91	$3.9B	0	0.00%	$31.9M	0.82%
TOTAL	**120**	**$6.5B**	**0**	**0.00%**	**$57.8M**	**0.89%**

Table 8: Essential Facility Damage due to a M7.5 Castle Mountain Scenario in the Municipality of Anchorage

ESSENTIAL FACILITY	TOTAL FACILITIES (HAZUS OUTPUT AVAILABLE)	TOTAL FACILITIES VALUE (BUILDING AND CONTENTS)	FACILITIES WITH 5% LOSS RATIO OR HIGHER	PERCENT FACILITIES WITH 5% LOSS RATIO OR HIGHER	TOTAL LOSS	LOSS RATIO
EOC	1	$68.7M	0	0.00%	$1.4M	2.10%
FIRE	19	$374.2M	0	0.00%	$3.4M	0.90%
HEALTH CARE	7	$2.2B	0	0.00%	$20.4M	0.95%
POLICE	2	$56.8M	0	0.00%	$703,196	1.24%
SCHOOL	91	$3.9B	0	0.00%	$24.4M	0.63%
TOTAL	**120**	**$6.5B**	**0**	**0.00%**	**$50.3M**	**0.77%**

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 is a loss ratio, which is calculated as the total losses (including building and contents loss)/total building and contents value.

Of the essential facilities with a Hazus earthquake output, the project team found that the M7.1 Border Ranges Scenario has the highest total loss at $115 million (also displayed in Map 9). This would account for nearly 1.78 percent of defined facilities within the Municipality of Anchorage. For all three scenarios, no Emergency Operation Centers would experience a loss ratio of 5 percent or higher, allowing emergency services to be maintained and monitored during an estimated earthquake scenario. For the M7.1 Border Ranges Scenario, the team estimated that 10 facilities would experience a 5 percent or higher loss ratio. The facilities are schools (five buildings), fire (four buildings), and police (one building). The team projected that schools would have the highest total loss values of all defined facilities. A detailed breakout of facilities is provided in the Areas of Mitigation Interest tables in Section 13 of this Risk Report. Additional information is also available in the Risk Database included with this Risk Report.

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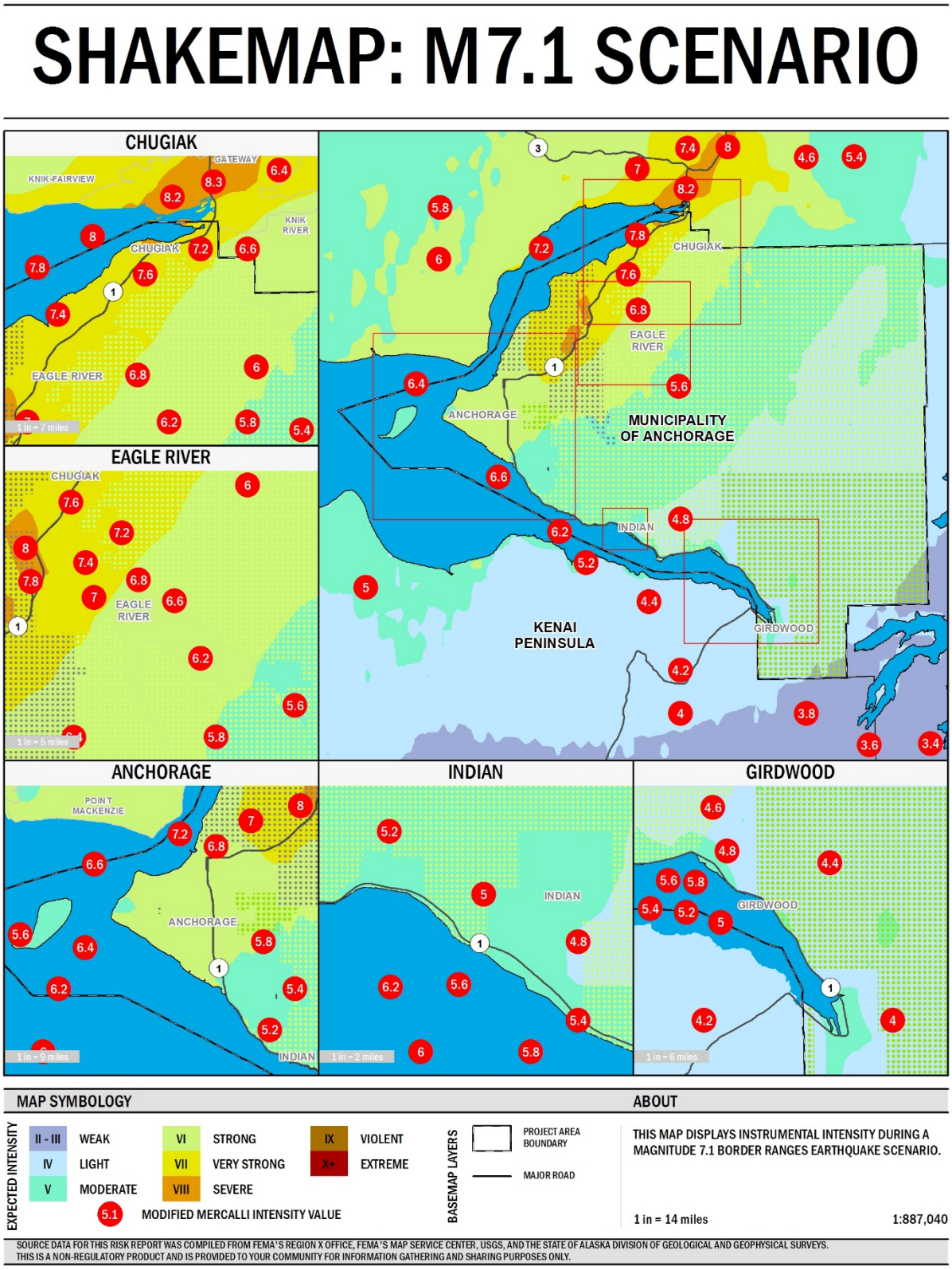
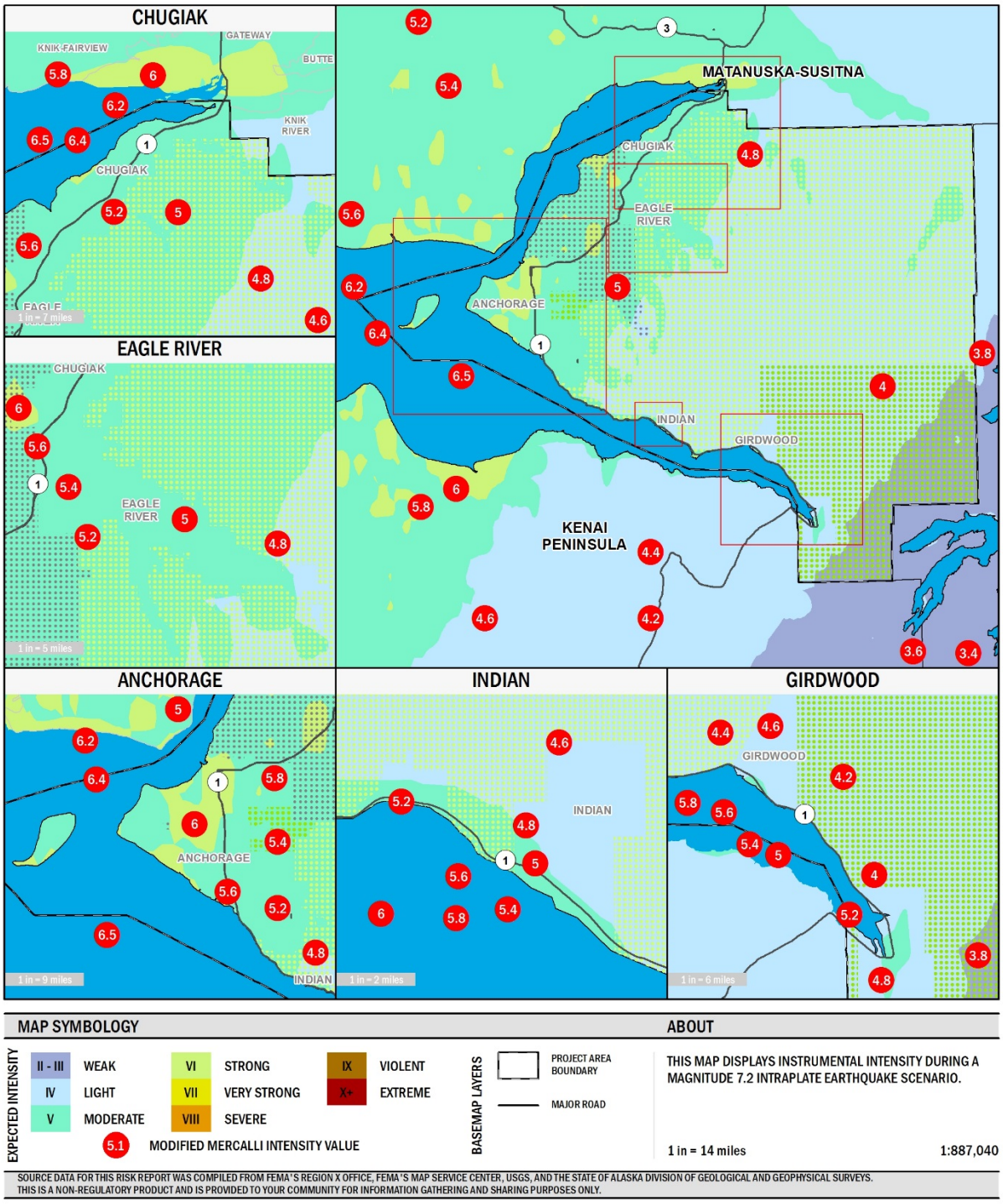
Map 3: ShakeMap of the M7.1 Border Ranges Scenario

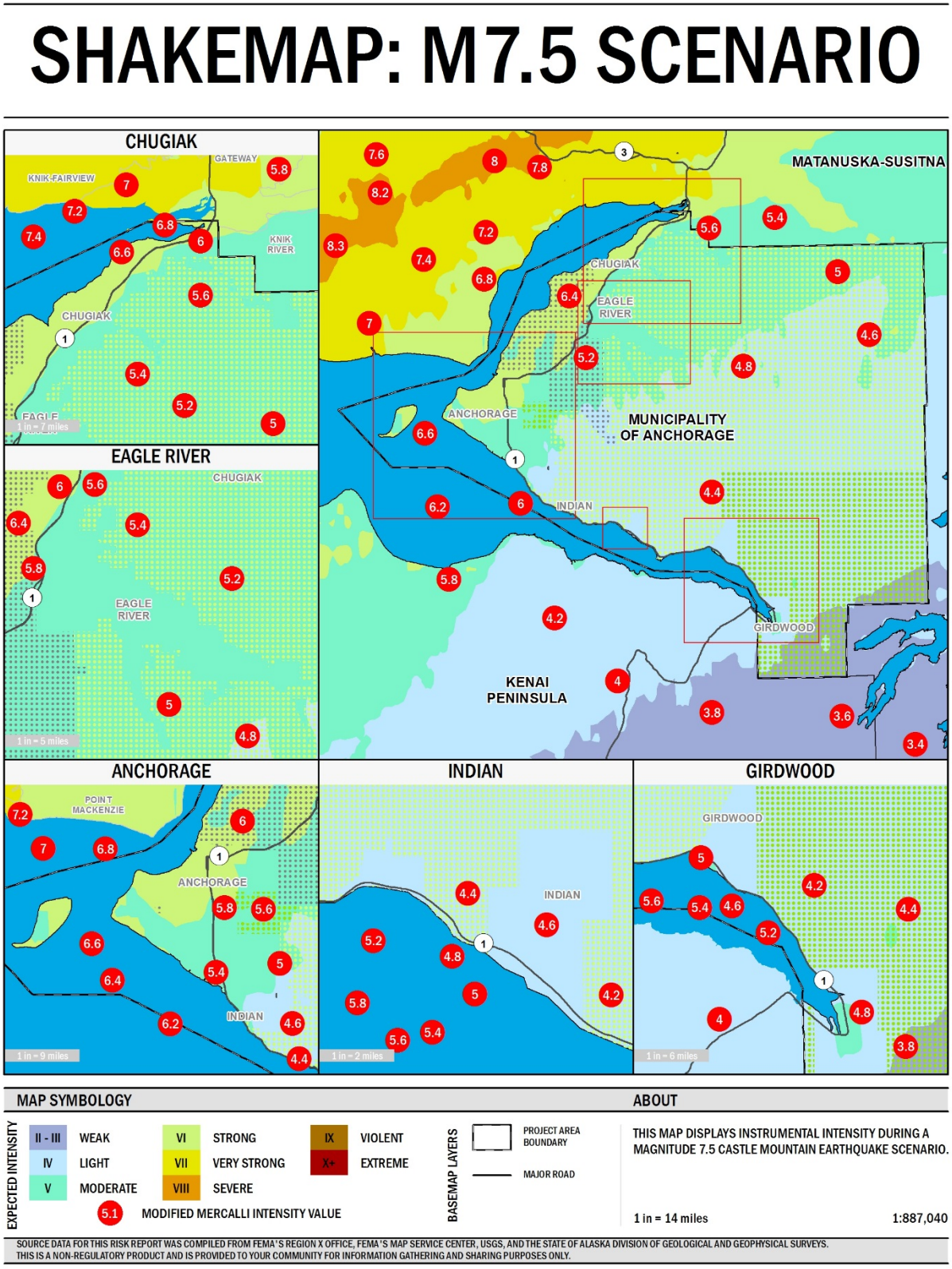


Map 4: ShakeMap of the M7.2 Intraplate Scenario

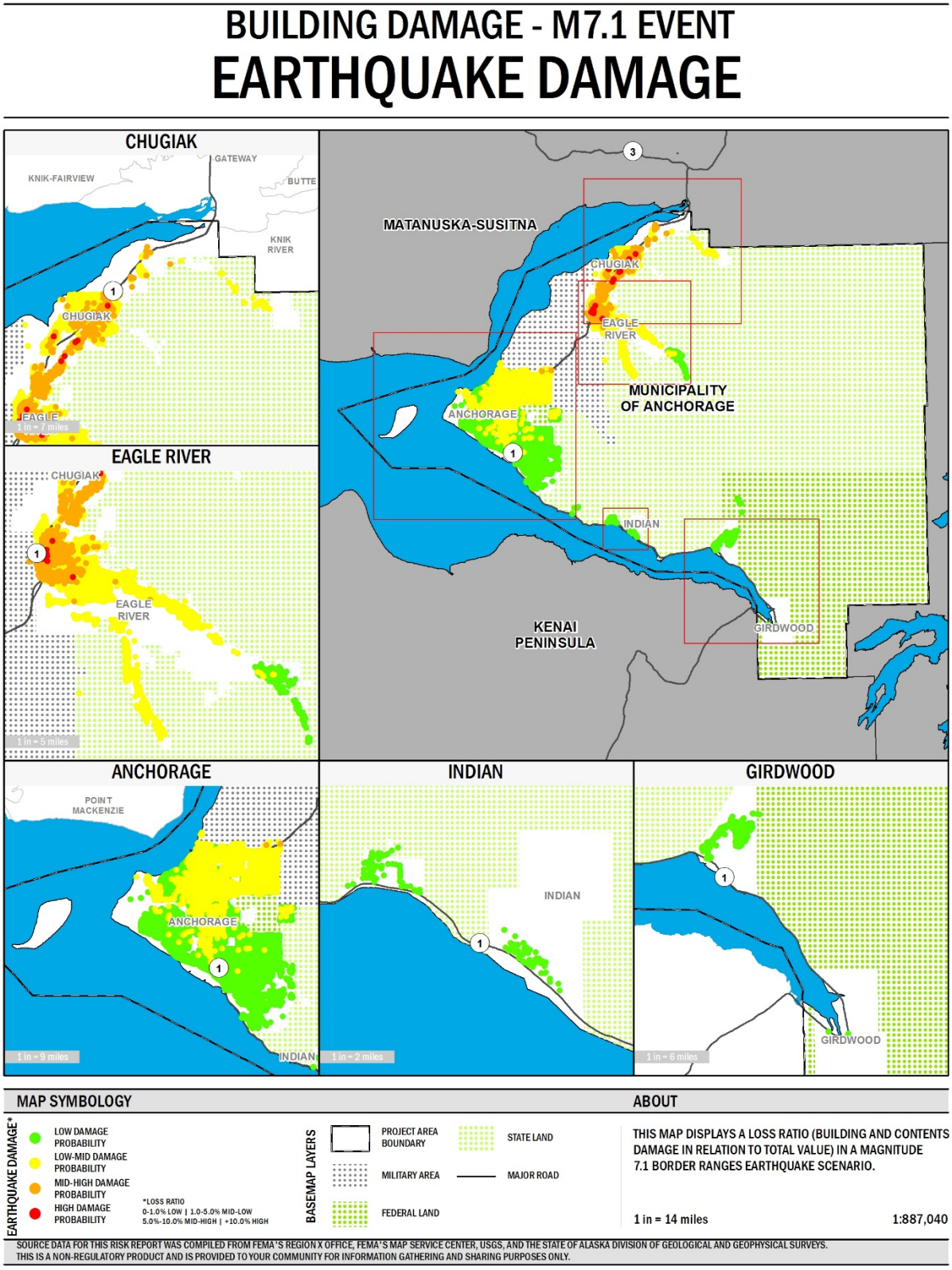
SHAKEMAP: M7.2 SCENARIO



Map 5: ShakeMap of the M7.5 Castle Mountain Scenario

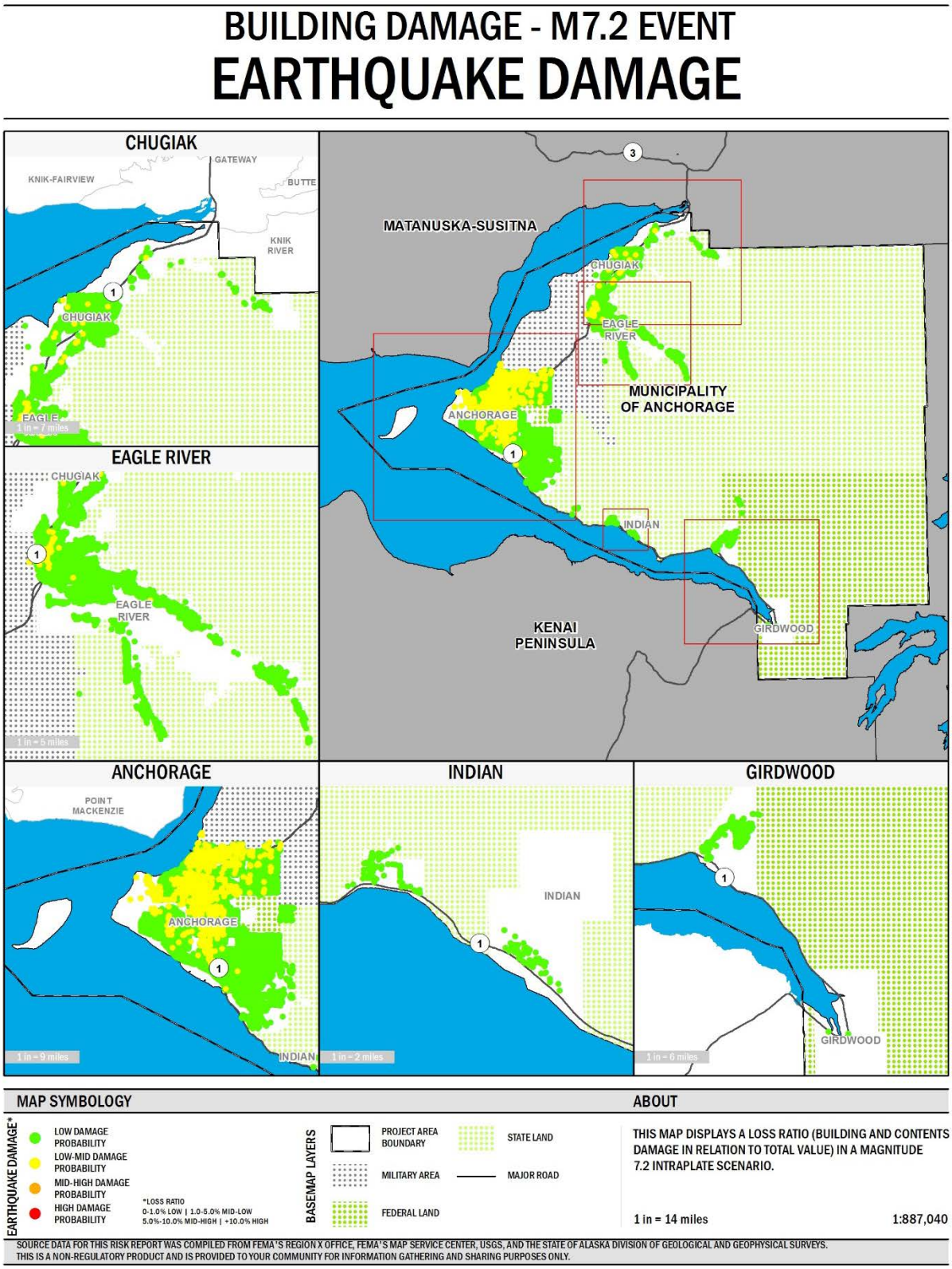


Map 6: M7.1 Border Ranges Scenario - Damage Referenced as Loss Ratio in the Municipality of Anchorage



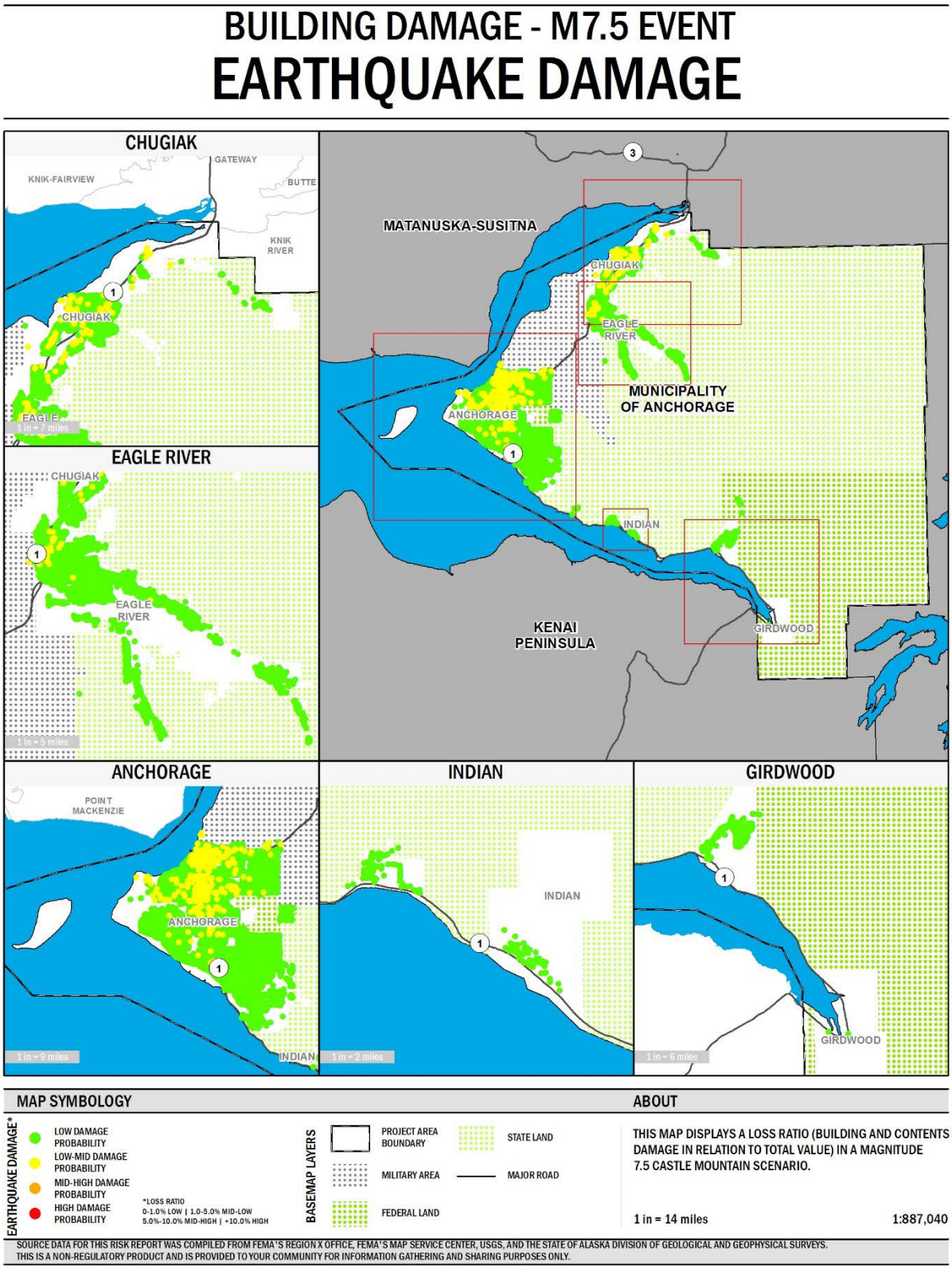
**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Map 7: M7.2 Intraplate Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage*



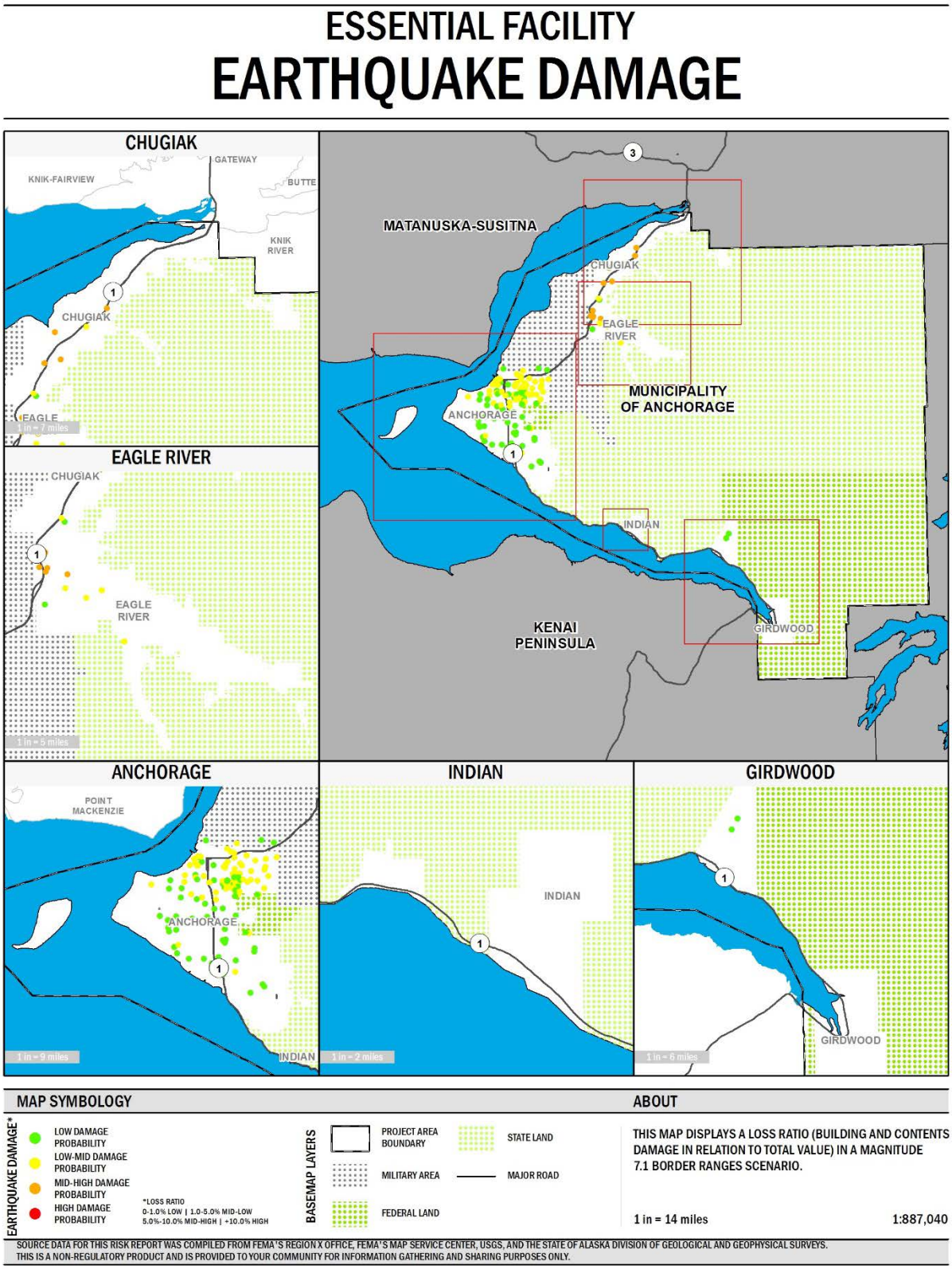
**Damage does not factor collateral effects like landslides, land subsidence, liquefaction, fire, flooding, or tsunami.*

Map 8: M7.5 Castle Mountain Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage*



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

Map 9: M7.1 Border Ranges Scenario – Damage Referenced as Loss Ratio in the Municipality of Anchorage to Essential Facilities*



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

Transportation and Utility Assessment

Hazus also provided 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 communication. The project team took the transportation and utility information from the original Hazus database. *No local updates were applied, so the number of facilities could vary greatly from what actually exists.* Table 9 provides an overview of potential damage to transportation systems in the event of an M7.1 earthquake, summarized at the Municipality level.

Table 9: Transportation System Impacts for the M7.1 Border Ranges Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS/ SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	21	86	90	$2.5B	$207.5M	8.43%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$6.7M	22.68%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
Bus	Facilities	1	0	1	1	$1.3M	$300,000	23.08%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.9M	22.60%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	2	13	14	$93.8M	$19.8M	21.11%
TOTAL		**463**	**23**	**449**	**454**	**$4.1B**	**$239.1M**	**5.91%**

Table 10 provides an overview of potential damage to transportation systems in the event of an M7.2 earthquake. Table 11 identifies potential transportation losses related to an M7.5 earthquake. Table 12 provides an overview of the utility systems in the event of an M7.1 earthquake. Table 13 and Table 14 provide overviews of the utility systems in the event of an M7.2 earthquake and M7.5 earthquake, respectively. Tables 10 through 14 also are summarized at the Municipality level.

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Table 10: Transportation System Impacts for the M7.2 Intraplate Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	0	99	99	$2.5B	$25.6M	1.04%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$5.5M	18.61%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
Bus	Facilities	1	0	1	1	$1.3M	$250,000	19.23%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.0M	18.60%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	0	14	14	$93.8M	$15.0M	15.97%
TOTAL		**463**	**0**	**463**	**463**	**$4.1B**	**$50.3M**	**1.24%**

Table 11: Transportation System Impacts for the M7.5 Castle Mountain Scenario in the Municipality of Anchorage

TRANSPORTATION SYSTEM	COMPONENT	LOCATIONS / SEGMENTS	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Highway	Segments	23	0	23	23	$476.5M	---	---
	Bridges	99	0	99	99	$2.5B	$43.0M	1.75%
	Tunnels	2	0	2	2	$58.1M	---	---
Railway	Segments	282	0	282	282	$181.2M	---	---
	Bridges	4	0	4	4	$1.1M	---	---
	Facilities	11	0	11	11	$29.5M	$5.1M	17.40%
Light Rail	Segments	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
	Facilities	0	0	0	0	---	---	---
Bus	Facilities	1	0	1	1	$1.3M	$250,000	18.66%
Ferry	Facilities	0	0	0	0	---	---	---
Port	Facilities	8	0	8	8	$21.5M	$4.0M	18.66%
Airport	Runways	19	0	19	19	$726.3M	---	---
	Facilities	14	0	14	14	$93.8M	$12.7M	13.55%
TOTAL		**463**	**0**	**463**	**463**	**$4.1B**	**$65.0M**	**1.61%**

Minimal economic losses for transportation systems are projected for the M7.1 Border Ranges Scenario. However, the degree of economic loss to these systems under the M7.2 Intraplate and M7.5 Castle Mountain Scenarios varies. Highway bridges and port and airport facilities are at the greatest risk. Port and airport facilities have estimated loss ratios that average 18.4 percent and are 100-percent functional after Day 1. In total dollars, highway bridges are the most affected. Over $42 million would be lost during the M7.5 Border Ranges Scenario. Collectively, transportation systems are estimated to lose more than $1 billion, which represents an average loss ratio of 1.42 percent.

Table 12: Utility System Impacts for the M7.1 Border Ranges Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

Table 13: Utility System Impacts for the M7.2 Intraplate Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

Table 14: Utility System Impacts for the M7.5 Castle Mountain Scenario in the Municipality of Anchorage

UTILITY SYSTEM	COMPONENT	FACILITIES / SEGMENTS (KM)	MODERATE DAMAGE OR GREATER	FUNCTIONALITY		INVENTORY VALUE	ECONOMIC LOSS	LOSS RATIO
				After Day 1	After Day 7			
Potable Water	Facilities	0	0	0	0	---	---	---
	Pipelines	10,700	0	0	0	$214.0M	---	---
Waste Water	Facilities	4	0	0	0	$327.7M	---	---
	Pipelines	6,420	0	0	0	$128.4M	---	---
Oil Systems	Facilities	1	0	0	0	$100,000	---	---
	Pipelines	NA	0	0	0	---	---	---
Natural Gas	Facilities	0	0	0	0	---	---	---
	Pipelines	4,280	0	0	0	$85.6M	---	---
Electric Power	Facilities	5	0	0	0	$676.5M	---	---
Communication	Facilities	34	0	0	0	$4.2M	---	---
TOTAL		**44 / 21,400**	**0**	**0**	**0**	**$1.4B**	---	---

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 Risk Report.

Building Code Analysis

The Center for Climate and Energy Solutions (C2ES) Report from the March 2016 Disaster Resilience Workshop documented a lack of city codes that encourage building resilience. The loss data from Hazus and the design code analysis highlight the buildings and areas potentially affected by earthquakes. Local officials can use this data for building code considerations, for identification of properties for mitigation projects, and areas to target for additional outreach. The highlighted areas of greatest impacts and potential mitigation actions, based on the above Hazus analysis, are discussed in the community-specific section of this Risk Report (Section 13, Areas of Mitigation Interest).

By performing an additional analysis, the project team identified that many buildings were constructed to a specific building code. Hazus identifies key changes in earthquake building codes, based on year. Homes built before 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-resistant building components. Buildings built after 1975 are considered high code. The dates for local building codes may be slightly different from the dates shown below; however, local officials can use the information 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 15.

Table 15: Pre-Code and Moderate-Code Buildings in the Municipality of Anchorage

COMMUNITY NAME	TOTAL NUMBER OF BUILDINGS	TOTAL PRE-CODE BUILDINGS	PERCENT PRE-CODE BUILDINGS	TOTAL MODERATE-CODE BUILDINGS	PERCENT MODERATE-CODE BUILDINGS	TOTAL HIGH-CODE BUILDINGS	PERCENT HIGH-CODE BUILDINGS
Anchorage	71,430	2	0.00%	20,607	28.85%	50,821	71.15%
Chugiak	2,896	0	0.00%	448	15.47%	2,448	84.53%
Eagle River	9,038	0	0.00%	909	10.06%	8,129	89.94%
Girdwood	1,388	0	0.00%	298	21.47%	1,090	78.53%
Indian	130	0	0.00%	24	18.46%	106	81.54%
AK Bureau of Land Management	496	0	0.00%	58	11.69%	438	88.31%
Chugach State Park	16	0	0.00%	1	6.25%	15	93.75%
Chugach National Forest	16	0	0.00%	2	12.50%	14	87.50%
Elmendorf Air Force Base	29	0	0.00%	1	3.45%	28	96.55%
Fort Richardson Military Reservation	25	0	0.00%	7	28.00%	18	72.00%
TOTAL	**85,464**	**2**	**0.00%**	**22,355**	**26.16%**	**63,107**	**73.84%**

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 Municipality of Anchorage has two pre-code buildings (built before 1941, without a wood frame), and just over 26 percent of all facilities are moderate code. The remaining almost 74 percent were built to meet high-code specifications. The areas with the highest percentage of moderate-code buildings are Anchorage (28.85 percent), Fort Richardson Military Reservation (28 percent), and Girdwood (24.47 percent). Anchorage has the largest number of moderate-code buildings (20,607). Areas with the highest percentage of high-code buildings include Elmendorf Air Force Base (96.5 percent), Chugach State Park (93.7 percent), and Eagle River (89.9 percent). By volume, the community with the most high-code buildings is Anchorage with 50,821.

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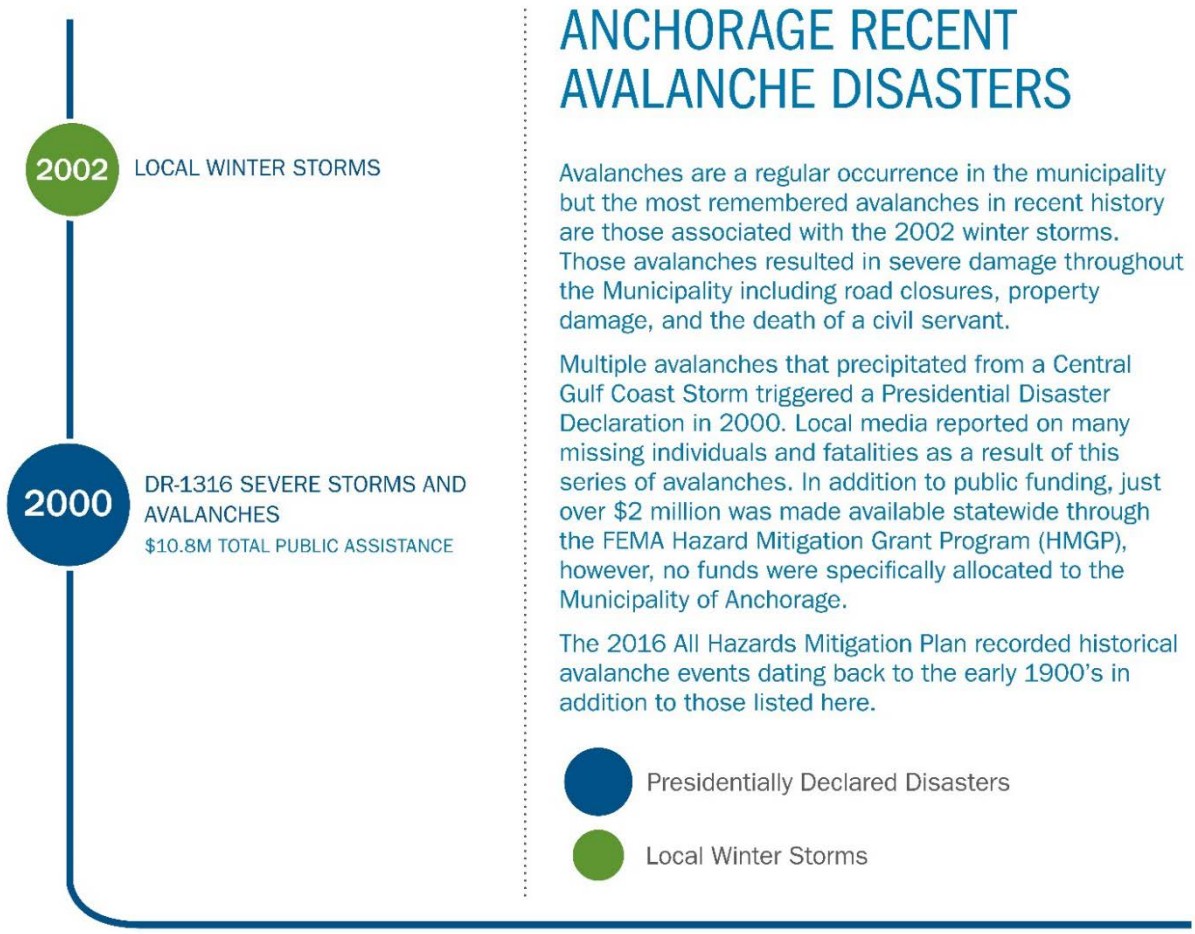
7. Avalanche Exposure Assessment

Avalanche Hazard Overview

Within the Municipality of Anchorage, there are two main types of snow avalanches: loose snow and slab. Other types of avalanches include cornice collapse, ice, and slush. Loose snow avalanches typically occur on slopes above 35 degrees and leave behind an inverted V-shaped scar. They are often caused by snow overloading (common during or just after a snowstorm), vibration, or warming (triggered by rain, rising temperatures, or solar radiation). Slab avalanches are the most dangerous types of avalanches and happen when a mass of cohesive snow breaks away and travels down the mountainside. As it moves, the slab breaks up into smaller cohesive blocks.

The figure below depicts the history of Presidential Disaster Declarations for avalanches in Anchorage and summarizes funding sources for hazard assistance.



Note: Information on the timeline has been pulled from the FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having a winter storm and avalanche disaster type.

Figure 10: Anchorage Recent Avalanche Disasters

Avalanche Exposure Assessment Overview

Avalanches occur within the Municipality of Anchorage every year, but typically occur in more remote areas. Avalanches can occur anywhere, but gullies, steep snow-covered slopes, and areas below steep ridges are particularly susceptible. To identify avalanche-prone areas in Anchorage, Arthur Mears conducted the Anchorage Snow Avalanche Zoning Analysis in 1982 (full report in Appendix B). The area with the potential for the largest avalanches is the Girdwood/Crow Creek area. Evidence of snow avalanches is prominent along the mountainsides above the Girdwood Valley. The western mountainside has high and moderate avalanche danger from Turnagain Arm to California Creek. Avalanche hazard is moderate to high on the eastern mountainside at the head of the valley, near the day lodge and resort area, and southeast of Virgin Creek. Other areas south of the Anchorage Bowl that may experience avalanches are Bird Creek, Indian, and Rainbow. North of the Anchorage Bowl, the areas near the South Fork of the Eagle River, Eagle River, Peters Creek (especially near what is locally known as 4-mile), and Mirror Lake/N.W. Spur of Mount Eklutna have avalanche potential. Another avalanche-prone area is the Seward Highway between the flats near Bird Point and the entrance to the Girdwood Valley (Map 10). The results of this exposure assessment, which identified various locations within the Municipality of Anchorage as at risk of avalanche occurrences, are summarized in Table 16.

Table 16: Parcel Improvement Exposure Associated with Avalanche in the Municipality of Anchorage

COMMUNITY NAME	TOTAL NUMBER OF BUILDINGS	BUILDINGS IN AVALANCHE HAZARD AREA	PERCENT BUILDINGS IN AVALANCHE HAZARD AREA	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS)	BUILDING VALUE EXPOSURE IN AVALANCHE HAZARD AREA	PERCENT BUILDING VALUE EXPOSURE IN AVALANCHE HAZARD AREA
Anchorage	71,430	4	0.01%	$57.5B	$2.1M	0.00%
Chugiak	2,896	5	0.17%	$1.7B	$2.3M	0.13%
Eagle River	9,038	111	1.23%	$4.8B	$56.2M	1.16%
Girdwood	1,388	75	5.40%	$513.7M	$59.0M	11.49%
Indian	130	---	---	$69.0M	---	---
AK Bureau of Land Management	496	---	---	$417.4M	---	---
Chugach State Park	16	1	6.25%	$52.8M	$534,208	1.01%
Chugach National Forest	16	10	62.50%	$111.0M	$4.7M	4.25%
Elmendorf Air Force Base	29	---	---	$281.3M	---	---
Fort Richardson Military Reservation	25	---	---	$331.4	---	---
TOTAL	**85,464**	**206**	**0.24%**	**$66.0B**	**$124.9M**	**0.19%**

In the Municipality of Anchorage, 206 structures are vulnerable to avalanche hazards. Most of the avalanche risk areas are west of Anchorage. Eagle River and Girdwood have the largest number of structures within avalanche hazard areas. Eagle River has 111 structures within avalanche hazard areas, and Girdwood has 75 structures within avalanche hazard areas. Girdwood does not have the highest

amount of structures within the avalanche hazard area, but the community does have the highest estimated building value exposure. In total, 0.24 percent of structures in the Municipality of Anchorage are vulnerable to potential avalanche hazard occurrences, which places nearly $125 million dollars in building value at risk.

Local officials can use the avalanche analysis to consider areas where an avalanche ordinance could be adopted, to identify individual properties for mitigation projects, and areas for targeted outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

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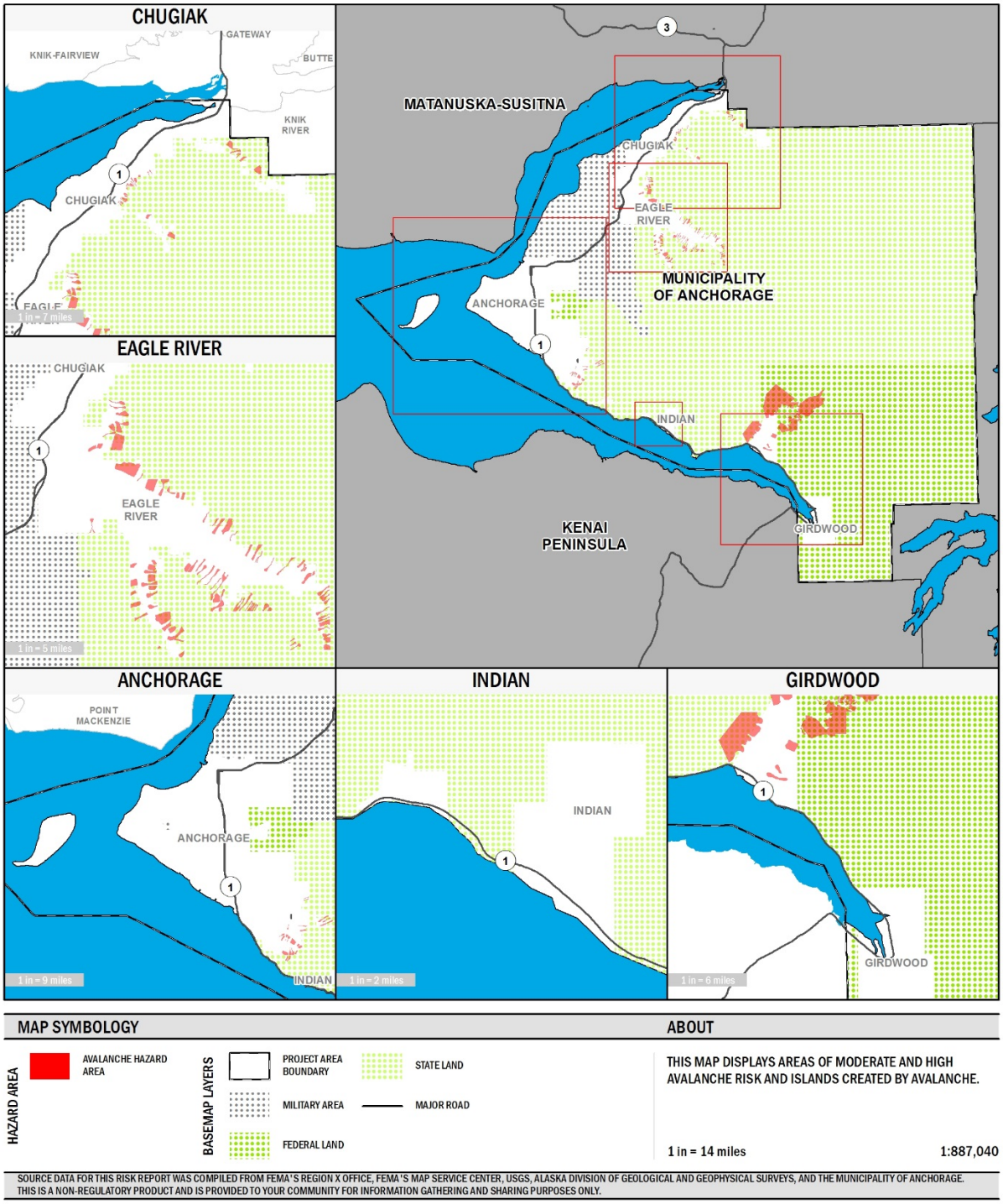
Map 10: Avalanche Risk in the Municipality of Anchorage

AVALANCHE



8. Dam Failure Exposure Assessment

Dam Hazard Overview

To date, the Municipality of Anchorage has not had a presidentially declared disaster caused by dam failure. While the number of dams within the Municipality of Anchorage is limited, sudden flooding hazards do exist. Dam failure could cause damage to critical infrastructure, property damage, and fatalities.

Ten dams were initially suggested for inundation assessments including Eklutna, Lake 'O' the Hills Dam, Lower Fire Lake, Campbell Lake, Westchester Lagoon, Lower Eklutna, Ship Creek, Gregory Lake, Otter Lake, and Explorer Glacier Pond. Spatial data for the following dams was provided: Eklutna Lake, Lake 'O' the Hills, and Lower Fire Lake. The 2011 Municipality of Anchorage Hazard Mitigation Plan (HMP) explains that the Lake 'O' the Hills Dam is a privately-owned dam that impounds a recreational lake. Its creation diverted water from its original path to a recreational lake. The dam is located 8.6 miles from the Municipality of Anchorage and is built to an elevation of 827 feet. Lake 'O' the Hills Dam failed in 1972, resulting in one fatality. Repeated failure of the Lake 'O' the Hills Dam could cause damage to critical infrastructure, property damage, and fatalities.

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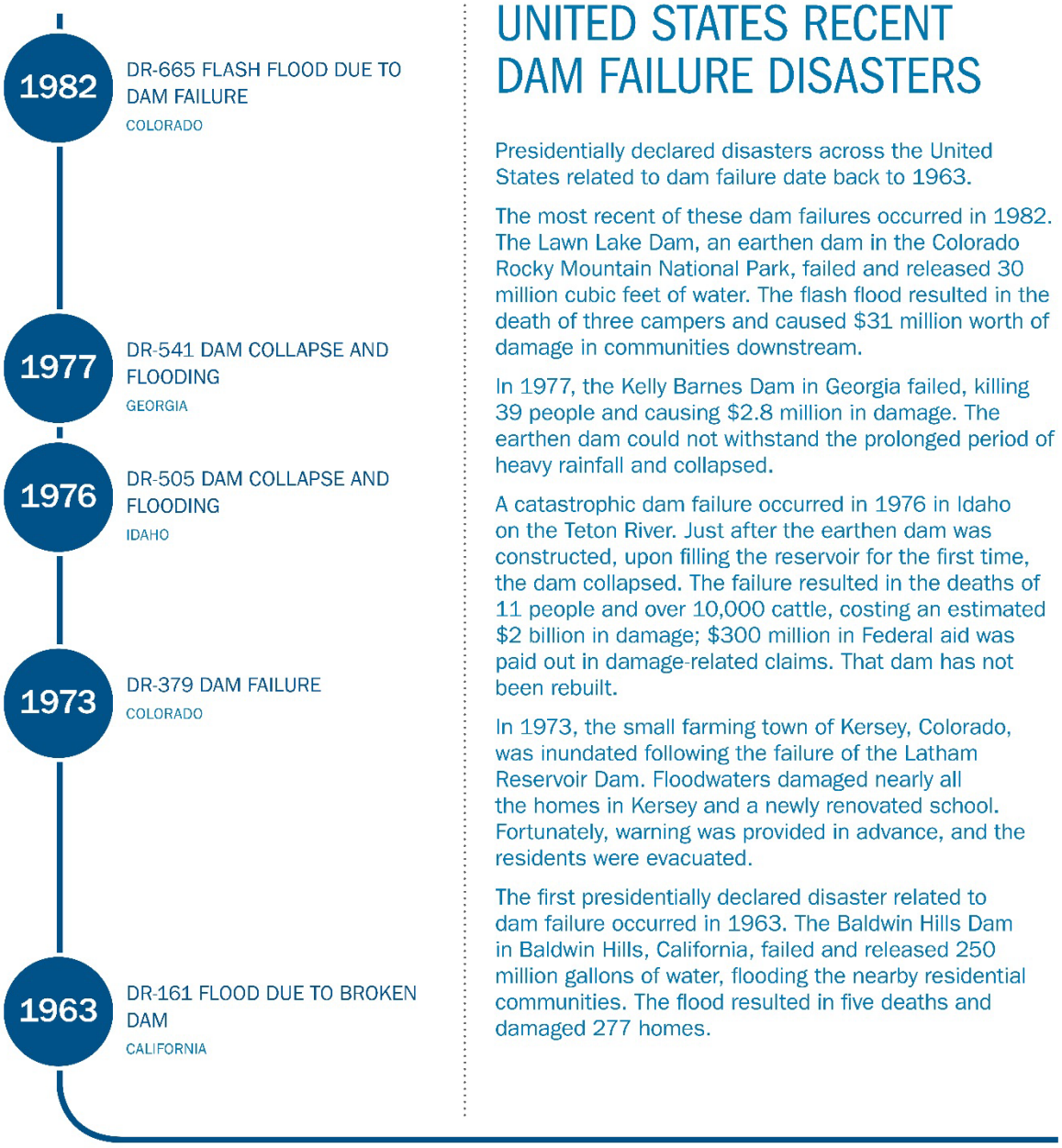

Note: Information on the timeline has been pulled from the FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having "dam" as a term found in the incident title.

Figure 11: Summary of United States Dam Failure Presidentially Declared Disasters

Dam Failure Exposure Assessment

For this study, the dam failure exposure assessment performed by the project team measured potential impacts of dam inundation based on the failure of dams. Dam flooding is estimated based on the inundation by floodwater of a specified area being protected by a dam or levee. Dam inundation areas

vary based on the type of structure, location of structural elements, and flooding source being addressed. Table 17 identifies areas vulnerable to flood inundation based on dam failure.

Table 17: Exposure Associated with Dam Failure within the Municipality of Anchorage

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF IMPACTED BUILDINGS	EKLUTNA LAKE INUNDATION AREA		LAKE 'O' THE HILLS INUNDATION AREA		LOWER FIRE LAKE INUNDATION AREA	
			TOTAL EXPOSED VALUE (BUILDING AND CONTENTS IN DOLLARS)	PERCENT OF TOTAL VALUE EXPOSED	TOTAL EXPOSED VALUE (BUILDING AND CONTENTS IN DOLLARS)	PERCENT OF TOTAL VALUE EXPOSED	TOTAL EXPOSED VALUE (BUILDING AND CONTENTS IN DOLLARS)	PERCENT OF TOTAL VALUE EXPOSED
Anchorage	$57.5B	16	---	---	$8.6M	0.01%	---	---
Chugiak	$1.7B	23	$17.1M	0.99%	---	---	---	---
Eagle River	$4.8B	130	---	---	---	---	$39.9M	0.82%

An estimated 169 structures are identified as being at risk from one of three dam failure scenarios. Exposure to dam failure and inundation is greatest with the Lower Fire Lake inundation relative to exposure from dam failure and inundation from Eklutna Lake and Lake 'O' the Hills. The total exposed dollar value correlating with dam failure at the Lower Fire Lake inundation area is nearly $40 million. In all inundation areas, less than 1% of the total community's building and content value is exposed.

Communities can use the dam failure inventory assessment to identify properties for mitigation projects as well as areas for additional outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

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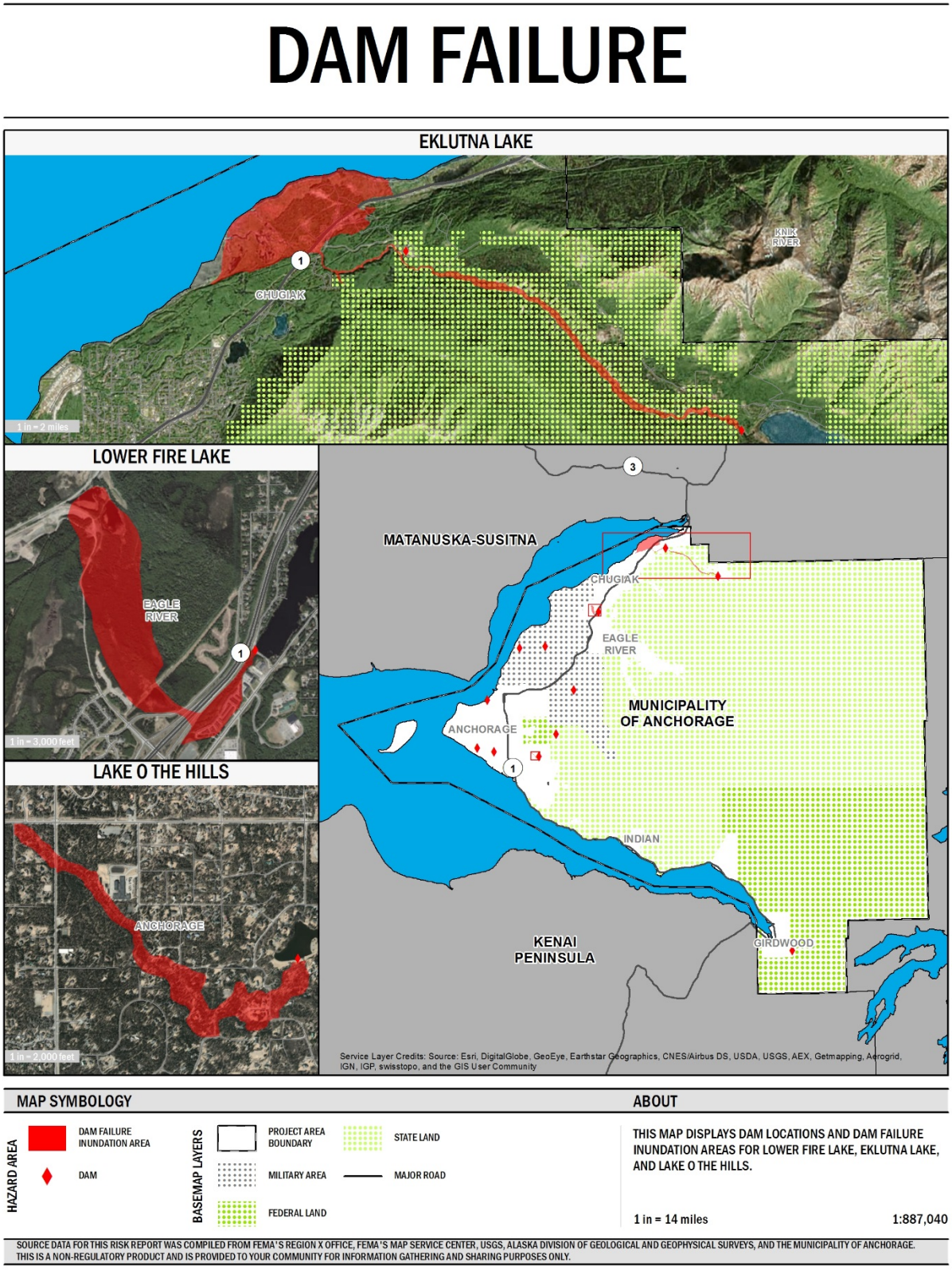
Map 11: Inundation and Loss Estimates for Lake 'O' the Hills Dam Failure



9. Landslide Exposure Assessment

Landslide Hazard Overview

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

Landslide Exposure Assessment

To estimate where landslide hazard occurrences could potentially affect properties within the Municipality of Anchorage, the project team performed a spatial analysis to identify vulnerable structures with an estimated potential loss based on exposure. For this exposure assessment, the team compared the locations of improved parcels to the geographic extent of deep transitional landslides (Jibson and Michael, 2009). Spatial data for shallow landslide zones are not available. The results of the exposure assessment are shown in Table 18.

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Note: Information on the timeline has been pulled from the FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having "landslide, mudslide, or rockslide" as terms found in the incident title.

Figure 12: Recent Presidentially Declared Landslide Disaster History for Alaska

Table 18: Parcel Improvement Exposure Associated with Landslide in the Municipality of Anchorage

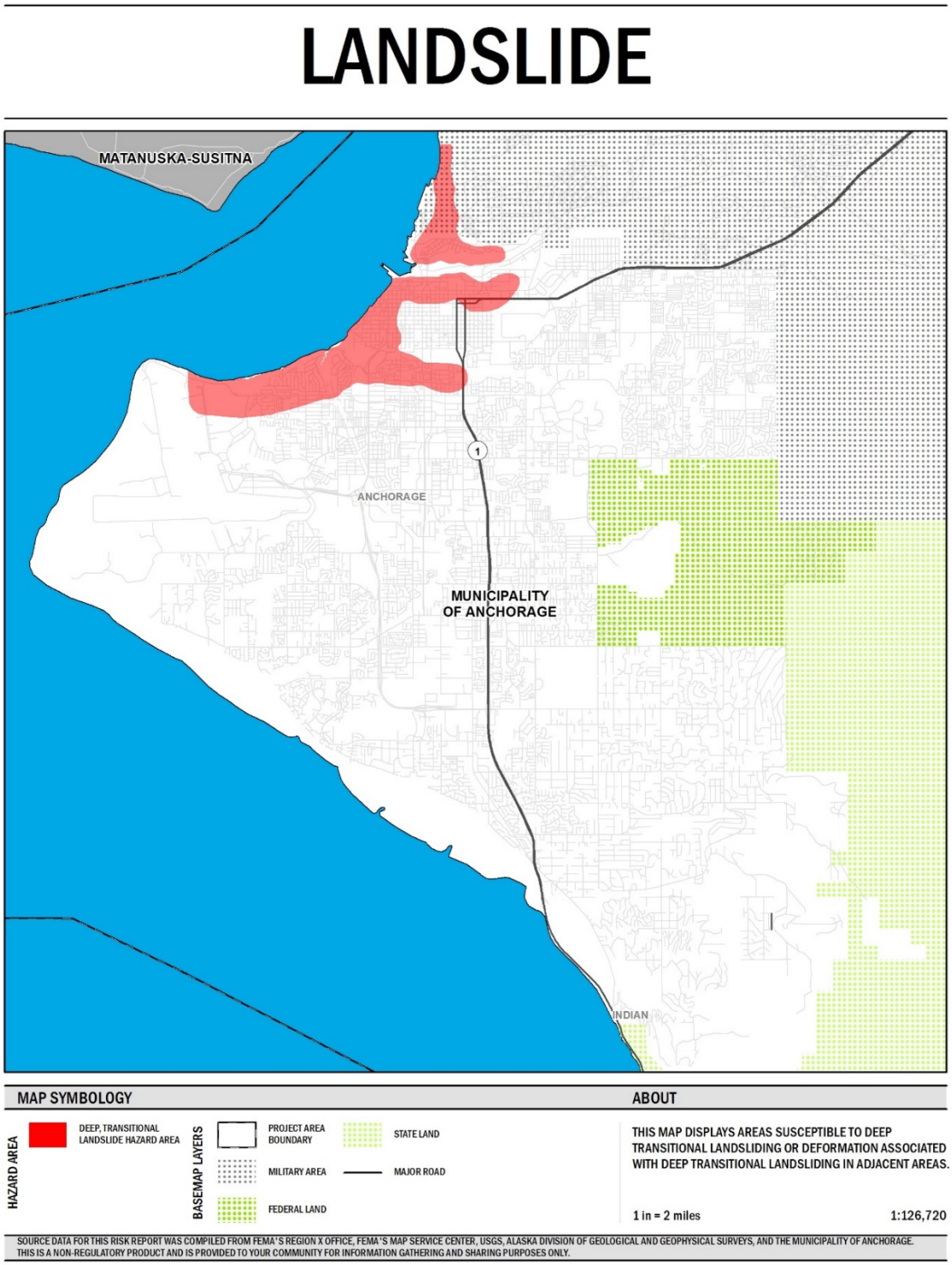
COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS)	TOTAL NUMBER OF BUILDINGS IN HAZARD AREA	DEEP, TRANSITIONAL LANDSLIDE ZONE		SHALLOW LANDSLIDE ZONE	
			TOTAL DOLLAR LOSS	LOSS RATIO	TOTAL DOLLAR LOSS	LOSS RATIO
Anchorage	$57.5B	5,088	$6.3B	10.93%	*	*
Chugiak	---	---	---	---	*	*
Eagle River	---	---	---	---	*	*
Girdwood	---	---	---	---	*	*
Indian	---	---	---	---	*	*
AK Bureau of Land Management	---	---	---	---	*	*
Chugach State Park	---	---	---	---	*	*
Chugach National Forest	---	---	---	---	*	*
Elmendorf Air Force Base	$281.3M	4	$16.2M	5.76%	*	*
Fort Richardson Military Reservation	---	---	---	---	*	*
TOTAL	**$57.8B**	**5,092**	**$6.3B**	**10.90%**	*	*

*Pending Municipality of Anchorage spatial data
Note: Loss ratio is the dollar losses/total value.

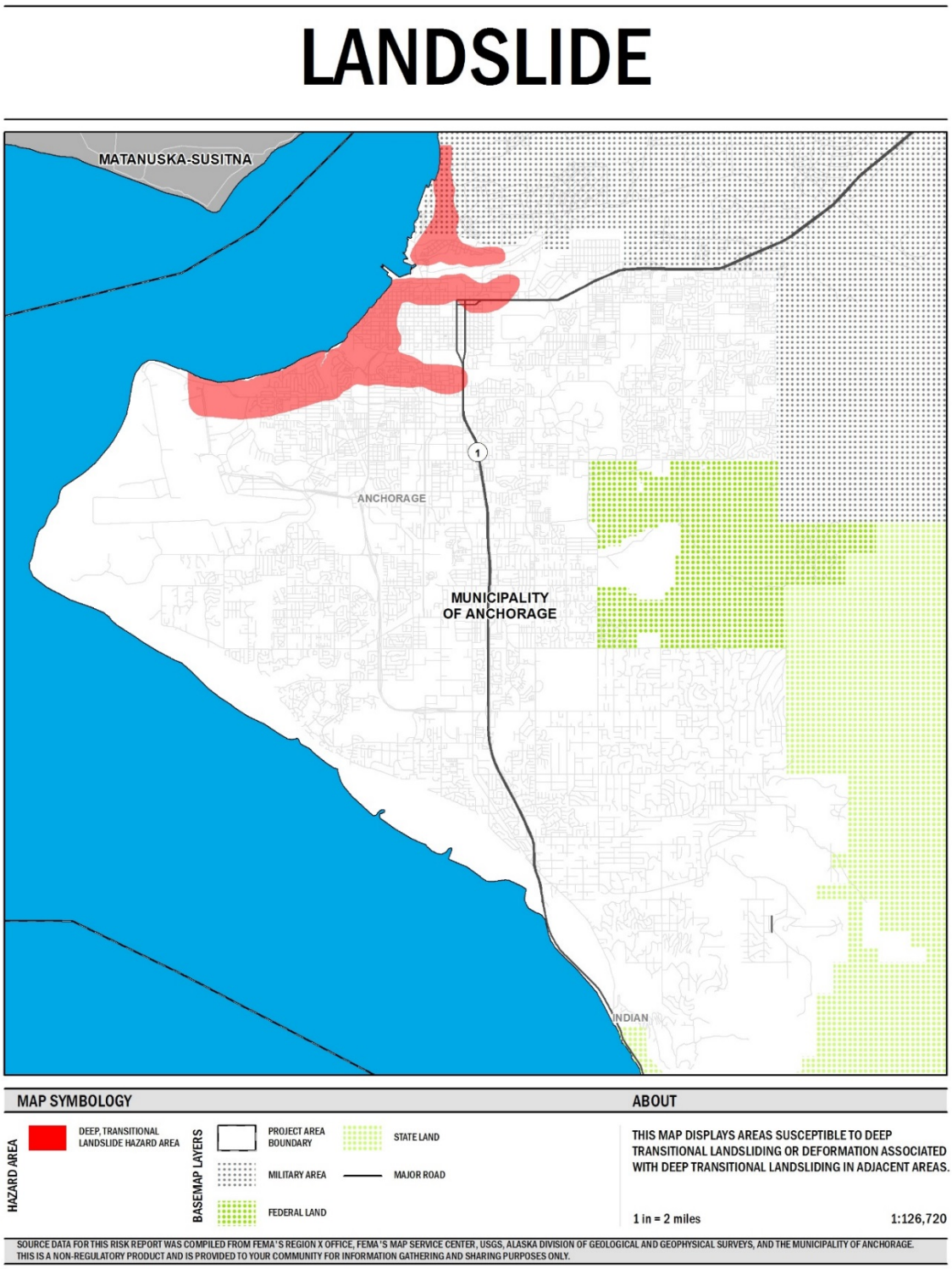
Approximately $6.3 billion of building and contents value (5,092 improved parcels) in the studied communities are at risk from a deep, transitional landslide hazard occurrence. Deep, transitional landslide risk produces more loss than shallow landslide occurrences. A translational slide is a landslide where the mass moves along a somewhat planar (flat) surface with little rotation or backward tilting. This can cause the mass to build up, resulting in a relatively coherent, heavy mass slide. Roughly 10.9 percent of the vulnerable buildings are exposed to this type of hazard event. Anchorage and Elmendorf Air Force Military Reservation receive the majority of exposure from potential landslide hazards.

Local officials can use the landslide inventory assessment to identify properties for mitigation projects as well as areas for additional outreach. Areas of greatest impact and potential mitigation actions are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 12: Deep, Transitional Landslide Risk in the Municipality of Anchorage



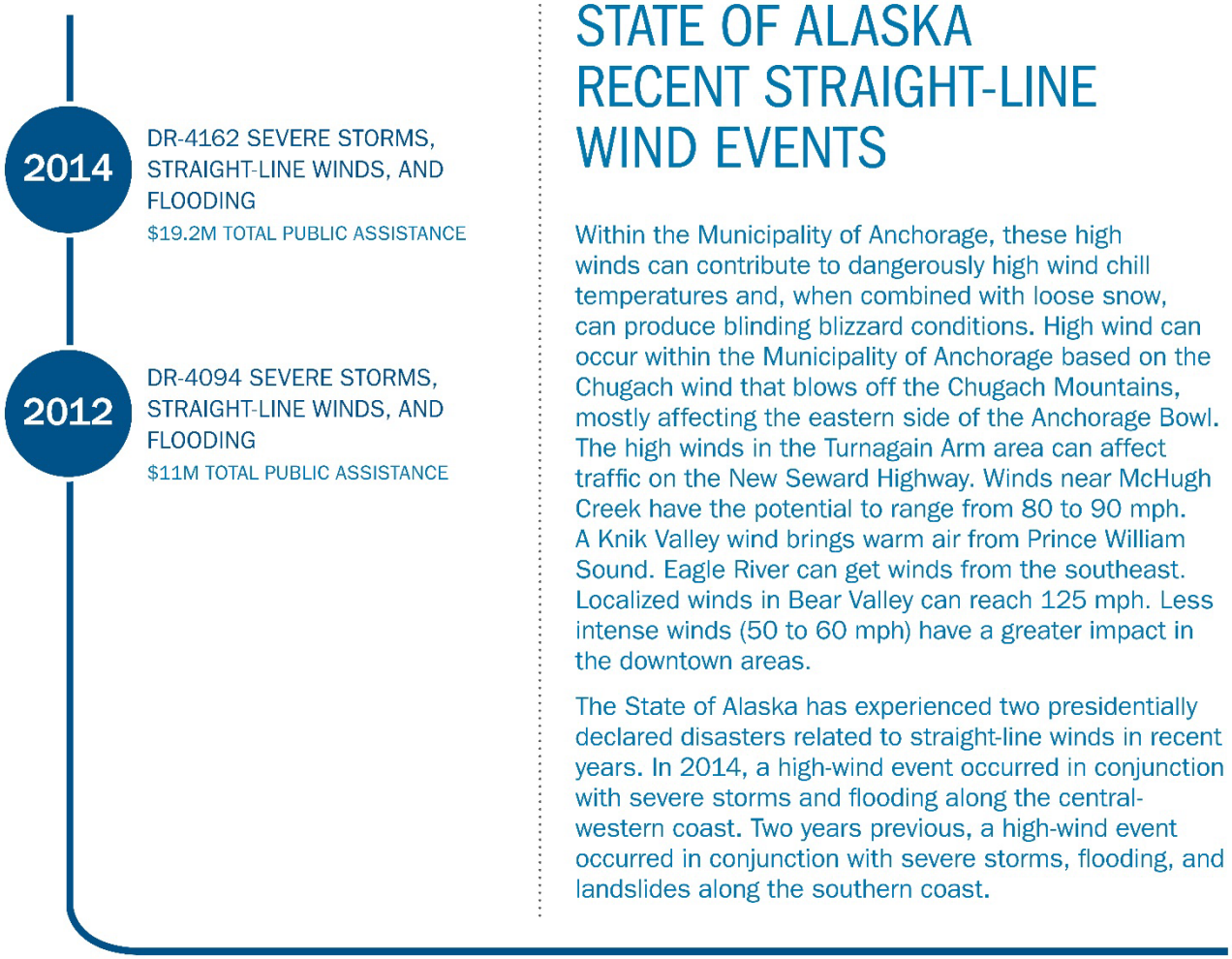
Map 13: Shallow Landslide Risk in the Municipality of Anchorage



10. Wind Exposure Assessment

Wind Hazard Overview

Extreme winds other than tornadoes occur in all regions of the United States. A straight-line wind is generally any wind that is not associated with rotation (i.e., not a tornado). These high winds can vary from zero to 200 mph. High-wind events do not have narrow tracks like tornadoes; therefore, the associated wind damage can be extensive and affect larger areas. Objects like trees, structures, vehicles, and power lines/power poles can be collapsed or destroyed, and roofs, windows, and residences can be damaged by an increase in high-wind occurrences.



Note: Information on the timeline has been pulled from the FEMA Disaster Declarations Summary - Open Government Dataset, the FEMA Hazard Mitigation Program Summary - Open Government Dataset, and FEMA's Disasters web page. The summaries listed above are categorized as having "straight-line wind" as a term found in the incident title.

Figure 13: Presidentially Declared Disasters for Straight-Line Wind in the State of Alaska

Wind Exposure Assessment

Wind risk within the Municipality of Anchorage is associated with wind speed, which the project team divided into four separate zones based on 3-second gusts. Wind Risk data was obtained from the City of Anchorage. For this exposure assessment, the team compared locations of improved parcels to the geographic extent of high wind. The results of the assessment are summarized in Table 19.

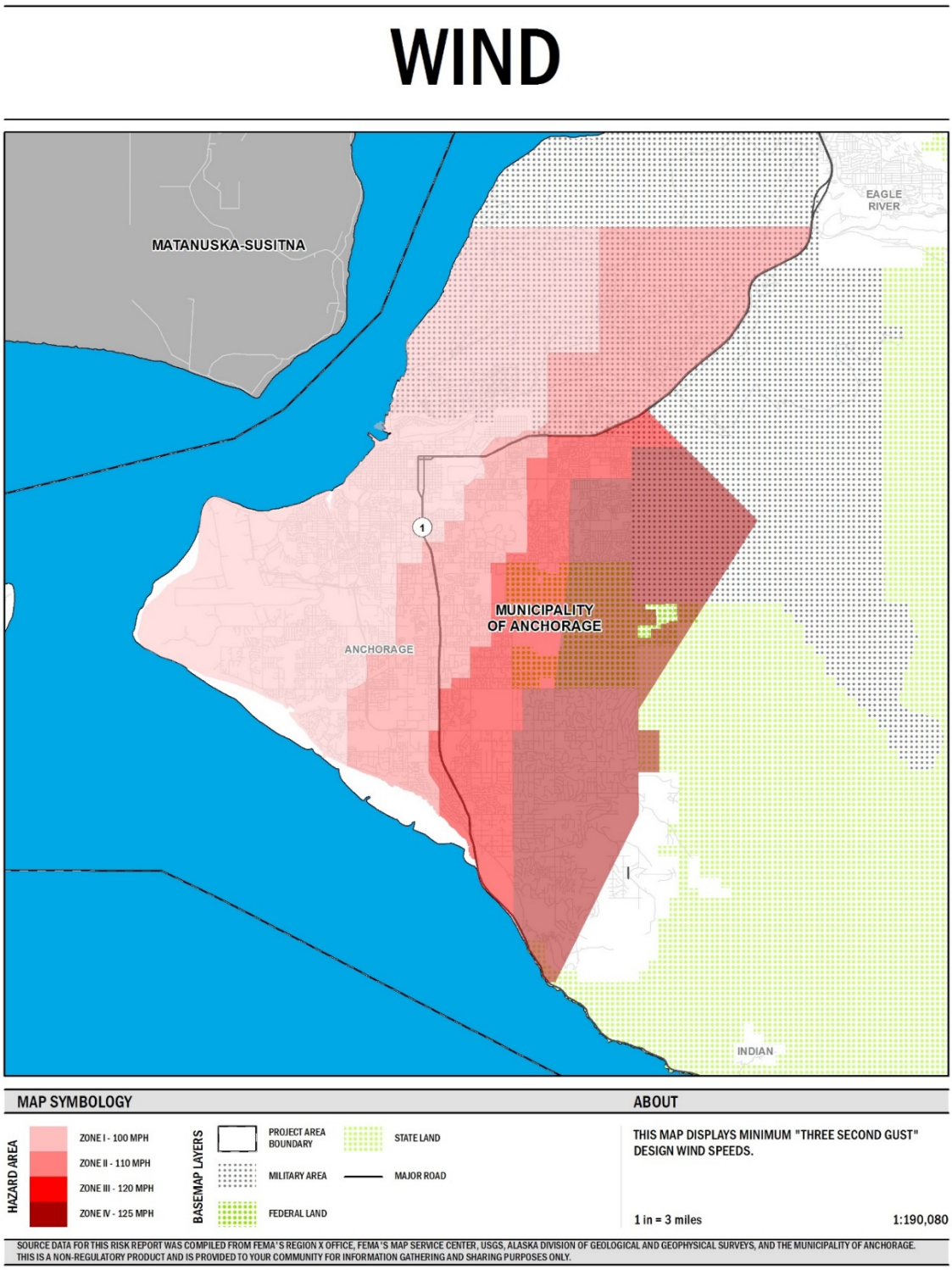
Table 19: Parcel Improvement Exposure Associated with High-Wind Events in the Municipality of Anchorage

COMMUNITY NAME	TOTAL ESTIMATED VALUE (BUILDINGS AND CONTENTS IN DOLLARS) IN HAZARD AREA	ZONE I 3-SECOND GUST: 100 MPH		ZONE II 3-SECOND GUST: 110 MPH		ZONE III 3-SECOND GUST: 120 MPH		ZONE IV 3-SECOND GUST: 125 MPH	
		BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE	BUILDING VALUE	PERCENT BUILDING VALUE
Anchorage	$57.4B	$26.2B	45.70%	$15.4B	26.77%	$9.7B	16.82%	$6.1B	10.71%
Indian	$252,979	---	---	---	---	---	---	$252,979	100.00%
AK Bureau of Land Management	$356.3M	---	---	---	---	$276.8M	77.68%	$79.5M	22.32%
Elmendorf Air Force Base	$281.3M	$20.3M	7.23%	$256.0M	91.02%	$4.9M	1.75%	---	---
Fort Richardson Military Reservation	$305.8M	---	---	$152.1M	49.73%	$153.7M	50.27%	---	---
TOTAL	**$58.3B**	**$26.2B**	**45.00%**	**$15.8B**	**27.04%**	**$10.1B**	**17.29%**	**$6.2B**	**10.68%**

Most of the estimated building and contents values are in the Zone I 3-second gust area ($26.2 billion). Zone I contains 3-second wind gusts over 100 mph. Zone II (110-mph wind gusts) and Zone III (120-mph wind gusts) include $15.8 and $10.1 billion in building and contents values, respectively. Zone IV (3-second wind gusts of 125 mph) contains $6.2 billion in building and contents values. Chugiak, Eagle River, and Girdwood do not have identified high wind hazards. High wind hazards have the potential to impact various regions within the Municipality of Anchorage, including downtown and populated areas.

Local officials can use the high-wind inventory assessment to identify areas for mitigation action. The areas of impact are discussed in Section 13, Areas of Mitigation Interest. All results, databases, and maps are provided in the Risk Assessment Database included with this Risk Report.

Map 14: 3-Second Wind Gust Zones in the Municipality of Anchorage



11. Wildfire Exposure Assessment

Wildfire Hazard Overview

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

The Municipality of Anchorage's location in the boreal forest causes concerns about risk. Fuel, weather, and topography influence wildland fire behavior. The amount of fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. The primary fuels in wildland fires are living and dead vegetation. Weather is the most variable and uncontrollable factor in wildland fire fighting. Weather includes temperature, relative humidity, wind, and precipitation. High temperatures and low humidity encourage fire activity, while low temperatures and high humidity help retard fire behavior. Wind dramatically affects fire behavior and is a critical factor in the spread and control of the fire. Topography directs the movement of air, which can also affect fire behavior. When the terrain funnels air, as in a canyon, it can result in a faster-spreading fire.

No declared wildfire disasters have been identified in the Municipality of Anchorage; however, the potential exists. Every year, the Anchorage Fire Department puts out dozens of fires that could have been disastrous if not contained early. Between 2001 and 2006, the Municipality of Anchorage had 622 wildfire calls that burned approximately 200 acres (Anchorage All Hazards Mitigation Plan, 2011). Most recently, in the summer of 2016, 778 acres burned south of Anchorage after a campfire was left unattended (Alaska Division of Forestry). This became known as the McHugh Fire. The fire resulted in temporary closures of the Chugach State Park and the Seward Highway, and caused flight restrictions in the fire area. Fire crew efforts and wet weather suppressed the flames, and no structures were damaged. Map 15 provides a visual of past fire incidents documented by the Bureau of Land Management and the Municipality of Anchorage and includes the McHugh fire footprint.

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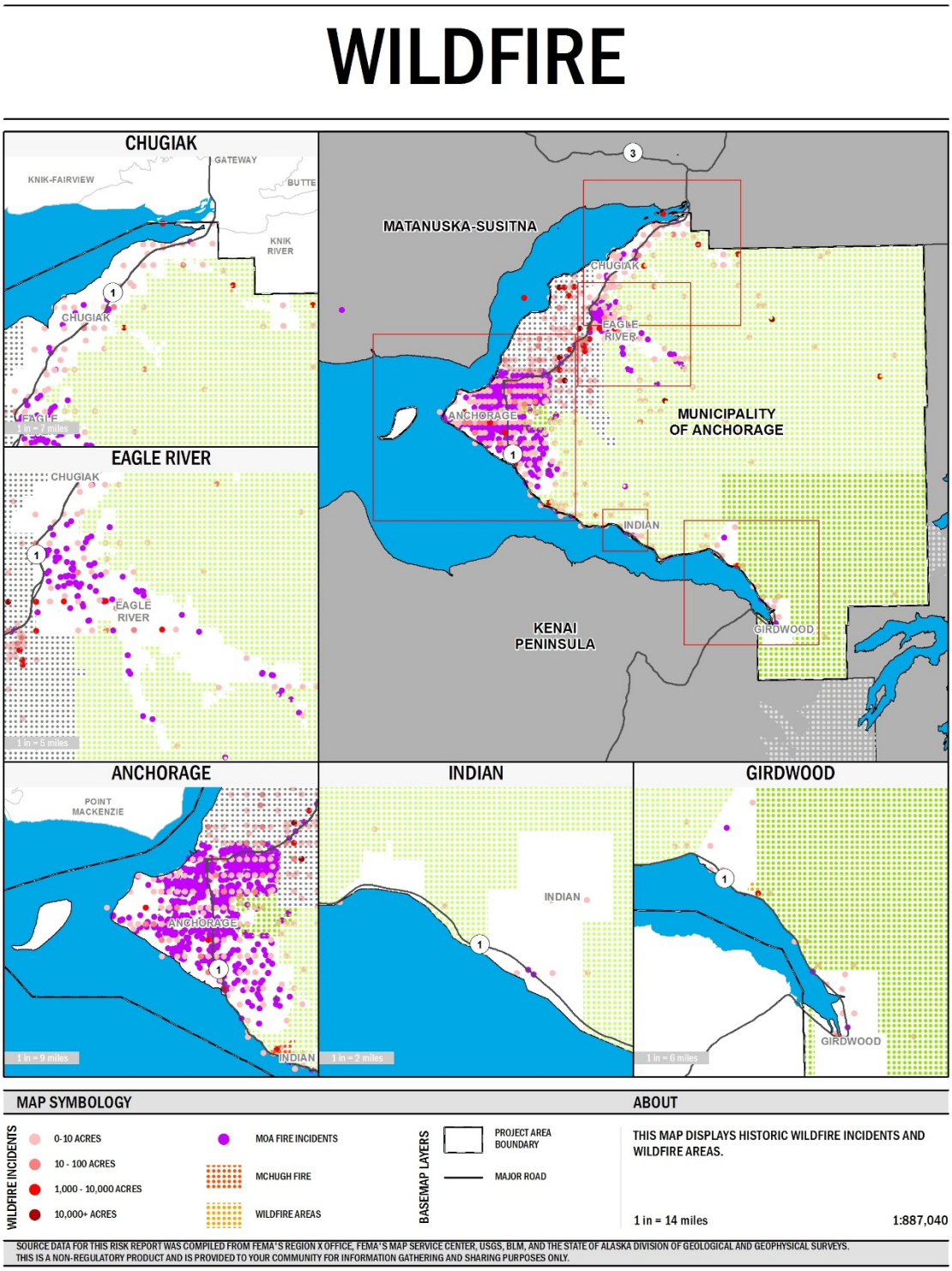
Map 15: Historic Wildfire Incidents within the Municipality of Anchorage



12. Plan Integration

A community is best able to reduce its risk when hazard mitigation becomes a fully considered part of its normal planning processes. That means the community's existing planning mechanisms—the plans, policies, codes, and programs that guide development—are informed by data on natural hazards, support the community's mitigation goals, and are used to implement its mitigation strategy. When these tools all reference and support each other, it helps the community protect people and property, identify actions and activities to reduce losses, and maintain important services after a hazard event.

This Risk Report and accompanying Risk Assessment Database should therefore not be viewed in isolation; it can be an integrated part of planning processes within the Municipality of Anchorage. The data summarized in the report may be used to support day-to-day decision making and longer-term planning efforts, such as updates to comprehensive plans and other regulatory tools that inform land use decisions.

This section will provide a brief overview of how risk data, hazard mitigation, and local plans can work together and strengthen each other; highlight some of the ways that the Municipality of Anchorage is already doing this; identify additional steps to take; and describe the benefits of these efforts. For a more in-depth look at this topic, visit https://www.fema.gov/media-library/assets/documents/89725 for a guidance on plan integration, or visit https://www.fema.gov/media-library/assets/documents/31372 for additional recommendations, case studies, and tools.

Using the Risk Report

Among the ways that local officials can use this report is in the development of community plans. The risk assessment can help communities generate appropriate strategies and avoid decisions that increase exposure to risk. Communities may wish to consult this report when developing or updating the following:

- Local HMP
- Comprehensive plan
- Land use maps or designations
- Zoning ordinance
- Subdivision regulation
- Building codes
- Future planned development areas
- Capital improvement plan
- Transportation projects
- Utility projects
- Economic or community development strategies
- Evacuation routes
- Emergency response plans
- Continuity of operations plans
- Growth management plans
- Conservation and restoration priorities
- Water resource inventory areas
- Critical area regulation

The datasets delivered with this report can be incorporated into any mapping used to support the development of these plans and projects. The risk assessment can also be used in stakeholder outreach and public meetings that are part of planning processes. Specific sections may be useful in certain planning contexts. For example, the socioeconomic trends highlighted in Section 4—such as the fact that Anchorage has a higher percentage of non-English speaking residents than the State—should help inform community engagement and outreach tactics.

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Overall Integration

In addition to the potential uses of this Risk Report and Risk Assessment Database, there are steps communities can take to make natural hazard mitigation an integrated part of local planning. The community's comprehensive plan, HMP, and other tools that inform land use decisions should all work together toward unified goals and objectives.

Integrating natural hazard mitigation into comprehensive planning has many benefits. Integration will:

- Enhance both the comprehensive planning process and the natural hazard mitigation strategy;
- Reduce a community's vulnerability to disasters;
- Support effective pre- and post-disaster decision making;
- Create effective planning tools;
- Help to efficiently return an affected community to normalcy following a hazard event;
- Provide a forum for analysis of potentially sensitive issues;
- Improve coordination and information sharing among departments; and
- Increase awareness and implementation of natural hazard mitigation.

The relationship between a community's comprehensive plan and HMP is key to achieving this. The comprehensive plan establishes policies that are intended to guide day-to-day land use decisions and capital facilities expenditures. These policies have a major impact on whether people and property are exposed to natural hazards. Meanwhile, the HMP forms the groundwork for a community's long-term strategy to reduce disaster losses.

Table 20: Interconnection of the Comprehensive Plan and HMP

HOW THE COMPREHENSIVE PLAN SUPPORTS THE HMP	HOW THE HMP SUPPORTS THE COMPREHENSIVE PLAN
• The comprehensive plan is a key regulatory capability that can be used to implement the HMP's mitigation strategy and guide development away from high-hazard areas. • Including hazard information and goals in the comprehensive plan elevates the importance of mitigation and makes it part of the community's overall vision.	• Through the HMP planning process, the community has already identified its biggest risks and vulnerabilities, most important goals, and top mitigation priorities. • The HMP identifies data sources for obtaining up-to-date information on natural hazards and high-hazard areas.

Integration in the Municipality of Anchorage

The Municipality of Anchorage's All Hazards Mitigation Plan was approved in 2016 and will not expire until 2021. Multiple mitigation strategy goals of the HMP, including Objective 2.2 and Action 6, support the integration and increased coordination between the hazard mitigation goals outlined in the HMP and existing and future plans, including the Capital Improvement Program, Comprehensive Plan, and other long-range plans and capital improvement budgets.

The 2020 Anchorage Bowl Comprehensive Plan's Land Use and Transportation Policies and Strategies and Design and Environment Policies and Strategies sections present the following policies that can be supported by the mitigation strategies in the HMP:

- Policy Number 3: The Municipality shall employ development strategies for the Anchorage Bowl in order to accommodate additional dwellings.

- Policy Number 13: New rural residential subdivisions shall be designed to: c) protect, maintain, or avoid sensitive environmental areas (wetlands, steep slopes, drainage ways, unsuitable soils, geohazard areas).

- Policy Number 72: The Municipality shall minimize the incidence of new developments for human occupancy in high natural hazard areas.

Furthermore, the Implementation Policies and Strategies section outlines that there is a responsibility to synchronize long-range municipal land use plans, transportation plans, and land management plans of local, State, and Federal agencies with Anchorage 2020.

Improving Integration

To achieve effective integration, communities should make sure their comprehensive plans include background information on natural hazards; clearly identify any hazard-prone areas in the community; and incorporate mitigation goals, objectives, policies, and projects into the appropriate plan sections.

While the hazardous areas component provides a clear opportunity to integrate hazard mitigation into the comprehensive plan, it is not the only element pertinent to hazard mitigation. Language on hazard mitigation strategies or actions may be integrated across all elements of the plan. Communities may want to consider how their mitigation priorities relate to these components:

- Rural areas and natural resource lands
- Services, facilities, and utilities
- Transportation
- Shorelines
- Urban Communities
- Economic development
- Parks, open space, and cultural resources

Other specific steps that the Municipality of Anchorage can take to improve plan integration include the following:

- Within the Land Use section of the comprehensive plan, address all hazards found in the HMP and reflect their rankings.
- Increase the connection between residential and commercial development and hazard mitigation efforts in the Land Use Future Growth Action list.

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- Expand the Four Possible Growth Scenarios maps in the Comprehensive Plan Appendix to include risk assessment data that shows spatial analysis of hazard extents to ensure that growth is not occurring in high-hazard areas.
- Update the municipality's floodplain ordinance to reference the HMP and evaluate whether the ordinance reflects the HMP's and comprehensive plan's flood-specific prioritized actions.

FEMA can assist communities that are preparing to update an existing planning document, provide examples of successful integration, and/or help communities come up with an integration strategy.

13. Areas of Mitigation Interest

This section of the Risk Report takes risk findings from Hazus models and other hazard overlays and focuses on specific areas where mitigation efforts should occur. These areas are called AOMIs and were developed through conversations with each community during the Risk MAP process as well as through analysis of various datasets for flood, earthquake, and tsunami hazards. The AOMI targets areas where potential damage, economic loss, and casualties could occur from a hazard event.

FEMA has provided strategies for mitigation in these specific areas. These resilience strategies advise ways the risks to hazards can be reduced, thereby decreasing potential damage, economic loss, and casualties during hazard events. The resilience strategies suggest potential projects for hazard mitigation, encouraging local collaboration, and communicating how various mitigation activities can successfully reduce risk. This information is intended to serve as a tool for discussion among local stakeholders to develop strategies specific to a community's socioeconomic and political geographies. The strategies are samples of a starting point. The AOMI section in this Risk Report provides a high-level summary of the critical facilities that will be most impacted by a chosen hazard scenario. The Risk Assessment Database provides a comprehensive analysis of all critical facilities provided in the Municipality of Anchorage assessor's dataset and the estimated damage costs from all the hazard scenarios presented in this Risk Report. Other plans, such as the Anchorage HMP and Comprehensive Plan, provide additional details that complement the information provided here and they are reviewed in this section.

Municipality of Anchorage

Areas of Mitigation Interest and Recommended Resilience Strategies

The project team completed an assessment of the Municipality of Anchorage based on Hazus earthquake models and exposure assessments in mapped 0.2-percent-annual-chance and 1-percent-annual-chance flood hazard areas, areas where wildfires have historically occurred, and avalanche, dam failure, landslide, and wind hazard areas. Table 21 highlights facilities in the Municipality of Anchorage that FEMA's analysis shows to be most affected by these hazards.

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Table 21: Municipality of Anchorage Areas of Mitigation Interest

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M7.2 EARTHQUAKE	M7.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
ANCHORAGE	EOC	ANCHORAGE EMERGENCY OPERATIONS CENTER	$68,658,180	$1,402,320	2.04%	EARTHQUAKE
ANCHORAGE	FIRE	ANCHORAGE FIRE STATION 3	$54,129,820	$1,042,780	1.93%	EARTHQUAKE
ANCHORAGE	FIRE	ANCHORAGE FIRE STATION 4	$9,016,580	$164,730	1.83%	EARTHQUAKE
ANCHORAGE	SCHOOL	PAIDEIA COOPERATIVE SCHOOL	$14,285,230	$257,520	1.80%	EARTHQUAKE
ANCHORAGE	SCHOOL	WILLIAM TYSON ELEMENTARY SCHOOL	$24,009,160	$416,910	1.74%	EARTHQUAKE
ANCHORAGE	SCHOOL	MEARS MIDDLE SCHOOL	$67,616,130	$1,174,140	1.74%	EARTHQUAKE
ANCHORAGE	SCHOOL	TUDOR ELEMENTARY SCHOOL	$24,055,530	$392,160	1.63%	EARTHQUAKE, FLOODING
ANCHORAGE	SCHOOL	STELLAR SECONDARY SCHOOL	$18,839,480	$307,130	1.63%	EARTHQUAKE
ANCHORAGE	SCHOOL	UNIVERSITY OF ALASKA ANCHORAGE	$34,082,250	$547,250	1.61%	EARTHQUAKE
ANCHORAGE	EOC	ANCHORAGE EMERGENCY OPERATIONS CENTER	$68,658,180	$1,402,320	2.04%	EARTHQUAKE
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 32	$649,100	$7,810	1.20%	EARTHQUAKE
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 33	$678,170	$6,320	0.93%	EARTHQUAKE
CHUGIAK	SCHOOL	MIRROR LAKE MIDDLE SCHOOL	$71,926,930	$581,120	0.81%	EARTHQUAKE
CHUGIAK	FIRE	CHUGIAK VOLUNTEER FIRE STATION 31	$2,582,270	$15,480	0.60%	EARTHQUAKE
CHUGIAK	SCHOOL	BIRCHWOOD ELEMENTARY SCHOOL	$148,863,910	$852,250	0.57%	EARTHQUAKE
CHUGIAK	SCHOOL	CHUGIAK ELEMENTARY SCHOOL	$24,959,950	$135,890	0.54%	EARTHQUAKE

LOCATION	CATEGORY	NAME	TOTAL VALUE (BUILDING AND CONTENTS)	ESTIMATED LOSS FROM M7.2 EARTHQUAKE	M7.2 EARTHQUAKE LOSS RATIO	IDENTIFIED HAZARDS
EAGLE RIVER	POLICE	ANCHORAGE POLICE DEPARTMENT SUBDIVISION	$8,745,160	$91,110	1.04%	EARTHQUAKE
EAGLE RIVER	FIRE	ANCHORAGE FIRE STATION 11	$921,450	$8,810	0.96%	EARTHQUAKE
EAGLE RIVER	SCHOOL	EAGLE RIVER ELEMENTARY SCHOOL	$19,830,490	$165,760	0.84%	EARTHQUAKE
EAGLE RIVER	SCHOOL	HOMESTEAD ELEMENTARY SCHOOL	$23,821,620	$184,290	0.77%	EARTHQUAKE
EAGLE RIVER	SCHOOL	EAGLE ACADAMEY CHARTER SCOOL	$9,987,480	$70,450	0.71%	EARTHQUAKE
EAGLE RIVER	FIRE	CHUGIAK VOLUNTEER FIRE STATION 35	$6,279,370	$35,610	0.57%	DAM FAILURE, EARTHQUAKE, FLOODING
EAGLE RIVER	SCHOOL	RAVENWOOD ELEMENTARY SCHOOL	$21,441,140	$116,210	0.54%	EARTHQUAKE
EAGLE RIVER	SCHOOL	ALPENGLOW ELEMENTARY SCHOOL	$24,272,600	$131,560	0.54%	EARTHQUAKE
EAGLE RIVER	SCHOOL	GRUENING MIDDLE SCHOOL	$51,237,560	$270,710	0.53%	EARTHQUAKE
EAGLE RIVER	FIRE	SOUTH FORK VOLUNTEER FIRE	$1,324,240	$5,750	0.43%	EARTHQUAKE, FLOODING
EAGLE RIVER	POLICE	ANCHORAGE POLICE DEPARTMENT SUBDIVISION	$8,745,160	$91,110	1.04%	EARTHQUAKE
GIRDWOOD	FIRE	GIRDWOOD FIRE DEPARTMENT STATION 41	$9,285,180	$11,330	0.12%	EARTHQUAKE, FLOODING

Note: Hazards are considered identified if the following applies:

1. Earthquake: Subject is at risk to earthquake regardless of estimated loss
2. Flood: Subject is within a 0.2-percent-annual-chance or 1-percent-annual-chance flood hazard area
3. Avalanche: Subject is within a parcel along an identified avalanche hazard area
4. Dam Failure: Subject is within a dam failure inundation area
5. Landslide: Subject is within a deep, transitional landslide hazard area
6. Wind: Subject is within a Zone III or IV wind area

Subjects with the location of Anchorage were limited to a M7.2 earthquake loss ratio of 1.5 percent or higher.

Center for Climate and Energy Solutions Disaster Resilience Workshop and Risk MAP

The Center for Climate and Energy Solutions (C2ES) hosted a Disaster Resilience Workshop in Anchorage March 29-30, 2016. The goal of the workshop was to assess the Municipality's resilience according to the "Ten Essentials" of Disaster Resilience according to the publication by the United Nation's International Strategy for Disaster Reduction. Attendees of the workshop included representatives from the State, Municipality, Port of Alaska, utilities, local businesses, environmental organizations, economic organizations, Tribal organizations, and other local stakeholders.

The workshop resulted in the completion of a scorecard based on the "Ten Essentials" and documented local needs and conclusions for these criteria. The below table lists the C2ES conclusion for each of the "Ten Essentials" and provides an explanation, where applicable, of how the Risk MAP data and process can support the results of the C2ES Workshop.

Table 22: "Ten Essentials" of Disaster Resilience and Connections to Risk MAP

ESSENTIAL #	C2ES CONCLUSION	FEMA RISK MAP SUPPORT
1	Organize for Resilience: Anchorage has a strong organizational foundation for disasters, having experienced earthquakes and other events. Long-term resilience to climate change has been less covered, and the municipality could strengthen coordination externally (e.g., with neighboring jurisdictions, community groups, the private sector).	Generally, climate change models in Alaska predict a warming trend in temperatures and longer duration of precipitation events with higher intensities. This could result in larger, more frequent flooding events and warmer summers with a higher probability of wildfires. The Risk MAP data can be used to further assess flood and wildfire risk and vulnerabilities, as well as to inform land use planning decisions by identifying infrastructure and populations at risk to different scenarios and implementing regulations with higher building standards in identified high-risk areas. Additionally, this analysis can assist with focusing outreach activities to targeted audiences and geographic areas.
2	Identify, Understand, and Use Current and Future Risk Scenarios: Anchorage has a good understanding of acute shocks (e.g., earthquakes, wildfires) and has planned for these events, but chronic stresses (e.g., coastal erosion, changes in hydrology) are less understood and planned for.	The Risk MAP data can enhance existing understanding of acute shocks. This data should be reviewed by the local emergency planning committee, integrated into the next update of the Municipality's HMP, and can facilitate the planning committee's discussion on risk and vulnerability to more chronic stresses and whether they should also be added into the local HMP.
3	Strengthen Financial Capacity for Resilience: Anchorage's financial planning for resilience, its understanding of the costs and benefits of resilience investments, and its use of incentives collectively represent the weakest of the "Ten Essential" areas reviewed. There is no "financial atlas" of where funding for resilience purposes may come from that embraces all possible public and private sources.	The data developed through the Risk MAP process can be used to support cost-benefit analysis of risk reduction strategies. For example, the loss estimations provided through the Hazus earthquake modeling can be used to explore the costs and benefits of seismic retrofitting. State subject matter experts present at the Risk MAP resilience Workshop can provide guidance on available grant funding to support risk reduction activities.
4	Pursue Resilient Urban Development: Design standards and building codes in Anchorage focus on resilience to earthquakes and have not yet taken other types of resilience into account. Green infrastructure is one area that could also be used more.	The Risk MAP data can support cost-benefit analysis for changes in regulations and standards. For example, the avalanche risk assessment data can be used to support discussions regarding the adoption of an avalanche ordinance. The Risk MAP Resilience Workshop will bring Building Science subject matter experts and materials to allow for further consultation and coordination.

ESSENTIAL #	C2ES CONCLUSION	FEMA RISK MAP SUPPORT
5	Safeguard Natural Buffers to Enhance the Protective Functions Offered by Natural Ecosystems: Anchorage has some information on the recreational and tourism benefits of ecosystems, but no information on the resilience benefits. Much of the existing research on ecosystems has focused on rural Alaska.	FEMA has published material on the natural and beneficial functions of floodplains. The publication explores the valuable functions of pristine or restored floodplains and their contributions to flood reduction and prevention. FEMA can bring a hard copy of this information to the Risk MAP Resilience Meeting.
6	Strengthen Institutional Capacity for Resilience: Internal municipal coordination on planning and resilience is stronger than coordination with external partners. Anchorage could take steps to improve outreach to residents, community groups, the private sector, etc.	Risk MAP data can be used to conduct targeted outreach to businesses and homeowners specific to the hazards they are vulnerable to. Additionally, FEMA has developed multiple outreach resources which the Municipality can leverage to conduct outreach activities.
7	Increase Societal and Cultural Resilience: Because of existing economic and social issues in Anchorage, the societal and cultural capacity for resilience—connectedness—is low. The city has a very diverse population with almost 100 different languages in a city with around 300,000 people. The municipality could work with existing community networks to conduct outreach, education, and trainings on various issues.	Hazard-specific outreach materials are available from FEMA and can be translated into several languages. Additionally, FEMA and the State offer trainings and additional outreach materials. These needs can be discussed during the Risk MAP Resilience Meeting.
8	Increase Infrastructure Resilience: The State's reliance on Anchorage for its infrastructure, the lack of redundancy, and limited entry points make the city's critical infrastructure (e.g., the port) vulnerable to disasters. Increased coordination among groups and infrastructure improvements will be increasingly necessary for planning.	The Risk MAP Resilience meeting can serve as a coordination opportunity between these various groups to begin discussing risk reduction goals and strategies. Additionally, the local mitigation planning team can coordinate annual meetings to discuss and implement these strategies.
9	Ensure Effective Disaster Response: Anchorage is tactically strong because of the city's experience with disaster response, and therefore has coordinated across various groups for pre-planning and responding. There are some strategic weaknesses that could be addressed through additional coordination, involvement, and outreach, for example in drills and trainings.	Reviewing the Risk MAP Areas of Mitigation Interest (in Table 21) with first responders can help facilitate discussion on critical facilities and inherent vulnerabilities. This data can be used to support emergency planning, including disaster exercises, emergency response plans, and evacuation plans. Additionally, the local mitigation planning team can include first responders in their annual review and update process of the hazard mitigation plan.
10	Expedite Recovery and Build Back Better: Anchorage is stronger on relief than recovery and could benefit from additional scenarios of events that could occur and from exploring how to recover from those events.	The risk assessments documented in the Risk MAP Risk Report can be used as the basis for exercise scenario development. Additionally, the FEMA Risk MAP Resilience Workshop will bring State and Federal subject matter experts on recovery to support the efforts of the Municipality of Anchorage.

Hazard Mitigation Plan and Comprehensive Plan Analysis

The Municipality of Anchorage All-HMP, effective 2016, and the Anchorage 2020 Comprehensive Plan identify some of the hazard mitigation projects in Table 23 that can be aided by information in this Risk Report.

Table 23: Municipality of Anchorage All-Hazard Mitigation Plan and Comprehensive Plan Analysis

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
	PLAN TYPE	PLAN LINK	PROJECTS	
Flood Hazard Area: Spatial data identifies flood hazard areas for 1-percent-annual-chance and 0.2-percent-annual-chance events (only properties in Anchorage, Chugiak, Eagle River, Girdwood, Indian, and the AK Bureau of Land Management with buildings [improvements] were incorporated into the analysis).	Hazard Mitigation Plan	Action 19	The Municipality of Anchorage shall continue to apply floodplain management regulations for development in the floodplain and floodway.	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.
tHazus Flood Output: Spatial and tabular data provide specific building and content loss data for properties affected by flooding (select areas of Anchorage, Chugiak, Eagle River, Fort Richardson, and Girdwood).	Comprehensive Plan	Water Resources Policy 70	The ecological and drainage functions of Anchorage's aquatic resources shall be protected and, where appropriate, restored.	Promote new flood hazard data to the public through existing local events. Show flood hazard areas and how development decisions are made based on hazard information. In areas with repetitive loss properties, consider a buyout program to restore the land back to a natural drainage system.
Earthquake ShakeMap: Spatial data provide shaking intensity and ground motion following an earthquake. Data is provided for the M7.1 Border Rangers Fault Scenario, M7.2 Intraplate Scenario, and M7.5 Castle Mountain Scenario.	Hazard Mitigation Plan	Action 8	Identify critical infrastructure and other facilities that need to be seismically retrofitted or rebuilt to current seismic standards. AFD Fire Stations 8, 10, 11, & 12 are the only stations that have not been upgraded to meet current seismic requirements.	Use Hazus earthquake output and AOMI section to review loss ratios to critical facilities for provided earthquake scenarios. Use the loss information to prioritize retrofit projects.

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
Hazus Earthquake Output: Spatial and tabular data provide specific building and content loss data for properties affected by the M7.1 Border Ranges Scenario, M7.2 Intraplate Scenario, and M7.5 Castle Mountain Scenario.	Comprehensive Plan	Residential Policy 13-c	New rural residential subdivisions shall be designed to protect, maintain, or avoid sensitive environmental areas (wetlands, steep slopes, drainageways, unsuitable soils, geohazard areas).	Host or link to new earthquake ShakeMap hazard data and Hazus outputs on the local permitting website. Use data to prioritize development standards, code enforcement, structure relocation, and educational outreach.
Avalanche Risk Assessment: Spatial and tabular data identify building and content loss for structures located within the avalanche hazard area in Anchorage, Chugiak, Eagle River, Girdwood, Chugach State Park, and Chugach National Forest.	Hazard Mitigation Plan	Action 18	Update snow avalanche mapping for Chugiak/Eagle River, Anchorage Bowl, and Turnagain Arm/Girdwood.	Incorporate avalanche Risk Report Risk Database spatial and tabular data into updated snow avalanche maps.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [avalanche] natural hazard areas.	Use the avalanche risk assessment to identify areas prone to avalanche hazards. Regulate and/or restrict new development in these areas.
Dam Failure Risk Assessment: Spatial and tabular data identify building and content loss for structures located within inundation areas caused by the failure of the Eklutna Lake, Lake 'O' the Hills, and Lower Fire Lake dams. Impacted buildings were located in Anchorage, Chugiak, and Eagle River.	Hazard Mitigation Plan	Action 26	Map estimated dam inundation areas within the Municipality and evaluate alternative methods to mitigate the potential risk of a dam failure in these areas.	Incorporate dam failure Risk Report Risk Database spatial and tabular data into updated dam inundation maps.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [dam failure] natural hazard areas.	Use the dam failure risk assessment to identify areas prone to dam failure inundation hazards. Regulate and/or restrict new development in these areas.
Landslide Risk Assessment: Spatial and tabular data identify building and content loss for structures located within deep transitional landslide zones in Anchorage and on Elmendorf Air Force Base.	Hazard Mitigation Plan	Objective 2.1	Educate individuals and businesses about hazards, disaster preparedness, and mitigation.	Use landslide hazard area special data within deep transitional landslides to prioritize educational outreach and mitigation actions to residents most affected by landslide events; prioritize the community of Anchorage and Elmendorf Air Force Base.
	Comprehensive Plan	Residential Policy 13-c	New rural residential subdivisions shall be designed to protect,	Host or link to new landside hazard data and Hazus outputs on the local

RISK REPORT DATA	RISK REPORT DATA CAN SUPPORT THE FOLLOWING			RISK REPORT LINK
			maintain, or avoid sensitive environmental areas (wetlands, steep slopes, drainageways, unsuitable soils, geohazard areas).	permitting website. Use data to prioritize development standards, code enforcement, structure relocation, development restrictions and regulations, and educational outreach.
Wind Risk Assessment: Spatial and tabular data identify building and content loss for structures exposed to high wind. Wind gusts are measured in four zones based on 3-second gusts; Zone I - 100 mph, Zone II - 110 mph, Zone III - 120 mph, and Zone IV - 125 mph. Impacted communities included Anchorage, Indian, AK Bureau of Land Management, Elmendorf Air Force Base, and Fort Richardson Military Reservation.	Hazard Mitigation Plan	Objective 2.1	Educate individuals and businesses about hazards, disaster preparedness, and mitigation.	Use wind risk assessment hazard area special and tabular data within the communities most affected by high winds to prioritize educational outreach and mitigation actions; prioritize the communities of Anchorage, Indian, AK Bureau of Land Management, Elmendorf Air Force Base, and Fort Richardson Military Reservation.
	Comprehensive Plan	Water Resources Policy 70	The Municipality shall minimize the incidence of new developments for human occupancy in high [wind] natural hazard areas.	Host or link to new wind risk assessment hazard data on the local permitting website. Use data to prioritize development standards, code enforcement, structure relocation, and educational outreach.
Wildfire Risk Assessment: A comprehensive assessment of wildfire risk was unable to be conducted in this report due to lack of data.	Hazard Mitigation Plan	Action 29	Review existing zoning ordinances to determine if additional wildfire mitigation measures could be incorporated to address wildfire mitigation which has been proposed for inclusion in updates to Title 21. Consider adoption of the International Code Council Wildland Urban Interface Code (current edition).	Use wildfire historic occurrence data to demonstrate the need for the Municipality to further study and understand its risks and vulnerabilities to wildfires.
	Comprehensive Plan	Residential Policy 13-d	New rural residential subdivisions shall be designed to incorporate wildland fire safety design standards.	Use wildfire historic occurrence data to demonstrate the need for the Municipality to further study and understand its risks and vulnerabilities to wildfires.

Recommended Resilience Strategies

Based on the assessment above, the strategies summarized in Table 24 are recommended. Additional strategies can be found by referencing the FEMA publication, *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards,* available at https://www.fema.gov/media-library/assets/documents/30627.

Table 24: Municipality of Anchorage Recommended Resilience Strategies

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Multi-Hazard	In the Municipality, the largest percentage of non-English-speaking residents speak Asian and Pacific languages at home, which can be attributed to the larger populations of Filipino, Korean, and Hmong residents.	• Provide outreach materials (both written and verbal) in multiple languages. • Know where vulnerable populations are located and assist with personal preparedness, appropriate evacuations, and after-event repairs.
Flood	Of the 85,378 buildings in the project area, 432 are in Zones A, AE, AH, or AO. The highest projected building losses are in Anchorage, which accounts for almost 75 percent of exposure in the Municipality. An estimated $376 million of at-risk facilities could be lost in a riverine flood event. A $376-million loss accounts for a 0.58-percent loss ratio of the studied buildings.	• 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	Losses estimated from the M7.2 Intraplate Scenario event were high across all communities. The total building and content dollar loss was estimated at close to $468 million, with a municipality-wide loss ratio of 0.71 percent. Fort Richardson Military Reservation (1.15 percent) and Elmendorf Air Force Base (1.08 percent) have the highest loss ratios. The largest total loss values are projected for Fort Richardson Military Reservation ($3.8 million) and Elmendorf Air Force Base ($3.0 million).	• 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.
Avalanche	Eagle River and Girdwood have the largest number of buildings within avalanche hazard areas. Eagle River has 111 structures within avalanche hazard areas and Girdwood has 75 structures. Girdwood has the highest estimated building value exposure (11.49 percent). In total, the Municipality of Anchorage has 0.19 percent of structures vulnerable to potential avalanche hazard occurrences, which places close to $125 million dollars at risk.	• Map avalanche risk hazard areas • Adopt and enforce building codes that set standards for building in high-risk areas. • Develop an outreach program regarding avalanche risk for homeowners, business owners, and winter sports recreation participants. • Consider structural mitigation for at-risk critical infrastructure and facilities • Maintain avalanche prevention programs. • Establish early warning capabilities and outreach mechanisms.
Dam Failure	An estimated 169 structures are identified as exposed from one of three dam failure scenarios. Exposure associated with the Lower Fire Lake inundation area are greater than those estimated for Eklutna Lake and Lake 'O' the Hills. The total estimated dollar exposure correlated with dam failure at the Lower Fire Lake inundation area is close to $40 million. All scenarios have less than 1 percent of the total value exposed to inundation areas.	• Map dam failure inundation areas. • Develop an outreach program on dam failure risk for homeowners and business owners. • Adopt higher regulatory floodplain standards in mapped dam failure inundation areas. • Establish early warning capability downstream of listed high-hazard dams.

HAZARD	PROBLEM STATEMENT	RECOMMENDED STRATEGIES
Landslide	Approximately $6.3 billion (5,092 improved parcels) in the studied communities are identified in a deep, transitional landslide hazard occurrence. Roughly 10.9 percent of the vulnerable buildings are exposed to this type of hazard event. Anchorage and Elmendorf Air Force Military Reservation receive the majority of exposure from potential landslide hazards.	• Apply stabilization measures and debris flow measures to reduce damage in sloping areas. • Restrict development in landslide zone areas. • Relocate critical infrastructure outside of landslide zones. • Develop a buyout program for homes in landslide areas. • Provide educational and outreach materials to educate residents about risks.
Wind	Most of the estimated building values reside in a Zone I 3-second gust area ($26.2 billion). Zone I identifies areas subject to 3-second wind gusts over 100 mph. Zone II (110 mph) and Zone III (120 mph) include $15.8 and $10.1 billion in assets, respectively. Zone IV (3-second wind gust of 125 mph) contains $6.2 billion in assets. Chugiak, Eagle River, and Girdwood contain no high-wind hazard data.	• Adopt and enforce building codes that set standards for building in high-wind regions. • Retrofit residential buildings and critical facilities to reduce wind damage. • Protect powerlines and infrastructure from tree branches, maintain secure power poles, and bury powerlines when possible. • Improve public awareness of severe wind through outreach activities.
Wildfire	Between 2001 and 2006, the Municipality of Anchorage had 622 wildfire calls that burned approximately 200 acres (Anchorage All Hazards Mitigation Plan, 2011). Most recently, in the summer of 2016, 778 acres burned south of Anchorage after a campfire was left unattended (Alaska Division of Forestry).	• Study and understand the wildfire risks to ingress and egress in residential areas. • Mitigate future losses by regulating development in wildfire hazard areas through land use planning. • Develop a wildland-urban interface code to regulate for safer construction and incorporate mitigation consideration into the permitting process. • Create defensible space around structures and infrastructure. • Implement a Fuels Management Program. • Participate in the FireWise program.

While Federal funding for these projects is limited, FEMA recommends incorporating them into the Natural Hazards Mitigation Plan should disaster funds become available. Additional funding may be available through the capital improvement planning process; bond authority; or other local, State, or private funding sources. More information on how to mitigate the effects of natural hazards can be found in the FEMA *Local Mitigation Planning Handbook* at www.fema.gov/media-library/assets/documents/31598?id=7209.

Additional information on integrating the Municipality of Anchorage HMP with the local planning process is provided in the FEMA document *Hazard Mitigation: Integrating Best Practices into Planning,* available at www.fema.gov/media-library/assets/documents/19261?id=4267.

14. References Cited

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Anchorage All Hazards Mitigation Plan, 2011

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Jibson, R.W., and Michael, J.A., 2009, Maps showing seismic landslide hazards in Anchorage, Alaska: U.S. Geological Survey Scientific Investigations Map 3077, scale 1:25,000, 11-p. pamphlet. [Available at URL http://pubs.usgs.gov/sim/3077]Appendix A

Earthquake Hazus Analysis

The project team used the Hazus Advanced Engineering Building Module (AEBM) for this analysis. The underlying approach to AEBM procedures is a combination of the nonlinear static (pushover) analysis methods of the National Earthquake Hazards Reduction Program Guidelines and other sources (namely, the ATC 40 document: *Seismic* E*valuation and Retrofit of Concrete Buildings*, Applied Technology Council and California Seismic Safety Commission, 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 a 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. The AEBM Inventory is structured to accept a "portfolio" of individual buildings, each uniquely defined by (latitude/longitude) location, and 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 can be used to evaluate individual buildings or a group of buildings of a similar type.

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15. Appendix B

Additional Referenced Materials

Disaster Resilience Scorecard Preliminary Review: C2ES Workshop with the City of Anchorage, AK March 29-30.

Mears, A. (1982). *Anchorage Snow Avalanche Zoning Analysis: Prepared for Municipality of Anchorage.* Gunnison, Colorado: Mears, Arthur I. P.E., Inc.

Scroggin, David A. and Batatian, L. Darlene, Avalanche Hazard Investigations, Ordinances, and Zoning, Salt Lake County, Utah. ISSW 2004.

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Salt Lake County Code of Ordinances, Title 19 Zoning, Chapter 19.75 Geological Hazards Ordinance, Section 19.75.083 Avalanche Considerations.

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