

2023

State of Alaska
State Hazard Mitigation Plan



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LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
AAOKH	Alaska Arctic Observatory and Knowledge Hub
ADOT&PF	Alaska Department of Transportation and Public Facilities
AEC	Alaska Earthquake Center
AECOM	AECOM Technical Services, Inc.
AICC	Alaska Interagency Coordination Center
APIP	Alaska Partnership for Infrastructure Protection
AKRR	Alaska Railroad
ANCSA	Alaska Native Claims Settlement Act of 1971
ANTHC	Alaska Native Tribal Health Consortium
APRFC	Alaska Pacific River Forecast Center
ARCS	Alaska Rural Communication Service
ARRC	Alaska Railroad Company
AS	Alaska Statute
AURA	Arctic Urban Risks and Adaptations
AVO	Alaska Volcano Observatory
BAR	Burned Area Rehabilitation
BCA	Benefit Cost Analysis
BLM	Bureau of Land Management
BRIC	Building Resilient Infrastructure and Communities
°C	degrees Celsius
CDBG-DR	Community Development Block Grant–Disaster Recovery
CDBG-MIT	Community Development Block Grant–Mitigation
CF	critical facility
CFR	Code of Federal Regulations
CRS	Community Rating System
CWDG	Community Wildfire Defense Grant
CWIFP	Corps Water Infrastructure Financing Program
CWPP	Community Wildfire Protection Program
DCCED	Department of Commerce, Community and Economic Development
DCRA	Division of Community and Region Affairs
DEC	Department of Environmental Conservation
DEM	Digital Elevation Model
DGGS	Alaska Division of Geological & Geophysical Surveys
DHS&EM	Division of Homeland Security and Emergency Management

DMA 2000	Disaster Mitigation Act of 2000
DMVA	Department of Military and Veteran Affairs
DNR	Department of Natural Resources
DOF	Division of Forestry
DOT/PF	Department of Transportation and Public Facilities
DSE	Dam Safety Engineer
EAP	emergency action plan
EOP	emergency operation plan
EPA	U.S. Environmental Protection Agency
ERP	emergency response plan
°F	degrees Fahrenheit
FDL	frozen debris lobe
FEMA	Federal Emergency Management Agency
FHWA	Federal Highways Administration
FMAG	Fire Management Assistance Grants
FPA	Floodplain Administrator
GIS	geographic information system
HHPD	High Hazard Potential Dam
HIA	Hazard Impact Assessment
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUD	U.S. Department of Housing and Urban Development
IBC	International Building Code
ICC	Increased Cost of Compliance
I-Codes	International Codes
IECC	International Energy Conservation Code
IEBC	International Existing Building Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IRC	International Residential Code
km	kilometer(s)
KPB	Kenai Peninsula Borough
M	Magnitude
MAP	Mapping, Assessment, and Planning
MLW	Mining, Land and Water
MMI	Modified Mercalli Intensity
MOA	Municipality of Anchorage
Mw	Moment Magnitude
NCRF	National Coastal Resilience Fund
NEHRP	National Earthquake Hazard Reduction Program
NFIP	National Flood Insurance Program
NOAA	National Ocean and Atmospheric Administration

NPS	National Park Service
NRCS	Natural Resource Conservation Service
NSF	National Science Foundation
NSGP	Nonprofit Security Grant Program
NTHMP	National Tsunami Hazard Mitigation Program
NTWC	National Tsunami Warning Center
NWI	National Wetland Inventory
NWS	National Weather Service
PGA	Peak Ground Acceleration
PSGP	Port Security Grant Program
PSHA	Probabilistic Seismic Hazard Analysis
REAA	Regional Educational Attendance Area
RMC	Risk MAP Coordinator
RVS	Rapid Visual Screening
SCERP	Small Community Emergency Response Plan
SDE	Substantial Damage Estimations
SEOC	State Emergency Operations Center
SHMP	State Hazard Management Plan
SHSP	State Homeland Security Program
SNAP	Scenarios Network for Alaska + Arctic Planning
State	State of Alaska
THSGP	Tribal Homeland Security Grant Program
UA	University of Alaska
UAA	University of Alaska, Anchorage
UAF	University of Alaska, Fairbanks
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
VIP	Village Infrastructure Protection
WPDG	Wetland Program Development Grant
Y-K	Yukon-Kuskokwim

EXECUTIVE SUMMARY

Alaska experiences many severe natural hazards; therefore, it is vital to have a proactive and comprehensive hazard mitigation strategy. Mitigation measures save lives, reduce injuries, protect critical infrastructure, and decrease financial losses. They can range from public education and land use planning to specific construction actions that reduce hazard losses.

The 2023 Alaska State Hazard Mitigation Plan (Alaska SHMP) is the culmination of a cooperative partnership between the Alaska Division of Homeland Security and Emergency Management (DHS&EM), the Federal Emergency Management Agency (FEMA), and other state and federal agencies, education centers, and community agencies. The Alaska SHMP serves as the strategy document for Alaska's hazard mitigation program while also meeting FEMA requirements for a five-year State Hazard Mitigation Plan update under the Stafford Act. The Alaska SHMP is a living document that is updated annually as new information is obtained.

Successful mitigation is a state-wide effort involving an informed public, dedicated community leaders, and active agencies who jointly strive to prevent, reduce, or eliminate natural hazard impacts. DHS&EM acknowledges the importance of the participation of local boroughs and communities, governmental agencies, universities, subject matter experts, private sector partnerships, and the public, and have incorporated their contributions into this document. Alaska's hazards, vulnerabilities, and mitigation strategy are incorporated into this plan along with data accumulated from 106 approved local, multi-jurisdictional, and tribal hazard mitigation plans.

Based on the results of the risk assessment (Chapter 4), and review of the goals identified in past SHMPs, the Alaska SHMP Task Force revised and streamlined the goals for this 2023 Alaska SHMP update:

- Goal 1: Increase public awareness about the risks from and resilience to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard potential dams.
- Goal 2: Identify locations and State of Alaska (State) critical facilities (CFs) that are vulnerable to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard potential dams; and support local and tribal communities through technical and/or financial assistance in their efforts to do the same.
- Goal 3: Implement projects to reduce risks and increase resilience to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard potential dams; and support local and tribal communities through technical and/or financial assistance in their efforts to do the same.

This 2023 Alaska SHMP update considers the following population and critical facilities:

Table ES-1 shows the population of Alaska from April 2020 to July 2022 with population changes and net migration by economic region.

Table ES-1: Population of Alaska by Economic Region, Borough, and Census Area, 2010 - 2022

Area Name					Natural Increase		Net Migration		Population Change		Average Annual	
	Census	Census	Estimate	Estimate	(Births-Deaths)		(In-Out Migrants)				Growth Rate (Percent)	
	April 2010	April 2020	July 2021	July 2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022
Alaska	710,231	733,391	736,105	736,556	67,000	8,222	-43,840	-5,057	23,160	3,165	0.32	0.19
Anchorage/ Matanuska-Susitna Region	380,821	398,328	399,496	401,562	36,349	4,191	-18,842	-957	17,507	3,234	0.45	0.36
Anchorage, Municipality of	291,826	291,247	290,410	289,810	28,113	3,137	-28,692	-4,574	-579	-1,437	-0.02	-0.22
Matanuska-Susitna Borough	88,995	107,081	109,086	111,752	8,236	1,054	9,850	3,617	18,086	4,671	1.84	1.90
Gulf Coast Region	78,631	81,619	81,700	82,481	4,821	466	-1,833	396	2,988	862	0.37	0.47
Chugach Census Area	6,684	7,102	7,028	7,013	497	83	-79	-172	418	-89	0.61	-0.56
Copper River Census Area	2,955	2,617	2,637	2,619	126	-17	-464	19	-338	2	-1.21	0.03
Kenai Peninsula Borough	55,400	58,799	59,108	60,017	2,833	253	566	965	3,399	1,218	0.60	0.91
Kodiak Island Borough	13,592	13,101	12,927	12,832	1,365	147	-1,856	-416	-491	-269	-0.37	-0.92
Interior Region	112,021	109,425	111,552	110,588	12,636	1,849	-15,232	-686	-2,596	1,163	-0.23	0.47
Denali Borough	1,826	1,619	1,658	1,645	101	29	-308	-3	-207	26	-1.20	0.71
Fairbanks North Star Borough	97,581	95,655	97,729	96,747	11,645	1,747	-13,571	-655	-1,926	1,092	-0.20	0.50
Southeast Fairbanks Census Area	7,026	6,808	6,897	7,046	610	86	-828	152	-218	238	-0.32	1.53
Yukon-Koyukuk Census Area	5,588	5,343	5,268	5,150	280	-13	-525	-180	-245	-193	-0.45	-1.63
Northern Region	26,445	28,870	28,342	27,774	3,837	555	-1,412	-1,651	2,425	-1,096	0.88	-1.72
Nome Census Area	9,492	10,046	9,715	9,682	1,418	228	-864	-592	554	-364	0.57	-1.64
North Slope Borough	9,430	11,031	11,033	10,746	1,164	161	437	-446	1,601	-285	1.56	-1.16
Northwest Arctic Borough	7,523	7,793	7,594	7,346	1,255	166	-985	-613	270	-447	0.35	-2.62
Southeast Region	71,664	72,286	72,683	72,218	3,382	159	-2,760	-227	622	-68	0.09	-0.04
Haines Borough	2,508	2,080	2,621	2,575	30	3	-458	492	-428	495	-1.87	9.45

Area Name	Census April 2010	Census April 2020	Estimate July 2021	Estimate July 2022	Natural Increase		Net Migration		Population Change		Average Annual	
					(Births-Deaths)		(In-Out Migrants)		2010– 2020	2020– 2022	Growth Rate (Percent)	
					2010– 2020	2020– 2022	2010– 2020	2020– 2022			2010– 2020	2020– 2022
Hoonah-Angoon Census Area	2,149	2,365	2,357	2,349	47	-3	169	-13	216	-16	0.96	-0.30
Juneau, City and Borough of	31,275	32,255	32,237	32,202	1,860	137	-880	-190	980	-53	0.31	-0.07
Ketchikan Gateway Borough	13,477	13,948	13,930	13,762	657	24	-186	-210	471	-186	0.34	-0.60
Petersburg Borough	3,203	3,398	3,376	3,357	132	2	63	-43	195	-41	0.59	-0.54
Prince of Wales-Hyder Census Area	6,172	5,753	5,747	5,720	254	-19	-673	-14	-419	-33	-0.70	-0.26
Sitka, City and Borough of	8,881	8,458	8,408	8,350	287	24	-710	-132	-423	-108	-0.49	-0.57
Skagway Borough, Municipality of	968	1,240	1,206	1,146	55	4	217	-98	272	-94	2.46	-3.50
Wrangell, City and Borough of	2,369	2,127	2,102	2,084	20	-17	-262	-26	-242	-43	-1.08	-0.91
Yakutat, City and Borough of	662	662	699	673	40	4	-40	7	0	11	0.00	0.73
Southwest Region	40,649	42,863	42,332	41,933	5,975	1,002	-3,761	-1,932	2,214	-930	0.53	-0.97
Aleutians East Borough	3,141	3,420	3,586	3,685	69	9	210	256	279	265	0.85	3.32
Aleutians West Census Area	5,561	5,232	5,118	5,003	192	27	-521	-256	-329	-229	-0.61	-1.99
Bethel Census Area	17,013	18,666	18,485	18,207	3,149	552	-1,496	-1,011	1,653	-459	0.93	-1.11
Bristol Bay Borough	997	844	824	800	27	5	-180	-49	-153	-44	-1.66	-2.38
Dillingham Census Area	4,847	4,857	4,729	4,673	615	72	-605	-256	10	-184	0.02	-1.72
Kusilvak Census Area	7,459	8,368	8,163	8,158	1,742	323	-833	-533	909	-210	1.15	-1.13
Lake and Peninsula Borough	1,631	1,476	1,427	1,407	181	14	-336	-83	-155	-69	-1.00	-2.13

Source: Alaska Department of Labor and Workforce Development. 2023.

Table ES-2: State-Owned Facility Types, Counts, and Estimated Values

State Facility Type	Count	Estimated Value
Airports	53	\$1,903,146,376
Corrections	154	\$820,515,116
Education	37	\$215,845,525
Emergency Services	58	\$30,092,700
Healthcare/Nursing Homes/Protected Populations	64	\$811,938,925
Law Enforcement	62	\$177,786,920
Libraries & Museums	3	\$143,425,000
Maintenance	380	\$637,851,010
Office Facilities	864	\$2,492,806,048
Ports & Harbors	46	\$47,254,100
Total	1,721	\$7,280,661,720

Notes: State Risk Management Office. Data include estimated values of insured state assets.

Table ES-3: Transportation Facilities

Facility Type	Count
Airports	289
Bridges	1,272
Ferry Terminals	39
Harbors	149
Maintenance Facilities	81
Ports	13
Railroad Facilities	14
Total	1,857

Notes: State-wide transportation facilities with various ownership (duplicates removed from table above, but comprehensive value information is not available). Numbers include state-owned and other ownership for airports, ferry terminals, and harbors.

Table ES-4: Transportation Route Mileages

Facility Type	Miles
Roads	14,231
Alaska Railroad	695
Total	14,926

Table ES-5: Local Community Critical Facilities

Facility Type	Count	Estimated Value
Bridges/Culverts	3	\$2,000,000
Community	1,418	\$82,952,000

Facility Type	Count	Estimated Value
Education	331	\$127,500,829
Emergency	330	\$4,446,110
Government	568	\$26,083,000
Health	205	\$16,963,365
Housing	149	\$1,130,000
Transportation	10	\$44,594,857
Utilities	2,791	\$157,952,536
Total	5,805	\$463,622,697

Notes: Local community critical facility data are incomplete and may include duplicate data from state-owned critical facilities. This information has been collected from historical inventories and local and tribal hazard mitigation plans. Estimated values are not available for most communities and are therefore incomplete.

Table ES-6: Statewide Snapshot of Vulnerability and Prioritized Mitigation Actions

Hazard Type	# of Critical Facilities	Est. Value of Critical Facilities	Population	Housing Units	Recent Development	Planned Development	Multi-Hazard Mitigation Actions	Priority Mitigation Actions
Glacier	108	\$322,429,922	24,832	12,336	Bridge, road, airport, ports and harbor, trails replacement, improvement, reconstruction, and new construction; planning, maintenance, research, training, preservation.	Bridge, road, airport, ports and harbor, trails replacement, improvement, reconstruction, and new construction; planning, maintenance, research, training, preservation.	Mitigation Planning Database Expansion; Local and Tribal Hazard Mitigation Planning Support; Local and Tribal Community Mitigation Strategies Link-Up to State Mitigation Strategy; Risk Map Expansion; Alaska Climate Change Impact Mitigation Program Expansion; Alaska Statewide Digital Elevation Model Update; Statewide Transportation Facilities Comprehensive Dataset Expansion; UAF/SNAP Database Expansion; Expansion of SCERP Program; State Critical Facility Rapid Visual Screenings Expansion; State Critical Facility Structural Hardening Assessments; Rural Resilience Workshop Expansion	
Avalanche	9	\$7,367,000	2,751	1,365				Avalanche Susceptibility Map Expansion
Permafrost	1,009	\$5,094,563,254	502,395	218,391				
Earthquake	1,704	\$7,229,826,803	727,780	323,204				Continuation of Building Safety month; Increase Awareness of the Shakeout Program/Drill
Flood (coastal)	787	\$4,483,814,145	248,422	118,046				Coastal Community Flood Assessment Expansion; Shoreline Change Mapping Expansion; Coastal and Riverbank Stabilization Program; National Flood Insurance Program Expansion
Flood (riverine)	215	\$693,021,479	75,124	32,755				Shoreline Change Mapping Expansion; Flood Buyout Expansion; Coastal and Riverbank Stabilization Program; National Flood Insurance Program Expansion; Wetland Map Expansion; Wetlands Action Plan Templates
Erosion	2	\$950,000	16,372	5,535				Erosion Forecast Mapping Expansion; Shoreline Change Mapping Expansion
Ground failure (landslide)	92	\$165,206,482	14,688	7,345				Landslide Susceptibility Map Expansion
Tsunami (seiche)	114	\$428,785,304	118,890	55,445				Tsunami Inundation Mapping Program Expansion; Tsunami Operations Workshop Expansion; TsunamiReady Expansion
Volcano (ash)	1,077	\$5,422,889,421	591,100	326,199				Increase Instrumentation and Data Accessibility for the National Volcano Early Warning System; Volcano Awareness Month
Severe weather	1721	\$7,220,661,720	736,566	326,200				StormReady Expansion
Wildland Fire	1,720	\$7,276,944,939	736,566	329,199				Wildfire Exposure Map Expansion; State Critical Facility Defensible Space Assessments; Hazard Fuel Reduction Program Expansion; Community Wildfire Protection Plan Outreach Expansion; Alaska Firewise Expansion
High-Hazard Potential Dams	26	unknown	4,000	unknown				Inundation Mapping Quality and Program Expansion for HHPD; Complete HHPD Failure Dataset; HHPD Remedial Investigations and Repair

See Section 4 for statewide risk detail for each hazard and Table 4.3-1 for Local Jurisdiction Probability and Magnitude.

All hazards identified have a high probability of occurrence depending on location.

See Table 4.4-1 for details regarding historic and planned development projects.

1 INTRODUCTION

1.1 HAZARD MITIGATION PLANNING

Title 44 of the Code of Federal Regulations (CFR), Subpart M, Section 206.401, defines hazard mitigation as “any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.” As such, hazard mitigation is any work to minimize the impacts of any type of hazard event before it occurs.

Hazard Mitigation Planning today has been driven by the federal Disaster Mitigation Act of 2000 (DMA 2000). DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 (Title 42 of the United States Code Section 5121 et seq.) by repealing the act’s previous mitigation planning section (409) and replacing it with a new mitigation planning section (322). This new section emphasized the need for state, tribal, and local entities to closely coordinate mitigation planning and implementation efforts. This new section also provided the legal basis for the Federal Emergency Management Agency’s (FEMA’s) mitigation plan requirements for the Hazard Mitigation Assistance (HMA) grant programs.

Hazard mitigation plans at the state, tribal and local level aim to reduce losses from future disasters. All 50 states in the U.S. have Hazard Mitigation Plans (HMPs), as well as almost 25,000 local governments and over 200 tribal governments.

The purpose of this Alaska State Hazard Mitigation Plan (SHMP) is to:

- Identify and profile relevant hazards;
- Analyze the people and facilities at risk; and
- Develop mitigation actions to reduce or eliminate hazard risk.

The implementation of the mitigation actions is the end result of this process. Mitigation planning involves coordination of needed mitigation efforts with state, Federal, and local partners. The mitigation actions include both short- and long-term strategies that may involve planning, policy changes, programs, projects, and other activities.

The SHMP is also necessary to maintain eligibility for FEMA mitigation grant funding. The State is able to utilize this funding for mitigation planning to reduce our vulnerability to disasters, and if there is a disaster, to have access to funds to address the impacts of the disaster.

The original Alaska SHMP was approved by FEMA in 2002 and last updated in 2018. FEMA requires SHMPs to be updated every 5 years.

1.2 2023 STATE HAZARD MITIGATION PLAN OVERVIEW

This SHMP follows the 2022 updated FEMA guidelines which became effective in April 2023. This 2023 SHMP has been thoroughly updated and revised since the 2018 Plan, and has a new layout based on the updated FEMA guidelines. The 2023 Alaska State HMP structure has been updated to include the following sections:

- **The Executive Summary** highlights the hazards, critical infrastructure and priority mitigation action items addressed in the plan.
- **Section 1 Introduction** includes background information on hazard mitigation planning and brief descriptions of each section.
- **Section 2 Background** includes a summary of relevant background information on the State of Alaska, including geography, demographics, and economy.
- **Section 3 Planning Process** includes an overview of the SHMP planning process, including a timeline and milestones. It includes a review of the legacy 2018 plan and the new layout of the 2023 plan, including new sections added to address the updated FEMA guidelines of 2022. The section includes descriptions of the task force, planning team and agency Subject Matter Experts (SMEs) and their involvement with the planning process. This section then details public and stakeholder outreach and involvement in the planning process.

- **Section 4 Hazard Identification and Risk Assessment** includes detailed descriptions and historical narratives for each of the nine hazards addressed in this plan, including: Cryosphere and Permafrost Degradation; Earthquake; Flood and Erosion; Ground Failure; Tsunami and Seiche; Volcano; Severe Weather; Wildland Fire and Community Conflagration; and High Hazard Potential Dams. The section includes hazard impact tables of vulnerable populations and critical facilities. An overall summary of vulnerability for each hazard is also provided.
- **Section 5 State Capabilities** includes an assessment of the state's ability to manage mitigation of the relevant hazards.
- **Section 6 Mitigation Strategy** identifies the state's primary mitigation goals; presents the prioritized mitigation action plan; describes the progress the State has made in hazard mitigation since the 2018 Plan; and describes the updated prioritization process used in the 2023 plan.
- **Section 7 Local Planning and Coordination and Capability Building** identifies the process of how the State supports local mitigation planning and the integration of the 2023 SHMP with local planning efforts.
- **Section 8 Plan Review, Evaluation and Implementation** describes the process that will be followed to evaluate and maintain the plan on an annual basis, and the process to be followed every five years for the plan updates through 2028.
- **Section 9 Plan Adoption and Assurances** includes information about the formal adoption of the SHMP.
- **Section 10 High Hazard Potential Dams** outlines the way that High Hazard Potential Dams (HHPD) are addressed in the 2023 SHMP and refers the reader to pertinent sections.
- **Section 11 Fire Management Assistance Grants** outlines the way that Fire Management is addressed in the 2023 SHMP and refers the reader to pertinent sections.
- **Section 12 References**
- **Appendices**

2 BACKGROUND

2.1 GEOGRAPHY

2.1.1 Regions

The Alaska Department of Community, Commerce and Development's Division of Community and Region Affairs (DCRA) provides the Alaska Regions map depicting how Alaska is divided into eight distinct regions based upon variations in climate, terrain, and economics (Figure 2-1).



Figure 2-1: Alaska Regions Map

Source: Division of Community and Region Affairs

The state is also divided into six economic regions: Northern, Interior, Southwest, Anchorage/Matanuska-Susitna, Gulf Coast and Southeast. Figure 2-2 depicts the economic regions in Alaska.

Alaska Economic Regions

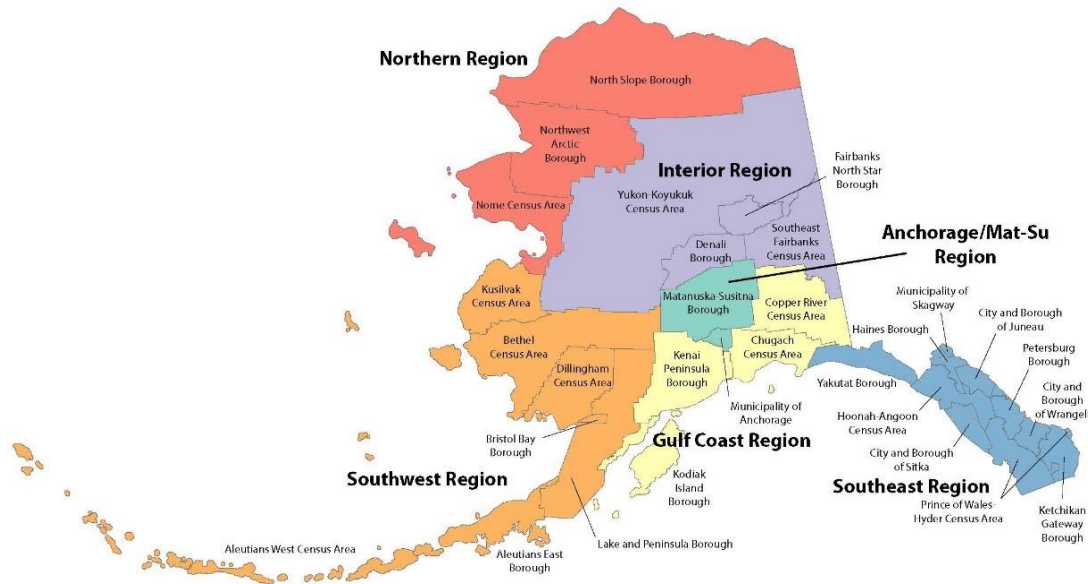


Figure 2-2: Alaska Economic Regions

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section.

<https://live.laborstats.alaska.gov/cen/maps/state/current/EconRegions.pdf>

2.1.2 Land Ownership

With 656,425 square miles, Alaska is the largest state in the U.S. by land area, and is approximately one-fifth the area of the lower, contiguous 48 states. There are roughly 1.3 people per square mile in Alaska compared to the national average of 93 people per square mile (U.S. Census Bureau 2021).

Nearly 90 percent of the land in Alaska is publicly owned, including both federal and state land ownership. Approximately 65 percent of Alaska is owned and managed by the U.S. Federal government as public lands, including national forests, national parks, and national wildlife refuges. The State of Alaska owns 24.5 percent of the land. Ten percent of the land in Alaska is owned by 12 regional Native corporations and dozens of local Native corporations created under the Alaska Native Claims Settlement Act of 1971 (ANCSA). Less than 1% of the land is owned privately. (State of Alaska 2023).

2.1.3 Cities, Towns and Boroughs

The State of Alaska's constitution establishes a policy of maximum self-government for its citizens. Its 19 existing boroughs are not the equivalent of county governments in the emergency management context. Emergency services in Alaska are provided by independent regional service areas throughout the state. Some boroughs and municipalities have government-run emergency management systems similar to county-style agencies, while most boroughs have area-wide powers focusing on education, land-use planning, and tax assessment/collection. The boroughs cover approximately 38 percent of the land mass and encompass most of the state's population. The rest of the population resides in a vast, sparsely inhabited rural area called the Unorganized Borough. The state's Unorganized Borough is not politically subdivided and is managed by the Alaska Legislature in accordance with the Alaska State Constitution, Article 10, Subparagraph 6.

Alaska is also divided into Regional Educational Attendance Areas (REAA); school attendance areas located in Alaska's Unorganized Borough. The borough and REAA grouping enables the state to effectively identify government responsibilities and define locational disaster impacts when requesting federal disaster declarations.

Population and Area

Table 2-1 depicts the 2022 populations and land areas of the six economic regions broken down by boroughs and census areas.

Table 2-1: 2022 Alaska Population Statistics by Borough, Census Area and Economic Region

Area	Population	Area (sq. mi.)
Alaska	736,556	656,425
Anchorage/Mat-Su Region		
Anchorage, Municipality of	289,810	1,706.80
Matanuska-Susitna Borough	111,752	24,706.97
Gulf Coast Region		
Kenai Peninsula Borough	60,017	16,017.42
Kodiak Island Borough	12,832	6,688.86
Chugach Census Area	7,013	9,530
Copper River Census Area	2,619	24,692
Interior Region		
Denali Borough	1,645	12,641
Fairbanks North Star Borough	96,747	7,334.81
Southeast Fairbanks Census Area	7,046	24,831.06
Yukon-Koyukuk Census Area	5,150	145,575.55
Northern Region		
Nome Census Area	9,682	22,969.46
North Slope Borough	10,746	88,823.63
Northwest Arctic Borough	7,346	35,663.28
Southeast Region		
Haines Borough	2,575	2,343.39
Hoonah-Angoon Census Area	2,349	6,555.26
Juneau, City and Borough of	32,202	2,704.03
Ketchikan Gateway Borough	13,762	4,856.93
Petersburg Borough	3,357	2,900.65
Prince of Wales - Hyder Census Area	5,720	5,267.73
Sitka, City and Borough of	8,350	2,870.06
Skagway, Municipality of	1,146	433.93
Wrangell, City and Borough of	2,084	2,556
Yakutat, City and Borough of	673	7,623.28
Southwest Region		
Aleutians East Borough	3,685	6,985.23
Aleutians West Census Area	5,003	4,393.03

Bethel Census Area	18,207	40,627.14
Bristol Bay Borough	800	481.98
Dillingham Census Area	4,673	18,333.99
Kusilvak Census Area	8,158	17,077.06
Lake and Peninsula Borough	1,407	32,922

Source: Alaska Department of Labor and Workforce Development. 2023.

2.1.4 Alaska Native Regional Corporations

The State of Alaska has 229 federally recognized tribes. Federally recognized tribes possess certain inherent rights of self-government. ANCSA extinguished aboriginal land titles and mandated the creation of private, for-profit corporations owned by Alaska Native shareholders. Tribes located in Alaska do not have a land base. Through ANCSA, Alaska Native corporations hold title to roughly 44 million acres of land held through private corporate ownership.

Alaska Native regional corporations are owned by over 140,000 Alaska Native shareholders and hold title to nearly 27 million acres of land across Alaska. Alaska Native regional corporations manage the land for the benefit of their shareholders. There are currently 12 operating Alaska Native regional corporations (https://www.akrdc.org/alaska-native-corporations#Corp_Profiles):

- Ahtna, Incorporated
- Aleut Corporation
- Arctic Slope Regional Corporation
- Bering Straits Native Corporation
- Bristol Bay Native Corporation
- Calista Corporation
- Chugach Alaska Corporation
- Cook Inlet Region, Incorporated
- Doyon, Limited
- Koniag, Incorporated
- NANA Regional Corporation
- Sealaska Corporation

2.1.5 Climate

Extremely diverse geography has a significant effect on Alaska's climate. Alaska's climate falls into five major zones:

- **Maritime zone** which includes southeast Alaska, the south coast and southern islands. This zone is characterized by cool summers, mild winters, and heavy rain throughout the year.
- **Maritime continental zone** which includes the western portions of Bristol Bay and west-central zones. Summer temperatures in this zone are moderated by the open waters of the Bering Sea but temperatures in winter are more continental in nature due to the presence of sea ice in the coldest months of the year.
- **Transition zones** are between maritime and continental zones in the southern portion of the Copper River zone, Cook Inlet zone, and the northern extremes of the south coast zone. These zones are characterized by semi-arid atmosphere, long, cold winters and mild summers.
- **Continental zones** make up the remainders of the Copper River and west central divisions and the interior basin. These zones are characterized by extreme temperature differences. This climate zone encompasses most of the central part of the state and is characterized by extremely cold winters and warm summers.
- **Arctic zone** is characterized by seasonal extremes in temperatures. Winters are long and harsh and summers are short but warm. Temperatures can range from 60 degrees below zero Fahrenheit to 78 degrees Fahrenheit.

2.2 DEMOGRAPHICS

Alaska's 2022 population estimate is 736,556 with a median age estimated as 36.5 years old. Table 2-2 depicts the demographics of Alaska.

Table 2-2: Alaska Population Demographics

Race and Hispanic Origin	Estimated Population (percent)
White Alone	64.5
Black or African American alone	3.6
American Indian and Alaska Native alone	15.7
Asian alone	6.6
Native Hawaiian and Pacific Islander alone	1.6
Hispanic or Latino	7.5

Source: Alaska Department of Labor and Workforce Development. 2023.

2.3 ECONOMY

Alaska's economy is driven by the oil and gas, tourism, fishing, timber, mining, and agricultural industries.

Oil was discovered in Prudhoe Bay, located on the arctic coast, in 1968. Construction of the 800-mile Trans-Alaska Pipeline began in 1974 and was completed in 1977. The pipeline is the largest privately financed construction project in history. The oil and gas industry is the largest component of Alaska's economy with nearly 85 percent of the state budget supplied by oil revenues.

Alaska contains half of the nation's coal reserves and its largest silver and zinc mines. Gold in Alaska's streams and mountains still lures miners to work private claims.

Tourism is a major sector of Alaska's economy and is the second largest primary employer. Alaska attracts over 1.1 million visitors annually.

Rich fishing waters off the coasts of Alaska make it one of the world's finest sources for wild seafood. Each year, Alaska harvests approximately 6 billion pounds of seafood. Alaska is the number one producer of wild salmon in the world and has the only salmon industry certified as "sustainable" by the Marine Stewardship Council.

Forests in Alaska provide renewable economic resources. Alaska contains 28 million acres of commercial forests. Alaska's timber industry supplies the world with logs, lumber, pulp, and other forest products. Southeast Alaska contains the Tongass National Forest, a 16.8-million-acre rainforest. The Chugach National Forest is the nation's second largest National Forest with 4.8 million acres.

About 15 million acres of land in Alaska are considered suitable for farming. Alaska currently has 1 million acres in production. Long daylight hours in summer provide growing conditions for vegetables of extraordinary size.

3 PLANNING PROCESS

This section provides an overview of the planning process; identifies the planning team members and key stakeholders; documents public outreach efforts; and summarizes the review and incorporation of existing plans, studies, and reports used to develop this SHMP.

Standard State Mitigation Plan Regulation Checklist
PLANNING PROCESS
S1. Does the plan include a description of the process used to develop the plan? [44 CFR §§ 201.4(b) and 201.4(c)(1)]
S1-a. Does the plan describe the current process used to update the plan, including how the plan was prepared, the schedule or time frame, specific milestones and activities, the agencies and stakeholders who were involved in the process, and if the mitigation planning process was integrated to the maximum extent possible with other state planning efforts?
S2. Does the plan describe how the state coordinated with other agencies and stakeholders? [44 CFR §§ 201.4(b) and 201.4(c)(1)]
S2-a. Does the plan describe how the state coordinated with other state agencies, appropriate federal agencies, and other stakeholders, and how they were involved in the process?

Source: FEMA, 2022

3.1 PLANNING PROCESS OVERVIEW

3.1.1 Legacy 2018 State Hazard Mitigation Plan Review

The planning process kicked off in July 2022 with a review of the 2018 SHMP to determine the areas that needed to be updated. FEMA updated the guidelines for State and local mitigation plans in April 2022, to be effective April 2023. The 2023 SHMP was revised from the 2018 SHMP in order to address the new FEMA guidelines and to provide an update to the State's mitigation strategies, hazards, and planning process.

Table 3-1 provides an overview of the sections in the 2018 Plan and describes how the Plan sections were modified for the 2023 SHMP.

Table 3-1: 2018 SHMP Plan Review

Section	Recommended Updates
1 – Introduction	Section streamlined and updated
2 – Background	Section streamlined and updated
3 – Planning Process	Section updated Plan Maintenance now addressed in 2023 SHMP Section 8 State Capabilities now addressed in 2023 Section 5
4 – SHMP Adoption	Section updated Plan Adoption now addressed in 2023 SHMP Section 9
5 – Hazard Analysis Process	This section was incorporated into 2023 Section 4.1, Hazard Identification
6 – Natural Hazards	Hazard Identification [Natural Hazards] and Risk Assessment now addressed together in 2023 Section 4
7 – Other Hazards	HHPD Failure is now addressed in Section 4 and Section 10. Public Health is addressed in Appendix A
8 – Risk Analysis	Hazard Identification and Risk Assessment are addressed together in 2023 Section 4
9 – Mitigation Strategy	Updated and addressed in 2023 Section 6

Table 3-1: 2018 SHMP Plan Review

Section	Recommended Updates
10 – Enhanced State Mitigation	The State of Alaska is not eligible for the Enhanced SHMP Component; this section was thus removed
11 – References	Updated with newly available information; References are Section 12 of 2023 Plan
12 – Attachments	Section removed; some portions moved to Appendices
13 – Appendices	Updated and streamlined

As part of the 2022 FEMA guideline updates, several new sections were added to the 2023 SHMP. Table 3-2 describes these new sections.

Table 3-2: New Sections added to the 2023 SHMP

Section	Description
4 – Hazard Identification and Risk Assessment – Future Conditions Including Climate Change	Climate change information had been included in the 2018 Plan, but was significantly augmented in the 2023 Plan. Each hazard profile in the 2023 SHMP has this new section focused on future conditions including climate change.
5 – State Capabilities	Previously included in 2018 SHMP Section 3
7 – Local Planning Coordination and Capability Building	New section as per FEMA 2022 updated guidelines
8 – Review, Evaluation, and Implementation	Plan Maintenance; previously included in 2018 SHMP Section 3
9 – Adoption and Assurances	Previously included in 2018 SHMP Section 4
10 – High Hazard Potential Dams profiled in the 2023 SHMP	New section as per FEMA 2022 updated guidelines HHPD hazards and risk addressed in Section 4; Section 10 refers reader to plan section where FEMA requirements are addressed
11 – Fire Management Assistance Grants profiled in the 2023 SHMP	New section as per FEMA 2022 updated guidelines

Climate Change

As part of the 2022 FEMA guideline updates, sections on future conditions including climate change have been expanded and/or added to the hazard profiles in Section 4.1 of the 2023 SHMP. Additional consideration and data on projected changes to the hazards due to climate change were incorporated where available, including:

- Probability of Future Events;
- Projected Changes in Location;
- Range of Anticipated Intensities;
- Frequency; and
- Duration.

3.1.2 2023 State Hazard Mitigation Plan Task Force

The State Hazard Mitigation Plan Task Force was established as the core group of decision makers guiding the process of the State HMP Update.

- The Task Force had multiple meetings early in the planning process to make decisions on the planning process and the layout of the 2023 SHMP.
- The contractor and Task Force lead have regular communications by email and phone calls.
- The contractor provided weekly updates to the DMVA - DHS&EM documenting progress on the plan update.

Table 3-3: 2023 SHMP Task Force

Organization, Department / Agency	Title	Name
DMVA - DHS&EM	State Hazard Mitigation Officer	Terry Murphy
DMVA - DHS&EM	Hazard Mitigation Plan Manager	Erin Leaders
DMVA - DHS&EM	BRIC Program Manager	Rick Dembroski;
	Hazard Mitigation Grant Manager	Rai Simpliciano;
		Garrett Brooks
AECOM	Project Manager	Allison Payne
AECOM	Mitigation Lead Planner	Anna Davis
AECOM	GIS Lead	Courtney Brozovsky
AECOM	Planner	Arika Mercer
Fairweather Science, LLC	Hazard and Risk Lead Planner	Laura Young
Fairweather Science, LLC	Planner	Olivia Kavanaugh

Table 3-4: 2023 SHMP Task Force Meetings

Date	Topic
June 7, 2022	Kick-Off
June 21, 2022	Public Outreach
June 28, 2022	Revised Plan Layout
July 19, 2022	Underserved Communities, Community Lifelines, Stakeholders, High Hazard Potential Dams, Planning Team
November 9, 2022	Risk Analysis, Critical Facilities, Mitigation, Public Outreach, Underserved Communities Representation
March 30, 2023	Internal Draft Hazard Identification and Risk Assessment Review
June 22, 2023	Executive Summary and Public Draft Status

3.1.3 2023 State Hazard Mitigation Planning Team

DHS&EM established the State Hazard Mitigation Planning Team (Planning Team) to serve as the primary planning team for the 2023 SHMP update process. The Planning Team kick-off meeting was held July 26, 2022, and described the planning process and the roles and responsibilities of the State DHS&EM, the Planning Team, and the contractor. Planning Team related communications were emailed to members as needed throughout the SHMP update process. A schedule of the SHMP update process was provided at the kick-off meeting. The responsibilities of the Planning Team were described, including updating data on historic hazards, risk information, and critical facilities, updating the mitigation actions, and reviewing the Draft Plan.

A list of the Planning Team member agencies and titles of agency representatives is provided in Table 3-5.

Table 3-5: 2023 SHMP Planning Team

Organization, Department / Agency	Title
State Agencies	
Department of Military and Veteran Affairs, Division of Homeland Security and Emergency Management (DMVA/DHS&EM)	Director
DMVA/DHS&EM	Planning Program Manager I
DMVA/DHS&EM	BRIC Program Manager

DMVA/DHS&EM	State Hazard Mitigation Officer
DMVA/DHS&EM	HMGP Program Manager
DMVA/DHS&EM	Hazard Mitigation Plan Manager
Department of Commerce, Community and Economic Development (DCCED)	Local Government Specialist, Risk Map, ACCIMP
DCCED	National Flood Insurance Program (NFIP) Coordinator for Alaska
DCCED	Local Government Specialist, AK Floodplain Coordinator
Department of Environmental Conservation (DEC)	Environmental Program Specialist III/Disaster Coordination & Tribal Liaison
Department of Health (DOH)	Planner II
Department of Natural Resources (DNR)	Program Manager (Natural Resource Manager 3)
DNR/Mining, Land, & Water (MLW)	State Dam Safety Engineer
DNR/MLW	Division Operations Manager
DNR/Division of Geological and Geophysical Surveys (DGGS)	Chief, Geologic Hazards Section
DGGS	Geologist
DGGS	Coastal Hazards Program Manager
DNR/Division of Forestry (DOF)	Fire Protection Programs Fire Planner
DNR/DOF	State Forester and Director
Department of Transportation and Public Facilities (DOT/PF)	Director, Southcoast Region
DOT/PF	Central Region Director
DOT/PF	Northern Region Director
DOT/PF	Northern Region Safety Officer
Department of Public Safety (DPS)	Assistant State Fire Marshall
University of Alaska (UA)	Statewide Risk Services Emergency Planner / Continuity Director
University of Alaska Fairbanks (UAF)/Geophysical Institute/Alaska Earthquake Center	State Seismologist
University of Alaska Fairbanks (UAF)/Geophysical Institute	Tsunami Modeler
Alaska Energy Authority	Director, Renewable Energy and Energy Efficiency Programs
Alaska Railroad (AKRR)	Director, Project Management
AKRR	Environmental Analyst II
AKRR	Chief Operating Officer
Federal Agencies	
Bureau of Land Management (BLM)	State Aviation Manager
Denali Commission	Federal Co-Chairman
Denali Commission	Project Manager-Infrastructure
National Ocean and Atmospheric Administration (NOAA), National Tsunami Warning Center (NTWC)	Director
NOAA, National Weather Service (NWS)	Anchorage Warning Coord. Meteorologist

NOAA, NWS	Regional Operations Center Meteorologist in Charge
NOAA, NWS	Alaska Fire PM
NOAA, NWS	Climatologist-Climate Program Manager
NOAA, NWS	Warning Coord. Meteorologist Regional and Deputy Chief
NOAA, NWS	Deputy Chief Alaska Region Environmental Scientific and Services Division/Regional Warning Coord. Meteorologist
U.S. Army Corp of Engineers (USACE)-Alaska Region	Chief - Hydraulics & Hydrology
U.S. Department of Housing and Urban Development (HUD)	Director, Field Office
U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS)	State Resource Conservationist
USDA, NRCS	State Conservation Engineer
U.S. Geological Survey (USGS)	Alaska Regional Director
Tribal Representation	
Alaska Native Tribal Health Consortium (ANTHC)	Director of Climate Initiatives

Table 3-6: 2023 SHMP Planning Team Meetings

Date	Topic
July 26, 2022	Kick-Off
September 22, 2022	Launch Hazards Update
November 15, 2022	Launch Risk Assessment and Mitigation Updates
April 26, 2023	Administrative Draft for Planning Team Review

Natural Hazards Subject Matter Experts

Vital contributions to the 2023 SHMP Update came from agency Subject Matter Experts (SMEs) on the various natural hazards. Some of these SMEs were not active participants in the Planning Team but served under their agency leads who were a part of the Planning Team. Table 3-7 shows the agencies responsible for contributions to each specific natural hazard addressed in the SHMP.

Table 3-7: Natural Hazards Profiles Updates - Agency Contributions

Natural Hazards	Agency	Title
Cryosphere and Permafrost Degradation	DNR/Division of Geological and Geophysical Surveys (DGGS)	SME
	U.S. Geological Survey (USGS)	SME
Earthquake	DNR/Division of Geological and Geophysical Surveys (DGGS)	SME
	University of Alaska (UAF)	State Seismologist
Flood and Erosion	Department of Commerce, Community and Economic Development (DCCED) DNR/Division of Geological and Geophysical Surveys (DGGS)	SME

Table 3-7: Natural Hazards Profiles Updates - Agency Contributions

Natural Hazards	Agency	Title
Ground Failure	DNR/Division of Geological and Geophysical Surveys (DGGS)	SME
Tsunami and Seiche	DNR/Division of Geological and Geophysical Surveys (DGGS)	SME
	National Ocean and Atmospheric Administration (NOAA), National Tsunami Warning Center	SME
	University of Alaska Fairbanks (UAF)/Geophysical Institute	Tsunami Modeler
Volcano	DNR/Division of Geological and Geophysical Surveys (DGGS)	SME
	U.S. Geological Survey (USGS) – Alaska Volcano Observatory (AVO)	SME
Severe Weather	National Ocean and Atmospheric Administration (NOAA), National Weather Service (NWS)	State Climatologist
Wildland Fire and Community Conflagration	DNR/Division of Forestry (DOF)	
	Department of Public Safety (DPS)	Assistant State Fire Marshall
High Hazard Potential Dams	DNR/Mining, Land, & Water (MLW)	State Dam Safety Engineer
Public Health (Appendix A, not a full hazard profile)	DOH, Division of Public Health	Emergency Health Planner

3.1.4 2023 State Hazard Mitigation Plan Schedule and Milestones

The development of the 2023 SHMP was a collaborative effort between DHS&EM, the contractor, and the Planning Team. The planning process officially kicked off in July 2022 and ended in October 2023. A timeline of the major planning tasks and milestones by month, including planning team meetings, is provided in Table 3-8.

Table 3-8: 2023 SHMP Schedule and Milestones

Date	Milestones
June 2022	Establishment of Planning Team members by State DHS&EM
July 2022	Initial public outreach activities began via DHSEM Facebook, DHSEM Mitigation website, and the DHSEM LinkedIn Public Survey #1 released
August 2022	Hazard profiles drafting commenced
September 2022	Hazard profiles sent to respective agencies to review and update data
October 2022	Hazard figures created Hazard impact assessments drafted
November 2022	Hazard profile update status

Table 3-8: 2023 SHMP Schedule and Milestones

Date	Milestones
	Critical Facilities update status
December 2022	Stakeholder outreach via email Drafting of State Capabilities
January 2023	Draft mitigation actions developed Draft State Capabilities reviewed by State DHS&EM
February 2023	Draft Mitigation actions reviewed by State
March 2023	Internal Draft for Task Force Review Public Survey #2 released
April 2023	Administrative Draft SHMP for Planning Team Review
May - June 2023	Updates/Response to Comments on Planning Team Draft Mitigation prioritization action plan developed Preparation of Public Draft
July 2023	Public Draft posted for 30 day comment period Additional public outreach Additional stakeholder outreach and involvement
August/September 2023	Updates/Response to Comments on Public Draft SHMP Preparation of Final Draft SHMP
September 2023	Submittal of Final Draft SHMP to FEMA
September/October 2023	Adoption of Final SHMP

3.1.5 Planning Process Integration into Other State Planning Efforts

Table 3-9: Integration of 2023 SHMP Into Other State Plans and Programs

Plan / Program	Integration
Emergency Operations Plan (EOP)	The State of Alaska Emergency Operation Plan integrates components of the 2023 Alaska State Hazard Mitigation Plan to provide a basis for understanding the fundamental emergency situations the state is most susceptible to. It includes a detailed summary of Alaska's vulnerability to disasters associated with the following hazards: Cryosphere; Earthquake; Flood and Erosion; Ground Failure; Health Emergencies and Pandemic; Tsunami and Seiche; Volcano; Severe Weather; Wildland Fire and Community Fire; High Hazard Potential Dams; Oil Spills and Hazardous Materials; and Technological, Human Caused, and Terrorism. (<i>State of Alaska EOP, Section 1.4: Hazard Analysis</i>)

Integration of Recent Studies

During the 2023 SHMP update planning process, the planning team reviewed and incorporated pertinent historical information and new data that became available since the legacy 2018 SHMP received FEMA final approval. This data included newly available plans, studies, reports, and technical research. These data were reviewed and referenced where applicable for the SHMP's jurisdictional information, hazard profiles, risk analysis, and vulnerability assessment. Complete references are listed in Section 12.

A list of the major relevant plans and reports reviewed and incorporated into the 2023 SHMP is provided in Table 3-10.

Table 3-10: Integration of Recent studies into the 2023 SHMP

Plan / Program	Integration
AEC 2022 Seismicity Year in Review (2023)	Used map to show location, number, and extent of recorded earthquakes statewide in 2022.
Alaska Seismic Hazards Safety Commission- Earthquake Risk (2023)	Used information to update the earthquake hazard profile (Section 4.1.2).
DGGS Alaska Coastal Mapping Gaps & Priorities for the Assessment of Coastal Flood and Erosion Hazards (2018)	Used multiple figures in the erosion hazard profile section (Section 4.1.3.2) to describe location and extent of coastal erosion throughout Alaska.
DHSE&M 2022 Disaster Cost Index	Incorporated recent disaster declarations into each hazard profiles to describe history and extent of recent disasters.
Dynamical downscaling for Southeast Alaska: Historical climate and future projections (Lader et al. 2020)	Referenced study in the flooding section (Section 4.1.3.1.11.2) to describe how increased precipitation and climate change will influence future flooding events and locations in Alaska.
National Weather Service Alaska Sea Ice Program (2023)	Used interactive mapping tool to show daily sea ice extent on January 18, 2023 (Figure 4.1.1-17).
National Weather Service Weather Related Fatality and Injury Statistics (2023)	Used updated weather fatality statistics to show current and past trends of weather-related fatalities and injuries (Figure 4.1.1-26).
NOAA- Is sea level rising? Yes, sea level is rising at an increasing rate (2023)	Referenced study in flooding hazard profile (Section 4.1.3.1) to describe the factors attributing to global sea level rise and how climate change is influencing future sea level rise.
Quantifying Debris Flood Deposits in an Alaskan Fjord Using Multitemporal Digital Elevation Models (Balazs et al. 2021)	Used aerial image of the Japanese Creek alluvial fan and levee in Seward, Alaska in the flooding hazard profile to describe alluvial fan flooding (Figure 4.1.3-4).
Statewide Threat Assessment: Identification of Threats from Erosion, Flooding, and Thawing Permafrost in Remote Alaska Communities (2019)	Used multiple figures in the report to identify communities assessed for flooding, erosion, permafrost thaw \and level of threat/vulnerability.
UAF/SNAP Sea Ice Atlas (2023)	Used interactive mapping tool to compare sea ice concentrations from 1850 to 2021 (Figure 4.1.1-18).
USACE Silver Jackets Flood Mitigation Project (2023)	Used updated graph in the flooding section to show the number, category, and extent of historic flood events from 1890-2021 (Figure 4.1.3-2).
USGCRP- Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment (2018)	Used information and multiple figures to describe how climate change will influence hazard events in Alaska.

3.2 COORDINATION WITH OTHER AGENCIES AND STAKEHOLDERS

3.2.1 State and Federal Agencies

DHS&EM's mitigation staff actively pursues and effectively engages State and Federal agencies and jurisdictions with developing strong mitigation programs. Agencies strive to jointly educate the population to facilitate increasing their hazard reduction knowledge needed when they seek funding to reduce their hazard event impacts and damages.

DHS&EM staff have regular communication and coordination with State and Federal agencies regarding mitigation activities across the state. Some examples include:

- Annual FEMA Consultations
- State/FEMA mitigation coordination calls

- Weekly FEMA planning check-in meetings
- Weekly meetings with NFIP
- Weekly meetings with Division of Community and Regional Affairs (DCRA)

3.2.2 Public Involvement

The Task Force met with the State Public Information Office (PIO) early in the process to make a plan for increasing public involvement in the SHMP. The decision was made to produce two online surveys where participants could directly provide feedback on hazards of concern in their communities and their own hazard preparedness. Public flyers with links to the online surveys were created and distributed in hard copy and electronically. Electronic versions of the flyers were distributed on the DHS&EM Facebook and LinkedIn social media pages. Hard copies were distributed at various in-person events. Some Planning Team members also shared the flyers directly through their agencies.

Table 3-11 lists public outreach efforts for the 2023 SHMP.

Public Survey Responses

- Survey #1 received 101 responses.
- Survey #2 received 34 responses.
- Comments were received on survey #2 until the end of the 30-day Public Comment Period on August 25.
- Responses to all surveys were reviewed for their contributions to hazard data, mitigation actions, etc.
- Public survey questions, responses and summary data are included in Appendix B.

Table 3-11: Public Outreach Efforts

Date	Outreach Effort
July 2022	Community Outreach Event with DHS&EM in Cordova - Distributed public flyer with survey link
July 2022 – August 2023	Public flyers posted on DHSEM Facebook and LinkedIn social media pages, with periodic refresh of posts
July 2022	Circulated public flyer with link to Survey #1
August 2022	Alaska State Fair – Distributed public flyer with survey link
September 2022	City of Houston – Houston Days Public Event - Distributed public flyer with survey link
September 2022	Matanuska-Susitna Regional Medical Center Disaster Awareness Event – Distributed public flyer with survey link
October 20-22 2022	DHS&EM hosted a booth at the annual Alaska Federation of Natives Convention and shared flyers and information on hazard mitigation
November 18, 2022	Jennifer Adleman, FEMA Community Planner, presented at Accelerate Alaska Conference to promote awareness of the 2023 SHMP update process
January 2023 – August 2023	Circulated information on public involvement in the 2023 SHMP on the State-wide “What’s Up” email distribution list, hosted by Trustees for Alaska, The Alaska Center, and The Alaska Conservation Foundation.
January 2023	Circulated public flyer with link to Survey #1 to various Borough and City Representatives across the state
January 2023	DHS&EM Get Ready Alaska Podcast (Spotify) with Erin Leaders, DHS&EM Hazard Mitigation Plan Manager – Focus on SHMP Public Involvement
March 2023 – July 2023	Circulated public flyer with link to Survey #2 on DHS&EM Social Media pages

Table 3-11: Public Outreach Efforts

Date	Outreach Effort
June 2023	Circulated public flyer with link to Survey #2 to various Borough and City Representatives across the state
July 25 – August 25 2023	Public Draft posted on DHS&EM website for duration of 30 day public comment period

3.2.3 Local Jurisdictions

City and Borough representatives were contacted by email in January 2023 and invited to participate in the SHMP planning process. City and Borough stakeholders included those listed in Table 3-12. The email explained the SHMP update process and encouraged feedback from the stakeholders.

Local jurisdictions were contacted by email again in June 2023 to announce that the Public Draft would soon be made available for comment. Stakeholders were also provided both public flyers with links to the surveys and were encouraged to post the flyers on their individual websites.

A link to the Public Draft SHMP was shared with all stakeholders by email in July of 2023. Feedback and comments were encouraged.

Table 3-12: City and Borough Government Representatives

City/Borough	Title
Municipality of Anchorage (MOA)	Emergency Manager
Matanuska Susitna Borough (MSB)	Emergency Manager
City and Borough of Juneau (CBJ)	Emergency Programs Manager
Kenai Peninsula Borough (KPB)	Emergency Manager
Fairbanks North Star Borough	Emergency Operations Director
Aleutians East Borough	Administrator
Bristol Bay Borough	Borough Manager
Denali Borough	Emergency Manager
Haines Borough	Emergency Operations Incident Commander
Ketchikan Gateway Borough	Ketchikan Fire Chief
Kodiak Island Borough	Borough Manager
Lake and Peninsula Borough	Borough Manager
North Slope Borough	Borough Mayor
Northwest Arctic Borough	Borough Mayor
Petersburg Borough	Borough Manager
Sitka	Fire Chief
Skagway	Borough Manager
Wrangell	Fire Chief
Yakutat	Borough Manager

3.2.4 Tribal Representatives

Underserved communities in Alaska include a wide array of rural Native communities. In an effort to include input from these communities, the State reached out to various Native organizations to include Tribal representation on the planning team and as stakeholders.

The Director of Climate Initiatives from the Alaska Native Tribal Health Consortium (ANTHC) served as a Tribal Representative on the planning team. ANTHC staff reviewed the SHMP Administrative Draft and provided comments and feedback. ANTHC provides funding and project management to complete Tribal hazard mitigation plans; flood, erosion, and permafrost engineering studies; and development of mitigation projects for Tribal jurisdictions across Alaska.

In addition, representatives of the Tanana Chiefs Conference, Bristol Bay Native Association, Kodiak Area Native Association and the Aleutian Pribilof Islands Association also agreed to review the State HMP as stakeholders.

3.2.5 Community Lifelines

Alaska State Community Lifelines contacts were contacted by email in January 2023 and invited to participate in the SHMP planning process. Community Lifelines contacts included those organizations listed in Table 3-13. The email explained the SHMP update process and encouraged feedback from Community Lifelines organizations.

Community Lifelines contacts were contacted by email again in June 2023 to announce that the Public Draft would soon be made available for comment. Community Lifelines contacts were also provided both public flyers with links to the surveys and were encouraged to post the flyers on their organization's websites.

A link to the Public Draft SHMP was shared with all community lifeline contacts by email in July of 2023. Feedback and comments were encouraged.

Table 3-13: Community Lifelines

Community Lifeline Organization	Title
Department of Public Safety (DPS)	Statewide Search and Rescue Coordinator
Department of Public Safety (DPS)	State Fire Marshall
Salvation Army	Emergency Disaster Services Director
Red Cross of Alaska	Regional Disaster Program Officer
Department of Health	Emergency Preparedness and Response Manager
Alaska Energy Authority	Executive Director
DHSEM Telecommunications	Planner
Department of Transportation and Public Facilities (DOTPF)	Safety Officer
Department of Environmental Conservation (DEC)	Division of Administrative Services Director
Alaska Partnership for Infrastructure Protection (APIP)	Emergency Management Planner, Co-Chair APIP

4 HAZARD IDENTIFICATION AND RISK ASSESSMENT

Standard State Mitigation Plan Regulation Checklist
HAZARD IDENTIFICATION AND RISK ASSESSMENT
S3. Does the risk assessment include an overview of the type and location of all natural hazards that can affect the state? [44 CFR § 201.4(c)(2)(i)]
S3-a. Does the plan include a current overview of all natural hazards that can affect the state, including the type, location and previous occurrences?
S4. Does the risk assessment provide an overview of the probabilities of future hazard events? [44 CFR § 201.4(c)(2)(i)]
S4-a. Does the risk assessment provide an overview of the probability of future hazard events that includes projected changes in the location, range of anticipated intensities, frequency, and/or duration of each natural hazard?
S4-b. Does the probability include considerations of changing future conditions, including climate change (e.g., long-term weather patterns, average temperature, and sea levels) on the type, location and range of anticipated intensities of identified hazards?
S5. Does the risk assessment address the vulnerability of state assets located in hazard areas and estimate the potential dollar losses to these assets? [44 CFR §§ 201.4(c)(2)(ii) and 201.4(c)(2)(iii)]
S5-a. Does the risk assessment include an overview and analysis of the vulnerability to state assets from the identified hazards as well as a summary of the most vulnerable assets?
S5-b. Does the risk assessment estimate potential dollar losses to state assets located in identified hazard areas?
S6. Does the risk assessment include an overview and analysis of jurisdictions' vulnerability to the identified hazards and the potential losses? [44 CFR §§ 201.4(c)(2)(ii) and 201.4(c)(2)(iii)]
S6-a. Does the risk assessment provide an overview and analysis of vulnerable jurisdictions based on the state and local government risk assessments?
S6-b. Does the risk assessment include an overview and analysis of the potential losses to the identified vulnerable structures based on estimates in the local risk assessments as well as the state risk assessment?
S7. Was the risk assessment revised to reflect changes in development? [44 CFR § 201.4(d)]
S7-a. Does the plan provide a summary of recent development and potential or projected development in hazard-prone areas based on state and local government risk assessments?

Source: FEMA 2022.

This section identifies and profiles the hazards that occur in Alaska. A hazard analysis includes identifying, screening, and profiling each hazard. Hazard identification includes recognizing the natural events that threaten an area. Natural hazards result from unexpected or uncontrollable natural events of sufficient magnitude. Even though a particular hazard may not have occurred in recent history, all natural hazards that may potentially affect Alaska were considered. Those hazards that are unlikely to occur or for which the State has determined as having a very low risk were eliminated from consideration.

Economic, hazardous materials, and terrorism-related hazards are beyond the scope of this plan. These hazards are monitored by regulatory agencies and are not addressed in the State HMP. The 2018 HMP discussed “other hazards,” including High Hazard Potential Dams (HHPD) and Public Health. In accordance with FEMA’s new 2022 guidelines, HHPDs are profiled with the other hazards in this section. Public Health hazards are addressed in Appendix A.

Hazard profiling requires extensive research to determine the hazard type and characteristics, history, magnitude, frequency, location, extent, and likelihood. The State identifies hazards through scientific research and literature, historical and community anecdotal information, and by reviewing pertinent plans. Hazard mapping determines geographic extent of the hazard and proximity to populated areas and critical

facilities. A natural phenomenon, such as a volcanic eruption, is only considered a hazard when people and property are potentially affected. “Risk” is the likelihood of harm resulting from a hazard.

The planning team chose to address hazards that occur most frequently, cause the most damage, and have the highest response and recovery costs. The planning team chose to address the following hazards that potentially threaten Alaska: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland fire and community conflagration, and HHPD. Some of these hazards are influenced by changing climate conditions. For this 2023 update all hazards have been reviewed and updated to include the recent events that have occurred since the last plan update in 2018.

Table 4-1: Hazard Screening and Identification

Hazard Type	Should It Be Profiled?	Explanation
Cryosphere and Permafrost Degradation (Glacier, Permafrost, Sea Ice, Snow Avalanche)	Yes	There are many locations in Alaska where both surface and subsurface water is frozen year-round. This includes sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground (such as permafrost).
Earthquake	Yes	Alaska experiences over 100 earthquakes every day. Many are located in remote, unpopulated locations. The potential population impacts of earthquakes range from very low to severe.
Flood and Erosion	Yes	Snowmelt run-off and rainfall flooding occur during spring thaw and the fall rainy season. Minor flood events regularly cause damage. Severe damages occur from major floods and storm surge. Alaska experiences erosion from storm surge; coastal ice run-up; coastal wind scour along the shoreline; and riverine high water flow scour along the area’s rivers, streams, and creek embankments; as well as damages from coastal or riverine ice flows, wind, surface runoff, and boat traffic wakes.
Ground Failure	Yes	Ground failure occurs throughout Alaska. This section is focused on landslide-associated ground failure.
Tsunami and Seiche	Yes	This hazard has historically impacted Alaska’s southern coastal community and infrastructure.
Volcano	Yes	Volcano-generated ash periodically impacts Alaska communities, with impacts most severe for communities closer to volcanoes. Volcanic ash can create severe air quality, water quality, marine, and road transportation impacts, disrupt utility operations, etc. Tephra can impact those communities closest to volcanoes.
Severe Weather	Yes	Severe weather impacts the entire state, with climate change and changing El Niño/La Niña Southern Oscillation patterns generating increasingly severe weather events. Winter storms, heavy or freezing rain, thunderstorms, typhoon remnants, and subsequent secondary hazards such as riverine or coastal storm surge floods, landslides, snow, wind, etc. all impact Alaska.
Wildland Fire and Community Conflagration	Yes	Alaska communities with surrounding forest and/or tundra can become very dry in summer months with weather (such as drought and lightning) and human-caused incidents igniting dry vegetation in the adjacent area (e.g. burning trash outside the landfill burn box, camp fires, etc.). Fire proximity can also create urban/wildland fire interface challenges.
High Hazard Potential Dams	Yes	This plan update includes HHPD as outlined in FEMA’s updated 2022 guidance for State HMP development. HHPDs exist in various

Hazard Type	Should It Be Profiled?	Explanation
		communities across Alaska. These dams and their potential risks are discussed in this section.

Examinations of the hazards in Section 4.1, Hazards, include several factors:

- Hazard characteristics
- Location
- History
- Extent
- Impact
- Probability

Based on FEMA’s new 2022 guidance, the above hazard information has been updated to consider recent events since the last plan update, and now include the following:

- Projected changes in location
- Range of anticipated intensities
- Frequency
- Duration
- Future conditions including climate change
 - Characteristics/Nature
 - Probability of location changes
 - Range of anticipated intensities

Each profiled hazard is assigned an impact rating (i.e., magnitude or severity) based on its individual characteristics (Table 4-2). Recurrence probability is also defined based on specific criteria within each hazard profile, or utilizing the criteria identified in Table 4-3.

Table 4-2 Hazard Magnitude/Severity Criteria

Magnitude/Severity	Criteria
4 – Catastrophic	• Multiple deaths. • Complete shutdown of facilities for 30 or more days. • More than 50 percent (%) of property is severely damaged.
3 – Critical	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least two weeks. • More than 25% of property is severely damaged.
2 – Limited	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than one week. • More than 10% of property is severely damaged.
1 – Negligible	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10% of property is severely damaged.

Table 4-3: Hazard Probability of Future Events Criteria

Probability	Criteria
4 – Highly Likely	• Event is probable within the calendar year. • Event has up to 1 in 1 year chance of occurring (1/1=100 percent [%]). • History of events is greater than 33% likely per year.
3 – Likely	• Event is probable within the next three years. • Event has up to 1 in 3 years chance of occurring (1/3=33%). • History of events is greater than 20% but less than or equal to 33% likely per year.
2 – Possible	• Event is probable within the next five years. • Event has up to 1 in 5 years chance of occurring (1/5=20%). • History of events is greater than 10% but less than or equal to 20% likely per year.
1 – Unlikely	• Event is possible within the next ten years. • Event has up to 1 in 10 years chance of occurring (1/10=10%). • History of events is less than or equal to 10% likely per year.

Section 4.2 describes the state’s critical facilities, the vulnerability of state assets, and the vulnerability assessment methodology, along with detailed hazard risk analyses and associated vulnerability assessments. This analysis was completed using geographic information system (GIS) mapping tools to analyze, manage, and present spatial relational data.

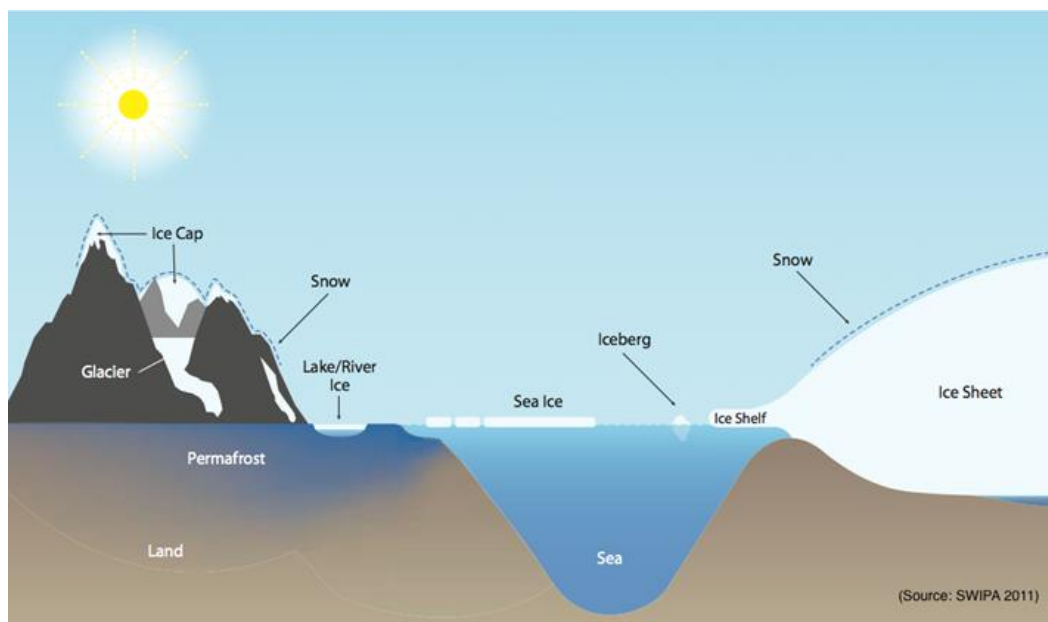
Section 4.3 describes the vulnerability of local jurisdictions.

Section 4.4 describes the changes in development since the 2018 SHMP.

4.1 HAZARD IDENTIFICATION

4.1.1 Cryosphere and Permafrost Degradation

The cryosphere is defined as those portions of Earth's surface and subsurface where water is in solid form, including sea, lake, and river ice; snow cover; glaciers; ice caps and ice sheets; and frozen ground (e.g., permafrost) (Figure 4.1.1-1). The components of the cryosphere play an important role in climate. Snow and ice reflect heat from the sun, helping to regulate our planet's temperature. They also hold Earth's important water resources and therefore regulate sea levels and water availability in the spring and summer. The cryosphere is one of the first places where scientists are able to identify global climate changes.



Source: AMAP 2011.

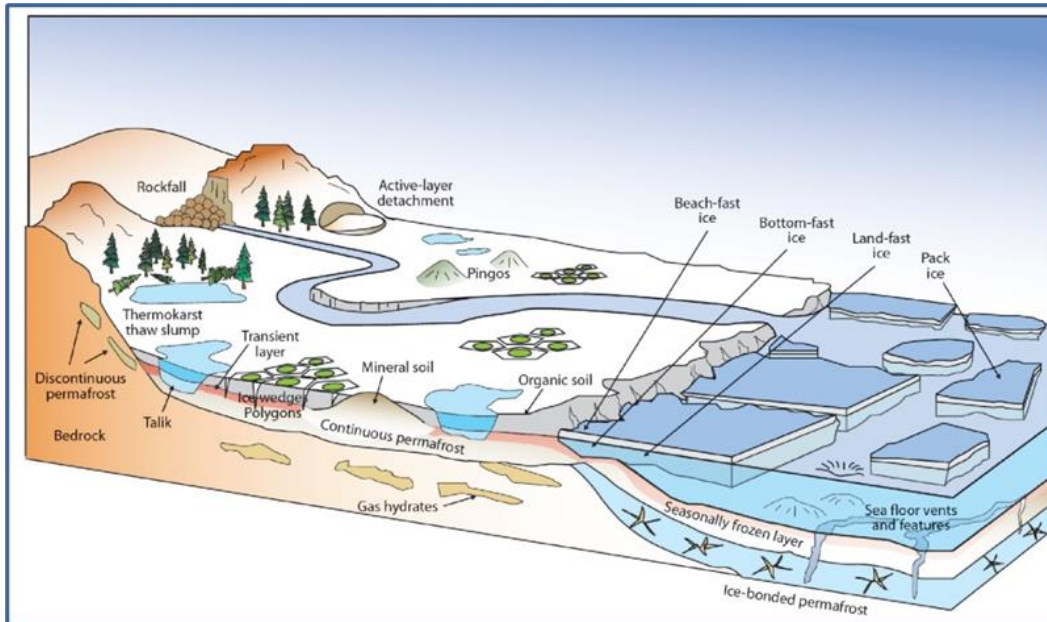
Figure 4.1.1-1: Diagram of Cryosphere Components

Cryosphere hazards can be divided into four major groups:

- Glaciers
- Permafrost and periglacial
- Sea ice
- Snow avalanche

Glaciers are made of compressed snow that has survived summer and transformed into ice. Over many years, layers of accumulated ice build into large, thickened ice masses. Due to the sheer mass of the accumulated ice, glaciers flow like very slow rivers. Presently, glaciers occupy about 10 percent of the world's total land area, with most located in polar regions. Today's glaciers are much reduced from those of the last Ice Age, when ice covered nearly 32 percent of the land and 30 percent of the oceans. Most glaciers lie within mountain ranges, which show evidence of a much greater extent of glaciers during the ice ages of the past 2 million years and a recent retreat of glaciers in the past few centuries. Hazards related to glaciers include ice collapses (e.g., glacial calving and ice fall avalanches), glacial lake outburst floods, and glacial surges.

Permafrost and periglacial hazards are caused by the effects of changing perennially frozen soil, rock, or sediment (known as permafrost) and the landscape processes that result from extreme seasonal freezing and thawing (Figure 4.1.1-2). Permafrost is found in nearly 85 percent of Alaska. It is thickest and most extensive in Arctic Alaska north of the Brooks Range but is present virtually everywhere and extends as much as 2,000 feet below the surface of the Arctic Coastal Plain. South of the Brooks Range, permafrost becomes increasingly thinner and more discontinuous, broken by pockets of unfrozen ground known as taliks, until it becomes virtually absent in Southeast Alaska, with the exception of pockets of high-elevation alpine permafrost.



The features in the figure are closely associated in northern latitudes. Source: AMAP 2011.

Figure 4.1.1-2: Schematic Diagram of Association Between Landscape, Permafrost, and Sea Ice

In the U.S., the presence of widespread permafrost results in classes of geologic hazards that are largely unique to Alaska. Permafrost is structurally important to the soils of Alaska, and the thawing of permafrost causes landslides, ground subsidence, and erosion as well as lake disappearances, new lake development, and saltwater encroachment into aquifers and surface waters. Usteq, from the Yup'ik word meaning “surface caves in,” is a catastrophic form of permafrost thaw collapse that occurs when frozen ground disintegrates under the compounding influences of thawing permafrost, flooding, and erosion. Permafrost loss, due to warming climate, can impact infrastructure installed onto or under the permafrost, leading to disruption in services, additional maintenance and engineering retrofit costs. Reduction in permafrost can also lead to increased or altered wildland fire risk.

Sea ice is frozen ocean water that forms, grows, and melts in the ocean (Figure 4.1.1-2). Sea ice grows during the winter and melts during the summer, but some sea ice remains all year in certain regions. The risks associated with ice processes and human activities are greatest in the Arctic and sub-Arctic regions because of the prevalence of sea ice in those high latitudes. Hazards from sea ice include threats to shipping from running into ice; equipment or personnel breaking through ice when it is used as a seasonal platform for development activities; ice push (*ivu*) and gouging of the land or seafloor; and slush ice buildup that can clog intake valves. Lack of sea ice during fall and winter increases the risk of coastal flooding and erosion from storms in northern and western Alaska because the ice is not there to protect the shore.

A **snow avalanche** is a mass of snow, ice, and debris that releases and slides or flows rapidly down a steep slope, either over a wide area or concentrated in an avalanche chute or track and can run out great distances beyond its source. Avalanches reach speeds of up to 200 miles an hour and can exert forces great enough to destroy structures and uproot or snap large trees. A moving avalanche may be preceded by an “air blast,” which is also capable of damaging buildings. Snow avalanches commonly occur in the mountains of Alaska during the winter and spring as the result of heavy snow accumulations on steep slopes but can also occur in urban areas impacting infrastructure and residential property.

Alaska is particularly vulnerable to cryosphere hazards, as much of its social and economic activity intersects with the environment where cryosphere hazards naturally occur.

4.1.1.1 Glaciers

4.1.1.1.1 *Characteristics/Nature/Types of Glacier Hazards*

Glacier hazards are wide ranging in both temporal and spatial scales and can impact people in both direct and indirect ways. Recent accelerated melting of glaciers in high-latitude regions is leading to unprecedented conditions that affect lives, infrastructure, and ecosystems in Alaska. This section discusses the following glacier hazards: calving, ice falls, ice avalanches, glacier detachments, glacial lake outburst floods, and glacier surges.

Calving is the breaking away of a mass of ice from a near-vertical ice face along the terminus of a glacier, often into a large body of water (Figure 4.1.1-3). Glacier calving can be accompanied by a loud cracking or booming sound as the blocks of ice break loose and crash into the water. The entry of the ice into the water can cause large, sometimes hazardous, waves that can swamp boats and inundate nearby shores. In July 2015, a magnitude 6.3 earthquake occurred 120 miles west of Bear Glacier in Kenai Fjords, triggering a 1-mile swath of ice to calve from the glacier and generate waves (a local tsunami) throughout the lagoon.



Source: USGS 2022.

Figure 4.1.1-3: Ice Calving from Glacier Front, Alaska

Ice falls are triggered by new or existing cracks (crevasses) in glacier ice that allow chunks of a glacier to break off and fall down the slope as a mass of broken ice. Similar to cornice collapses (see Section 4.1.1.4, Snow Avalanche), the mass of these ice falls often triggers snow avalanches on the slope below as they hit the snowpack. Ice falls are unrelated to precipitation, temperature, or other typical snow avalanche factors.

Ice avalanches are a glacier instability that occurs when a large volume of ice breaks away from a steep-sloped hanging glacier. Ice avalanches are larger than ice falls (which are less than 1.308 million cubic yards), and the effects can extend for several kilometers, with greater distances achieved when the event transitions into a highly mobile debris flow as a result of friction-induced melt and entrainment of rock and sediment. Ice avalanches have been associated with glaciers on steep, convex bedrock slopes and linked to such triggers as changes in atmospheric conditions (e.g., increases in temperature or precipitation), an unstable base (e.g., thermal or bedrock instabilities), and seismic events.

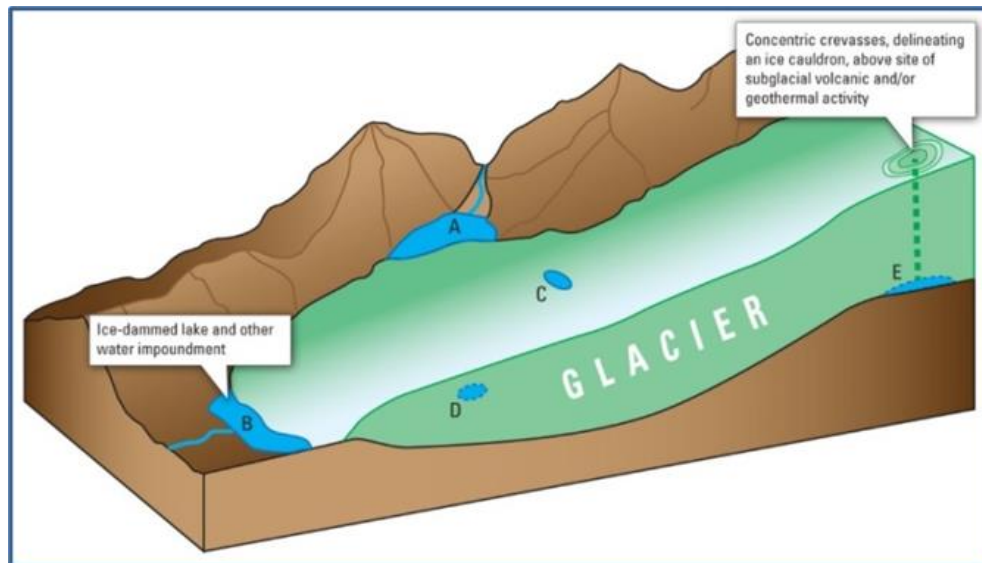
Glacier detachment hazards occur when large parts of a glacier detach catastrophically from their beds. The timing of these large-volume glacier hazards (which are greater than 1.308 million cubic yards) is almost impossible to predict and, in contrast to most other hazards in the cryosphere environment, they can happen independently of immediate weather events (e.g., heavy precipitation or rapid warming). In Alaska, ice collapses have been triggered by earthquakes on multiple occasions. Because of their large volume and high mobility, these events can have tremendously devastating effects and can cause additional hazards, such as flooding and landslides.

Glacial lake outburst floods, also known as jökulhlaups, occur when water is rapidly released from a glacial lake due to the sudden failure of an ice or moraine dam or as water overtops the dam as a result of waves caused by the mass wasting (landslide) of nearby unstable slopes, which can cause a landslide-generated tsunami. In the glacial system, ponds may form wherever water can be retained, and drainage restricted; there are five glacial lake types (Figure 4.1.1-4):

- An ice-marginal lake forms alongside a glacier when a tributary valley or distributary glacier gets dammed by the main trunk of a valley glacier or outlet glacier.
- A proglacial lake forms at the terminus of a valley glacier or outlet glacier.
- A supraglacial lake forms in depressions on top of a glacier.
- An englacial lake forms within a glacier in enlarged conduits and cavities in the ice.
- A subglacial lake forms underneath a glacier in a topographic depression or when subglacial debris creates a dam; subglacial volcanic or geothermal activity can also cause a subglacial lake to form.

Outburst floods can be incredibly destructive; depending on the water volume released and downstream topography, outburst floods can cause extensive damage to downstream infrastructure and threaten public safety. Through collaboration between state agencies, universities, and local cities, a monitoring program has been established in Alaska for ice-dammed lakes at Bear Glacier in the Kenai Mountains, Valdez Glacier in the Chugach Mountains, Russell Lake at Hubbard Glacier in the Saint Elias Mountains, and the Suicide Basin at Mendenhall Glacier in the Coast Range.

Glacier surge is when a glacier periodically undergoes a brief phase (typically lasting 1 to 4 years) of rapid flow, called a surge. Surges are generally interspersed with longer periods (typically 10 to 100 years) of near-stagnation. During a surge, a large volume of ice is displaced downstream at speeds of up to several yards per hour into an ice-receiving area, and the affected portion of the glacier is chaotically crevassed (i.e., cracked). In the interval between surges, the ice reservoir is slowly replenished by snow accumulation and normal ice flow, and the ice in the receiving area is greatly reduced by ablation (i.e., the natural removal of ice through melting, calving, and sublimation). Surging glaciers can also be particularly dangerous after surging because highly crevassed glacier snouts are unstable and subject to a higher incidence of calving, ice falls, and avalanches.



Shows the possible locations of impounded water that can form glacial lakes and potentially generate outburst floods: A, ice-margin lake caused by damming of a tributary valley or distributary glacier from the main trunk of a valley or outlet glacier; B, proglacial lake at the terminus of a valley glacier or outlet glacier from an ice cap or ice field; C, supraglacial lake ...; D, Englacial lake; and E, subglacial lake. Source: USGS 2018.

Figure 4.1.1-4: Glacial Lake Formation Diagram

4.1.1.1.2 Locations of Glaciers and Glacier Hazards

Glaciers and icefields currently occupy many of the mountain ranges in Alaska. Much of Alaska has been shaped by glaciation and deglaciation, and recent changes in climate are causing Alaska's glaciers to melt faster than most other places on the planet. These long- and short-term changes generate a range of glacier hazards, such as unstable water discharge rates, glacier lake outburst floods, glacier and slope instabilities, erosion and sedimentation, iceberg production, and glacier surges that can impact infrastructure and threaten public safety. Infrastructure and buildings located downstream of a glacier, for example low-lying residential areas along many rivers in coastal Southcentral Alaska, are at risk for flooding triggered by glacial lake outburst floods at higher elevations. In Alaska's coastal areas, unexpected glacial calving can become dangerous for cruise ships and recreationists. Glacier hazards can also start a chain reaction of other hazards, such as snow avalanches and debris flows. Because of Alaska's rapidly retreating glaciers, glacier hazard frequency is expected to increase (for example, more significant ice calving events during the summer and greater flooding and erosion caused by outburst floods from lakes forming in valleys previously occupied by glacier ice).

4.1.1.1.3 History of Glacier Hazard Events

This section focuses on potential and historical glacial lake outburst floods and has been updated with more recent events since publication of the 2018 SHMP.

- **Bear Glacier Ice-Dammed Lake, Kenai Mountains:** The Bear Glacier ice-dammed lake in Kenai Fjords National Park is located in the Kenai Mountains at an elevation of approximately 900 feet on the east side of Bear Glacier, 8.8 miles up-glacier from the terminus. Bear Glacier ice-dammed lake is fed by meltwater from the glacier itself and by water runoff (rain and snow meltwater) from upstream slopes. It generally empties in the late summer or early fall. The narrow strip of land that separates the proglacial lake from the ocean, creating a lagoon, was formed during a previous glacial retreat. The sand bar is a popular camping spot, and the lagoon is a popular kayaking destination to watch calving icebergs. When the ice-dammed lake bursts, it may cause significant water level increase in the

lagoon that could endanger campers and people recreating in the area. The lake drained from approximately November 4-13, 2020, resulting in an initial flood alert to the area.

- **Valdez Glacier Ice-Dammed Lake, Chugach Mountains:** The Valdez Glacier ice-dammed lake is located at an elevation of approximately 720 feet on the east side of Valdez Glacier, 4.5 miles up-glacier from the current glacier terminus. The water from outburst floods exits Valdez Glacier and enters Valdez Glacier Lake subaqueously, causing a rapid rise in the proglacial lake level, localized flooding, and increased Valdez Glacier stream discharge. The basin in which the lake forms was previously occupied by an unnamed tributary glacier to the east and is repeatedly filled from glacier, snow, and rain runoff. The Valdez Glacier ice-dammed lake produces annual to bi-annual outburst floods of varying magnitudes. One outburst event regularly occurs in June after spring snowmelt, and a second outburst event typically occurs in September or October in association with heavy rain from fall storms. These flood events have resulted in road closures for up to a week at a time.
- **Russell Ice-Dammed Lake at Hubbard Glacier, Saint Elias Mountains:** Hubbard Glacier and Russell Fjord are located north of Yakutat in the Saint Elias Mountains, Southeast Alaska. Earth's two-largest-recorded outburst floods occurred when the Hubbard Glacier ice-and-moraine dam breached, catastrophically releasing impounded water from Russell Lake. Hubbard Glacier is the largest tidewater glacier in North America, covering an area of approximately 1,460 square miles. In contrast to most glaciers in Alaska, Hubbard Glacier has advanced about 1.5 miles since 1895. Russell Fjord has no other outlet to the ocean than through Disenchantment Bay. Russell ice-dammed lake forms intermittently during times of glacial advance when Hubbard Glacier blocks the channel linking Russell Fjord and Disenchantment Bay at Gilbert Point. Outburst floods from Russell Lake have occurred when the ice dam has been breached, for example, in 1986 and 2002. Peak discharges during these events ranged from 1.9 million cubic feet per second to 3.7 million cubic feet per second. Glacial lake outburst floods from Russell Lake have the potential to have major socioeconomic consequences to the community of Yakutat, commercial and sport fisheries, and tourist and shipping industries as well as an impact sea life in the area. In June of 2022, a cruise ship collided with a small iceberg as it approached the Hubbard Glacier during a sightseeing trip.
- **Suicide Basin at Mendenhall Glacier, Coast Range:** Suicide Basin ice-dammed lake is a sub-glacial lake that forms in an over-deepened basin carved by a now detached-tributary glacier 2.2 miles up-glacier and on the east side of Mendenhall Glacier, approximately 10 miles northwest of Juneau in the Coast Range. Mendenhall Glacier terminates in the proglacial Mendenhall Lake, which drains into Mendenhall River. The river flows through a residential area and near critical infrastructure before reaching the ocean. The subglacial lake in Suicide Basin is fed by meltwater from surrounding glaciers and heavy rain in the early summer months. The ice-dammed lake in Suicide Basin has flooded annually since 2011; some years have multiple smaller floods and some years have only one large flood. The low-lying area along Mendenhall River is the most populated residential area of the City of Juneau, Alaska's capital. In 2014, an outburst flood from Suicide Basin caused the water level of Mendenhall Lake to gain 12 feet over the baseline and resulted in significant damage to riverside properties (Figure 4.1.1-5). In July of 2018, more than one billion cubic feet of water was unleashed into the Mendenhall River from Suicide Basin. Due to the ongoing risk from Suicide Basin, a monitoring program is ongoing (<https://www.weather.gov/ajk/SuicideBasin>).



Source: Eran Hood, UAS 2014

Figure 4.1.1-5: Juneau Area Outburst Flooding in the View Drive Neighborhood

4.1.1.1.4 Extent of Glacier Hazards

Glacier hazards can occur anywhere glaciers are located, and certain glacier hazards can cause impacts several miles away, particularly when they generate a combination or chain of processes, otherwise known as a hazard cascade, each part of the cascade potentially representing a hazard in itself. For example, a 2015 earthquake caused a 1-mile swath of ice to calve off Bear Glacier, generating a local tsunami within the lagoon. Outburst floods at Hubbard Glacier have resulted in peak discharges of 1.9 to 3.7 million cubic feet per second. Outburst floods at the Suicide Basin ice-dammed lake caused Mendenhall Lake to gain 12 feet over the baseline in 2014.

4.1.1.1.5 Impact of Glacier Hazards

The impacts of glacier hazards occur along a spectrum of spatial, temporal, and intensity scales and can range from negligible to catastrophic. The largest glacier-related disasters in terms of reach, damage, and lives lost are typically associated with cascading hazards involving glacier change. For example, slope failures and glacier detachments can trigger cascading hazards, especially when slope failures enter water bodies and cause outburst floods, debris flows, and tsunamis. Such cascading hazards can present a risk to people and infrastructure at great distances (tens of miles) from the initiating slope failure.

A surging glacier can advance quickly and override the ground in front of it, destroying anything in its path and possibly damming water flow to create a glacial lake that is a potential source of outburst flooding. Regular flooding in Juneau occurs from the Suicide Basin ice-dammed lake, causing property damages.

4.1.1.1.6 Probability of Glacier Hazard Events

Assessing glacier hazards as a function of probability is difficult in Alaska due to the lack of long-term quantitative data. As a result, probabilities are generally not available, but for some specific locations these hazards are highly likely based on historic events. However, as a relative measure of probability for certain types of hazards, susceptibility provides an indication of the likelihood of occurrence given consideration of site-specific conditions and characteristics as appropriate for specific types of hazards. For example, glacier melt modeling and basin geometry can be used to develop maps of glacial lake outburst flood susceptibility for glacierized watersheds.

4.1.1.1.7 Projected Changes in Locations of Glacier Hazards

Changes in climate can shift hazard zones and scales. As glaciers continue to rapidly retreat, the locations and types of glacier hazards will change. For instance, glacier retreat provides new land for development but also exposes over-steepened slopes that are prone to destabilization, increasing the threat of landslides. In the case of retreating calving glaciers, larger water bodies are often exposed, increasing the potential for rock avalanches to enter the water and generate devastating displacement waves, which increase the reach and intensity of the hazard.

4.1.1.1.8 Range of Anticipated Intensities of Glacier Hazard Events

The anticipated intensities for glacier hazards range from low intensity calving events to extreme intensity catastrophic glacier detachments or glacier-related landslides and associated hazard cascades that can lead to local devastation.

4.1.1.1.9 Frequency of Glacier Hazard Events

Glacier hazards occur at a range of frequencies. There is limited information about changes in the frequency of glacier hazards in Alaska, but the combination of increased rainfall, unusual warmth that increases glacier melt, more crevasses, and the retreat and steepening of glaciers appears to encourage glacier surges and influence glacier-related slope instabilities. For instance, a period of unusually warm air temperatures between 2012 and 2016 in Southeast Alaska coincided with an increase in ice/rock avalanche activity and size.

4.1.1.1.10 Duration of Glacier Hazards

Glacier hazards will persist in an area for at least as long as the glacier is present, and some glacier-related hazards will continue to be influenced by landscape responses after a catchment is deglaciated (e.g., debuttressing-influenced unstable slopes). The duration of specific glacier hazards can range from seconds (calving events) to years (surges).

4.1.1.1.11 Future Conditions of Glacier Hazard Events, Including with Climate Change

Glaciers are sensitive to changes in climate. As snow accumulation lags behind ice melt, glacier change has become one of the most important and widely recognized indicators of climate change. Historically unprecedented mountain glacier recession has proceeded on a global scale for more than 30 years in response to global air temperature increases. During this time, Alaska has warmed twice as fast as the global average, and glaciers have responded with increasingly negative cumulative mass balances and are a leading contributor to global sea level rise.

Glaciers in Alaska currently have one of the highest melt rates in the world, with annual thinning rates that reach several tens of feet per year for some glaciers terminating near sea level. This rapid and sustained melting and retreat of glaciers in Alaska is expected to continue as a consequence of continued temperature increases, as predicted unequivocally by all current climate models.

4.1.1.1.11.1 Characteristics/Nature

Rapid and accelerating glacier change increases the potential of glacier hazards and may exacerbate the hazard potential of other geophysical processes. For example, new ice-dammed lakes are being formed at the margins of large glaciers in valleys formerly occupied by small tributary mountain glaciers that have retreated; as climate change continues, more ice-dammed lakes are anticipated to form. Likewise, continued glacier retreat will lead to valley-wall unloading and possible permafrost thaw, potentially increasing rockfall and landslide incidences.

4.1.1.1.11.2 Locations

Rapid glacier change is occurring and is projected to continue in all glacierized regions of Alaska. Glacier hazards occur anywhere where glaciers are located or have recently affected the landscape.

4.1.1.1.11.3 Range of Anticipated Intensities

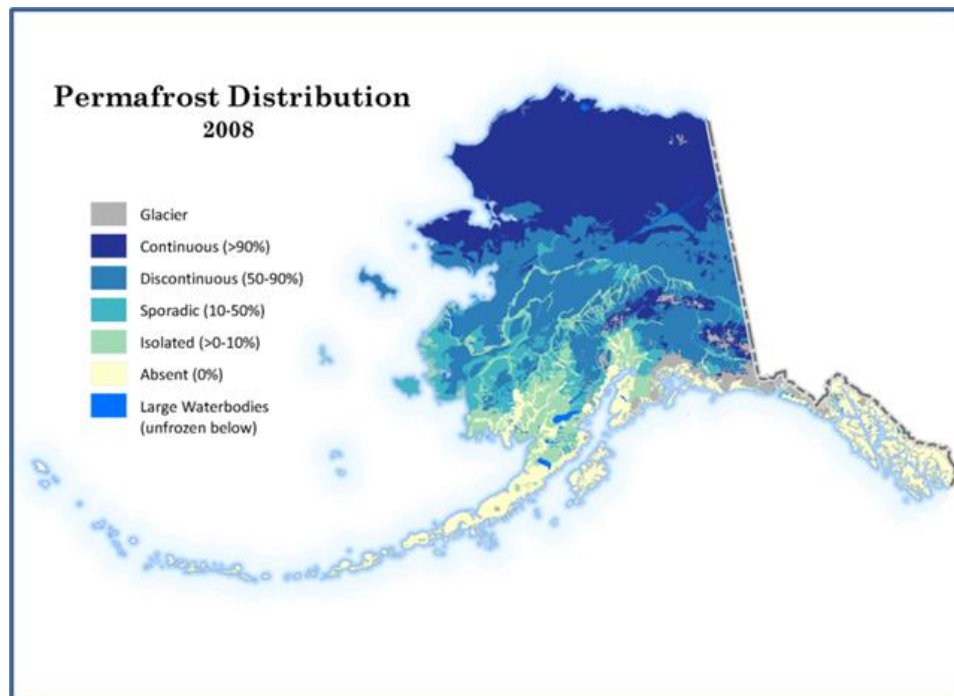
Glacier hazards will continue to occur where glaciers exist and in nearby settings where their influence extends. Although no direct information is available on predicting the intensity of future glacier hazards, rapid environmental change and more intense climate conditions are projected for various parts of Alaska in the coming decades.

4.1.1.2 Permafrost and Periglacial

4.1.1.2.1 Characteristics/Nature/Types of Permafrost and Periglacial Hazards

In the periglacial environment, the effects of freezing and thawing drastically modify the ground surface. Types of modification include the displacement of soil materials, migration of groundwater, and the formation of unique landforms. Many periglacial regions, such as Alaska, are underlain by permafrost that strongly influences geomorphic processes.

Permafrost, defined as ground with a temperature that remains at or below freezing (32 degrees Fahrenheit [°F] or 0 degrees Celsius [°C]) for two or more consecutive years, can include rock, soil, organic matter, unfrozen water, air, and ice. Regions with permafrost are typically categorized by percent of surface area underlain by permafrost (Figure 4.1.1-6): continuous (>90 percent), discontinuous (50 to 90 percent), sporadic (10 to 50 percent), and isolated (<10 percent) permafrost. Bodies of ice can occur in permafrost, including pore ice, segregated ice, tabular ice, and ice wedges, among other types. Large bodies of ground ice are referred to as massive ground ice. Permafrost with a high volume of ice is called ice rich permafrost.



Shows permafrost distribution in Alaska in 2008. Source: Jorgenson et al. 2008.

Figure 4.1.1-6: Permafrost Distribution Map for Alaska

Permafrost provides a stable foundation for structures and infrastructure in cold-climate regions if the temperature of the frozen ground is well below freezing. A major hazard of warming and thawing permafrost is that ground ice melts and the soil surface collapses. Fluctuations in temperature over the seasons also cause the ground to move as the upper layers freeze (i.e., ice lens formation) and thaw (i.e., loss of ice). Segregated ice lenses may form under wet conditions as the ground freezes, especially in

fine-grained soils such as silt or clay. On thawing, ground ice can cause an excess of liquid water that cannot be stored in the soil and needs to flow out of the soil as gravity consolidates the soil after thawing.

Aufeis (German for “ice on top”), or **icing**, occurs when a sheet-like mass of layered ice forms from successive groundwater flows during freezing temperatures. Groundwater is forced by hydraulic pressure to break through to the surface and flow on top of previously formed ice, which can occupy most or all of the riverbed and causes the liquid to flow around or over the ice. This ice accumulation means that even small flows in winter can create large hazards as the icing impinges on roads and buildings (Figure 4.1.1-7). Aufeis can also cause a secondary hazard during snowmelt, when meltwater is unable to occupy the ice-filled riverbed and instead flows unrestrained across the land and ice surface. The Dalton Highway aufeis flood, described in Section 4.1.3, Flood and Erosion, was exacerbated by meltwater.

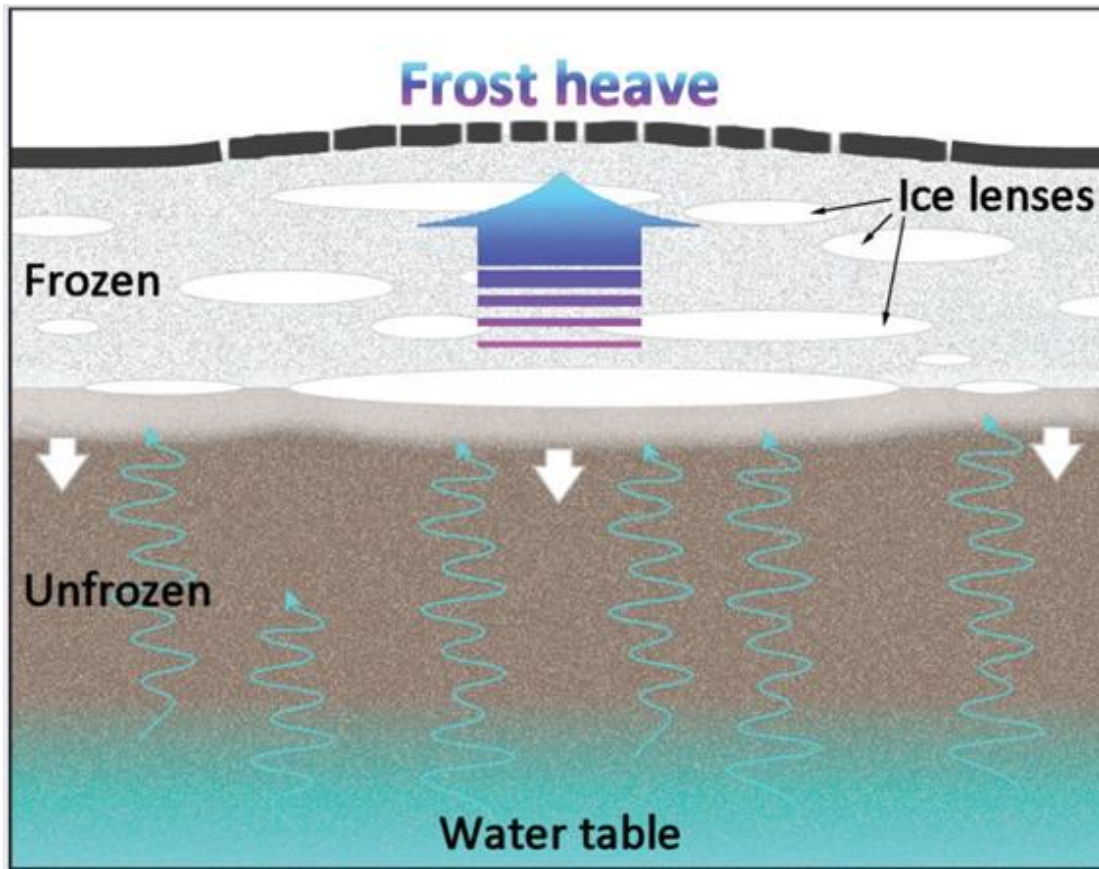


Source: DGGS 2022.

Figure 4.1.1-7: Aufeis at a Bridge Near Fairbanks, Alaska

Frost cracking results from the contraction of freezing soil. This contraction can be forceful enough that the ground cracks to release tensile stress, similar to what happens when mud dries to form mud cracks. In extreme cases, polygons may form from thermal contraction in very cold environments and develop ice wedges within the cracks from meltwater and blowing snow accumulation. Frost cracking can be hazardous when it occurs in road surfaces, breaking pavement, and roadbed structure.

Frost heaving occurs when the soil surface is lifted with great strength from below by seasonal ice lens development in fine-grained soils (Figure 4.1.1-8). The temperature gradient from the freezing surface into the unfrozen ground drives liquid water to the freezing front, where it can freeze into solid ice lenses. Buildings and roads are affected by the lifting force of the growing ice lenses, but the most destructive conditions occur when there is differential frost heave. Differential frost heave occurs when ice lens formation is non-uniform and only portions of the soil surface are pushed up—this can break building foundations and roads to pieces. A compounding effect of the seasonal ice lenses that cause frost heaving is that, on thawing, the soil is left supersaturated, meaning that the liquid is carrying the weight of the soil. Pressure on the supersaturated soil, such as driving on a road across the thawed ice heave area, causes horizontal (lateral) movement of the soil and destruction of the overlying roadbed. This pressure is the reason that roads can fail in spring, and why there are restrictions on axle weight.



Freezing takes place from the surface down (white arrows). When conditions are favorable, an ice lens begins to form a short distance behind the freezing front. Fed by liquid groundwater from warmer zones deeper in the soil profile, the lens will continue to grow for as long as the controlling mechanisms allow. Multiple lenses reflect fluctuations in these controls due to changes in surface temperature, soil texture, and water availability. The amount of vertical displacement (heave) is roughly equal to the combined thicknesses of the underlying ice lenses. Heaving causes pavement to crack. Source: Manz 2011.

Figure 4.1.1-8: Diagram of Frost Heave Formation

Frost jacking occurs when a solid object, such as a fence post or foundation block, is incrementally jacked out of the ground due to ice lens formation within the soil during repeated freeze-thaw cycles. Two mechanisms are believed to be responsible for frost jacking:

- Freezing soil grips the object and heaves upward due to expanding ice, thereby lifting the object out of the ground.
- Water trickles underneath a solid object and resultant ice growth during freezing pushes the object out of the ground. This process can cause foundations to break and buildings to collapse.

Thermokarst is a form of periglacial topography resembling karst, characterized by irregular surfaces and hollows, produced by the selective melting of ice in ice-rich permafrost (especially permafrost with massive ground ice). Degrading ice-rich permafrost causes differential settlement when voids are left behind by melting ice collapse. Sometimes this can form deep depressions (i.e., pits) when thick ground ice degrades, and the soils above it cave in, or thermokarst lakes where continued thawing along the margins of the lake causes the surface to collapse farther and the lake to expand over time.

When permafrost is present on steeper slopes and the water released from melting ground ice is greater than the pore volume of the thawed soils, slope materials can become unstable and flow downhill. This phenomenon is known as a retrogressive thaw slump or active layer detachment slide (see Section 4.1.4, Ground Failure). These features can continue to grow as long as massive ice is present in the collapsing ground and the remaining slopes are sufficiently steep.

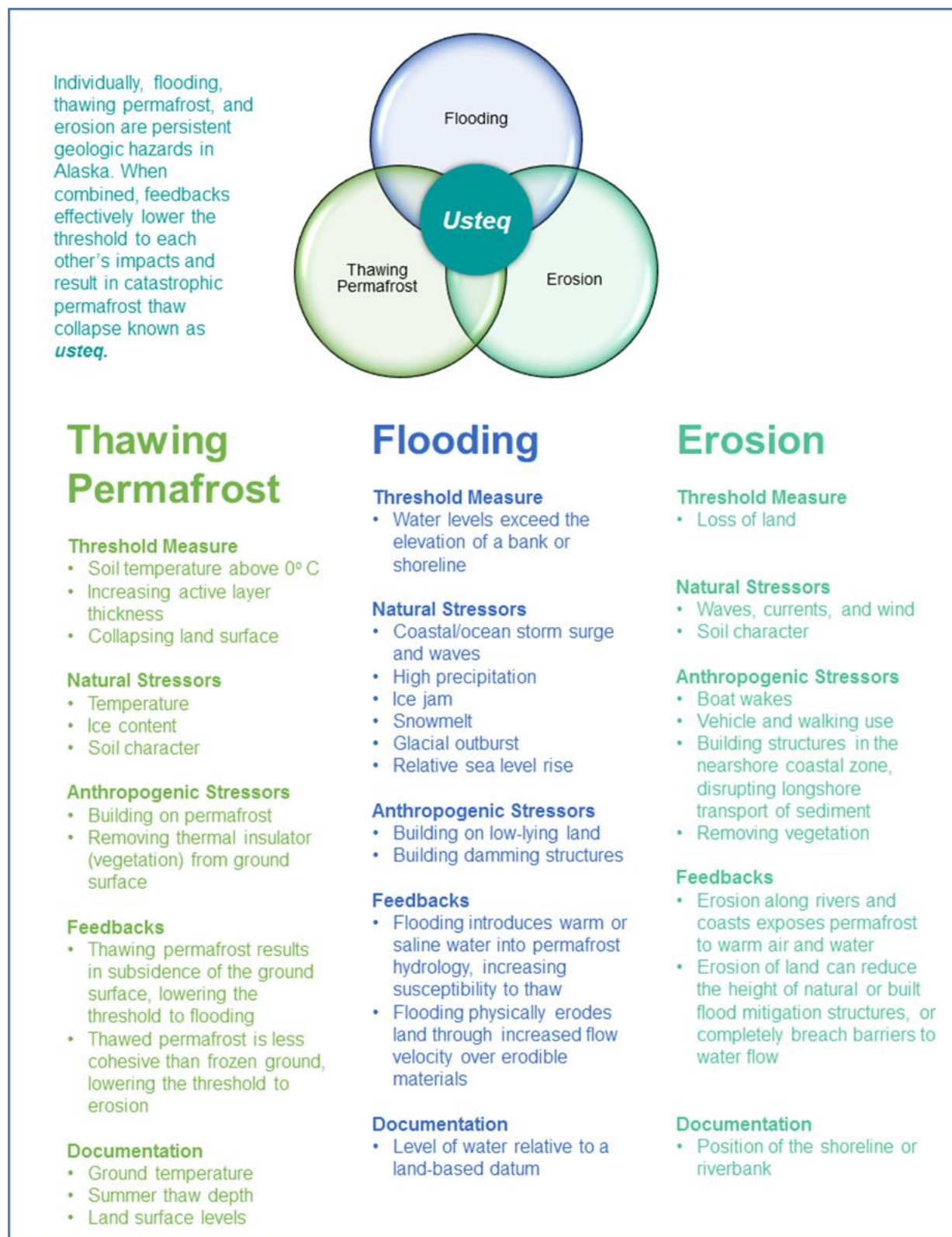
Usteq is a catastrophic form of permafrost thaw collapse that occurs when frozen ground disintegrates under the compounding influences of thawing permafrost, flooding, and erosion (Figures 4-9 and 4-10; see also Bronen et al. 2019). The compound hazard of usteq is much greater than its individual component processes; permafrost thaw, flooding, and erosion are parts of an escalating feedback loop. Although permafrost degradation on its own can be a slow or moderately rapid process, in combination with flooding (including storm surge) and erosion, permafrost thaw can happen very quickly. During usteq, permafrost thaw that was previously a slow, developing hazard becomes a high-impact disaster as the ground caves in and collapses.

There are three critical permafrost characteristics that strongly affect susceptibility to usteq: thermal state, ice content, and soil characteristics. In practice, the thermal state of permafrost refers to the temperature of the frozen ground. Permafrost reflects the long-term thermal stability of atmospheric temperatures, combined with the dynamics of snow accumulation; the stability of permafrost can be determined by measuring its temperature. When temperatures approach the melting point of ice in the ground, permafrost temperature remains more-or-less steady at that point until all ground ice has melted. During permafrost thaw, surface collapse can sometimes be measured instead of temperature to detect the progression of permafrost thaw. During wet summers, the effects of permafrost thaw can be accelerated when infiltrating water transports heat to the thawing front and water seeping from the ground carries sediment away from ground ice in thaw slumps.



Land lost to the ocean due to usteq. Source: USGS 2022 (<https://dggs.alaska.gov/hazards/permafrost.html>)

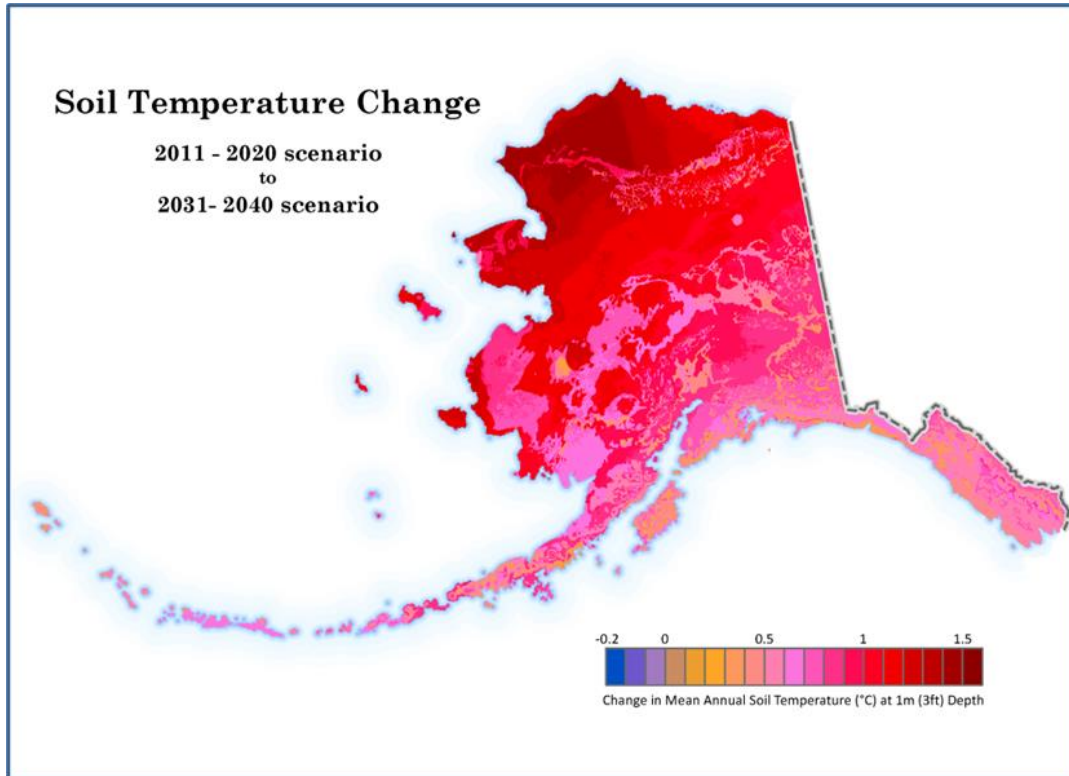
Figure 4.1.1-9: Structure at Elson Lagoon, Alaska



A catastrophic form of permafrost thaw collapse that occurs when frozen ground disintegrates under the compounding influences of thawing permafrost, flooding, and erosion. Source: DGGs 2022

Figure 4.1.1-10: Schematic of the Compounding Threat of Usteq

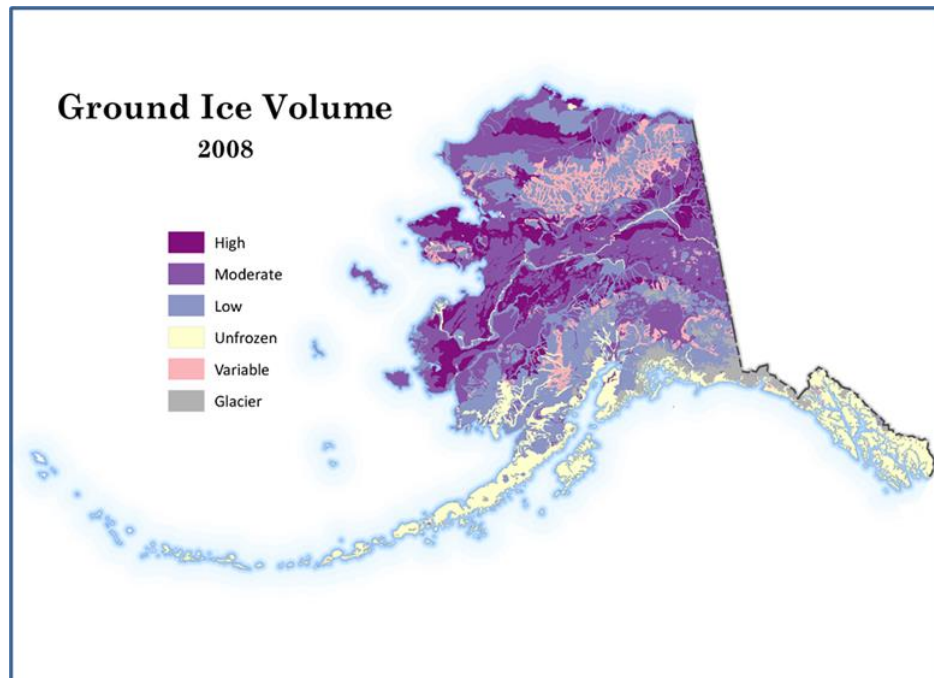
Permafrost temperatures throughout Alaska are showing warming trends (Figure 4.1.1-11); as permafrost approaches the freezing point (32°F/0°C), it becomes increasingly unstable and prone to collapse. Unstable permafrost requires little trigger to initiate degradation. Stability is also a function of the vegetation cover and thickness of the organic layer. Permafrost in colder climates does not have the level of insulating vegetative protection than permafrost in warmer climates has.



Scenarios span the next 20 years. This figure is one illustration of the many scenarios that scientists use to try to anticipate changes as climate warms; most models indicate that soil temperatures in Alaska are showing warming trends as global temperatures rise. Source: UAF et al. 2019.

Figure 4.1.1-11: Modeled Soil Temperature Potential Changes

Ice content, the second permafrost characteristic that strongly affects susceptibility to thaw, is the measure of frozen water in a given volume of permafrost (Figure 4.1.1-12). Because permafrost is by definition any earth material that remains below freezing for more than two consecutive years, permafrost composition is highly variable, ranging from solid rock to soils that are composed almost entirely of ice. Studies near Cape Halkett and Drew Point on the Arctic coast of Alaska have demonstrated that the rate of coastal erosion of ice-rich permafrost is much faster than the rate for non-ice-rich permafrost. In Alaska, yedoma (a type of permafrost consisting of loess and organic material that is believed to sequester large amounts of carbon), which may be tens of feet thick, occurs in the Arctic foothills, in the northern part of the Seward Peninsula, and in interior Alaska; these areas will be particularly susceptible to catastrophic thaw collapse as temperatures warm (Figure 4.1.1-13). For example, the In’upiat community of Noorvik sits on 65 to 100 feet of massive ground ice that will be at risk of collapse if current trends continue.



A higher volume of ground ice, especially in fine-grained soils, can make soils more unstable on thawing due to high pore water pressures in supersaturated soils and can lead to extreme ground settlement due to voids left by melting ice. Source: Jorgenson et al. 2008.

Figure 4.1.1-12: Map Showing Ground Ice Volume of Permafrost in Alaska



Source: NPS 2017.

Figure 4.1.1-13: Yedoma Exposed Along an Eroded Arctic Coast

The third permafrost characteristic that affects susceptibility to *usteq* is frozen soil or ground composition. Some soils (e.g., gravel) may have a high ice content but are thaw stable when the ice melts, but other soil types (e.g., silt) disintegrate and collapse when the supporting ice structure turns to water and saturates the soil material. When large areas of thick, ice-rich, fine-grained substrate thaw, there is potential for extreme consequences, including large-scale land surface lowering and collapse, sinkholes, and landslides.

Feedback mechanisms become particularly significant for affected communities in coastal and riverine environments, where river or ocean water from local flood events or storms can reach far inland and contribute to permafrost degradation. Warming temperatures initiate permafrost thaw, causing the land surface to sink (a form of ground subsidence). This lowered land surface is more vulnerable to storm surges and flooding, which exacerbate the hazard and lead to catastrophic hyper-erosion and inundation. Coastal storms that bring saltwater into contact with unstable permafrost can magnify thawing impacts (for example, at Kwigillingok on the Yukon-Kuskokwim Delta). Modeling shows that saltwater accelerates coastal permafrost thaw, even if temperature effects are ignored.

Permafrost is present and is collapsing throughout most of Alaska. Thawing permafrost alone is considered a specific hazard, but *usteq* is an additional unique, compound hazard. Although some communities will have thawing with little or no flooding or erosion, it is when all three processes combine that the effects become catastrophic.

Elevated community risk factors for *usteq* include permafrost thermal state, soil ice content, and soil characteristics, as noted above, but also coastal vulnerability and riverbank vulnerability. Measuring permafrost thaw vulnerability can be accomplished by:

- Measuring soil temperature and evaluating whether it is approaching thaw vulnerability thresholds (in most cases 32°F)
- Measuring summer thaw depth and determining if this depth is increasing
- Monitoring ground surface levels to look for long-term subsidence

Modeling and data sharing are critical to mitigating *usteq* threats to Alaska communities and infrastructure. On-the-ground observations, in conjunction with remotely sensed data, provide the necessary information required to develop realistic models of the interacting environmental hazards and how to integrate their effects into a unified understanding of the threat. Data inputs and results must be shared so that all stakeholders have equal access and can independently evaluate and use the information for diverse needs and priorities. Partnerships that link local community observers with universities and government agencies researchers have already formed to create effective teams that contribute critical data to help understand and evaluate Alaska's thawing permafrost, flooding, and erosion challenges. These partnership networks include the Alaska Native Tribal Health Consortium's Local Environmental Observer Network. ([Search – Local Environmental Observer Network \(leonetwork.org\)](https://leonetwork.org)); the Alaska Sea Grant-funded Shoreline Erosion Monitoring Project (<https://seagrant.uaf.edu/research/projects/summary.php?id=1041>); the University of Alaska, Fairbanks (UAF) Alaska Arctic Observatory and Knowledge Hub (AAOKH) (<https://www.arctic-aok.org>); and Permafrost Pathways, a new community-based monitoring project initiated by the Alaska Institute of Justice and Woodwell Climate Research Center (<https://www.akijp.org/permafrost-pathways/>).

Frozen debris lobes, a form of degrading permafrost landslide, are another type of *usteq* hazard. They are slow moving but threaten the Dalton Highway.

4.1.1.2.2 Locations of Permafrost and Periglacial Hazards

Permafrost is found beneath nearly 85 percent of Alaska (see Figure 4.1.1-6). It is thickest and most extensive in Arctic Alaska north of the Brooks Range and becomes increasingly thinner and more discontinuous southward until it is virtually absent in Southeast Alaska except for pockets of high-elevation alpine permafrost.

4.1.1.2.3 History of Permafrost and Periglacial Hazard Events

This section describes historical permafrost and periglacial hazard events and has been updated from the 2018 SHMP.

- Fall 2001 usteq at Shishmaref: Winds and high tides combined to strike the Shishmaref coastline from October 5 through October 7, 2001 and eroded the coastline as much as 50 feet inward. Some sections of the sand scarp were undercut by as much as 16 to 20 feet due to the surf melting the underlying permafrost.
- Spring and fall 2016 usteq at Kivalina: Repeated episodes of usteq, triggered by storms, struck Kivalina in 2016. The fall usteq threatened the Kivalina airport. The tribal government of Kivalina declared a disaster, but the Obama administration declined to issue a Presidential disaster declaration.
- Fall 2016 usteq at Newtok: An usteq claimed at least 40 feet of ground between Newtok and the Ninglick River, with blocks of tundra the size of minivans slumping and being carried away by floodwaters. The town is built on permafrost plateaus that are just 6 to 10 feet above river level, and the ground is disintegrating. The tribal government of Newtok declared a disaster, but the Obama administration declined to issue a Presidential disaster declaration.

4.1.1.2.4 Extent of Permafrost and Periglacial Hazards

As noted previously, permafrost is found beneath nearly 85 percent of Alaska (Figure 4.1.1-6). It is thickest and most extensive in Arctic Alaska north of the Brooks Range and becomes increasingly thinner and more discontinuous southward until it is virtually absent in Southeast Alaska except for pockets of high-elevation alpine permafrost. North of the Brooks Range, permafrost is as thick as 2,000 feet (and in northern Siberia has been measured as thick as 5,000 feet). Permafrost can harbor ice in many forms, ranging from massive ice bodies to ice lenses to disseminated interstitial ice crystals. Thawing causes landslides, ground subsidence, and erosion as well as lake disappearances, new lake development, and saltwater encroachment into aquifers and surface waters. Usteq—catastrophic permafrost collapse accompanied by flooding and erosion—is particularly destructive. Aufeis can form in low-lying areas such as along creeks. Periglacial hazards result from the effects of repeated freezing and thawing; and include frost cracking, frost heaving, and frost jacking, and can occur anywhere in the state.

4.1.1.2.5 Impact of Permafrost and Periglacial Hazards

Permafrost and periglacial processes can impact both built and natural environments. Impacts include a full range of damage, from comparatively minor (negligible) bending or buckling of human-built features due to heterogeneous movement to complete destruction of infrastructure and buildings (catastrophic) due to ground failure (usteq) and flooding (aufeis). Mountain permafrost degradation can increase the likelihood of landslides. Degradation of mountain permafrost and rapid glacier retreat (see Section 4.1.1.1) has been linked to large rock slope failures in southern Alaska, where the upper limit of the failure corresponds to the lower altitudinal limit of permafrost. Tsunami-generating large rock slope failures in southern Alaska have devastated entire fjords (e.g., Taan and Lituya Bay fjords).

Permafrost changes can also impact the nature, rate of spread, and suppression effort required for wildland fire, as the materials available to burn change in water content and temperature.

Permafrost and periglacial processes have generated comparatively slow ongoing phenomena in the past, but changes in climate have increased the magnitude and frequency of damaging permafrost collapse. Recent degradation of permafrost in Alaska is leading to emerging biogeochemical threats that have the potential to disrupt ecosystem function and endanger human health.

4.1.1.2.6 Probability of Permafrost and Periglacial Hazard Events

As the climate continues to warm, it is probable that permafrost will continue to melt and increase damages to infrastructure and property as well as increase the number and severity of usteq. Based on historic events, it is highly likely that these events will continue to occur on an annual basis in some areas.

4.1.1.2.7 Projected Changes in Locations of Permafrost and Periglacial Hazards

As the climate continues to warm, permafrost areas of Alaska are becoming increasingly susceptible to permafrost hazards. Regions previously stable are anticipated to experience more permafrost degradation, especially in areas where the permafrost is ice rich.

4.1.1.2.8 Range of Anticipated Intensities of Permafrost and Periglacial Hazard Events

The intensity of permafrost hazard events will vary from minor to severe. Areas of ice-rich materials impacted by increasing permafrost thaw can lead to increased erosion intensity and hazard potential. See Section 4.1.3 on erosion hazards. Usteq is a leading aspect of coastal erosion and flooding, and many areas along the coast will experience intensifying flooding, saltwater incursion, and permafrost degradation over the next decades. Areas with the most ground ice will experience elevation loss as the ice melts and the land level collapses.

4.1.1.2.9 Frequency of Permafrost and Periglacial Hazard Events

Permafrost processes and their degradation will occur on a spectrum of frequencies. For example, frost cracking, heaving, and jacking are annually occurring events with minor but cumulative impacts, whereas large, catastrophic rock slope failures are less common at the present time. Most permafrost degradation is expected to occur in the fall when active layer depths are at a maximum and the loss of ice-rich permafrost is most likely.

4.1.1.2.10 Duration of Permafrost and Periglacial Hazards

Permafrost hazards range from short term to long term. Frost heave, frost jacking, and active layer deepening, which cause movements of mere inches, occur annually for a few months each year, but loss of massive ice in permafrost occurs over decades with collapses on the order of tens of feet. Total loss of permafrost is not expected to happen in less than a few centuries.

4.1.1.2.11 Future Conditions of Permafrost and Periglacial Hazard Events, Including with Climate Change

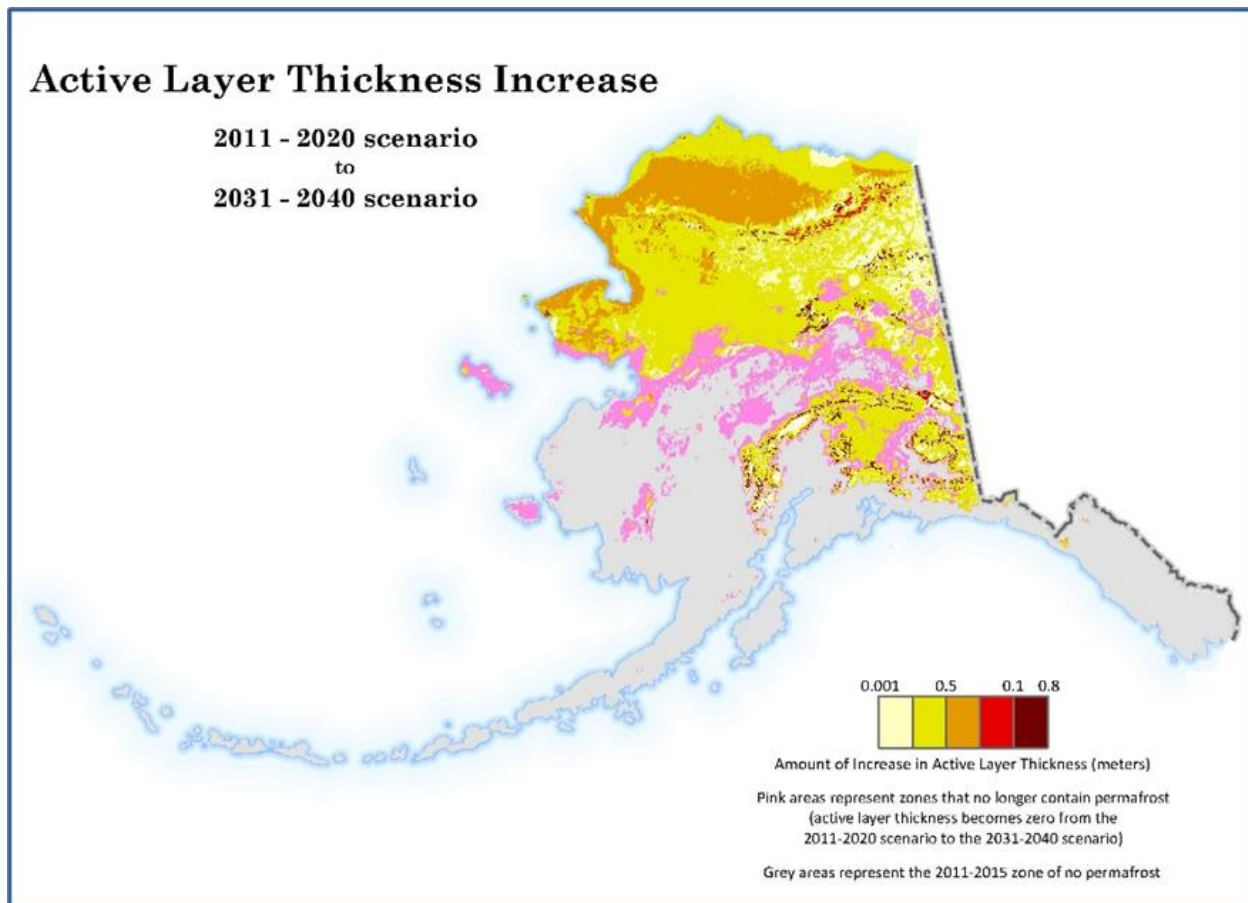
Permafrost is at an increased risk of thawing as a result of climate change. The major climatic factor leading to warming and thawing permafrost is an increase in air temperatures. Another important factor is the potential increase in snow depth predicted by the majority of climate models. Snow insulates permafrost from low winter temperatures, which leads to an increase in ground temperatures and diminishes permafrost stability. When soils are warm, permafrost becomes unstable and is sensitive to catastrophic collapse in conjunction with flooding and erosion. Even in non-ice-rich soils, freezing binds soil particles together, and process-driven models show more material is available for erosion and transport when the soil is thawed, leading to increased exposure of underlying or adjacent frozen material to thermal and physical stressors. Even a small warming of permafrost can cause a reduction in its bearing capacity, impacting its ability to support structures. This warming happens before the soils completely thaw and, depending on soil type, can happen when temperatures are between 20°F and 30°F.

Scientific data on the impacts of changing climate on the active layer (i.e., the surface layer above the permafrost that thaws each summer) is unclear, but on the decadal timescale (i.e., tens of years), the depth of the active layer, depending on the ice content of the upper permafrost, looks to be increasing (Figure 4.1.1-14). This increase is potentially destructive to permafrost stability if the ground is not completely refreezing in winter and leads to talik development. Taliks are areas of unfrozen ground within predominately frozen permafrost areas. Taliks exist over winter and have the potential to change many physical processes in the upper part of the soil, especially the hydrology. If permafrost is ice-rich,

taliks may greatly accelerate surface collapse. Critical thresholds are being approached in many parts of Alaska and are not limited to the southern edge of the permafrost. The lack of protective vegetation in the north can allow faster thaw when a heat wave reaches there, and rapid collapse has been observed even north of 80 degrees latitude.

Failures of large rock slopes in Southeast Alaska, where permafrost is present only at high elevations, have been linked to a combination of gradual long-term warming and record high mean near-surface air temperatures. Due to warming conditions, thawing, and refreezing have reached deeper into the rock surfaces—water is penetrating deeper into cracks and freezing, which loosens rocks due to ice formation and expansion in cracks. Continued warming in other mountainous areas of Alaska where permafrost and glaciers are rapidly degrading could respond similarly.

Groundwater is affected by the presence of permafrost, and a lack of permafrost in the future will change where groundwater can be found. Aufeis, a direct result of groundwater discharge to the surface, will form in different areas compared to where it forms today, which will create road hazards during winter as this type of flooding does not stop during the winter months.



The map shows modeled potential change in the thickness of the active layer in Alaska over the next 20 years. Calculations indicate that the active layer will thicken everywhere in Alaska as climate warms. The areas where existing permafrost will disappear are shown in pink. This is just one illustration of the many scenarios that scientists use to try to anticipate changes as climate warms. Source: UAF et al. 2019.

Figure 4.1.1-14: Active Soil Thickness Layer

4.1.1.2.11.1 Characteristics/Nature

Permafrost changes due to a warming atmosphere are both fast and slow. A combination of warmer summers and winters with deep snow cover will allow for fast near-surface permafrost degradation, which will lead to landslides and thaw slumps in the permafrost regions. Slow decadal warming response will show collapse of the surface due to the cumulative loss of ground ice. Permafrost is resilient in areas where there is a lot of protective vegetation and peat; these areas of permafrost will be maintained longest.

4.1.1.2.11.2 Locations

Climate change will affect permafrost everywhere in the state, but the northern region is most likely to see the most catastrophic changes in the next decades due to massive ice degradation, erosion, and flooding (usteq). The south already sees the results of permafrost loss in high-altitude permafrost, where frozen ground was holding rocks together that now come apart, resulting in massive slope failures. The location of aufeis will likely change due to the free movement of groundwater in areas that were previously frozen.

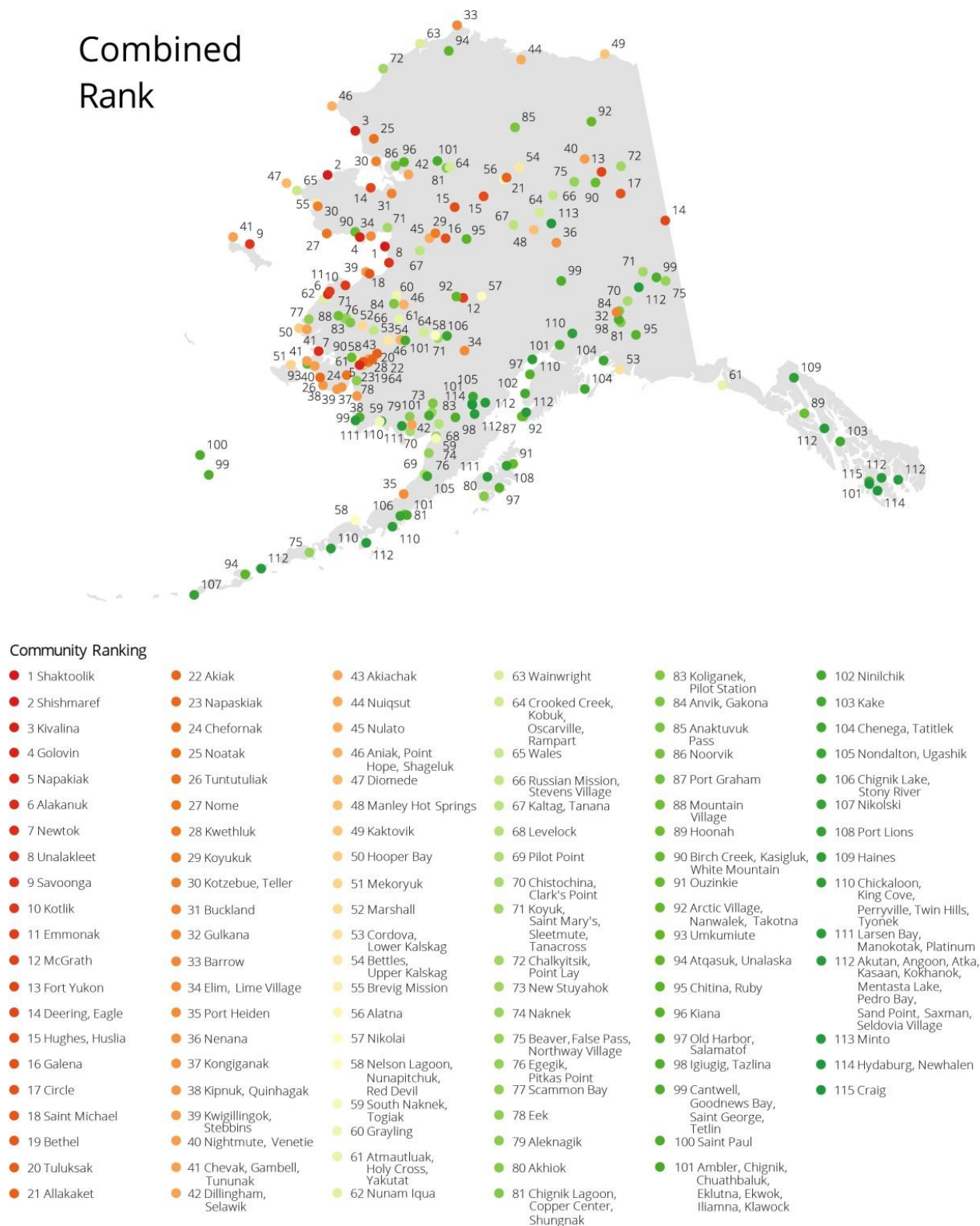
In 2019, the Denali Commission and UAF released the Statewide Threat Assessment to assess environmental threats to public infrastructure in 187 communities in Alaska. The report first evaluated the individual threats associated with erosion, flooding, and thawing permafrost in Alaska communities and then evaluated the combined threat imposed by the interactions between erosion, flooding, and thawing permafrost, including usteq. Usteq is a subset of the combined threats but was not separated for the purpose of the study, and the authors found that usteq was the most difficult to predict because it incorporates the uncertainties associated with each individual threat. The report also found that any one of these threats can be catastrophic in a community and that each threat generally operates at different timescales and impacts infrastructure through different processes. When combined, the impacts can be exacerbated, resulting in usteq. When the threat of permafrost thaw is high in a location also subject to erosion and flooding, the occurrence of usteq may be a high probability. The report illustrates the importance of employing the threat rankings to identify those communities that require a detailed investigation of threats from erosion, flooding, and thawing permafrost (UAF et al. 2019).

In Figure 4.1.1-15, the top-five most environmentally threatened communities are Shaktoolik, Shishmaref, Kivalina, Golovin, and Napakiak. Newtok ranks seventh because the individual threat rankings show that even though Newtok ranks first for the threat of erosion and permafrost, it ranks forty-first for the threat of flooding. However, Newtok is clearly impacted by usteq, and it is the combination of erosion in ice-rich permafrost that presents an immediate and ongoing threat. Although consideration of the combined rating alone does not place Newtok at a higher level of risk than the top five communities, the influence of usteq acts as a driver for Newtok's well-documented erosion threat (UAF et al. 2019, page 5-15).

4.1.1.2.11.3 Range of Anticipated Intensities

The frequency and magnitude of permafrost collapse is expected to increase dramatically with changing climate. Entire communities built on ice-rich, fine-grained sediments will be at risk of extreme usteq. Coastal erosion in northern Alaska will be exacerbated. Degradation of alpine permafrost will lead to larger and more common slope failures.

Combined Rank



Map shows the locations of the most environmentally threatened communities (red) to the least environmentally threatened communities (dark green). Prepared by Erin Trochim, Alaska Climate Adaptation Science Center; UAF et al. 2019

Figure 4.1.1-15: Combined Threat Risk Map

4.1.1.3 Sea Ice

4.1.1.3.1 Characteristics/Nature/Types of Sea Ice Hazards

Sea ice hazards are common in the Arctic, where extreme cold weather conditions freeze the ocean's surface. Some of these hazards are also relevant for freshwater systems, such as rivers and lakes. The Arctic Ocean freezes over vast areas to ice thicknesses of more than 3 feet annually. A large portion of this area melts during the summer, but usually some of the annual ice remains to become multi-year ice that can freeze again and become much thicker. Sea ice and its associated hazards are complex and dynamic due to the interaction of wind, temperature, first-year ice, and multi-year ice with a variety of human activities related to transportation, subsistence living, coastal erosion, and resource extraction (Eicken and Mahoney 2015).

Sea ice hazards have been present since the first people ventured out into the sea ice for hunting and travel. Population growth, demand for resources, and the warming climate of the last century have spurred more interest in arctic exploration and there has been an increase in the number of cruises into high-latitude waters. Even the indirect consequences of sea ice activity can be hazardous to ship traffic; for example, in August 1996 the cruise ship *Hanseatic* ran aground in Simpson Strait near Gjoa Haven, Northwest Territories, because winter sea ice had moved a buoy that was supposed to be marking a shoal.

This section discusses the following types of sea ice hazards: drifting ice (iceberg), grounded floeberg, ice push (ivu), landfast ice breakout, and slush ice.

Drifting ice (iceberg) is ice that has broken free of its source (sea ice or glacier) and floats in an ocean or lake. Icebergs come in all shapes and sizes, from ice-cube-sized chunks to ice islands up to 4,250 square miles (about the size of Connecticut). Icebergs pose a danger to ships traversing high-latitude waters.

A **grounded floeberg** is a massive piece of sea ice composed of pressure ridges or hummocks that has separated from an ice pack and become lodged in shallow water.

An **ice push (ivu)** is a surge of ice from an ocean or large lake onto the shore. Ivus are caused by currents, strong winds, or temperature differences that push ice onto the shore, creating immense ice piles that can be shoved far inland and are capable of moving and destroying infrastructure and buildings (Figure 4.1.1-16).



Photo of an ivu after a 2011 Bering Sea storm. Source: DGGs 2022.

Figure 4.1.1-16: Ivu near Golovin, Alaska

A **landfast ice breakout** occurs when grounded pressure ridges that anchor sea ice to the shallow ocean bottom fail or unground, and previously stationary ice detaches from the coast and drifts away to form a floeberg.

Slush ice is a mixture of snow and ice crystals floating on the surface of the ocean. The ice crystals, called frazil, represent the first stages of sea ice growth. Slush ice can build up on vessels and equipment and clog intake valves.

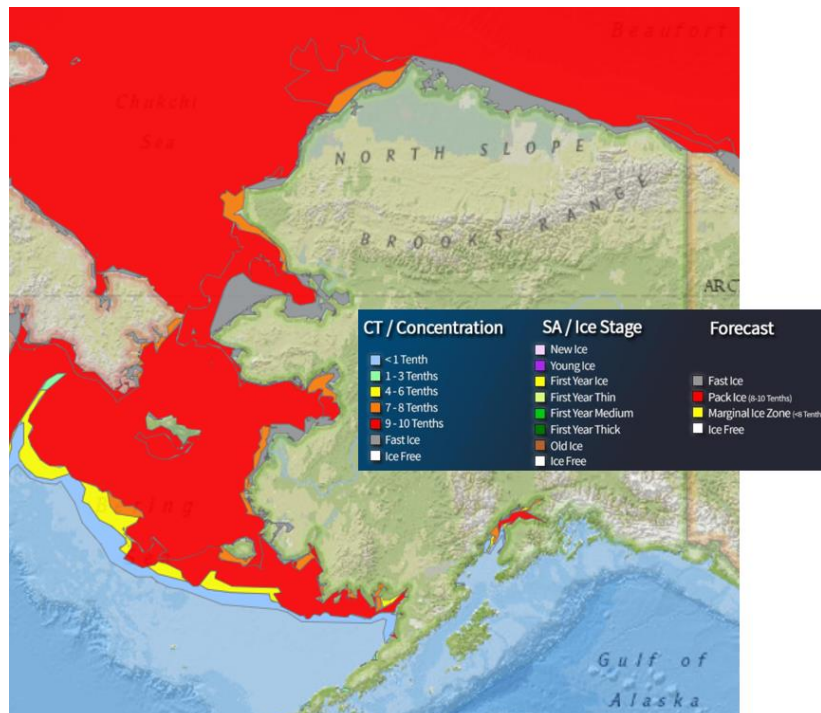
With commercial shipping routes in the Arctic Ocean becoming more commonly traveled, ships are increasingly experiencing impacts from sea ice. Even small amounts of ice can create problems for valves and water intake for jet propulsion. Icebreakers are typically used to break sea ice to reduce collision hazard, but multi-year ice can be too thick and pose a problem for ice breakers.

Oil pipelines and communication cables are typically laid on or buried in sediment on the bottom of the ocean. Where sea water is shallow, iceberg gouging can be a problem when the ice thickness is greater than the water depth. Propelled by the wind, these ice masses push through the sediment and can disrupt cables or pipelines.

4.1.1.3.2 Locations of Sea Ice Hazards

Sea ice is always moving, depending on thickness, wind, and currents. Depending on activities, the locations of the hazards associated with sea ice are unpredictable. Ivus can happen at any location where the right conditions exist.

The National Weather Service's Alaska Sea Ice Program provides daily sea ice extent, forecasts, and 3-month outlooks. Figure 4.1.1-17 is an Alaska Sea Ice Program graphic that shows the daily sea ice extent (locations and concentrations of sea ice) on January 18, 2023.

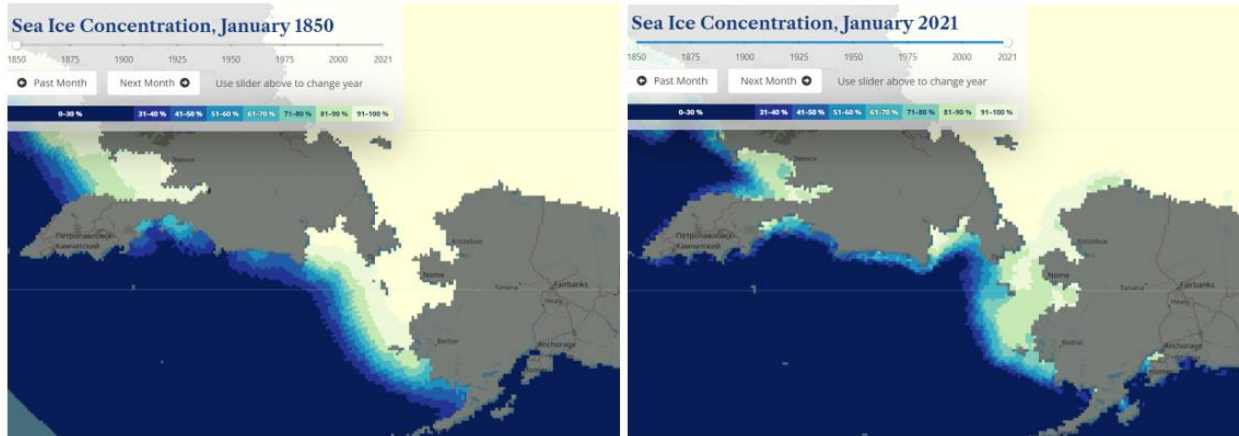


Source: NWS 2023a.

Figure 4.1.1-17: Alaska Sea Ice Extent and Concentrations, January 18, 2023

4.1.1.3.3 History of Sea Ice Hazard Events

This section has been updated since the 2018 HMP. The UAF Center for Climate Assessment and Policy has developed a historical Sea Ice Atlas that shows annual sea ice from 1850 to the present (Figure 4.1.1-18). The following graphics show January 1850 compared to January 2021.



Source: UAF/SNAP 2023.

Figure 4.1.1-18: Comparison of Sea Ice Concentrations, 1850 to 2021

Ivus are relatively common along the coast of Northwest Alaska. The ivu shown on Figure 4.1.1-16 happened during a Bering Sea Storm in 2011. During the winter of 2016, anomalous sea ice conditions and a powerful storm culminated in a destructive erosion event along the Chukchi Sea coastline of Cape Espenberg. On December 3, 2020, an ivu alert was issued for northwest Alaska from Point Lay to Wainwright, with ice buildup possible all the way from Utqiagvik to Point Hope.

4.1.1.3.4 Extent of Sea Ice Hazards

Sea ice hazards are present in all areas where sea ice can form (see Figure 4.1.1-18, which shows representative locations of sea ice and concentrations from January 1850 to January 2021). In the Alaskan Arctic, sea ice is known to freeze to thicknesses of more than 3 feet annually.

4.1.1.3.5 Impact of Sea Ice Hazards

Ice floes and ice breakout events typically occur just offshore. Slush ice can be a problem anywhere on freezing water. Ice push (or ivu) is an on-land coastal hazard. The impacts from ice floes are on moving or fixed assets in the ocean such as shipping vessels, pipelines, and drill platforms and range from negligible to critical. Ice breakout events mainly affect the sea ice transportation routes that supply offshore exploration operations but could also affect subsistence hunters. An ivu is a major concern for onshore buildings or pipelines.

All sea ice hazards occur on an annual basis. Drifting icebergs are more likely in summer and fall when ice is moving due to wind. Ice breakout events and ivus are most likely in the winter or spring when the ice warms up and winds are strong. Changes in length and extent of sea ice seasons can impact animal migration and subsistence hunting harvests.

4.1.1.3.6 Probability of Sea Ice Hazard Events

Sea ice hazards are an annual occurrence but are often not reported. Ice shoves commonly occur in late fall or early spring when ice is relatively unstable due to higher temperatures. They can also occur in mid-winter, as shown by the 2016 ice shove event at Cape Espenberg, Alaska. The probability of a sea ice hazard occurring is highly likely based on historic events.

4.1.1.3.7 Projected Changes in Locations of Sea Ice Hazard

Sea ice hazards can occur anywhere there is sea ice. Ivus will happen along the shore of a freezing water body. Sea ice projections and forecasts change annually depending on ocean temperature and weather patterns.

4.1.1.3.8 Range of Anticipated Intensities of Sea Ice Hazard Events

The intensities of sea ice hazards range from small areas of floating slush to immensely powerful and destructive ivus that can move and crush buildings.

4.1.1.3.9 Frequency of Sea Ice Hazard Events

All sea ice hazards are annual.

4.1.1.3.10 Duration of Sea Ice Hazards

Sea ice hazards can persist all winter. Ivus can occur rather quickly in association with large storm events or more slowly as a result of persistent wind.

4.1.1.3.11 Future Conditions of Sea Ice Hazard Events, Including with Climate Change

Sea ice and climate are intimately linked. There are three timeframes to consider concerning the impacts of sea ice as climate changes:

1. Long-term concerns: Regulation of the global climate
2. Intermediate-term concerns: Coastal erosion
3. Immediate concerns: Transportation

Global climate: Sea ice plays an important role in the regulation of atmospheric temperature on a global scale. Snow and ice reflect a large portion of the incoming solar radiation back into space before this radiation can be converted into heat that would be trapped in the atmosphere. Without sea ice, the snow-covered area of the Earth would be dramatically smaller, and the dark ocean water would absorb short-wave radiation, resulting in a much warmer planet.

Coastal erosion: Sea ice reduces wave development in the open ocean during winter months. Landfast ice can also mitigate wave action, nearshore ocean currents, and storm surge on the coastline by providing a physical barrier that minimizes coastal sediment transport. When waves and elevated water levels exceed beach elevations, relatively warmer, saline water can thermally destabilize coastal permafrost, and waves can mechanically erode coastal beaches, bluffs, and dunes. Many villages are located along Alaska's coastline and are threatened by eroding shores.

Transportation: Many transportation forms can be affected by sea ice, both positively and negatively. Native people travel on sea ice to access subsistence hunting areas; reduced sea ice cover and thickness can create challenging and dangerous hunting conditions. Industrial development relies on sea ice routes to supply off-shore operations. These routes often make use of the more-stable landfast ice near the shore, but warming conditions reduce the annual duration and extent of landfast ice. Thinner ice, a consequence of warming climate, is vulnerable to being broken during storms, making sea ice roads impassable.

Climate warming affects sea ice in many different ways. As discussed above, sea ice and snow cool the planet by increasing albedo (i.e., reflecting solar energy) over polar regions. The current trends in atmospheric warming are causing a reduction in sea ice extent, which results in an increase in short-wave radiation absorption in the atmosphere. Delayed freezing in the fall allows longer periods of ice-free seas, and wave action can damage the shores for a longer duration, particularly in the fall when larger storms are typical. Direct use for transportation can be affected both positively and negatively: as Arctic sea routes are open longer, they can be used for shipping during a longer season, but the time frame during

which surface travel is possible on the sea ice is reduced and thinner ice can break more easily in response to stress on the ice.

Ice gouging is potentially reduced due to a reduction in multi-year ice and the reduced thickness of annual ice, but an increase in pressure ridges resulting from thinner ice can lead to much thicker ice locally, which in turn can lead to more gouging by icebergs.

4.1.1.3.11.1 Characteristics/Nature

Climate change, over time, could affect the nature and character of sea ice hazards, with a reduction of thick annual sea ice in the near-shore environment. Until that time, while sea ice is still thick enough to use as a transportation surface, there will be increased hazard of shifting and cracking.

4.1.1.3.11.2 Locations

Climate change is not expected to be regional, so these hazards are equally strong in all affected areas. These hazards typically occur along shorelines except for shipping lanes. Future shipping lanes opening across the Arctic could bring more people and increased risk for those routes that are being used for shipping goods. It is likely that those routes will change with shifting sea ice.

4.1.1.3.11.3 Range of Anticipated Intensities

More people are expected to use the Arctic due to warmer conditions, and it is generally expected that more people will be in a hazardous area for sea ice. The hazard itself could intensify in the shoulder seasons.

4.1.1.4 Snow Avalanche

Numerous snow avalanches occur in Alaska every year due to abundant avalanche-susceptible terrain and large amounts of snowfall. Many highways, railroads, and multiple communities are at risk of avalanche hazards every winter, some of which can be particularly destructive. The most recent extreme avalanche event took place near Valdez in January 2014 after a mid-winter rain event that triggered many full-depth wet snow avalanches throughout Southcentral Alaska. This avalanche blocked the only road connection to Valdez and dammed a river in Keystone Canyon, as shown on Figure 4.1.1-18.

4.1.1.4.1 *Characteristics/Nature/Types of Snow Avalanche Hazards*

A snow avalanche is a downhill mass movement of snow. The size, run-out distance, and impact pressure of a snow avalanche can vary. Large avalanches have the potential to kill people and wildlife, destroy infrastructure, level forests, and bury entire communities.

Snow avalanche formation is influenced by precipitation type and intensity, wind direction and speed, sensible heat, and radiation heating or cooling of snow (McClung and Schaerer 2006). Significant avalanche cycles (multiple avalanches naturally releasing across an entire region) are generally caused by long periods of heavy snow, but avalanche cycles can also be triggered by rain-on-snow events, rapid warming in the spring, and earthquakes.

An avalanche releases when gravity-induced shear stress on or within the snowpack becomes larger than its shear strength. The shear strength is reduced by the presence of weak layers or interfaces in the snowpack, such as buried faceted snow crystals or density differences between snow layers. Triggers can be natural (e.g., rapid weight accumulation during or just after a snowstorm or rain event, warming temperatures, and seismic shaking) or artificial (e.g., human weight or avalanche-control artillery). There are four distinct avalanche types, as well as cornice collapse, that occur under varying snowpack and weather conditions in Alaska. Each avalanche type is named based on its snow release characteristics:

- Cornice collapse
- Loose snow avalanche

- Slab avalanche
- Slush avalanche/flow
- Glide avalanche

A **cornice collapse** occurs when an overhanging snow mass breaks, separates, or is released. Cornices form on ridge crests or shoulders adjacent to gullies due to wind blowing the snow. The cornice is an indicator of predominant wind directions, as the cornice is formed on the lee (i.e., downwind) side of topographic features. Over time, the cornice can develop weaknesses in its structure and its attachment to the slope may fail. A cornice collapse often triggers a loose snow or slab avalanche as it adds sudden and significant stress onto the snowpack below.

A **loose snow avalanche**, also known as a point release, initiates with a small amount of non-cohesive (loose) snow and quickly grows larger as it moves downhill and entrains more snow. This type of avalanche typically carries relatively small amounts of powder snow and virtually no other debris. However, a loose snow avalanche may trigger a larger slab avalanche on the same slope.

A **slab avalanche** releases as a block of cohesive snow when snow particles have stuck together to form one or more resistant layers. There is a wide range of slab characteristics possible, running the gamut from “soft” slab (weakly cohesive snow) to “hard” slab (very cohesive snow) and from “storm” slab (release of recently deposited storm snow) to “persistent” and “deep persistent” slab (release of a slab that failed on a weak layer deeper down in the snowpack). Due to their large release masses and because more snow is picked up along the way (snow entrainment), slab avalanches are the most destructive avalanche type. Human encounters with even small-sized slab avalanches are often fatal.

A **slush avalanche** is a fast-moving mixture of snow and water. It releases in isothermal snowpacks (snow temperature throughout the snowpack is 32°F) when liquid water permeates the snowpack and dramatically weakens the intergranular bond. Slush avalanches therefore typically occur in northern Alaska during the spring when warm temperatures and strong solar radiation quickly warm up the snowpack. Slush avalanches can release on slopes as gentle as 20 degrees. Their release is often slower than other avalanche types, but as the slushy snow runs downhill, it can reach speeds of over 40 miles per hour. Smaller, more fluid avalanches with higher water content are commonly referred to as slush flows.

A **glide avalanche** is preceded by a full-depth crack in the snowpack due to the entire snowpack sliding on the ground. A glide avalanche can consist of either moist/wet or almost entirely dry snow, but typically develops after some moisture is introduced to the snowpack. The avalanche release can occur seconds to months after the crack appears, though many glide cracks do not result in an avalanche at all. Glide cracks typically develop on convex slopes and rollovers. They are very difficult to forecast, and their release is triggered naturally and catastrophically.

An **avalanche path** comprises three main parts: a starting zone, a track, and a run-out zone (Figure 4.1.1-19). Local topography determines the shape and size of each part. Steep gullies that contain a stream or creek in the summer often function as avalanche paths in the winter but avalanches also release and run on simple and complex open slopes.

The starting zone is also called the release area. This area is the upper part of the avalanche path, where snow accumulates (creating a slab or point source release area) and where the avalanche begins its downhill movement. Starting zones are commonly located in the headwaters of a drainage where snow is accumulated on lee-side aspects of topographic features. Starting zones on open slopes are more difficult to identify. Sometimes multiple starting zones join into one track (e.g., several creeks funneling into one major gully).



Source: Crested Butte Avalanche Center 2023

Figure 4.1.1-19: Parts of an Avalanche Path

The track is the middle part of the path, where the avalanche transports the released snow downhill to the deposition (runout) zone. The avalanche accelerates and reaches its maximum velocity in the track, and can also pick up more snow, adding to its mass. The track can comprise both confined gullies and unconfined open slopes. Tracks can also branch onto adjacent slopes, creating successive avalanches.

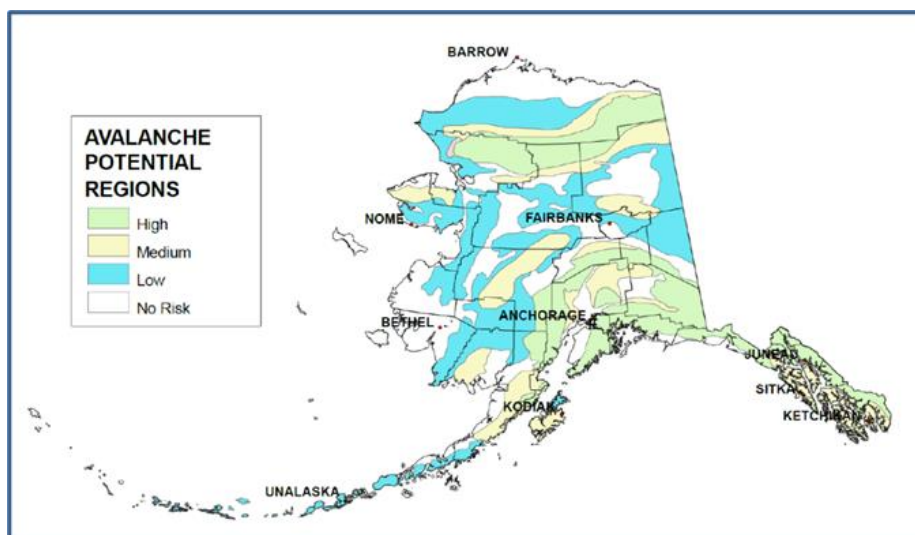
The run-out zone is the bottom part of the path, where the avalanche slows down and deposits debris. The avalanche impact pressure, which is a function of its snow density, volume (i.e., mass), and velocity, determines the amount of damage the avalanche could potentially cause. This measure is used for designing mitigation structures to protect infrastructure and buildings that are located in an avalanche risk zone.

Terrain factors that influence avalanche release are slope angle, aspect, and curvature as well as topography (terrain roughness). Avalanches are also controlled by vegetation cover and elevation, which are both factors in getting enough snow accumulation on the slope. Trees can break up the potential formation of a slab, and they can also detain avalanche flow by disruption and adding friction. Deforestation can therefore contribute to avalanche hazard risk. Avalanches typically release on slopes greater than 25 degrees and less than 60 degrees; this is the slope range where the snow can accumulate enough to build a slab, but also where snow tends to remain in place without sluffing off due to gravity. It is important to remember that avalanche run-out (deposition) can occur on all slopes.

4.1.1.4.2 Locations of Snow Avalanche Hazards

Snow avalanches mainly occur in mountainous regions on isolated steep slopes that lack forest-type vegetation (e.g., road cuts and exposed landslide surfaces). If sufficient snow cover persists for an avalanche to release, slopes that are 25 to 60 degrees could possibly slide, and any area *downslope* of a 25-to-60-degree slope could possibly be impacted by an avalanche. Although snow avalanches are a prominent hazard in most mountain ranges in Alaska, the avalanche hazard type that is most common varies. Weather and atmospheric conditions drive snowpack formation and hence avalanche potential. Alaska's mountain ranges can be divided into snow climates based on their topographic characteristics and proximity to the ocean (moisture source). There are three general snow climate types considered: maritime, continental, and transitional/intermountain (McClung and Schaerer 2006). Avalanche character differs between the snow climates. For example, in coastal areas of Southeast and Southcentral Alaska, heavy precipitation during winter storms results in rapid snow accumulation, often resulting in immediate storm slab avalanche activity. In the central Brooks Range of northern Alaska, it is not as much the amount of precipitation that leads to the buildup of avalanche starting zones, but the effect of wind-loading.

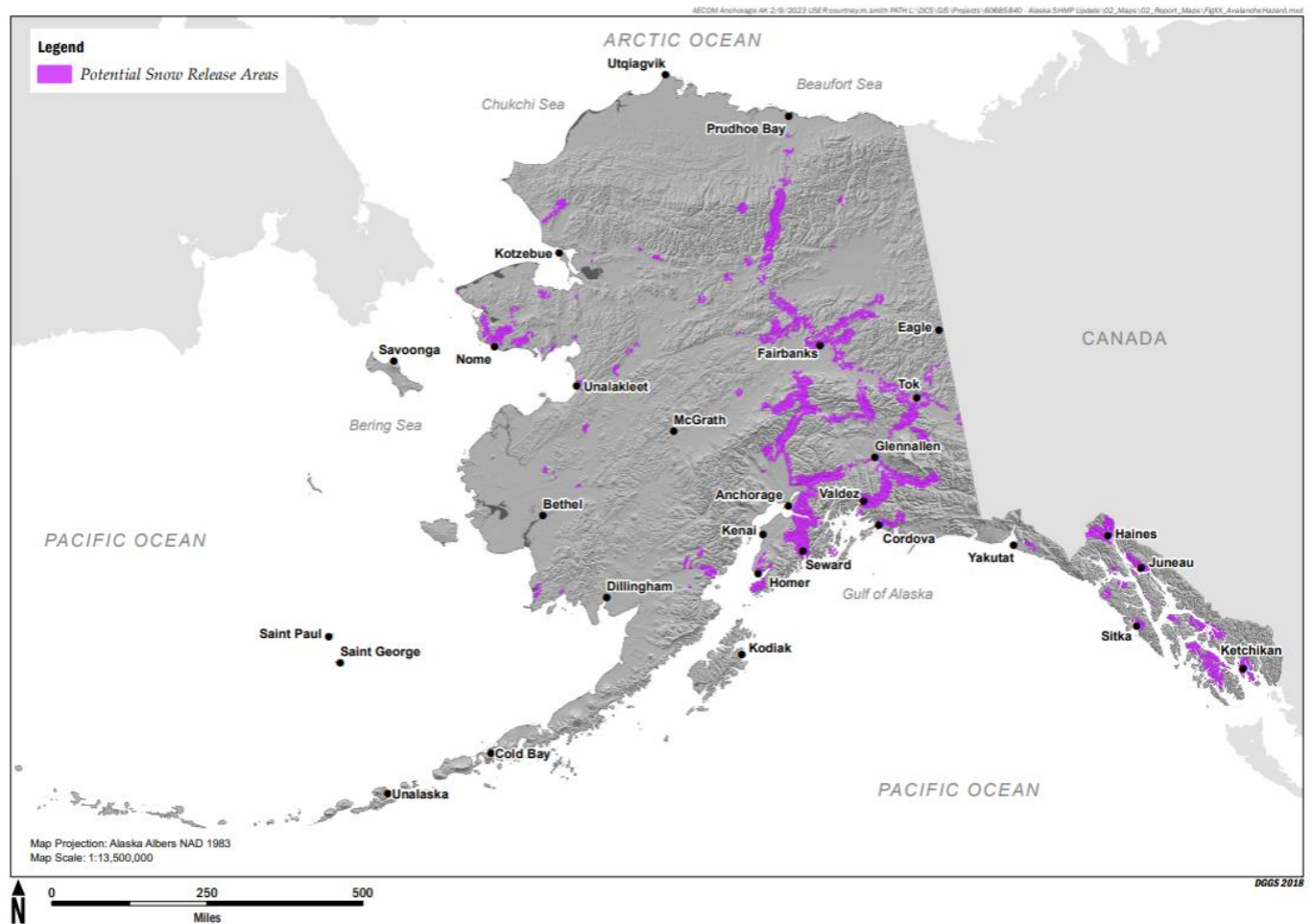
Figure 4.1.1-20 is a generalized avalanche-potential map of Alaska that was produced in 1980 by compiling and cross-correlating topographic relief, snow-avalanche regions, climatic zones, snowpack characteristics, and known and suspected avalanche activity. The map includes regions that had little or no snow avalanche occurrence data and is therefore provisional until better data are available and new analysis methods and avalanche modeling can be applied.



Source: Hackett and Santeford 1980

Figure 4.1.1-20: Alaska's Potential Snow-Avalanche Areas

New Alaska avalanche studies are currently being carried out by the State of Alaska Division of Geological and Geophysical Surveys and UAF. Figure 4.1.1-21 depicts potential snow avalanche release areas within a 6-mile buffer of roads in Alaska. The modeling uses digital topographic information as input and determines the potential release zones based on geostatistical parameters (e.g., elevation, slope, and curvature) and land cover (e.g., trees). This is a preliminary model result that does not include weather or snowpack parameters, but more advanced studies that will incorporate these elements are planned.



Source: DGGS 2018.

Figure 4.1.1-21: Potential Snow-Avalanche Release Areas

4.1.1.4.3 History of Snow Avalanche Hazard Events

This section has been updated since the 2018 HMP and lists some of the historical snow avalanche hazard events:

- January 2014 Valdez “Damalanche”:** In January 2014, the Richardson Highway was blocked by a huge avalanche that released above Keystone Canyon, near Valdez, due to heavy rain on top of snow (Figure 4.1.1-22). The snow became so saturated with water that the snowpack in the starting zone fractured all the way through to the ground, releasing a full-depth avalanche. The avalanche debris dammed Lowe River, and local residents as well as the press took to calling it a “damalanche.” The dammed lake covered about 100 acres with an estimated 81 million cubic feet of water. The event blocked all transportation by road to and from Valdez (and the important Alyeska oil terminal) for 12.25 days. There was approximately 100,000 tons of snow (140 feet deep) on the road, and the Alaska Department of Transportation and Public Facilities’ round-the-clock cleanup work was estimated to cost about \$250,000.



An avalanche blocked the road and impounded a lake in Keystone Canyon near Valdez in 2014. Source: Gorman 2014.

Figure 4.1.1-22: Keystone Canyon Avalanche

- December 2020 Southeast Storm (DR-4585-AK): Chilkat Lake avalanche in Haines area.
- March 2022 Eagle River Avalanche: Large avalanche between mile post (MP) 7 and 7.9 of Hiland Road in Eagle River was 300 to 400 feet wide and 120 feet deep. Blocked access and disrupted power to 145 homes.
- January 2023 Girdwood (south) Avalanche: A large avalanche (approximately 300 feet of track was covered) at rail MP 71.5, near mile 87 of the Seward Highway, caused an Alaska Railroad north-bound train to derail when the train struck a large debris pile covering the tracks. Two locomotives were fully derailed and a third was partially derailed while traveling from Whittier to Anchorage with approximately 7,000 tons of freight. No injuries were reported.

4.1.1.4.4 Extent of Snow Avalanche Hazards

Avalanche extents are highly variable, ranging from small snow sluffs to events such as the March 2022 Eagle River avalanche described above. The largest avalanches on record reach volumes of more than 130,000 cubic yards and lengths greater than a mile. Avalanches can occur anywhere there is an accumulation of snow on a slope (even on a building roof).

The extent of a snow avalanche occurrence depends on the magnitude and extent of a significant weather event (precipitation, warming temperatures, wind, etc.) adding stress on the snowpack and/or the extent of a weak layer present in the snowpack. For example, surface hoar crystals can form on the snow surface with sufficient air humidity during cold, clear nights. This type of snow grain is very strong while it stands upright. If left intact and not knocked over by wind, a thin layer of surface hoar crystals can carry a large vertical snow load when it gets buried. However, because of its very weak shear strength properties, a buried layer of surface hoar is notorious for causing widespread avalanche activity once stress (e.g., weight of snow, rain, artillery, or skiers) exceeds the shear strength. Freezing rain up to ridgetop levels can also result in a weak layer for avalanches later in the season. Once it is frozen and buried in the snowpack as an ice layer, it inhibits bonding to other snow layers and drives the formation of faceted snow grains, which are also weak in shear strength. Sometimes extensive avalanching in a region can be linked back to a weak layer buried several months earlier (Figure 4.1.1-23).

Keeping track of weak layer formations makes it possible to monitor the snowpack structure development and assess the potential avalanche danger with additional stresses on the snowpack. Avalanche forecasters at local avalanche centers in Alaska frequently study weak layer formation and assess the stability of the snowpack in the field within their region of interest and communicate their findings in daily or weekly avalanche advisory reports (see <https://www.cnfaic.org/for-avalanche-forecasts-concerning-the-U.S.-Chugach-National-Forest> and <https://www.hpavalanche.org/for-avalanche-forecasts-in-the-Hatcher-Pass-area-Talkeetna-Mountains>).



Long avalanche run-outs in Hatcher Pass, Talkeetna Mountains, in April 2021, prefaced by a buried layer of drizzle crust in February. Avalanches crossed both sections of the road and ran into Fishhook Creek. Deep piles of avalanche debris deposited on the road kept it closed for several weeks. This avalanche cycle was the largest on record since the 1980s. Source: Allie Barker, Hatcher Pass Avalanche Center.

Figure 4.1.1-23: Avalanche Run-outs in Hatcher Pass

4.1.1.4.5 Impact of Snow Avalanche Hazards

Snow avalanches are dangerous natural hazards that occur in mountainous areas. Approximately 30 percent of Alaska is subject to avalanche activity (Figure 4.1.1-20). Driven by gravity, these hillslope mass movements of snow can release on slopes of 20 to 60 degrees, but their run-out zones (where the debris is deposited) can include slopes that are less than 20 degrees, such as valley floors, and steep cliffs (slopes that are greater than 60 degrees). Large avalanches have the potential to kill people and wildlife, destroy infrastructure, level forests, and bury entire communities (Figure 4.1.1-24 shows snow avalanche damage to infrastructure). In many areas of the state, avalanches are considered catastrophic in terms of magnitude and severity and can lead to lengthy closures of important transportation routes (Figure 4.1.1-25), and snow avalanche is the weather-related natural hazard that causes the most fatalities in the state (Figure 4.1.1-26). The economic impacts of such avalanches, from impeding traffic to the cost of removing avalanche debris blocking transportation corridors, can be significant at both the local level and the state level.

Alaska is sparsely populated, with most development concentrated in relatively few areas. The exact number of avalanches that release annually cannot be determined. However, snow avalanches cause more fatalities in Alaska than any other natural hazard (Figure 4.1.1-26). Alaska leads the nation in avalanche accidents per capita and experiences multiple fatalities each year due to this hazard. In addition to human risk, road closure due to avalanches is costly. For example, a typical road closure with roughly 1,500 cubic feet of snow covering the road costs the Alaska Department of Transportation and Public Facilities approximately \$10,000 to remove. In the winter of 1999 to 2000, unusually high snowfall from the Central Gulf Coast Storm fueled avalanches in Cordova, Valdez, Anchorage, Whittier, Cooper Landing, Moose Pass, Summit, the Matanuska-Susitna Valley, and Eklutna. Total damages in these communities exceeded \$11 million, resulting in the first Presidential disaster declaration for an avalanche in U.S. history.



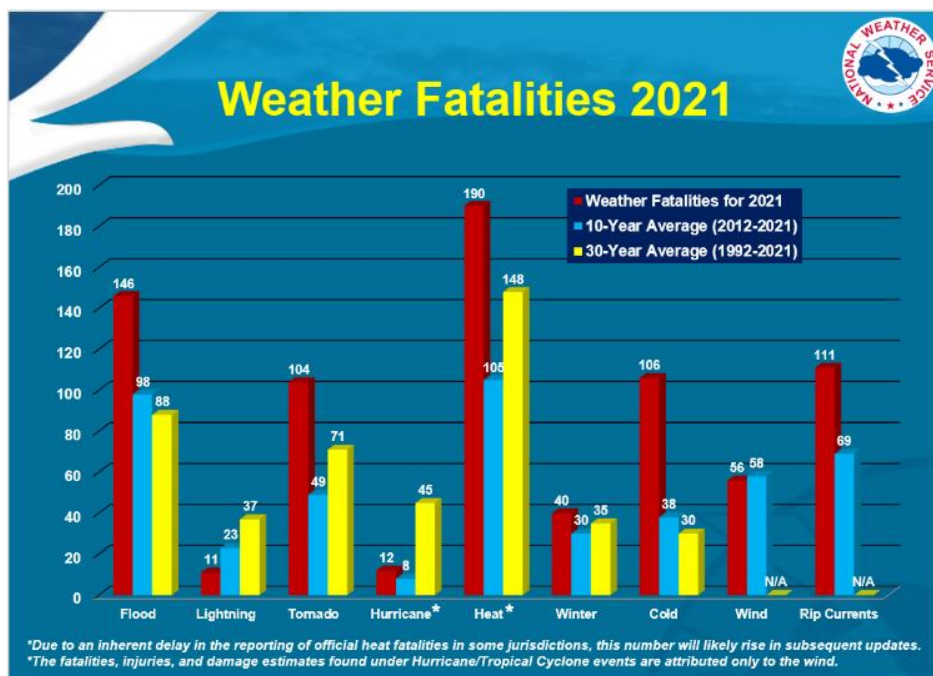
Avalanche path at Speel Arm, southeast of Juneau, Alaska, where an avalanche on April 16, 2008, destroyed a power line pole and disrupted electricity from the Alaska Electric Light & Power (AEL&P) facility at Snettisham Port to City of Juneau. Source: Wikstrom Jones, DGGS 2022.

Figure 4.1.1-24: Avalanche Path at Speel Arm



Avalanche debris cleared off Thane Road, Juneau, Southeast Alaska, in March 2020 in Snowslide Gulch. This avalanche path poses danger every year to the powerline and the road, which is the only access route between the residential neighborhood and the City of Juneau. Source: Wikstrom Jones, DGGS 2022.

Figure 4.1.1-25: Cleared Avalanche Debris in Juneau



Source: NWS 2023b. Weather-related Fatality and Injury Statistics. <https://www.nws.noaa.gov/om/hazstats.shtml>

Figure 4.1.1-26: Alaska's Weather-Related Fatalities, Avalanche.org, a partnership between the U.S. Forest Service National Avalanche Center and the American Avalanche Association, provides national avalanche fatality statistics. The following table details the number of fatalities in Alaska associated with avalanche from 2010 through January 19, 2023.

Table 4.1.1-1: Alaska Avalanche-related Fatalities from February 2010 through January 19, 2023

Year	Number of Fatalities
2010	5
2011	5
2012	6
2013	2
2014	1
2015	3
2016	5
2017	3
2018	2
2019	2
2020	3
2021	5
2022	1
Total:	43

Source: U.S. Forest Service National Avalanche Center (NAC) and American Avalanche Association (A3). 2023. Available at: Avalanche.org. Accessed January 19, 2023.

4.1.1.4.6 Probability of Snow Avalanche Events

Return periods are used for snow avalanches to estimate the risk that an avalanche will strike a position at least once in a specified time period. The return periods are typically categorized into 1, 5–10, 30, 50–100, and 200–300 years (McClung and Schaerer 2006). Due to the incomplete historical record of avalanche occurrences in Alaska, longer return periods cannot be stated with confidence. Some studies suggest that a warming climate is increasing avalanche risk due to changes in snow accumulation and moisture content, and loss of snowpack stability because of changing air temperature. Increased rain-on-snow event frequency is leading to an increase in avalanche hazards across Alaska. Based on historic avalanches, it is likely to highly likely that an avalanche causing infrastructure damage or road closures will occur.

4.1.1.4.7 Projected Changes in Locations of Snow Avalanche Hazards

Specific topographic parameters are required for an avalanche to form and release. Humans can modify a slope and artificially create new avalanche terrain by removing trees and increasing the slope angle (e.g., with road cuts). Although avalanche terrain parameters are well identified, observations indicate variations in avalanche release with respect to elevation based on the type of precipitation. Avalanches release more frequently at mid-level and lower elevations after heavy snowfall or rain. A change in wind pattern can cause wind slabs to form in atypical locations and pose a hazard downslope. A complete lack of snow in the entire avalanche path means that the snow avalanche hazard risk has completely diminished.

4.1.1.4.8 Range of Anticipated Intensities of Snow Avalanche Hazard Events

With sufficient snowpack present on a slope, the anticipated intensity of the avalanche hazard can be linked to the intensity of weather events and whether weak layers are present. Large avalanche cycles (multiple avalanches naturally releasing across a wide region) are generally caused by long periods of heavy snow, but avalanche cycles can also be triggered by rain-on-snow events, rapid warming in the spring, and earthquakes. Large avalanche cycles are more common in Alaska during pronounced climate events driven by changes in the Pacific Ocean, such as during La Nina/El Nino and the larger-scale Pacific Decadal Oscillation, which can cause warmer air temperatures and heavier precipitation than normal. However, the effects on air temperature and precipitation during these climate abnormalities vary across the state; consequently, the resulting likelihood of avalanche activity varies by region.

In recent years, Alaska has seen numerous snow avalanche events of large magnitude (e.g., the 2014 “damalanche” in Keystone Canyon [see Figure 4.1.1-22] and the 2021 Easter Cycle at Hatcher Pass [see Figure 4.1.1-23]). These events were preceded by significant weather events (e.g., drizzle crust formation in the high elevations/release area) and/or were triggered by heavy snowfall or rain-on-snow.

4.1.1.4.9 Frequency of Snow Avalanche Hazard Events

Avalanches classified as 100-year and 300-year events may occur at a shorter return interval in the future. Thus, avalanche paths that currently have significant regrowth of trees and where there is no record of previous avalanche activity might witness avalanche events of such magnitude that the vegetation cover would be disrupted, and recurring activity might happen sooner than previously observed (if ever observed).

4.1.1.4.10 Duration of Snow Avalanche Hazards

Storm slab avalanches commonly occur after approximately 30 centimeters of new snow have deposited on the slope or after 10 hours of heavy snowfall. Though rapid loading of snow, frequently occurring throughout the winter in maritime snow climates, often leads to a rapid response in avalanche activity, the avalanche cycle is often short lived (48 to 72 hours) as the snowpack stabilizes (snow grains bond) quickly in warm snow. Snowpack instabilities tend to persist much longer (weeks to months) in cold, shallow snowpacks typical for continental snow climates. The frequency and duration of snow avalanche hazard does not necessarily correlate to potential avalanche size.

4.1.1.4.11 Future Conditions of Snow Avalanche Hazard Events, Including with Climate Change

Some studies suggest that warming climate may increase avalanche risk due to changes in snow accumulation and moisture content and loss of snowpack stability because of changing air temperature. Increased rain-on-snow event frequency is leading to an increase in avalanche hazards all across Alaska. Rural and urban Alaska communities do not have many road options. Anchorage has the largest population. Yet it has one main road (north and south) connecting to the rest of the state road system. Most Alaska communities have road choke points such as bridges and steep terrain that are susceptible to multiple natural hazard impacts from earthquakes, floods, and ground failure events such as landslides, mudslides, and avalanches.

Rural community road systems may experience the same threats. However, remote-rural locations have limited road access to their immediate neighboring community, usually via one road. If that road access is blocked from natural hazard impacts, these communities will be restricted to receiving resupply by boat, barge, or aircraft.

4.1.1.4.11.1 Characteristics/Nature

The occurrence of specific avalanche hazard types is anticipated to change as future conditions shift with climate change. Warmer mid-winter air temperatures mean that the form of precipitation will change. Wet slab, wet loose, and glide avalanches may become more common during mid-winter due to rain-on-snow events. The duration of seasonal snow cover may be shortened, which means that the avalanche shedding cycle may occur earlier than normal.

4.1.1.4.11.2 Locations

Maritime snow climates may experience more fluctuating rain/snowlines throughout the winter season with bare ground at lower elevations and rain common up to ridgetop elevations. Intercontinental and continental snow climates may experience more rain-on-snow events and such events may occur up to higher elevations, including ridgetops. These rain-on-snow events complicate the snowpack structure as frozen wet layers become ice. Thick ice layers can stabilize the snowpack, but ice can also inhibit water vapor transport within the snowpack, which can drive the formation of faceted snow crystals with poor bonding structure. This type of formation means that some areas might experience a weaker snowpack structure that will be more prone to avalanche release. Alpine areas that typically have stable snowpack throughout most of the winter might start to avalanche more frequently as heavy loading of wet snow and wind-distributed snow from intensified and warmer storms may become more common in the future, and new forms of weak layers become more prevalent in the snowpack. Buried weak layers in the snowpack may also persist longer throughout the season, which could lead to larger, more devastating avalanches in the later part of winter and spring. Bare ground in the avalanche track at lower elevations in near-coastal areas will affect the avalanche flow and run-out extent, though not always resulting in a shorter run-out. Entrainment of warm and wet snow at lower elevations may enhance avalanche flow, which could make avalanche run-out longer than previously observed (Vera Valero et al. 2016).

4.1.1.4.11.3 Range of Anticipated Intensities

Increased incidents of midwinter rain events (rain-on-snow) are expected to lead to larger avalanches, as will more intense rainfall events. Release areas are expected to be larger, with potential for larger and more numerous events.

4.1.2 Earthquake

Alaska is one of the most seismically active regions in the world and is at risk of societal and economic losses due to damaging earthquakes. Tectonic deformation in Alaska is driven by the subduction of the Pacific plate beneath the North American plate at the Alaska-Aleutian subduction zone. Most of the Alaska-Aleutian subduction zone ruptured in a sequence of great earthquakes in the mid-20th century, the largest of which was the 1964 moment magnitude (M_w) 9.2 Great Alaska Earthquake. This earthquake ruptured approximately 800 kilometers (km) of the plate interface from the southwest edge of Kodiak Island to Cape Yamagata and is the second largest instrumentally recorded earthquake worldwide. Significant displacement on the megathrust caused severe shaking that lasted for more than 4 minutes, seafloor deformation that generated a trans-Pacific tsunami, multiple submarine and sub-aerial landslides that generated local tsunami events, and displacement on several upper crustal faults across the region.

The moment magnitude scale (MMS) is denoted with M_w, and generally implied with the use of a single M for magnitude and is the measure of an earthquake's magnitude based on its seismic moment. M_w and M are used interchangeably throughout this section.

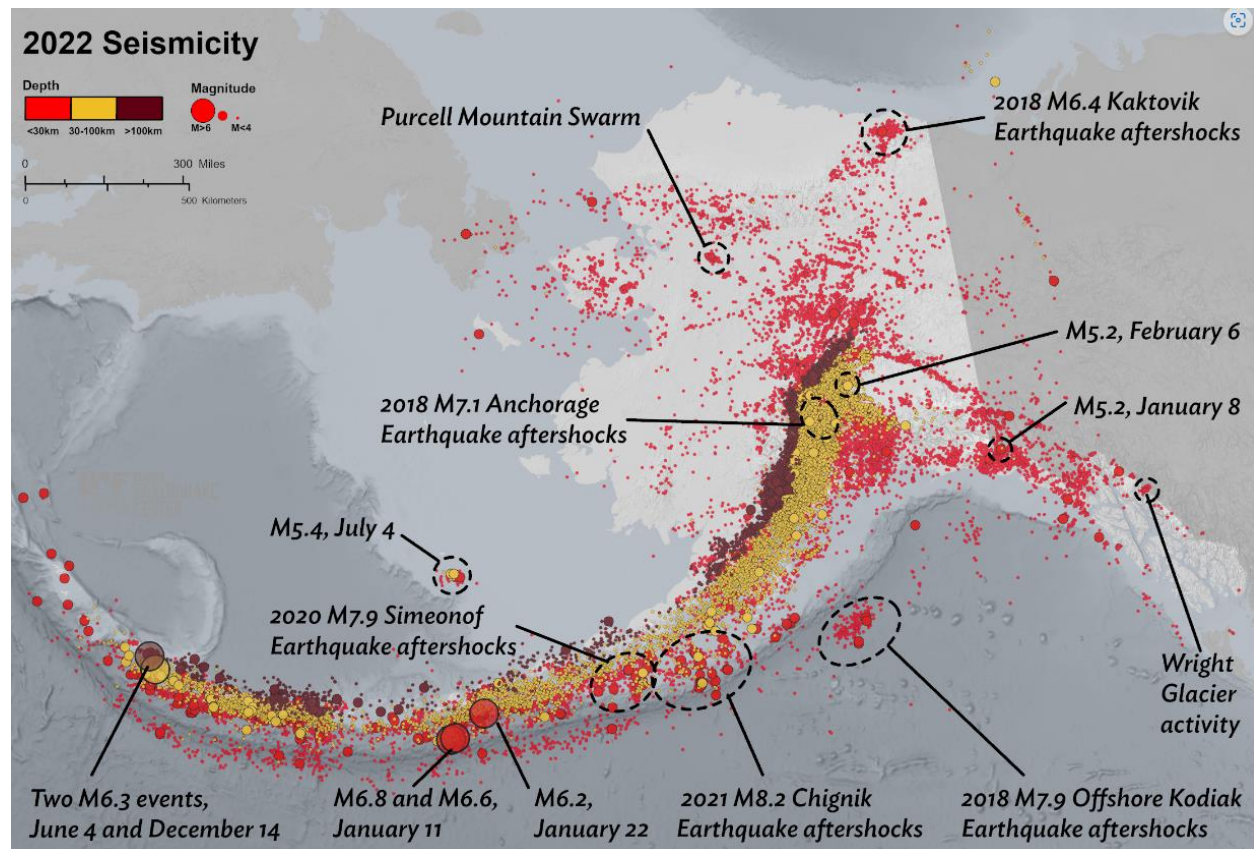
Significant earthquake hazards also exist in interior/mainland Alaska. In 2002, the Denali fault ruptured, causing the largest earthquake (magnitude [M] 7.9) of its kind in North America in over 100 years. On average, Alaska has one "great" (M>8) earthquake every 13 years, one M 7–8 earthquake every year, and six M 6–7 earthquakes every year (Alaska Seismic Hazards Safety Commission 2022). In addition, earthquakes that occur on tectonic plate boundary faults near the coast can generate tsunamis that impact coastal communities (see Section 4.1.5, Tsunami and Seiche, for discussion of tsunamis). Earthquakes have killed more than 130 people in Alaska in the past 60 years, and as population centers near active faults and coastlines continue to grow, it is imperative that Alaskans prepare for future events.

It is not possible to predict the time and location of the next big earthquake, but the active geology of Alaska guarantees that major damaging earthquakes will continue to occur and can affect almost anywhere in the state. Scientists have estimated where large earthquakes are most likely to occur, along with the probable levels of ground shaking to be expected. With this information—together with information on soil properties and landslide potential—it is possible to estimate earthquake risks in a given area. It is also possible to estimate the potential for earthquakes to generate tsunamis and to model the extent to which tsunamis will inundate coastal areas.

Some key Alaska earthquake statistics are noted below:

- The second-largest earthquake ever recorded occurred in Alaska (the 1964 Great Alaska Earthquake, M 9.2).
- Alaska has had approximately 11% of all of the recorded earthquakes in the world.
- Three of the 12 largest earthquakes in the world were in Alaska.
- Nine of the 12 largest earthquakes in the U.S. were in Alaska.
- In addition to the above-mentioned large earthquakes, since 1900 Alaska has had an average of:
- 45 magnitude 5–6 earthquakes per year
 - 320 magnitude 4–5 earthquakes per year
 - 3,000 earthquakes of all magnitudes per month (Alaska Seismic Hazards Safety Commission)

Alaska's typical annual earthquake distribution is shown on Figure 4.1.2-1.

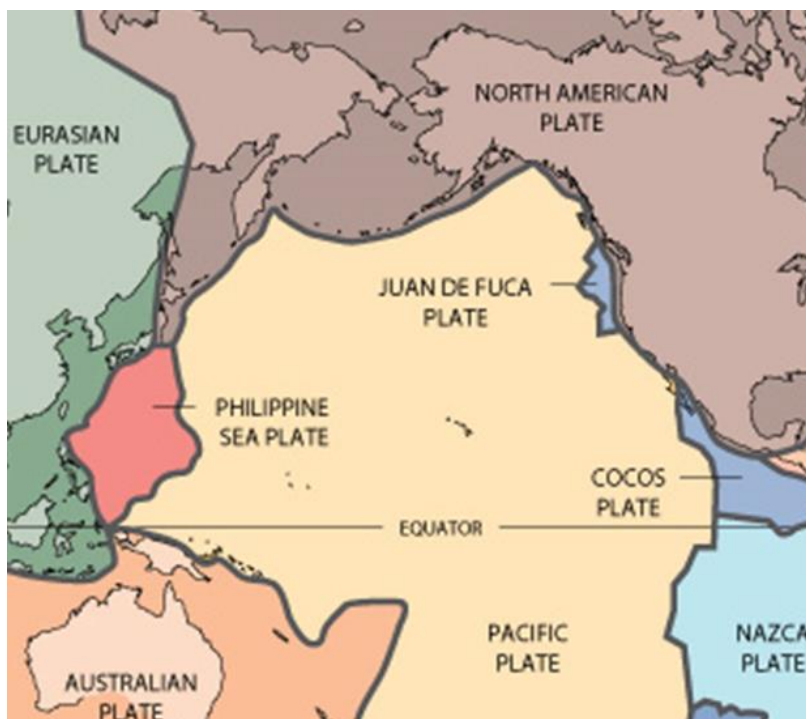


Earthquakes occurring in Alaska in one typical year. Source: AEC 2023. (Note, there is a lack of seismometers deployed in the northern portion of the state.)

Figure 4.1.2-1: Map of Typical Annual Earthquake Distribution in Alaska

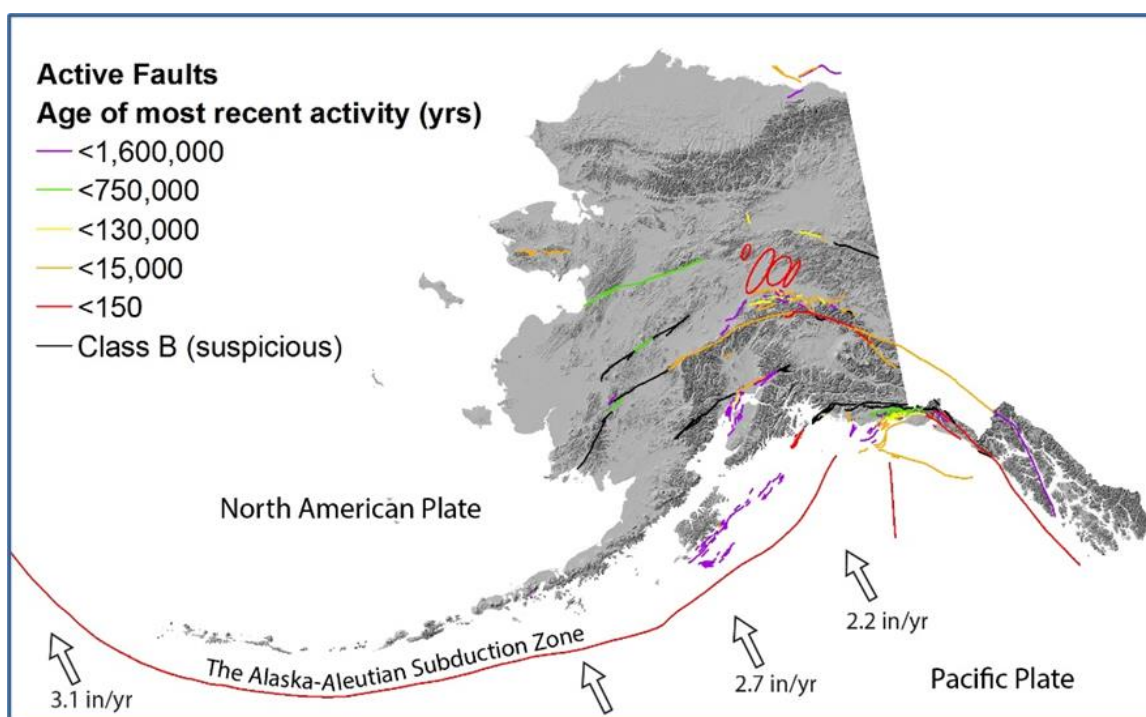
4.1.2.1 Characteristics/Nature/Types of Earthquake Hazards

Earthquake shaking is caused by the release of elastic strain energy that has accumulated on faults within or at the boundary between the Earth's tectonic plates. Tectonic plates are thin, brittle pieces of the crust (the outer, rigid layer of earth) that move across the Earth's surface relative to each other like slabs of ice on a lake. The plates are constantly in motion because of forces originating from within the Earth. The plates' motion causes energy buildup that is periodically released in earthquakes. Alaska is near a major tectonic plate boundary, known as the Alaska-Aleutian subduction zone, where one tectonic plate (the Pacific plate) is forced beneath its neighbor (the North American plate) (Figure 4.1.2-2). In addition to the major plate boundary, the subduction of one plate beneath the other causes distributed deformation on a network of faults extending more than 450 miles north into the interior of Alaska (Figure 4.1.2-3).



Source: USGS 2022a.

Figure 4.1.2-2: Major Tectonic Plates of the Pacific Region



Colored by activity recency. The North American Plate and the Pacific Plate are converging at the Alaska-Aleutian Subduction Zone at a rate of several inches per year. Source: DGGs 2018.

Figure 4.1.2-3: Alaska's Known-Active Faults

The point at the Earth’s surface directly above where an earthquake rupture begins is known as its “epicenter.” Although the epicenter usually experiences the most intense earthquake effects (e.g., shaking), the total area affected can cover hundreds of thousands of square miles, depending on the earthquake’s magnitude. Scientists cannot predict earthquakes, and because damage can occur only seconds after rupture initiation, it is important for every Alaskan to know what to do to minimize the risk posed by earthquakes.

The Mw scale is used to describe the size of moderate to large earthquakes and is objectively based on the amount of physical energy released in an event. The seismic moment of an earthquake (used to calculate the moment magnitude) is based on the area of fault that ruptures in the brittle crust, the average amount of slip (movement) that occurs between the two pieces of crust, and the force that was required to overcome the friction that was holding the pieces of crust together. The moment magnitude scale is logarithmic, meaning that each step up the scale corresponds to an increase of roughly 32 times the amount of energy released. For example, a Mw 8 earthquake releases approximately 32 times more energy than an M 7 earthquake and approximately 1,000 times more energy than a Mw 6. Conversely, larger earthquakes are less common than smaller earthquakes, such that the smallest earthquakes are extremely frequent, while the largest earthquakes are relatively infrequent. The moment magnitude scale succeeds the Richter and Local magnitude scales, which were based on the amplitude of shaking recorded on paper seismographs.

Earthquakes are also classified by their felt effects (e.g., the perceived shaking intensity). However, the effects of an earthquake are directly related to the distance from the earthquake rupture, among other parameters (such as the type of crust where the earthquake occurs). In general, the closer one is to an earthquake epicenter, the more severe the felt effects and damage will be. An earthquake’s intensity is described by the Modified Mercalli Intensity (MMI) Scale. As shown on Figure 4.1.2-4, the MMI Scale consists of 10 subjective intensity levels ranging from “not felt” to “extreme,” with varying amounts of damage associated with each. Figure 4.1.2-4 also depicts the relation of Modified Mercalli Intensity and ground acceleration (percent g), which is a measure of shaking strength.

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
MMI scale	I	II–III	IV	V	VI	VII	VIII	IX	X+

Source: Modified from Worden et al. 2012.

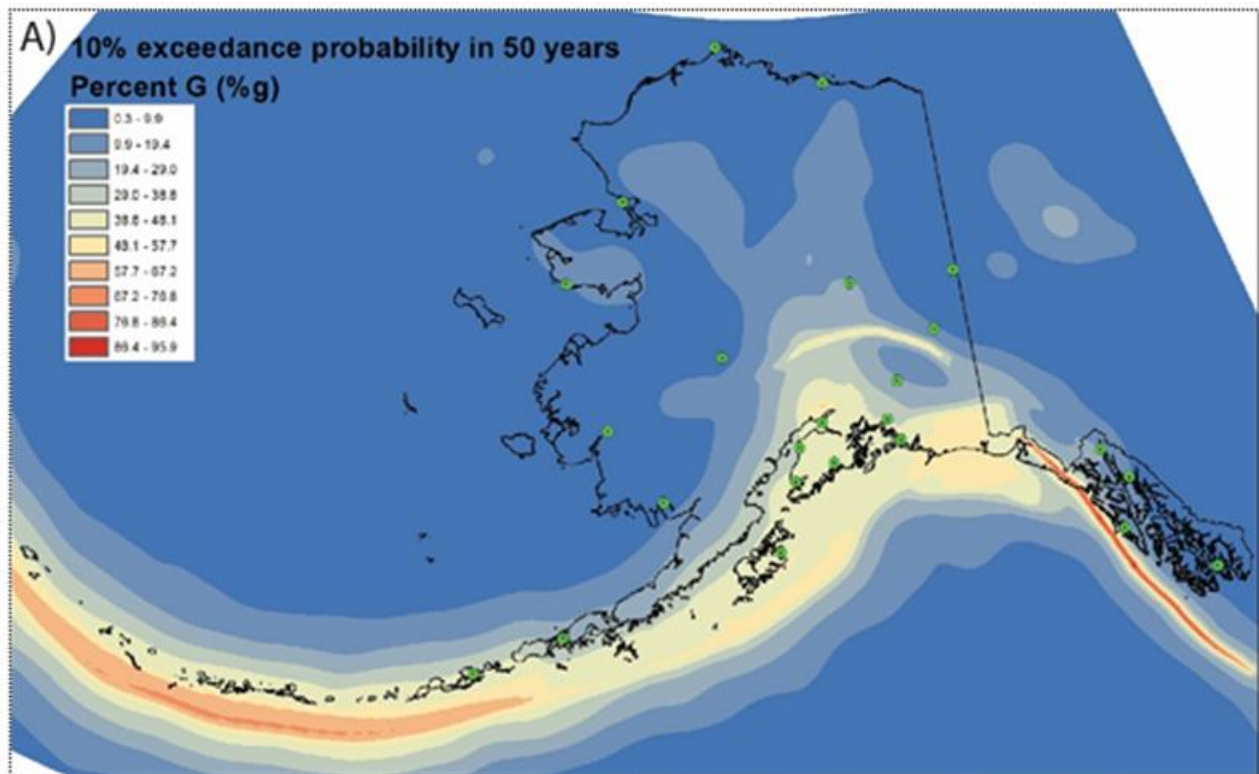
Figure 4.1.2-4: Perceived Shaking, Potential Damage, and Peak Ground Acceleration

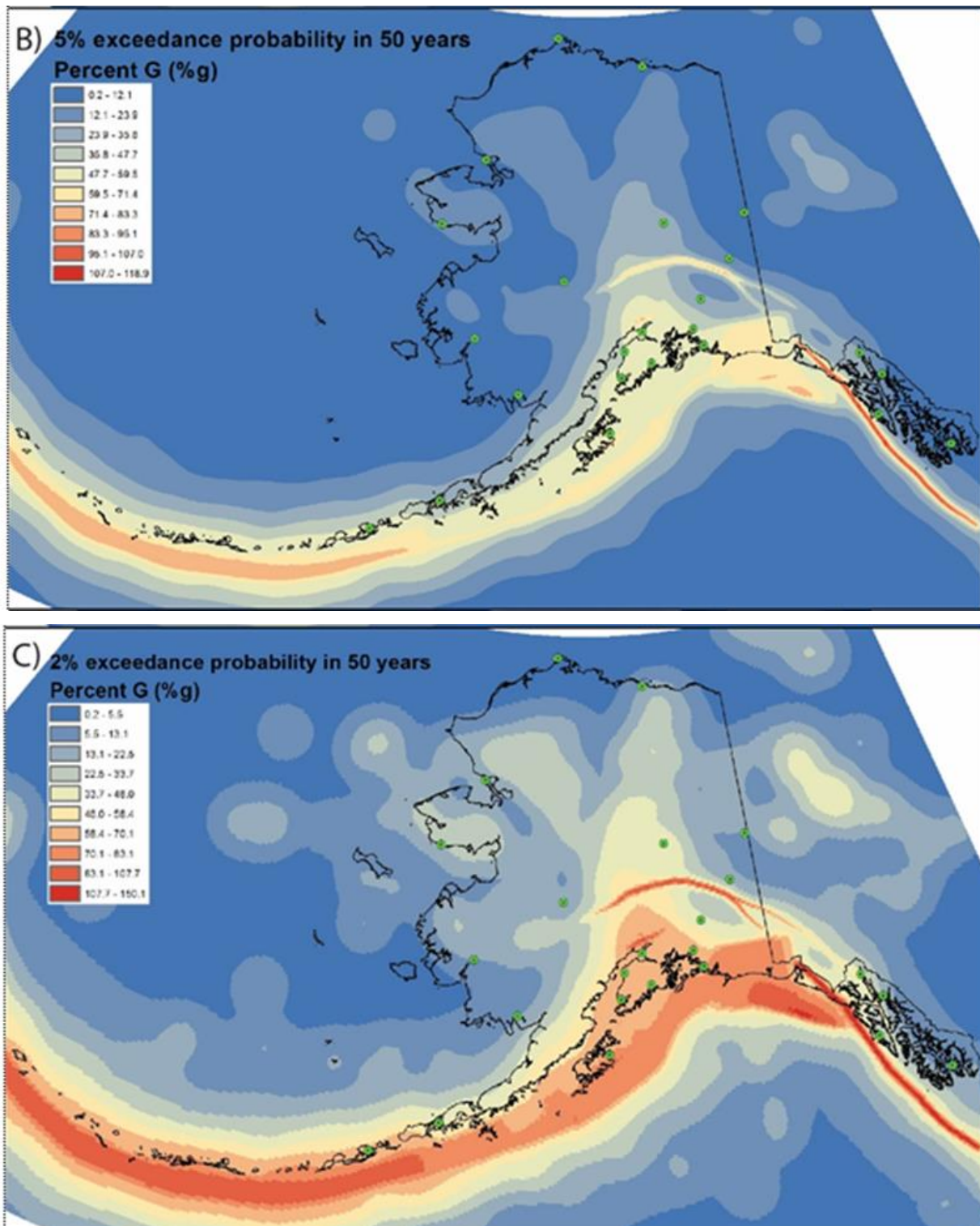
The varying degrees of damage associated with earthquakes are a direct result of the strong ground motions from seismic shaking. The objective classification of earthquake shaking at a point is based on ground accelerations. Ground accelerations (described as a percent of the acceleration due to gravity [%g]) are measured instrumentally and can be extrapolated between seismic stations after an earthquake occurs. In addition, ground accelerations are described at different “spectral wavelengths” to describe the types of shaking that affect different building styles; for example, spectral wavelengths of 0.2 second affect short, rigid buildings, whereas wavelengths of 1 second affect multi-story structures. The most universal metric used is Peak Ground Acceleration (PGA) at a point.

Because earthquakes are impossible to predict, scientists must use a unique approach to describing the hazards posed by earthquakes. Probabilistic Seismic Hazard Analyses (PSHAs) describe earthquake shaking levels and the likelihood that they will occur in Alaska. PSHAs are based on known, mapped geologic faults throughout Alaska and background seismicity from unknown faults. The result is a visual representation of the PGA that has a certain percent chance of being exceeded in a given amount of time

(usually 50 years, which is a typical life span for a piece of built infrastructure). Figure 4.1.2-5 (consists of three images) shows three peak ground acceleration maps: the 10%, 5%, and 2% probabilities that certain PGAs will be exceeded in the next 50 years in Alaska. The reason for three maps is earthquake hazard characteristics and their magnitudes. Small earthquakes are frequent, and there is a higher percent chance that they will happen in a given year (a 10% chance in 50 years means a 0.21% annual exceedance probability—there is a 0.21% chance that the earthquake will happen in a given year). Large earthquakes are infrequent, so there is lower percent chance that they will happen in a given year (a 2% chance in 50 years means a 0.04% annual exceedance probability—that is, there is a 0.04% chance that the earthquake will happen in a given year). However, when the infrequent, large earthquakes occur there are stronger ground accelerations.

To use these maps, first determine the type of earthquake of interest. For infrequent, large, and destructive earthquakes, use the 2% in 50 years exceedance probability (Figure 4.1.2-5C). Next, choose the location, and note the color of the map there. For example, choose Fairbanks and note that the city is in the yellow zone. Look at the explanation on the map to see that the range of ground accelerations that yellow represents (in this case, 34%g to 53%g for Fairbanks in Figure 4.1.2-5C. That means that in Fairbanks, the peak ground acceleration that has a 2% chance of being exceeded in 50 years (or 0.04% chance in a given year), which corresponds to shaking that is perceived as very strong to severe and may cause moderate to moderate/heavy damage (Figure 4.1.2-4).





Green dots show locations of significant population centers. Earthquakes with a high exceedance probability (e.g., 10% in 50 years) are common, and therefore are smaller earthquakes with less severe ground shaking. Earthquakes with a low exceedance probability (e.g., 2% in 50 years) are uncommon, but when they do occur, they are large and have more severe shaking. Source: USGS 2022b.

Figure 4.1.2-5: PGAs with 10%, 5%, and 2% Exceedance Probabilities in 50 Years

The major earthquake hazards can be categorized as follows:

- Strong ground motion
- Surface rupture
- Subsidence and uplift
- Earthquake-related ground failure
- Liquefaction and lateral spread
- Seiche
- Tsunami

The most common and perceivable effect of an earthquake is **strong ground motion**, which is ground shaking. Strong ground motion intensity is directly correlated with earthquake magnitude (i.e., the larger the earthquake magnitude, the more intense and widespread the ground shaking). Strong ground motion is also dependent on distance from the energy source; the strongest shaking occurs near the earthquake epicenter. The damage extent at a given location is dependent on many factors: the magnitude of the earthquake; distance from the epicenter; the local geology; and site-specific factors, such as building height and construction type.

A **surface rupture** occurs when the subsurface patch of fault that slips in an earthquake intersects the earth's surface. This intersection causes discrete, differential ground movement during intense earthquake shaking. The relative crustal block motion is dictated by the rupture's fault type, which can be horizontal, vertical, or a combination of both. Earthquakes larger than M 6.5 have sufficient energy to create surface ruptures, but whether this occurs is dependent on the earthquake's depth. The shallower the depth at which a significant earthquake occurs, the more likely it is to create a surface rupture. Permanent displacement along faults can be substantial. For example, the 2002 Denali rupture (M 7.9, right-lateral rupture) was roughly 211 miles in length and had maximum lateral offsets of 28.9 feet and maximum vertical offsets of 13.1 feet. Surface ruptures, as a product of intense strong ground motion, can cause severe damage to existing structures, including railways, highways, pipelines, and tunnels.

Subsidence is a widespread downward shift of the Earth's surface relative to a stationary datum (such as sea level), and **uplift** is the opposite, an upward shift of Earth's surface. Large earthquakes on the Alaska-Aleutian Subduction Zone can potentially cause widespread subsidence and uplift. If an earthquake causes a coastal area to subside, that area becomes more vulnerable to tsunami inundation. In many cases, the vertical changes occur under the ocean, affecting the seafloor. Subsidence and uplift occur because of the enormous amount of slip (up to 150 feet) that can occur on the dipping plate boundary fault. The 1964 Great Alaska Earthquake (Mw 9.2) caused subsidence of more than 65,000 square miles (up to approximately 6 feet of lowering) and uplift of more than 55,000 square miles (up to approximately 18 feet of uplift).

Earthquake strong ground motion heightens the possibility for **ground failure**. Ground accelerations can de-stabilize materials or re-mobilize existing slide deposits. The most common phenomena include landslides, rock falls, debris flows, and avalanches. Of particular concern for coastal Alaska and communities on steep-sided lakes are subaerial (land-based) and submarine slope failures that can trigger local tsunami waves (see Section 4.1.5, Tsunami and Seiche).

Liquefaction describes the phenomenon in which saturated, or partially saturated soil materials lose significant stiffness because of an applied stress, in this case, earthquake strong ground motion. The sudden shaking causes the soil to behave like a viscous fluid. Liquefaction or plastic flow in underlying materials can lead to lateral spread, creating subsequent soil or rock mass movement. Liquefaction and lateral spread can occur even in moderate earthquakes and are responsible for a tremendous amount of damage in historical earthquakes worldwide. As permafrost degradation continues because of climate change, the distribution of unconsolidated, moisture-rich soils will increase, and more Alaskans and infrastructure will be exposed to liquefaction hazards in future earthquakes.

A **seiche** is a temporary oscillation in the water level of a fully or partially enclosed water body (e.g., a lake or fjord). “Seiche” literally means “to sway back and forth,” and can be caused by several things. A seismic seiche is typically caused by earthquakes with vertical motions: the seismic waves from the earthquake pass through the area, creating standing waves in the water body. It may be difficult to isolate a particular causative mechanism near an earthquake epicenter, as seismic waves, landslides (submarine or subaerial), tsunamis, and tectonic tilting all may play a role in water level disturbance. At greater distances (i.e., over 600 miles), a seiche is mainly generated by seismic surface waves.

Earthquakes that occur at the subduction boundary between the Pacific and North American plates have a high likelihood of generating **tsunamis**. Such large megathrust earthquakes cause widespread vertical displacement along the seafloor, providing potential energy for a tsunami wave. See Section 4.1.5, Tsunami and Seiche, for a more detailed discussion of Alaska’s tsunami hazards.

Other related hazards include snow avalanche, landslides, and debris flows.

4.1.2.2 Locations of Earthquake Hazards

The entirety of Alaska is prone to earthquake effects. The following discussion is based on the Alaska Seismic Hazards Safety Commission’s website.

Scientists have long recognized that Alaska has more earthquakes than any other region of the United States and is one of the most seismically active areas of the world. The second largest earthquake ever recorded shook the heart of southern Alaska on March 27, 1964, with a magnitude of 9.2. The 1964 earthquake was slightly larger than the magnitude 9.0 Sumatra-Andaman Islands earthquake that devastated northern Sumatra in December 2004 and generated a tsunami that killed more than 280,000 people. The largest on-land earthquake in North America in almost 150 years occurred on the Denali fault in central Alaska on November 3, 2002, with a magnitude of 7.9.

It is not possible to predict the time and location of the next big earthquake, but the active geology of Alaska guarantees that major damaging earthquakes will continue to occur. Scientists have estimated where large earthquakes are most likely to occur, and the probable levels of ground shaking to be expected throughout the state (see Figure 4.1.2-1).

4.1.2.3 History of Earthquake Hazard Events

The Alaska Earthquake Center (AEC) states:

“The Earthquake Center detects an earthquake every ten minutes, on average. In 2018, we reported an all-time high of over 54,000 earthquakes in Alaska. As our monitoring network expanded, we reported more earthquakes because we were able to detect smaller earthquakes across more of the state. Thus, more earthquakes were reported as the Transportable Array project added new seismic stations in previously unmonitored areas.”

“The subduction zone produces very large earthquakes—as large as anywhere in the world—including three of the twelve largest earthquakes ever recorded. Magnitude 6 and 7 earthquakes can occur anywhere in Alaska.”

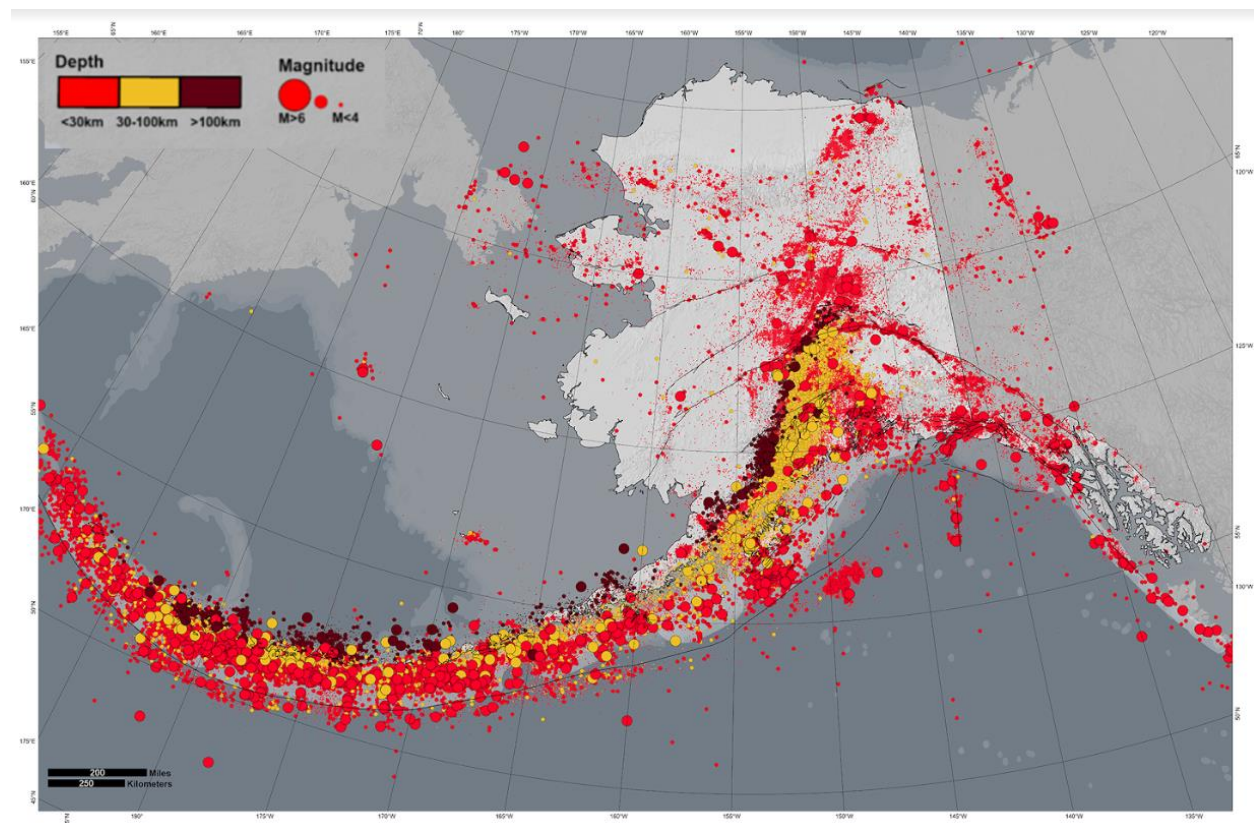
“We reported over 200,000 earthquakes in Alaska over the last five years. Thirty-four of those had magnitudes of 6 or greater, and six had magnitudes of at least 7. Seventy-five percent of all earthquakes in the United States with magnitudes larger than five happen in Alaska.”

Earthquake activity is typical for Alaska, as described by AEC:

“During August 2022, there were 3,643 earthquakes reported within the state. The largest earthquake was a magnitude 5.3 that occurred on August 1, 00:36:39 (Coordinated Universal Time [UTC]), 52 miles south of Akutan. All earthquakes of magnitude greater

than 4.0 were recorded along the subduction zone, except for a M 4.2 event in Chukchi peninsula (Russia). We continue to monitor seismic activity within Anchorage, offshore Kodiak, and the Simeonof-Chignik aftershock zones as well as crustal seismic activity in the Brooks Range, Seward Peninsula, and Bering Strait. About 150 earthquakes occurred in August, half of which occurred in Mt. Ogden in Southeast Alaska. Others were recorded in Prince William Sound, Icy Bay, and Yakutat Bay. Fifteen different earthquakes were reported as felt by the public.”

Note that most of 2022’s earthquakes (shown on Figure 4.1.2-6) are small-magnitude events, as small earthquakes are exponentially more common than large, destructive earthquakes. To emphasize this magnitude-frequency distribution, Figure 4.1.2-6 shows two main bins of earthquakes: small-magnitude ($M < 4$) earthquakes from just the last 10 years versus the entire catalog of $M \geq 4$ events, including some dating back to the early 1900s (though most events were recorded with modern seismometers after about 1990). Nearly all of Alaska is seismically active, but small-magnitude events are much more common.



Seismicity from the Last 10 years versus 30+ Years of Moderate to large ($M \geq 4$) Earthquakes. Source: AEC 2022. (Note, there is a lack of seismometers deployed in the northern portion of the state.)

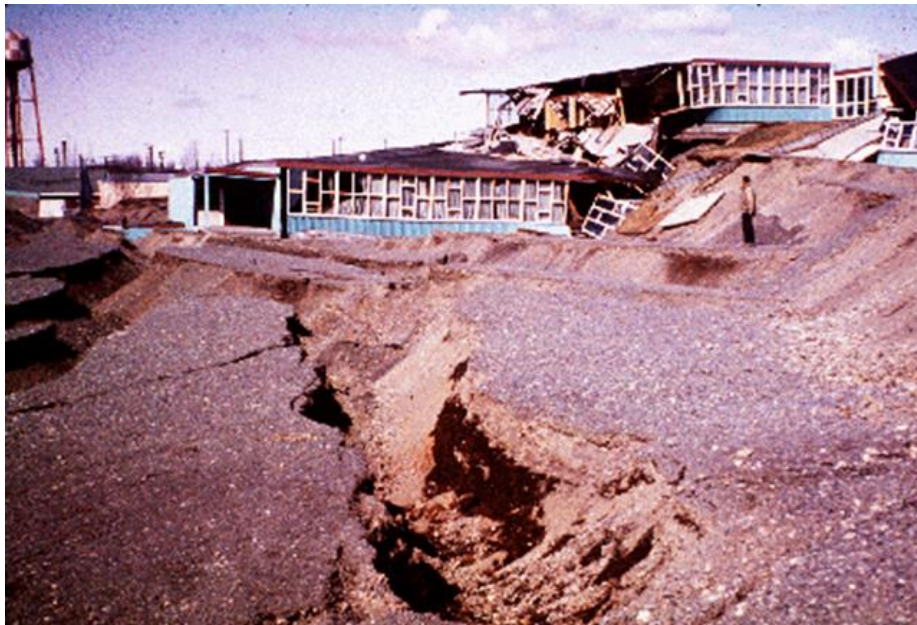
Figure 4.1.2-6: Statewide Seismicity Highlights the Abundance of Small-Magnitude ($M < 4$)

Descriptions of Alaska’s significant or notable earthquakes can be accessed via the AEC and the U.S. Geological Survey (USGS). Some of the significant events include the following (updated since the 2018 SHMP):

- 1957 Andreanof Islands Earthquake: A Mw 8.6 earthquake in the Andreanof Islands occurred in 1957. This great ($M > 8$) earthquake destroyed two bridges on Adak Island, damaged houses, and left an 18-foot-wide crack in a road. On Umnak Island, part of a dock was destroyed, and the Mount Vsevidof volcano erupted after being dormant for 200 years. The seismic shock generated a 50-foot

tsunami that smashed into the coastline at Scotch Cap, destroying the lighthouse; and a 26-foot tsunami washed away many Sand Point buildings and damaged oil lines. This tsunami continued to Hawai'i, where it destroyed two villages and inflicted about \$5 million in property damage on Oahu and Kauai Islands. The tsunami also caused minor damage in San Diego Bay, California, before traveling to such distant countries as Chile, El Salvador, Japan, and other areas in the Pacific region. More than 300 aftershocks were reported along the southern edge of the Aleutians, from Unimak Island to Amchitka Pass.

- **1964 Great Alaska Earthquake (also referred to as the Good Friday Earthquake):** The largest earthquake ever recorded in North American history (second-largest earthquake ever recorded worldwide) occurred along the east end of the Alaska-Aleutian subduction zone on Good Friday in 1964. The earthquake had an Mw of 9.2 and shook for approximately 5 minutes. Damages were heavy in many towns, including Anchorage, Chitina, Chenega Bay, Glennallen, Homer, Hope, Kasilof, Kenai, Kodiak, Moose Pass, Portage, Seldovia, Seward, Sterling, Tatitlik, Valdez, Wasilla, and Whittier. The earthquake caused significant ground deformation, and the triggered landslides, liquefaction, and lateral spread and tsunamis resulted in major damage throughout much of Southcentral Alaska (Figure 4.1.2-7). This great ($M > 8$) earthquake and ensuing tsunamis took 128 lives (113 tsunami-caused deaths and 15 earthquake-caused deaths) and resulted in about \$311 million in property losses. More than 200 bridges were destroyed or damaged due to lateral spread; flow failures, and damaged port facilities in Seward, Valdez, and Whittier. Ground failures (such as landslides and debris flows) were responsible for a large portion of the damage.



School destroyed by earthquake-related ground failure in the 1964 Great Alaska Earthquake. Source: USGS 1964.

Figure 4.1.2-7: Government Hill Elementary School

- **2002 M 7.9 Denali Earthquake:** A powerful (Mw 7.9) earthquake struck Alaska on November 3, 2002, rupturing the Earth's surface for approximately 210 miles along the Susitna Glacier, Denali, and Totschunda faults. Thankfully, this earthquake ruptured through a sparsely populated region, and even though it caused thousands of landslides, there was very little structural damage and no deaths. Although movement on the Denali fault caused right-lateral displacements of approximately 20 feet beneath the Trans-Alaska oil pipeline, the pipeline did not break, averting a major economic and

environmental disaster (Figure 4.1.2-8), largely because of the stringent design specifications based on geologic studies performed 30 years earlier. The pipeline is supported by Teflon coated beams that allow it to flex during lateral ground movement where it crosses the Denali fault. The Trans-Alaska Pipeline System (TAPS) transports about 17% of the domestic oil supply for the United States.



Location where Trans-Alaska Pipeline System crosses the Denali fault (2012). Note how pipeline shifted to left of center on the Teflon-coated beams. Source: USGS 2012.

Figure 4.1.2-8: Trans-Alaska Oil Pipeline’s Earthquake Mitigation Offset

- **2016 M 7.1 Iniskin Earthquake:** A Mw 7.1 earthquake struck on January 24, 2016, 53 miles west of Anchor Point and 161 miles southwest of Anchorage. The USGS reported an intermediate-depth strike-slip fault earthquake within the Pacific Plate’s subducted lithosphere. Intermediate-depth earthquakes have focal depths of between 70 and 300 km and indicate movement within subducted plates rather than where plates meet. Thus, this earthquake was less damaging than would normally be associated with a shallow M 7.1 earthquake. However, it did cause several power outages from Anchor Point to Willow and opened a fissure in Kalifornsky Beach Road in Kasilof. In Kenai, a ruptured gas main was responsible for blowing the roofs off two homes, sending them 40 feet into the air. Two other nearby homes burned down. In Anchorage, the Anchorage School District’s West High School and Romig Middle School sustained structural and non-structural damage. The Romig Middle School gymnasium was closed indefinitely due to a compromised roof, and the shared library with West High School was closed for a damaged ceiling.
- **November 2018 Anchorage Earthquake:** On November 30, 2018, a significant earthquake that measured at magnitude 7.1 produced strong seismic shaking that caused widespread and severe damage primarily within the Municipality of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough. The Municipality of Anchorage and Matanuska-Susitna Borough each issued local declarations of disaster emergency in response to this event. The disaster resulted in widespread and severe seismic shaking damage to major highways and critical community roads, bridges, and other transportation infrastructure; the undermining of road embankments and railroad tracks and the loss of track base (ground failure/liquefaction, etc.); widespread power, water, and communications

disruptions; structural collapse and fires to several community buildings; and severe damage to private homes and personal property. These conditions have required local emergency protective measures to protect life and property, including activation and staffing of emergency operations centers; emergency debris clearance of roads and railroad tracks to protect critical infrastructure and maintain access; placement of road barricades to protect roads and bridges; operation of mass shelters for affected residents; and school, business, and government office closures.

- **2020 July Simeonof Earthquake:** At 10:13 pm on July 21, 2020, the National Tsunami Warning Center (NTWC) in Palmer, Alaska, recorded a M 7.8 earthquake 61 miles south/southeast of Perryville and 75 miles south of Chignik. The magnitude and location of the earthquake triggered a tsunami warning for approximately 800 miles of coastline from Homer to Nikolski. Based on the warning, multiple communities along the Southern, Kodiak, Alaska Peninsula, and Eastern Aleutians coastline evacuated to higher ground. The State Emergency Operations Center (SEOC) recalled all operations staff and the Public Information Officer to support the community response. The SEOC received initial reports of strong earthquake shaking in several communities, including Sand Point, Cold Bay, Perryville, and Chignik. The NTWC issued wave arrival times for 10 communities with the first wave, if generated, to reach Sand Point by 11:15 pm and the rest of the communities over the next 2 hours. Several communities evacuated to higher ground. A major wave was not generated, but sea level gauges recorded a tsunami of 0.8 foot at Sand Point just after midnight on July 22. As a result, NTWC determined there was no threat and canceled the tsunami warning at 12:23 am. The USGS Shake Map produced for the initial shock showed the highest seismic shaking intensities in the Cold Bay, Sand Point, Perryville, and Chignik areas of the Alaska Peninsula. As of September 9, 2020, there had been 35 aftershocks above M 4.5 (2 M 6.1 aftershocks, 17 M 5.0+ aftershocks, and 16 M 4.5+ aftershocks). As of September 14, 2020, the SEOC had received disaster declarations from the City of Sand Point and Aleutians East Borough.
- **July 2021 Chignik Earthquake:** The M 8.2 Chignik earthquake occurred at 10:15 pm on July 28, 2021, southeast of the Alaska Peninsula on the interface between the subducting Pacific and overriding North American tectonic plates. The event occurred between the Shumagin Islands to the southwest and Kodiak Island to the northeast and was the largest earthquake in the area (and the entire United States) since 1965. This portion of the plate interface last ruptured in 1938 in a M 8.3 megathrust event. The Chignik event was also very close to and appears to have been influenced by the recent M 7.8 Simeonof Earthquake in the area previously identified as the Shumagin “seismic gap.” The NTWC issued a tsunami warning immediately after the event for communities between Samalga Pass and the Hitchinbrook Entrance, resulting in several community evacuations (Chignik Bay, Chignik Lagoon, Kodiak City, False Pass, Homer, King Cove, Nelson Lagoon, Old Harbor, Sand Point, Seward, and Unalaska). The warning was reduced to an advisory just over 2 hours after the events, and all recorded wave heights in the area were under 1 foot. Four minutes after the mainshock, a M 6.1 aftershock occurred. On August 14, a M 6.9 aftershock shook the same area.
- **Other Alaska earthquakes:** Many large earthquakes have affected other parts of Alaska. Since the early 1900s, three M>7 earthquakes have occurred within 50 miles of Fairbanks. Southeast Alaska also receives earthquakes from Queen Charlotte-Fairweather fault movement, including a Mw 8.1 earthquake in 1949, and a Mw 7.9 earthquake in 1958 that triggered a giant landslide-generated tsunami in Lituya Bay. Areas at greatest risk from earthquakes along this fault zone are the communities along the outer coast of Southeast Alaska (DGGS 2018).

4.1.2.4 Extent of Earthquake Hazards

As shown in the previous sections, the entirety of Alaska is subject to earthquake hazards. Extent can range from minor earthquakes that last mere seconds and are not felt to major seismic events (e.g., the M 9.2 Great Alaska Earthquake) that involve shaking that lasts for approximately 5 minutes. Alaska has changed significantly since the damaging 1964 earthquake, and the population has more than doubled. Many new buildings are designed to withstand intense shaking; some older buildings have been reinforced, and development has been discouraged in particularly hazardous areas.

Despite these precautions, and because practices to reduce vulnerability to earthquakes and tsunamis are not applied consistently, future earthquakes may still cause life-threatening damage to buildings, cause items within buildings to be dangerously tossed about, and disrupt the basic utilities and critical facilities that the public takes for granted.

The Federal Emergency Management Agency (FEMA) estimates that with the present infrastructure and policies, Alaska will have the second highest average annualized earthquake-loss ratio (ratio of average annual losses to infrastructure) in the country. Reducing those losses requires a public commitment to earthquake-conscious siting, design, and construction. The Alaska Seismic Hazards Safety Commission is committed to addressing these issues. Earthquake-risk mitigation measures developed by similar boards in other states have prevented hundreds of millions of dollars in losses and significant reductions in casualties when compared to other seismically active areas of the world that do not implement effective mitigation measures. The San Francisco (1989), Northridge (1994), and Nisqually (2001) earthquakes caused comparatively low losses because of mitigation measures implemented in those areas. Many of these measures were recommended by the states' seismic safety commissions (FEMA 2000).

4.1.2.5 Impact of Earthquake Hazards

Community impacts from significant ground motion, surface rupture, and ground failure may result in infrastructure damage or harm to Alaskans in nearly any part of the state. Impacts can range from negligible to catastrophic and can result in utility damage and transportation disruption where roads, ports, and harbors or airports that supply rural areas throughout the state are damaged. To illustrate these impacts, Figure 4.1.2-5 depicts peak ground accelerations at three different exceedance probabilities.

4.1.2.6 Probability of Earthquake Hazards

As indicated previously, it is not possible to predict when an earthquake will occur, but the USGS has conducted PSHAs for the state (see Figure 4.1.2-5). That modeling effort incorporates what is known about Alaska's active faults and current and past seismicity to develop the most-current PSHA maps available. These maps will be updated in 2023.

The hazard maps depict the peak ground accelerations expected at a point with 10%, 5%, and 2% exceedance probabilities in 50 years. A useful way to think about these exceedance probabilities is that a 10% chance in 50 years means that statistically this earthquake happens on average every 500 years (Figure 4.1.2-5A). A 5% chance in 50 years means that statistically this kind of earthquake happens every 1,000 years (Figure 4.1.2-5B). A 2% chance in 50 years, is the rare, large earthquake, and statistically it happens on average every 2,500 years (Figure 4.1.2-5C). For each of these exceedance probabilities, the color on the map at your location corresponds to a shaking intensity in percent of gravitational acceleration. See Figure 4.1.2-4 for a description of shaking at different percent gravity values.

See Section 4.2 Vulnerability Assessment, for detailed recurrence probability analyses.

4.1.2.7 Projected Changes in Earthquake Hazards

Earthquake locations are not expected to change on human timescales.

4.1.2.8 Range of Anticipated Intensities of Earthquake Hazards

The subduction zone produces very large earthquakes—as large as anywhere in the world—including three of the 12 largest earthquakes ever recorded. M 6 and M 7 earthquakes can occur anywhere in Alaska. Generally, minor earthquakes can range from events that last mere seconds and are not felt to major seismic events (e.g., the M 9.2 Great Alaska Earthquake) that involve shaking that lasts for approximately 5 minutes.

In 2018, 34 Alaska earthquakes were M 6 or greater and six were M 7. Seventy-five (75) percent of all earthquakes in the United States larger than M 5 happen in Alaska.

4.1.2.9 Frequency of Earthquake Hazards

The AEC detects an earthquake in Alaska about every 10 minutes, on average. AEC reported over 200,000 earthquakes in Alaska over the last 5 years. In 2018, the center reported an all-time high of over 54,000 earthquakes in Alaska because the monitoring network had been expanded.

4.1.2.10 Duration of Earthquake Hazards

Earthquake shaking duration is highly variable depending on location, depth, and distance from the source. As an example of a large event, the M 9.2 1964 Great Alaska Earthquake had a reported duration of 4 to 5 minutes.

4.1.2.11 Future Conditions for Earthquake Hazards, Including Climate Change

4.1.2.11.1 Characteristics/Nature

Earthquake characteristics and nature are not affected by climate change and are not expected to change on human timescales.

4.1.2.11.2 Locations

Earthquake locations are not affected by climate change and are not expected to change on human timescales.

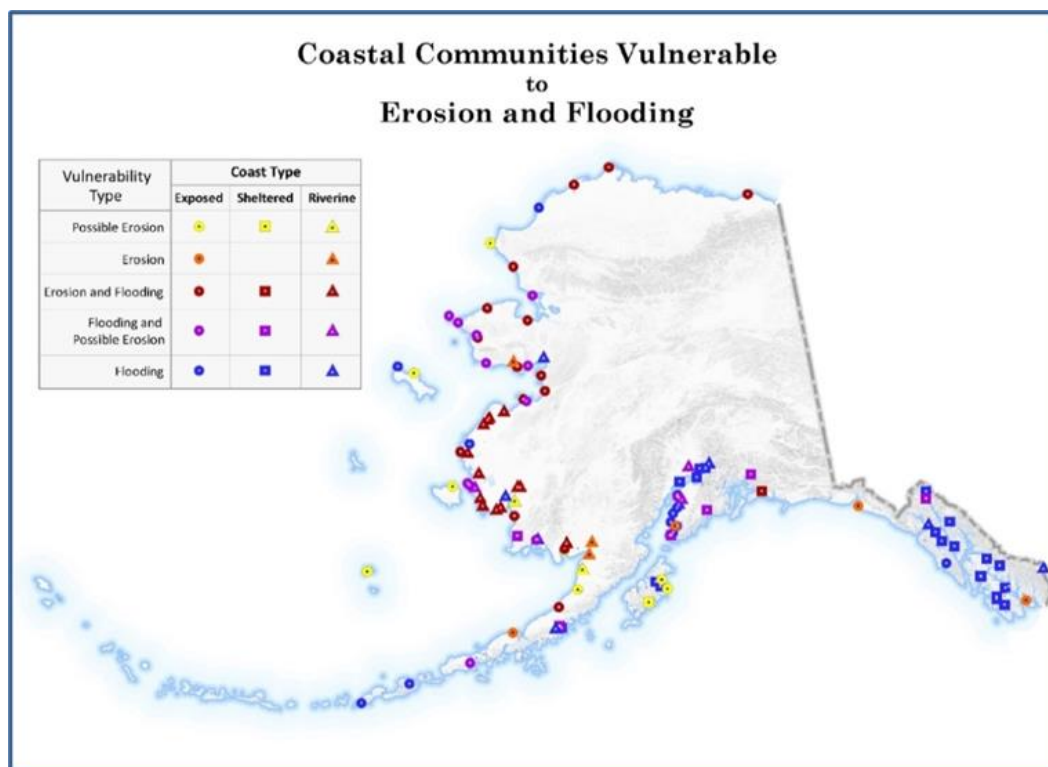
4.1.2.11.3 Range of Anticipated Intensities

Earthquake intensities are not affected by climate change and are not expected to change on human timescales.

4.1.3 Flood and Erosion

Approximately 6,600 miles of Alaska’s coastline and many low-lying areas along the state’s rivers are subject to severe flooding and erosion. In 2019, the University of Alaska, Fairbanks (UAF), Institute of Northern Engineering, the U.S. Army Corps of Engineers Alaska District (USACE), and the USACE Cold Regions Research and Engineering Laboratory completed the *Statewide Threat Assessment*, which assessed threats to public infrastructure associated with erosion, flooding, and thawing permafrost in 187 rural Alaska communities, most of which are coastal communities (UAF et al. 2019). Of the 187 communities assessed, 144 were found to be moderately or highly threatened by infrastructure damage from one or more of the environmental threats of erosion, flooding, or thawing permafrost, with 66 communities found to be moderately or highly threatened by infrastructure damage from flooding and/or erosion. Many of the problems are long-standing, although studies indicate that increased flooding and erosion are being caused in part by a changing climate (Simmonds and Keay 2009; Terenziet al. 2014; Vermaire et al. 2013).

Alaska is unique in the U.S. because of how permafrost interacts with flooding and erosion to exacerbate the impacts of these hazards. Frozen ground can disintegrate under the compounding influences of permafrost thaw, flooding, and erosion in an escalating feedback loop that can result in damage that is much greater than would be expected from the individual processes alone. See the discussion of *usteq* in Section 4.1.1.1.2, Characteristics/Nature/Types of Permafrost and Periglacial Hazards, for more information about this phenomenon.



Map shows communities experiencing known flooding (blue), erosion (yellow and orange), or both flooding and erosion (red and purple). The coasts of northern and western Alaska are particularly vulnerable to the combination of flooding and erosion. Source: DGGS 2018.

Figure 4.1.3-1: Alaska Erosion- and Flood-Threatened Coastal Communities

4.1.3.1 Flood

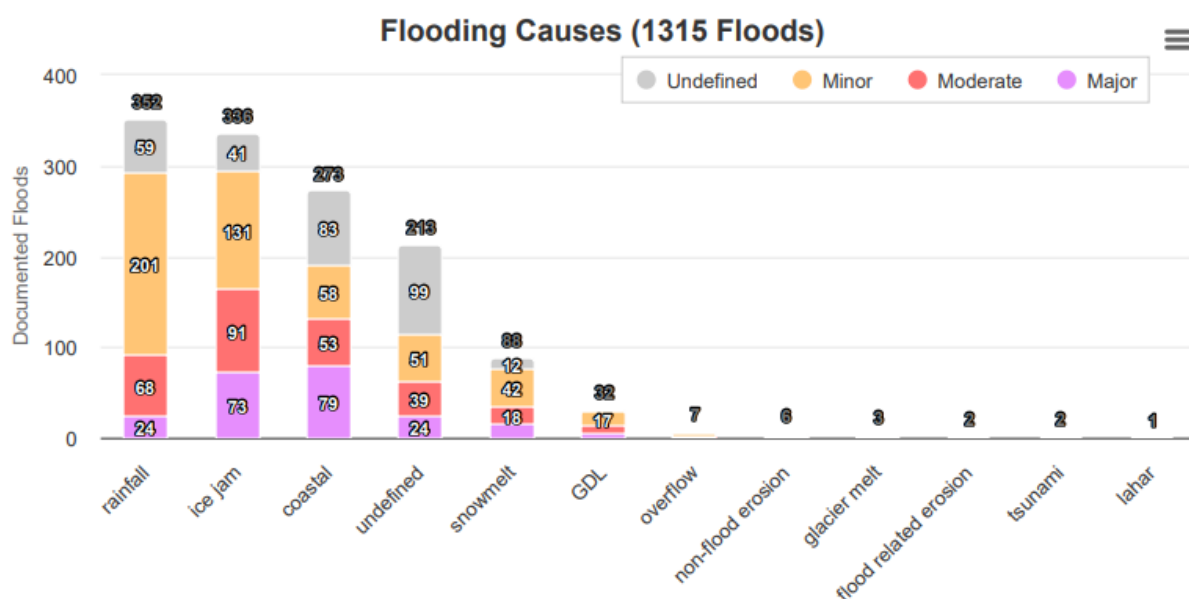
4.1.3.1.1 *Characteristics/Nature/Types of Flood Hazards*

Flood is the overflow of a body of water that inundates or submerges normally dry land. Water defeats natural or artificial barriers such as beaches, stream banks, and levees that would usually protect adjacent floodplains. Flooding is typically a natural event and considered a hazard only when people and property are at risk. Flooding is Alaska's most common disaster, often costing in excess of \$1 million annually and causing major disruptions to society and occasionally loss of life.

Flooding in Alaska occurs in riverine, coastal, lake environments (fluctuating lake levels and glacial lake outbursts), groundwater, and ice overflow (*aufeis*) with different processes and contributing factors in each of these environments. The major flood categories can be subdivided as follows:

- Riverine
 - Overbank
 - Rainfall-runoff
 - Snowmelt
 - Alluvial fan
 - Flash
 - Ice jam
- Coastal flood
 - Storm surge
 - Sea level rise
- Fluctuating lake levels
- Glacial lake outburst
- Groundwater
- Aufeis (ice overflow)

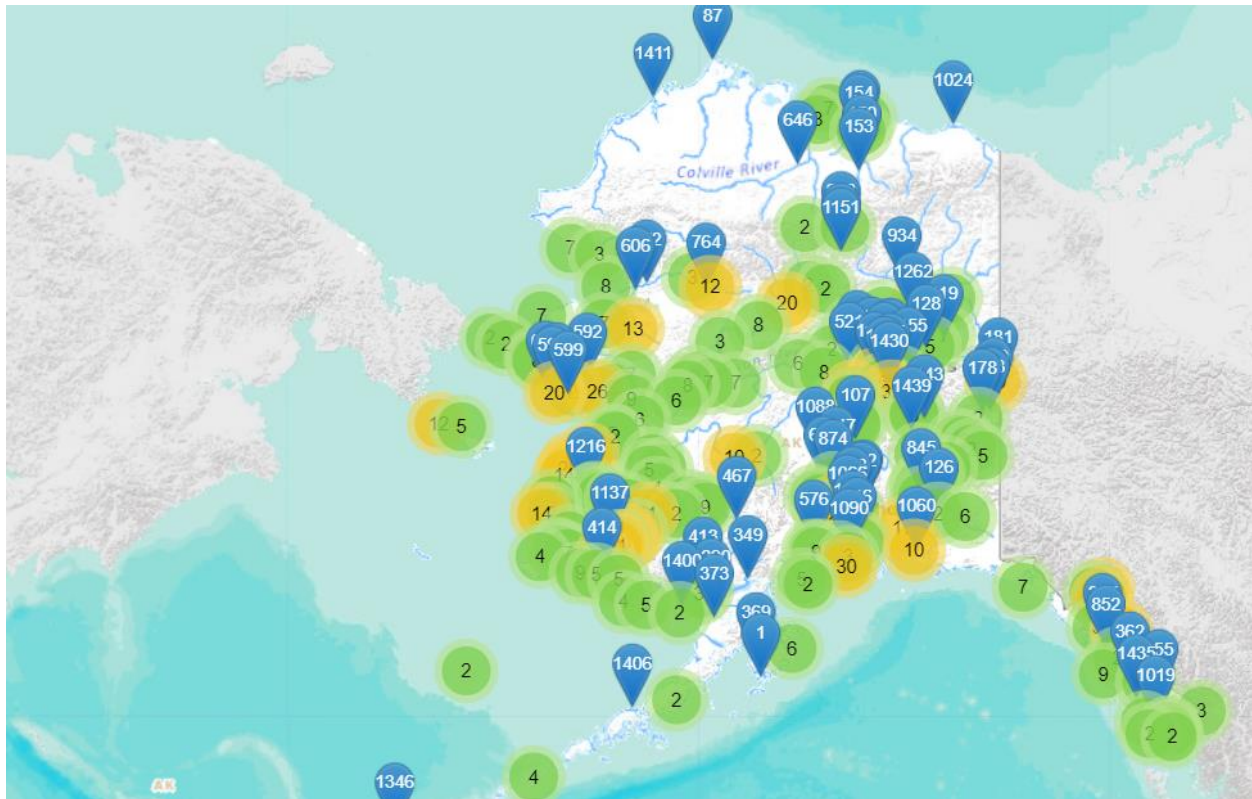
The causes of the 1,313 floods documented in Alaska between 1890 and 2021 are shown on Figure 4.1.3-2, as reported in local hazard mitigation plans, regional hazard mitigation plans, Alaska Pacific River Forecast Center (APRFC) River Notes, the National Weather Service (NWS) Storm Database, NWS warnings and watches, and some site-specific reports.



This figure tabulates documented Alaska flood events from 1890 to 2023, color-coded according to event magnitude. Undefined event magnitudes, shown in gray, are floods whose magnitudes are not known. “Undefined” flood causes are floods for which the cause is not known. Glacial-dammed lake floods include glacial lake outbursts. Source: USACE 2023 (Silver Jackets Flood Mitigation Project) (<https://www.weather.gov/source/aprfc/floodDB.html>).

Figure 4.1.3-2: Flood Cause Chart

The distribution of these flood hazards around the state is shown on Figure 4.1.3-3. This map and chart may under-represent actual events, due to a general lack of documentation in Alaska.



Documented Alaska flood events, 1890–2023. Blue tags are locations of single events, with NWS event identification number displayed; green circles are locations with 2 to 9 documented flood events, with number of events displayed; yellow circles are locations with 10 or more documented flood events, with number of events displayed. Source: USACE 2023 (Silver Jackets Flood Mitigation Project) (<https://www.weather.gov/source/aprfc/floodDB.html>).

Figure 4.1.3-3: Documented Flood Event Map

Riverine flooding occurs when river levels rise and overflow their banks or the edges of their main channel and inundate areas adjacent to the stream or river. The main driver of riverine flooding is rainfall, but additional factors may include snow accumulation and snow melt rates, and sediment transport that changes the topography of the river bed and banks. The damage from a river flood can be widespread as high water may affect rivers downstream, often causing dams and dikes to break and inundate nearby areas.

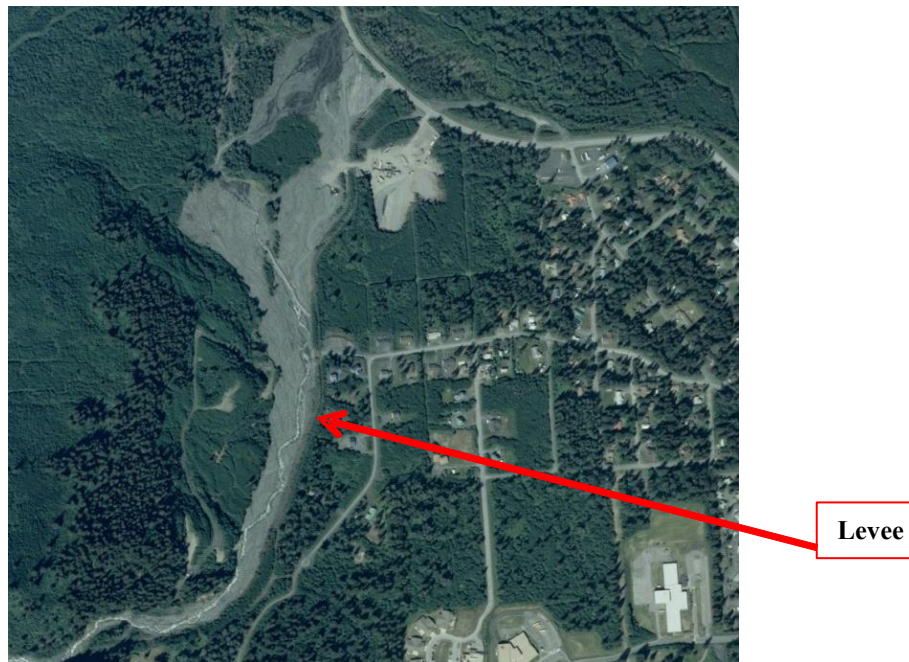
Overbank flooding is an umbrella term for when water rises and overflows the streambank. This type of flooding is the most common form of riverine flooding worldwide and can occur in any size channel, from small streams to large rivers. Rainfall-runoff and snowmelt floods are examples of overbank flooding.

Rainfall-runoff flooding is a common type of flooding in Alaska, typically occurring from late summer through the fall. These floods result from high rainfall amounts and accompanying high surface runoff rates. Rainfall intensity, duration, and distribution, and pre-existing soil moisture conditions and the geomorphic characteristics of the watershed all contribute to a flood's magnitude.

Snowmelt flooding occurs when the major source of water involved in a flood is melting snow. Unlike rainfall, which can reach the soil almost immediately, snowpack can store water for an extended period until temperatures rise above freezing and the snow melts. This frozen storage can delay the arrival of water to the soil for days, weeks, or even months. Once the snow begins to melt, the water behaves

much as it would if it had come from rain instead of snow by either running off, infiltrating into the soil, or both. However, snowmelt typically happens before soil thaw and can therefore be considered largely as surface runoff that results in rapid rise in river discharge. Flooding occurs when the storage capacities of rivers, lakes, and reservoirs are exceeded. Snowmelt flooding in Alaska typically occurs from April through June, depending on latitude and weather patterns, but is most common in the spring, when rapidly warming temperatures quickly melt the snow. Snowpack distribution and depth, spring weather patterns, and the geomorphic characteristics of the watershed determine the magnitude of flooding. Rainfall, high temperatures, melting glacier ice, and river breakup behavior can exacerbate snowmelt floods.

Alluvial fan flooding occurs on the surface of an alluvial fan or similar landform. An alluvial fan is a fan- or cone-shaped deposit of sediment that is built up by streams due to a decrease in the ability to carry material, typically where streams exit from a steep tributary valley onto a larger valley or flat plain. The floods originate at the valley or fan apex and are characterized by high-velocity flows; active erosion processes, sediment transport, and deposition; and unpredictable flow paths. When debris deposits fill the existing river channels on the alluvial fan, the water overflows the stream banks and floods land downstream. The overflow may establish new channels. Alluvial fan flooding frequently damages roads and infrastructure, as can be seen in the cities of Seward and Girdwood, and in communities along the Richardson, Haines, and Dalton highways (Figure 4.1.3-4).



An alluvial fan in Seward, Alaska. [A] Levee has been constructed to direct the flow of water and sediment away from developed areas. Source: Balazs et al. 2021

Figure 4.1.3-4: Aerial Image of Japanese Creek

Flash flooding is a rapid and extreme high-water flow into a previously dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event. Flash floods are usually caused by heavy rain associated with a severe weather event such as a thunderstorm, atmospheric river, or meltwater from ice or snow flowing over ice sheets or snowfields. They may also be caused by breaches in natural or manufactured dams. Usually swift moving, debris laden, and very destructive, these floods are sudden and potentially violent events. Topographic features such as narrow canyons and steep slopes are prone to flash flooding. Flash floods may also result from a dam failure.

Ice jam flooding occurs when water backs up into surrounding areas because a river or stream is blocked by ice buildup or other debris blockage. Ice jams may occur any time when ice is present, but typically form during the following three periods:

- Fall freeze-up
- Midwinter, when stream channels freeze and form anchor ice
- Spring breakup, when the existing ice cover weakens and breaks apart, flows downstream, and jams together at narrow sections of a stream channel where the ice blocks are forced to sink to the bottom from upriver water forces, forming a dam.

Ice jams commonly develop in areas of decreased channel slope, shallow sections, and river bends or constrictions, and they frequently impede waterways during spring break up. The water level rises upstream behind the ice jam. If the ice jam is higher than the riverbank, the adjacent land will flood. This effect is analogous to a dam, and if a community or development is nearby, low-lying structures will be subject to significant flooding and ice impact.

When the stream breaches the ice jam, the dammed water will drain rapidly and further damage structures as it flows back into its channel. The water level downstream will rise quickly and behave much like a flash flood, carrying large chunks of ice, trees, vegetation, and other debris.

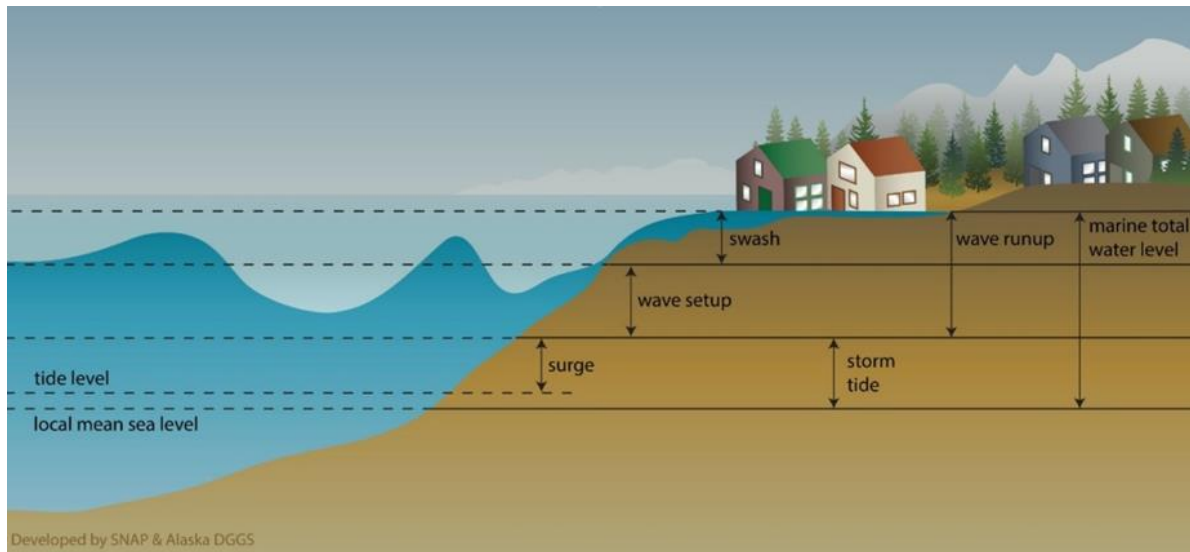
A serious ice jam will threaten areas upstream and downstream of its location. Six (6)-inch-thick ice can destroy large trees and knock houses off their foundations. Many of the record flood events along major rivers in Alaska are the result of ice jams, including recent large and destructive floods along the Kenai, Susitna, Kuskokwim, and Yukon rivers (Figure 4.1.3-5).



Source: NWS 2013.

Figure 4.1.3-5: 2013 Galena Ice Jam Flood (Yukon River is in the left portion of photo.)

Coastal flooding occurs along the coast when the combined effects of coastal storm surge, tides, waves (marine total water level) and sea level rise exceed the local land elevations of beaches and coastal plains (Figure 4.1.3-6).



Source: DGGS 2008.

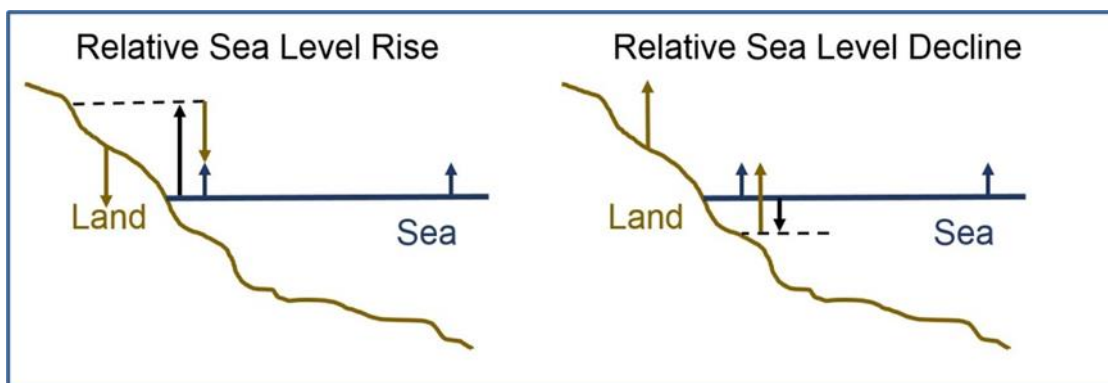
Figure 4.1.3-6: Schematic of Coastal Water Levels Leading to Flood Inundation

Storm surge is a rise in water above normally predicted astronomical tides. Flooding occurs when a storm reaches the coast and drives water landward. Storms also bring high winds to coastal areas, which move across water bodies and generate wind-driven waves and “setup” (the increase in water level due to the presence of breaking waves). The greater distance over which wind blows (i.e., the fetch), the larger the wind-generated waves. Local tide fluctuations can influence coastal flooding from a coastal storm, depending on timing and magnitude (see Figure 4.1.3-6).

There are many factors that can impact the severity of storm surge. Storm orientation and the shape and characteristics of the coast can exacerbate flooding along the coastline. Shallow embayments, such as Kuskokwim Bay and Norton Sound, with a shallow slope exert friction on incoming storm surge, which enhances water elevation as it moves toward the coast. If the orientation of the storm is directly perpendicular to the coast (hits the coast straight on), the combined effects of storm surge and waves are translated directly onshore. Storms approaching at a more oblique or parallel angle may divert surge and waves along the shore, resulting in less flooding. Low-elevation landforms such as deltas (e.g., the Yukon-Kuskokwim delta) are naturally more vulnerable to flooding, and even small storm events can cause substantial inundation. Low-lying sand spits and barrier islands, such as the islands on which Kivalina and Shishmaref are located, are subject to flooding. Storms have varying levels of impact on these regions depending on the morphology of the barrier island, including collision, overwash, and, more severely, inundation. Collision and overwash result in net dune erosion, with overwash resulting in net landward migration of the island. Inundation is the complete submersion of the island.

In Alaska, coastal flooding primarily occurs on the northern and western coastlines. Storms (low-pressure systems) from offshore of Russia make their way across the Bering Sea to impact areas from the Alaska Peninsula to the northwest Arctic. Storm systems that move across the North Slope during ice-free ocean conditions can lead to flooding at North Slope communities. Coastal floods around the state have been identified using available data sources, such as community reports and photographs; however, many events go unreported due to the lack of observing systems and limited communication networks.

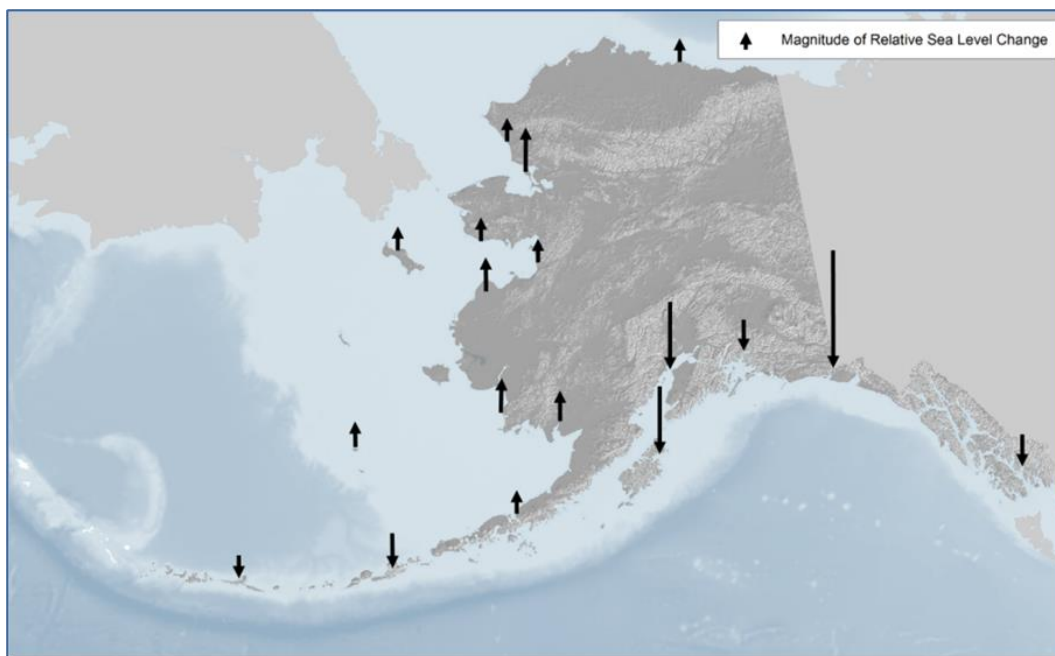
Sea level rise can impact the threshold for coastal flooding. Relative sea level change includes the combined effects of vertical land motion due to tectonics and glacier unloading and changes in sea level due to changes in ocean water volume (Figure 4.1.3-7). Globally, sea level is rising due to ocean thermal expansion, caused by warming ocean water, and increased land-based ice melt, such as glaciers and ice sheets (NOAA 2023).



Graphic represents the combined effects of vertical land motion and changes to eustatic sea level. “Eustatic sea level” means sea level driven only by the mass or volume of the oceans. In the first case (left), sinking land level coupled with rising sea level leads to relative sea level rise. In the second case (right), rising land level coupled with the same amount of sea level rise as in the first case leads to relative sea level decline. Source: DGGS 2018.

Figure 4.1.3-7: Schematic of Relative Sea Level Change

Relative sea levels in Alaska are either rising or falling, depending on local factors such as land subsidence, upstream flood control, erosion, regional ocean currents, variations in land height, and whether the land is still rebounding from the weight of glaciers from the last Ice Age (NOAA 2023) (Figure 4.1.3-8). Regions of southeast Alaska are rebounding from the loss of their glacier ice faster than global sea levels are rising, resulting in relative sea level lowering. In contrast, sediment loading from the Yukon and Kuskokwim rivers is causing subsidence of the land relative to global sea levels on the Yukon-Kuskokwim delta. Actual rates for these processes were estimated using modeling and limited field data for northern and western Alaska (DeGrandpre 2015), and because of these limits the calculated rates are highly uncertain. Rates in the southeast, southcentral, and the Aleutian Islands were calculated using long-term ocean water levels and land Global Positioning System (GPS) observations, resulting in better constraints (NOAA 2017).



Arrows show the direction and magnitude of relative sea level changes across Alaska. Source: NOAA 2017; DeGrandpre 2015.

Figure 4.1.3-8: Alaska's Relative Magnitude of Relative Sea Level Change Rates

Fluctuating lake levels is flooding that occurs from overflowing lakes. Generally, lakes prevent downstream flooding by storing large amounts of runoff. However, the area around the lake may flood during periods of excessive inflow. The Kenai and Skilak lake areas occasionally flood due to excessive rainfall, snowmelt, and glacier-dammed lake releases.

Glacial lake outburst flooding occurs when water is rapidly released from a glacial lake due to the sudden failure of an ice or moraine dam or to water overtopping the dam as a result of waves caused by mass wasting (landslide) of nearby unstable slopes into the lake. Sub-glacial releases occur when enough hydrostatic pressure builds to float the glacial ice; water then drains rapidly from the bottom of the lake.

Glacial lake outburst flooding is possible in many parts of the state. A U.S. Geological Survey (USGS) study documented 750 glacier-dammed lakes with potential for outburst floods in Alaska and adjacent portions of Canada (Post and Mayo 1971). The Copper, Snow, Tazlina, and Kenai Rivers all have periodic outbursts at approximately 2- to 5-year frequencies, and the Kennicott Glacier at McCarthy and the Valdez Glacier near Valdez outburst annually. See Section 4.1.1.1, *Glaciers*, for a more detailed discussion of this hazard.

Groundwater flooding occurs when water accumulates and saturates the soil. The water table rises to levels that flood low-lying areas, including structures, septic tanks, cellars, and other facilities. Groundwater flooding has been a significant problem in Fairbanks, especially downstream of the Moose Creek Dam near Chena River Lakes. In addition, the basements of structures along the Chena River may flood when the river stage remains high for more than a few days. Numerous rural or remote “boardwalk communities,” such as Newtok and Atmautluak, experience dire living conditions due to groundwater flooding. New types of groundwater flooding are developing as permafrost is warming. Cold permafrost causes contraction cracks that can release groundwater pressure; these cracks stop forming as the permafrost gets warmer. Formerly dry ice cellars in northern communities are now flooding due to warming permafrost.

Aufeis (ice overflow) flooding is caused by a surface ice mass (i.e., aufeis) that forms during the winter in a permafrost area by successive freezing of sheets of water that may seep from the ground or from a spring or river. Also known as “overflow ice,” “glaciering,” “icing,” or “naled,” most aufeis is less than a few hundred yards long; however, some can cover many square miles. Usually just a few feet thick, aufeis can reach a thickness of 30 feet or more. Aufeis in stream channels may force water up and over streambanks, resulting in flooding. In March 2015, aufeis along the Sagavanirktok River caused flooding of the adjacent Dalton Highway (Figure 4.1.3-9). See Section 4.1.1.2, *Permafrost and Periglacial*, for more information about aufeis.



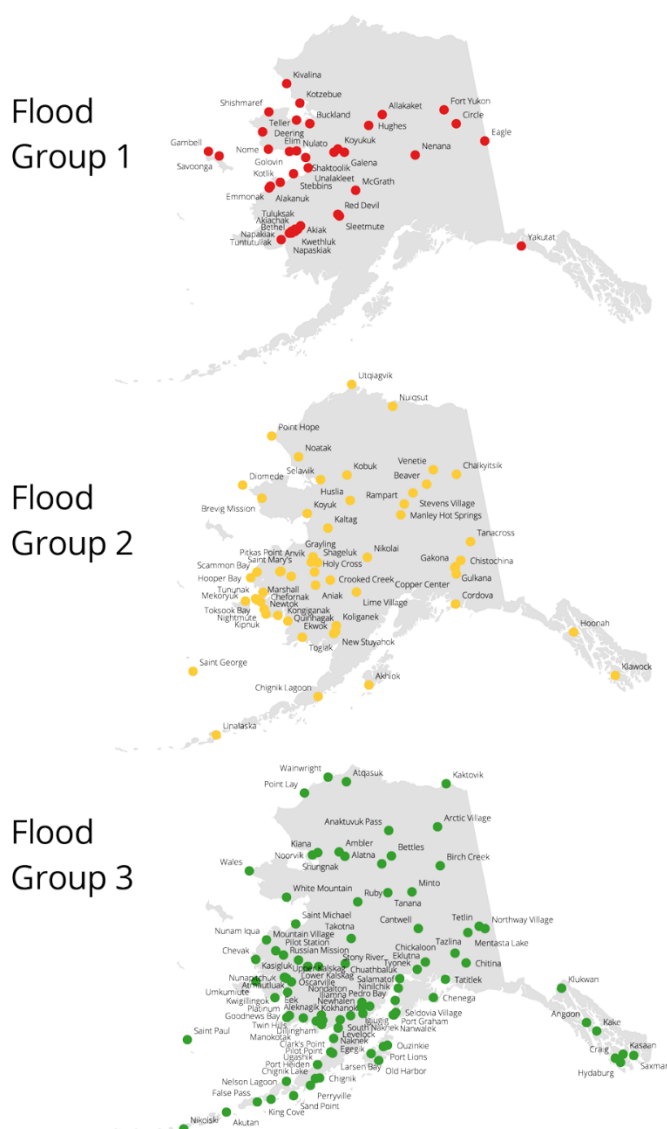
Flooding caused by aufeis on the Sagavanirktok River in 2015. Source: DOT/PF 2015.

Figure 4.1.3-9: 2015 Dalton Highway Flooding

4.1.3.1.2 Locations of Flood Hazards

Flood hazards impact many communities around the state that are situated along a coast, river, or lake, which traditionally are preferable locations for settlements. As described in Section 4.2.4 Vulnerability Assessment Methodology, the extent of flooding has been defined as a 0.5-mile buffer along communities identified as threatened by coastal flooding (per the definition of the Alaska Division of Geological & Geophysical Surveys [DGGs]) and a 0.25-mile buffer along riverine threatened communities (per the definition of the USACE). See Section 4.2.5 Vulnerability Exposure Analysis, for a detailed assessment.

The Alaska Statewide Threat Assessment evaluated 187 communities that are at risk of flooding. The communities with the greatest flood risk are in group 1 (labeled in red); communities with a moderate threat are in group 2 (labeled in yellow); and the communities with lower risk to flooding are in group 3 (labeled in green) (Figure 4.1.3-10).



Communities with the greatest flood risk are in group 1 (labeled in red); communities with a moderate threat are in group 2 (labeled in yellow); and the communities with lower risk are in group 3 (labeled in green).

Source: UAF et al. 2019.

Figure 4.1.3-10: Alaska Statewide Threat Assessment Communities Vulnerable to Flooding

4.1.3.1.3 History of Flood Hazard Events

Coastal and riverine communities throughout the state have lengthy flooding and erosion histories. Rapid snowmelt, ice jams, heavy precipitation, ice-free oceans, and seasonal variations all increase the risk of flooding. Flooding has overwhelmed wastewater treatment facilities, warranted entire community evacuations, inundated road systems, and forced agencies under considerable pressure to rebuild before winter. Given the limited highway infrastructure in Alaska, damaged runways, roads, and bridges may isolate communities for weeks and hamper disaster recovery projects for months or years. History of flood events can be difficult to report on fully due to the lack of available documents and records of all flooding events. Depending on when a community was established, flooding records may not be available before certain dates. In addition, certain events may have only been reported based on local knowledge available.

4.1.3.1.3.1 Rainfall-Runoff Flood Events

This section discusses some of the historical rainfall-runoff flood events in Alaska and has been updated since the 2018 SHMP.

1967 Chena River Flood: The “Great Flood,” as it is known, was the worst disaster in Fairbanks history; it occurred on August 12, 1967 (Figure 4.1.3-11). The high-water marks are still commemorated all over town with plaques and photos of that fateful day.



Source: UAF 1967.

Figure 4.1.3-11: 1967 Chena River Flood in Fairbanks

Excessive amounts of rain fell throughout July. Fairbanks received 3.34 inches (8.5 cm) of rain, almost double the July average of 1.84 inches (4.7 cm).

2008 Tanana Valley Flooding (DR-1796): From July 27 to August 6, 2008, flooding from excessive storm activity destroyed property and threatened life in the interior region of the state. The most severe damage occurred to buildings and infrastructure near the City of Nenana (Figure 4.1.3-12). In particular, the sewage lift stations required costly and extensive repairs. The lengthy unavailability of the sewer system created an unhealthy environment for the community. After repairs, the city completed a hazard mitigation project to protect the sewer system from future flooding.

As a result of this flooding, the Alaska Railroad Company (ARRC) temporarily stopped all northbound freight and passenger rail service due to track failures in the City of Nenana and in Healy Canyon. After the flooding, ARRC completed a series of mitigation projects designed to prevent future flood damage and service interruption in the Nenana area.



Source: DHS&EM 2008.

Figure 4.1.3-12: Rainfall-Runoff Flooding in Nenana

2012 September Storm (DR-4094): On September 4, 2012, a strong weather system produced high winds and heavy rains, resulting in severe and widespread wind damage and flooding throughout much of Southcentral and Interior Alaska. The series of storms threatened life and property in the Matanuska Susitna Borough, Kenai Peninsula Borough, the Alaska Gateway Regional Educational Attendance Area (REAA), and the Chugach area. The magnitude of the storm necessitated emergency protective measures enacted by the Rescue Coordination Center (RCC). Damages from wind and flooding were substantial and widespread.

2012 October Kuskokwim Delta Flood (AK-12-241): On October 5, 2012, a strong fall storm moved north into the Bering Sea and produced severe winds, heavy rain, and storm surges of up to 4 feet above mean tide levels in the Kuskokwim Delta, with severe impact to the Native Village of Napaskiak. The storm resulted in floodwaters surrounding the tribal-owned maintenance garage, undermining and shifting the building and its foundation; damage to the driveway ramp to the maintenance yard; and substantial damage to community boardwalks.

2013 October Kenai Peninsula Borough (KPB) Flood Disaster (DR-4161): Beginning October 27, 2013, heavy rains inundated much of the Kenai Peninsula. Seward, Homer, Kenai, Anchor Point, and the Tyonek area along Beluga Road, all of which reported major flood damage, prompting the Kenai Peninsula Borough to declare a local disaster and request state and federal assistance.

2018 October KPB Flooding: From October 12 to 16, 2018, numerous areas of the Kenai Peninsula Borough and the City of Seward suffered widespread flooding and related damages as a result of an unusually heavy and persistent rainfall event; both the City of Seward and the Kenai Peninsula Borough issued local declarations of disaster emergency in response to this event. The disaster led to widespread flooding of community roads, the Seward airport, and other facilities as well as severe threats to life and property.

2020 December Southeast Storm (DR-4585-AK): On December 1–2, 2020, a very strong atmospheric river impacted Southeast Alaska, with a series of other strong and moist weather fronts also affecting the area through December 8. The atmospheric river produced historic extreme precipitation over the far northern inner channels, including Haines, Alaska. Runoff from the rainfall and snowmelt caused massive road infrastructure damage from Ripinsky Ridge, overwhelming culverts and flooding areas away from steep terrain, including portions of the Haines airport. Governor Dunleavy declared a condition of disaster emergency for the entire Southeast Region of Alaska, including Haines Borough, Municipality of Skagway Borough, City and Borough of Juneau, City and Borough of Wrangell, Petersburg Borough, City and Borough of Sitka, Ketchikan Gateway Borough, and the Annette Island, Chatham, and Southeast Island REAAs.

2021 October Southcentral AK Storm (DR-4638-AK): Beginning October 29 and continuing through November 1, 2021, an atmospheric river storm system brought heavy rain, snow, and strong winds to much of Southcentral Alaska. The subtropical system impacted the Girdwood/Portage area within the Municipality of Anchorage (MOA) and the eastern portions of the KPB, including the City of Seward and the community of Cooper Landing. Rainfall continued into November 2 when a second, smaller storm entered the area, continuing to saturate soils and contribute to additional runoff. The storm's impacts were widespread and included numerous landslides and mudslides impacting state and local roads, including the Seward and Sterling Highways, eight locations along the ARRC tracks and right-of-way, and state-managed public-use trails.

4.1.3.1.3.2 Snowmelt Floods

This section discusses a historical snowmelt flood in Alaska.

2015 Fort Yukon Flooding (AK-15-252): Abnormally warm temperatures in mid-May 2015 rapidly melted snow in the highlands of northeastern Alaska and elevated water levels in the Yukon and Porcupine Rivers. By May 20, the water levels overtopped the Porcupine River in some locations and inundated the Fort Yukon area with up to 2 feet of water.

4.1.3.1.3.3 Ice Jam Floods

This section discusses historical ice jam floods in Alaska.

2007 Kenai River Ice Jam Flood (triggered by glacial lake outburst flooding): In the winter of 2007, the Skilak Glacier-dammed lake breached and released a 4-foot-high surge of water into the Kenai River. The sudden rise in water level dislodged the river ice. The ice moved downriver and impacted public and private riverbank fishing platforms, stairs, and elevated walkways. Ice continued downriver and formed ice jams in multiple locations. Behind the ice jams, water and ice overtopped the riverbanks and flooded several public campgrounds, fishing parks, and residential homes (Figure 4.1.3-13). Damage in the KPB extended from the community of Sterling to the City of Soldotna. Approximately 150 homes and riverside businesses reported damage to their buildings, fishing structures, and docks. Another 775 homes within the KPB sustained damage from the floodwaters and ice, and some roads became inundated and impassable.



Flooding triggered by a glacial lake outburst flood in its headwaters. Source: KPB 2007.

Figure 4.1.3-13: Kenai River Ice Jam Flood

2009 Spring Ice Jam Flooding on the Yukon River (DR-1843): This 2009 flood event was the largest disaster in Alaska in more than a decade; it involved communities along thousands of miles of the Kuskokwim and Yukon river systems. Ice jams formed along various points of the rivers, damming them, and causing water levels to rise and flood nearby communities. In addition, enormous ice chunks—some more than 15 feet thick—crashed into structures in the already-flooded communities of Eagle and Stevens Village (Figure 4.1.3-14).

Thirty-nine communities along the river systems, including the entire length of the Yukon River (1,980 miles long), sustained flood and ice damage in the month-long disaster. Challenges to the recovery teams were the remoteness of the communities and the fast-approaching winter season. The recovery effort included Public Assistance (PA), Individual Assistance (IA), U.S. Small Business Administration (SBA) disaster loans, and temporary housing.



Flooding due to the 2009 spring ice jam floods on the Yukon River. Source: DHS&EM 2009.

Figure 4.1.3-14: Ice and Flooded Structures in Stevens Village (left) and Eagle (right)

2013 Spring Floods (DR-4122): From May 17 through June 10, 2013, excessive snowpack and ice thickness, combined with rapid spring warming, resulted in ice jams and caused severe flooding throughout communities along the Yukon and Kuskokwim rivers (Figure 4.1.3-15). Large ice jam floods severely damaged approximately 194 homes and much of the infrastructure, prompting evacuations. Loss and damage to personal property and multiple businesses, including loss of revenue, resulted from this event. Impacts to public infrastructure included: hazardous and non-hazardous debris removal; emergency protective measures (leading to ongoing mass care operations); and damage to city and state roads, bridges, water and sewer systems, electrical generation and distribution systems, recreation areas, and fuel storage facilities.



Source: DHS&EM 2013

Figure 4.1.3-15: Ice Jam Flooding in Galena

2018 May Susitna River Flood (DR-4391): On the evening of May 11, 2018, an ice jam on the Susitna River north of Talkeetna, Alaska redirected river flow that flooded the ARRC track bed between mile posts (MPs) 235 and 252. Approximately 5 miles of rail and track bed were submerged under 10 feet of fast-moving water and 3- to 4-foot-thick ice blocks. Between MP 248 and 249, floodwaters completely

washed the track away and scoured railbed material, exposing a buried fiber optic communication line servicing communities to the north. This event also stopped all rail service between Talkeetna and Fairbanks, effectively interrupting all passenger and cargo service between Fairbanks and Anchorage for several days. A robust clean up and emergency repair effort was conducted between May 13 and May 25. The work required substantial mobilization due to the remote area and extensive repairs.

2020 Spring Flood: The NWS's APRFC forecasted a "dynamic" break-up on the State's major river systems such as the Yukon, Kuskokwim, Tanana and Koyukuk rivers with a corresponding above-average flood potential for rivers south of the Brooks Range. The high water along the Kuskokwim River in late April/early May 2020 was due initially to a warm up that caused break up on the Kuskokwim River that began on April 21 with Nikolai, and generally worked its way downriver. The river ice broke at Crooked Creek, 34 miles upriver of Napaimute, on April 29 and moved downriver toward Napaimute. A large ice jam formed at the mouth of the Kolmokof River approximately 10 miles downriver of Napaimute and caused unprecedented flooding of the old village of Napaimute and surrounding areas. On May 4, the Napaimute Traditional Council (NTC), declared a disaster emergency for the village due to the flooding. On May 6, the Organized Village of Kwethluk (OVK) contacted the State Emergency Operations Center (SEOC) and verbally declared a disaster emergency caused by rising floodwaters that had inundated roads and entered two homes. APRFC considered this flooding related to snowmelt runoff and not an ice jam. On May 11, the SEOC was contacted by the Native Village of Nunapitchuk reporting high water up to five-feet-deep in town due to snowmelt and tidal surge, but no impact to homes or community infrastructure. On May 14, the SEOC received a signed tribal declaration of local disaster from both the City and Native Village of Nunapitchuk.

2021 May Buckland Spring Flood: On May 13, 2021, the SEOC received a report that the village of Buckland was experiencing flooding due to an ice jam on the Buckland River which began late on May 12. The NWS issued a flood warning for the Buckland River on the morning of May 13. The NWS flood warning remained in effect until May 15. The flooding brought more than 5 feet of water and some river ice into the community. The water inundated homes, forced local evacuations, impacted the water treatment facilities, eroded roads and building foundations, and caused the release of hazardous materials from fuel storage tanks. On May 13, the City of Buckland signed a local disaster declaration requesting Northwest Arctic Borough (NWAB) and state assistance. The NWAB forwarded the declaration to the SEOC on May 14. On May 14, the NWAB mayor signed a disaster declaration requesting state assistance.

2022 May Spring Flood: On May 6, 2022, the NWS issued a flood warning for Manley Hot Springs that was followed by an ice jam on the Tanana River, causing community-wide flooding and considered the highest water levels in 45 years. The flooding inundated residential homes, roads, and infrastructure, caused community-wide power and communications outages, damaged roads, destroyed property, and required evacuation to high ground. On May 8, an ice jam occurred on the Kuskokwim River which caused flooding in Sleetmute and Red Devil that inundated residential homes, roads, and infrastructure, and local authorities in these communities declared a disaster emergency. On May 9, ice jam and snow melt flooding were reported in the area of Glennallen that inundated public infrastructure and damage to private property. On May 11, ice jams occurred on the Kuskokwim River, causing flooding in McGrath that inundated residential homes, roads, and infrastructure. On May 12, under authority granted by Alaska Statute 26.23.020(c), a disaster declaration was made.

4.1.3.1.3.4 Storm Surge Floods

This section discusses historical storm surge floods in Alaska.

2011 Alaska Severe Winter Storms and Flooding (DR-4050): The November 2011 Bering Sea cyclone was one of the most powerful extratropical cyclones to affect Alaska on record. A 10-foot storm surge caused damage or flooding in some 40 villages across western Alaska. The storm shredded roofs, damaged portions of seawalls in Nome and Unalakleet, flooded homes in Golovin (Figure 4.1.3-16), and

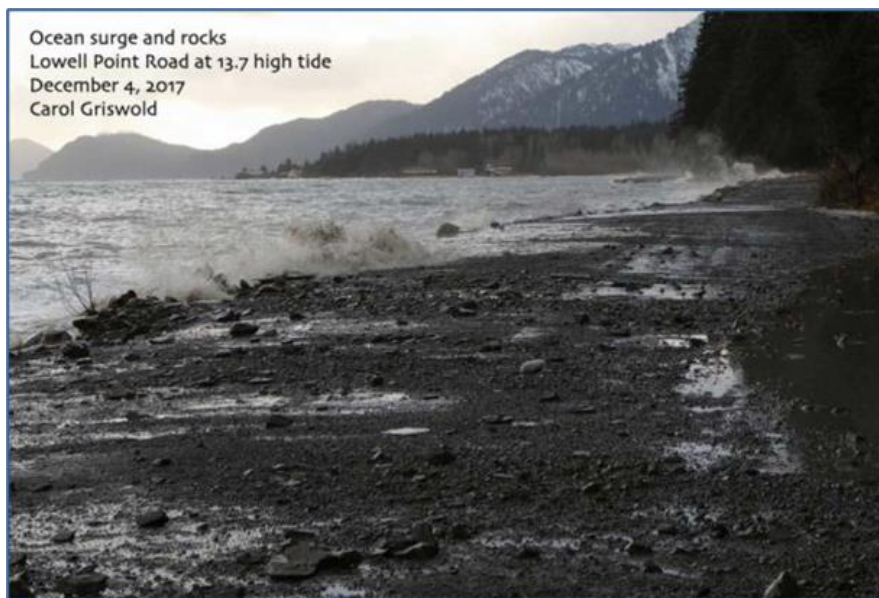
knocked out electricity in several areas. The damage, though generally minor and likely underreported, was widespread, covering a nearly 700-mile swath.



Source: Toby Anungazuk Jr., Chinik Eskimo Village 2011

Figure 4.1.3-16: Golovin Storm Surge Flooding

2017 Alaska Severe Storm (DR-4369): A storm from the Gulf of Alaska on December 4, 2017, resulted in heavy rain and a storm surge that caused significant damage to the Lowell Point area in the City of Seward on the Kenai Peninsula. High tides and a storm surge swept over the road and, along with waves, caused millions of dollars of damage (Figure 4.1.3-17). Lowell Point Road was reduced to one lane of traffic in some locations, with the road edge on the ocean side suffering damage from storm water erosion in most areas. Rockslides triggered by the storm also deposited loose rock on the roadway.



Source: Carol Griswold, Seward City News 2017

Figure 4.1.3-17: Seward's Storm Surge Flooding of Lowell Point Road

2020 November West Coast Storm: November 4–7, 2020, the west coast of Alaska was damaged by a strong coastal storm. This weather system brought blizzard conditions, elevated storm surge and significant coastal erosion into the region. On November 4, 2020, the storm moved into the western Bering Sea and then tracked northeast along the west coast of Alaska and impacted a large coastal area (over 600 miles), with gale force winds pushing a considerable storm surge across the region. While many villages experienced damage along their respective coastlines, the village of Shishmaref took the brunt of

this unusually long period of onshore winds, waves, and storm surge ranging from 5 to 6 feet above the normal high tide line against a shoreline unprotected by sea ice. The storm surge overtopped and breached protective berms, flooding the low-lying coastal area within the community. As a result, the community sustained substantial damages to an approximately 1-mile-long section of coastal beach berms and community roads. On November 9, 2020, the City, Native Village and Corporation of Shishmaref approved Resolution 21-03, declaring a local disaster emergency and requested State technical and financial assistance.

2022 September, Alaska Severe Storm, Flooding, and Landslides (DR-4672-AK): September 15 to September 20, 2022, the west coast of Alaska was hit by the remnants of a typhoon (Typhoon Merbok) originating near Japan. This event produced hurricane-force winds, higher than normal tidal ranges, and storm surges of up to 10 feet above mean sea level. The event caused wind damage and riverine and coastal flooding to approximately 40 cities and villages along an approximately 1,300-mile-long section of the Western and Northwestern Alaska coastline from the Yukon-Kuskokwim Delta to the North Slope. This storm was stated as the strongest storm in Western Alaska in over a decade. The state issued a disaster declaration on September 17, 2022.

4.1.3.1.3.5 Glacial Lake Outburst Floods

In Alaska, significant glacial lake outburst floods have been documented at Bear, Hubbard, Skilak, and Valdez glaciers, among others. See the Glacier Hazards section (Section 4.1.1.1.3) of this report for more historical information about glacial lake outburst floods.

4.1.3.1.3.6 Aueis Floods

2015 Dalton Highway Flooding (AK-15-253): Beginning on March 13, 2015, the Sagavanirktok River on the North Slope experienced an unprecedented ice overflow flood between mileposts 390 and 415 of the Dalton Highway, about 25–30 miles south of Deadhorse. Road clearing and overflow diversion efforts were hampered by very cold temperatures, high winds, and poor visibility.

4.1.3.1.4 Extent of Flood Hazards

Flood hazards impact many communities around the state. The extent of significant events has impacted over 1,300 miles of Western Alaska coastal communities, with areas seeing 10 feet above mean sea level storm surge. In Southeastern Alaska, catastrophic rainfall events have been recorded as 1 in 1000-year events. As described in Section 8 Vulnerability Exposure Analysis, the extent of flooding has been defined as a 0.5-mile buffer along communities identified as threatened by coastal flooding (DGGS 2022) and a 0.25 mile buffer along riverine threatened communities (USACE 2022). See Section 8 Vulnerability Exposure Analysis for detailed assessment.

4.1.3.1.5 Impact of Flood Hazards

Nationwide, floods result in more deaths than any other natural hazard. Flooding is Alaska's greatest threat, and can cause negligible to catastrophic property damage and losses which include the following:

- Structure flood inundation, causing water damage to structural elements and contents.
- High water flow storm surge floods scour (erode) coastal embankments, coastal protection barriers, and result in infrastructure and residential property losses. Additional impacts can include roadway embankment collapse, foundations exposure, and damaging impacts.
- Damage to structures, roads, bridges, culverts, and other features from high-velocity flow and debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, decreasing water conveyance and increasing loads which may cause feature overtopping or backwater damages.

- Damage to water, power, and communications infrastructure from inundation.
- Rescues and injuries from entrapment in flood waters and loss of transportation routes.
- Sewage, hazardous or toxic materials release, materials transport from wastewater treatment plant or sewage lagoon inundation, storage tank damages, and/or severed pipeline damages, which can be catastrophic to rural remote communities.

Floods also result in economic losses through business and government facility closure; utilities such as energy generation, communications, potable water, and wastewater; and transportation service disruptions. Floods result in excessive expenditures for emergency response and generally disrupt the community's normal function and quality of life. More information on erosion losses is found in Section 4.1.3.2.5.

Impacts and problems also related to flooding are deposition as well as embankment and coastal erosion. Deposition is the accumulation of soil, silt, and other particles on a river bottom or delta. Deposition leads to the destruction of fish habitat, presents a challenge for navigation, and prevents access to historical boat and barge landing areas. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion. Embankment erosion involves material removal from the stream or river banks, coastal bluffs, and dune areas. When bank erosion is excessive, it becomes a concern because it results in loss of embankment vegetation, fish habitat, and land, property, and essential infrastructure (BKP 1988).

4.1.3.1.6 Probability of Flood Hazard Events

Alaska has historically experienced numerous flood events, and it is highly likely that communities vulnerable to flooding will continue to see annual flooding. Many of these events are under-reported or not measured, and very few communities have a 100-year flood analysis. For this reason, recurrence probabilities are not easily computed for coastal flood hazards.

4.1.3.1.7 Projected Changes in Locations of Flood Hazards

Most flooding in Alaska occurs along rivers during spring ice break-up and heavy precipitation events as well as along coastal areas due to extreme storm events. In recent years, coastal storms and associated storm surge have been resulting in flooding along Alaska's north and northwestern coasts (Lynch and Brunner 2007; USACE 2009, Shen and Ristroph 2020). This is due to the increase in number of open water days due to delayed freezing and early break-up of ice cover (Rolph et al. 2018).

4.1.3.1.8 Range of Anticipated Intensities of Flood Hazard Events

The range of flood hazards intensities will vary from minor to severe depending on the type and nature of the flooding (see descriptions earlier in this section). Increased open water days due to climate change could increase the potential for higher intensity events.

4.1.3.1.9 Frequency of Flood Hazard Events

Gathering data on flood frequency in Alaska is difficult due a sparse gaging network, ranking near the bottom of all major hydrologic regions of the United States for percentage of area gaged except for very large basins (Curran et al. 2016). Additionally, it is recommended to have 10 years of peak-flow data to properly develop a flood frequency analysis for rivers and streams. For coastal flooding, a similar problem exists due to sparse monitoring networks across Alaska's vast coastline. Based on historic events, it is anticipated that those locations throughout the state vulnerable to flooding will flood with similar to more frequency in the future.

4.1.3.1.10 Duration of Flood Hazards

Flood duration is highly variable and dependent on many factors and can range from several hours to several days. Factors impacting flood durations are described in 4.1.3.1.1. As an example, during the 1995

Southcentral Alaska flood event, the lower Kenai River on the Kenai Peninsula crested September 24 and remained above flood stage for more than 10 days.

4.1.3.1.11 Future Conditions of Flood Hazard Events, Including with Climate Change

In 2012 and 2013, Alaska's riverine communities experienced two of the quickest spring thaws on record. The Special Supplement to the Bulletin of the American Meteorological Society (published in August 2013) noted that the climate of the Arctic in 2012 was dominated by continued significant changes in the cryosphere, with new records for minimum sea ice extent and permafrost warming in northernmost Alaska. Southerly airflow into the Arctic had a major impact on lake ice break-up, snow cover extent, and mass loss from Arctic glaciers and ice caps. Meltwater inundated many watersheds, and the swollen rivers broke their ice cover prematurely, forming large ice dams downstream. The 2013 Spring Floods disaster (DR-4122) was one of the largest events of its kind in Alaska's history.

Global sea level rise is expected to continue due to increased glacier and ice sheet melting, which add water volume to oceans, and thermal expansion of the ocean as ocean water warms (NOAA, 2018). Sea level rise is location dependent. Figure 4.1-3 depicts this inconsistency along Alaska's coastlines. Sea ice that annually forms offshore of Alaska's western and northern coasts is expected to form later and break up earlier in the year (Douglas, 2010). The extent of sea ice is also expected to be reduced during winter months (Wang and Overland, 2009). Reduction of sea ice during fall and winter storms expose the coast and open ocean to storm surges and waves and is expected to increase coastal flooding impacts (Simmonds and Keay 2009; Terenzi et al. 2014; Vermaire et al. 2013).

One of the notable changes in flooding comes from the increased occurrence of glacial outburst flooding in recent years. With a changing climate, Alaska has seen an increase in the size and number of glacial lakes due to deglaciation, which has the potential to impact downstream communities on rivers edge in addition to those in the vicinity of the lake (Shugar et al. 2020).

Model predictions show increases of heavy precipitation events, which could lead to flooding, particularly those with 2-year and 5-year historical return intervals in Interior Alaska (Bachand and Walsh 2022).

As the population expands into areas of potential flooding, along with climatic warming and increased heavy precipitation events, the frequency of flooding is likely to increase.

4.1.3.1.11.1 Characteristics/Nature

As mentioned previously, southerly airflow into the Arctic has a major impact on lake ice break-up, snow cover extent, and mass loss from Arctic glaciers and ice caps. Meltwater inundates watersheds and swollen rivers break their ice cover prematurely, forming large ice dams downstream. Atmospheric river events are increasingly common, as are rain on snow events, delivering large amounts of water to already-saturated landscapes.

4.1.3.1.11.2 Locations

Research projects that climate change is impacting the return period and intensity of precipitation-based flooding events in arctic regions (Bachand and Walsh 2022). With increased precipitation, in addition to early ice melt and later freezing, and more severe coastal storm events, many locations in Alaska will feel the impacts of climate change. Coastal regions typically protected from storms by sea ice may begin experiencing flooding from these events. Increased precipitation throughout the state of Alaska, with higher changes north of the Brooks Range, will lead to increases in rainfall-runoff flood events as well as other flood related hazards (Lader et al. 2020).

4.1.3.1.11.3 Range of Anticipated Intensities

The intensity and number of flood events are likely to increase due to increased precipitation events and with warming climate.

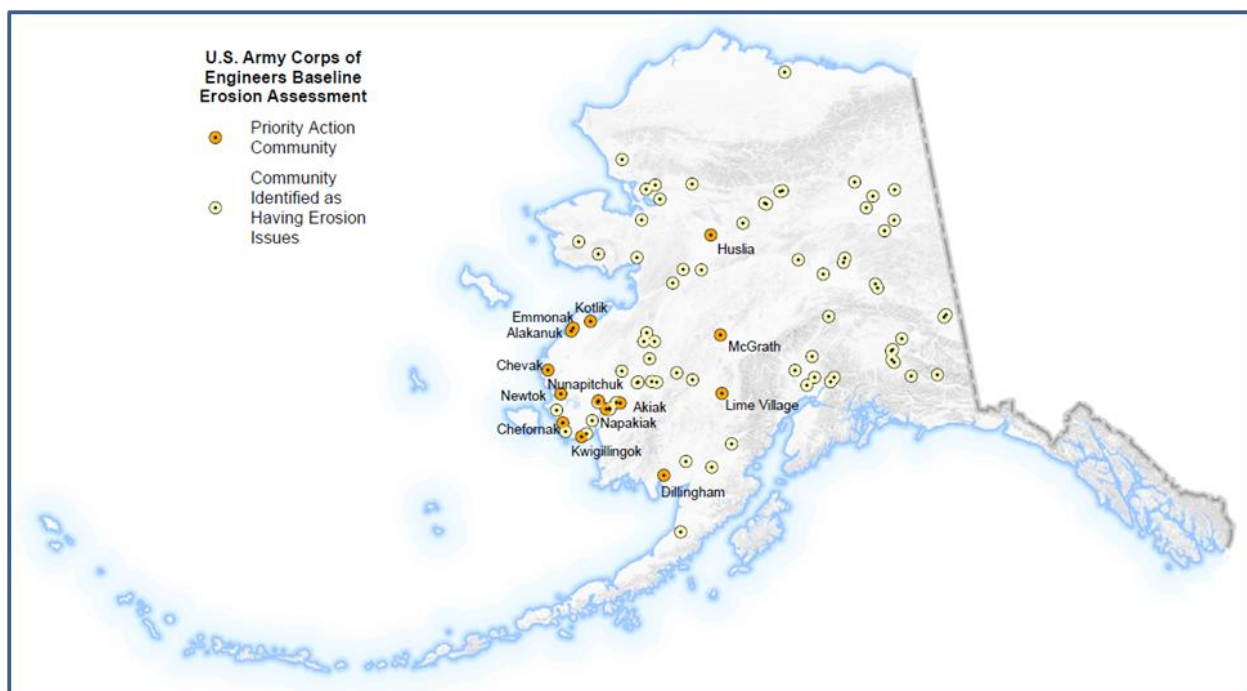
4.1.3.2 Erosion

4.1.3.2.1 Characteristics/Nature/Types of Erosion Hazard Events

Erosion is the action of surface processes (such as from water, ice, or wind) that removes soil, rock, or dissolved material from one location and transports it to another location. Erosion can be gradual or occur rapidly as the result of a flash flood, coastal storm, or other event. Most of the geomorphic change to a river system is due to peak flow events that can dramatically increase the erosion rate. Erosion is a problem in developed areas where disappearing land threatens development and infrastructure.

The USACE's 2019 Alaska Statewide Threat Assessment found that many of state's communities are subject to erosion hazards—187 communities along Alaska's rivers and coastline, mostly villages, reported erosion problems (Figure 4.1.3-18). There are three main erosion types in Alaska:

1. Coastal erosion
2. Riverine erosion
3. Wind erosion



Alaska communities with reported erosion problems. Sources: USACE 2009; Map by DGGS 2018

Figure 4.1.3-18: USACE Baseline Erosion Assessment

Coastal Erosion commonly occurs in Alaska because of the combination of hydrodynamic (waves and currents), physical (e.g., ivu [ice override] and human-caused), and thermal (e.g., permafrost thaw) processes that result in the transport of coastal sediments offshore or along the shoreline. Coastal retreat due to erosion can be significant and rapid.

Waves and currents act on the coastline on a wide range of time scales (from seconds to millennia). Coastal sediments are highly dynamic, shifting to respond to individual waves, tidal cycles, coastal storms, seasonal shifts in ocean currents and shelf circulation, relative sea level rise or fall, and others (Elko et al. 2014). Alaska's western and northern coastlines are subject to erosion from coastal storm waves and flooding (see Coastal Flooding). When sea ice is not present or is in low concentration, fall and winter storms can build storm surge and wave energy that significantly erode Alaska's coastline.

Engineered mitigation structures built in the nearshore zone (interface between ocean and land) work to:

- Strengthen the shoreline to prevent erosion;
- Capture sediment moving along the shoreline; and
- Lessen wave energy as it moves toward the shoreline.

These structures can have both positive and negative impacts on the coastal sediment dynamics that drive coastal erosion. For example, coastal structures known as “groins” are built to capture sediment in the direction of dominant coastal currents and result in erosion on the leeward side. Other human activities, such as dredging and driving vehicles on beach surfaces, can work to erode coastal sediments. When sea ice is present in the nearshore, ice-pack movement can shift and result in ice override, or “ivu” (see Sea Ice). Ivus have been large enough to move buildings off their foundations and push nearshore sediments far inland.

Much of Alaska’s coast also contains perennially frozen ground, or permafrost (see Permafrost Section 4.1.1.2). Permafrost is subject to thermal degradation from both air and ocean temperatures, greatly increasing its susceptibility to erosion. Coastal bluffs with high ice content (commonly found in northern and northwestern Alaska) develop thermoerosional niches from undercutting due to thermal degradation by waves at the bluff base, followed by collapse of entire blocks of frozen ground (Gibbs and Richmond 2015) (Figure 4.1.3-19).



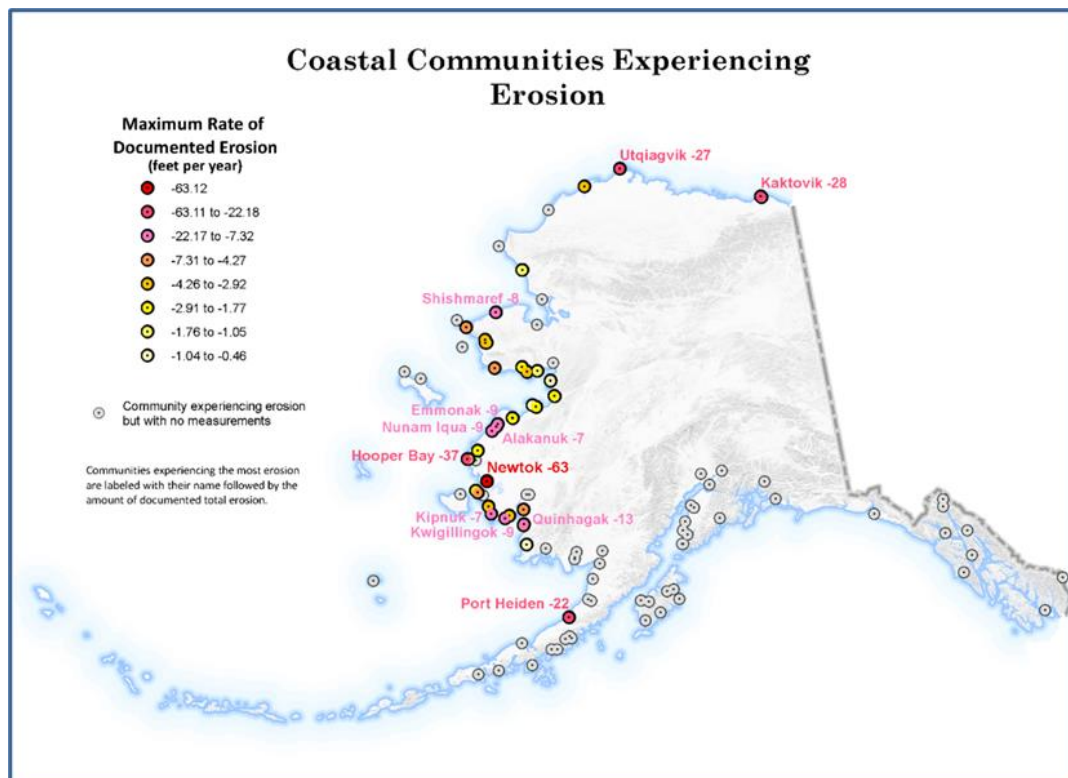
An example of thermal degradation between the Staines and Sagavanirktok rivers. Note collapsing coastal bluffs and drained thermokarst lake (yellowish-brown area). Source: Gibbs and Richmond 2015

Figure 4.1.3-19: A Typical Northern Alaska Coast Experiencing Thermal Degradation

Coastal erosion affects sand and gravel beaches and coastal bluffs throughout the state, but the regions impacted most dramatically are the North Slope, Northwest Arctic, Bering Strait, Yukon-Kuskokwim Delta, and Bristol Bay regions, as well as areas of southcentral Alaska. Much of Alaska, including regions in the Aleutian Islands, southeast, and southcentral, has rocky coastlines. Rocky coastlines are much less vulnerable to coastal erosion as compared to sand and gravel beaches and coastal bluffs. Figure 4.1.3-20 shows coastal erosion rates from northern and western Alaska, providing a visual of erosion hazards; the map is derived from analyses conducted by the DGGS, the National Park Service (NPS) (Manley and Lestak 2012), and the USGS (Gibbs and Richmond 2015). Shorelines were examined periodically to determine how quickly they erode; more negative means greater erosion. Shoreline change rates were

calculated for some of the most vulnerable parts of the state, although some locations that experience erosion were not included because of limited availability or access to data.

Coastal erosion is also more likely to occur during sea ice-free conditions; normal fall and winter storms can have much greater impacts on a coastline unprotected by offshore and nearshore sea ice. Off-shore, sea ice mitigates wave and surge development, while nearshore ice provides a physical buffer to wave attack. In the future, sea ice in the Bering, Chukchi, and Beaufort seas is expected to form later in the year and break up earlier in spring (Douglas 2010). Sea ice concentration and thickness are also expected to decrease, allowing storms to more easily break up sea ice and thus impede its capability to reduce a storm's coastal impacts. Ice-free ocean conditions will also result in changing ocean processes, which will likely impact the distribution and behavior of coastal sediments.



Showing maximum documented erosion rates (ca. 1950–2016) for Alaska coastal and tidally-influenced communities, where data or past studies were available. Coastal communities identified as possibly experiencing coastal erosion problems by the U.S. Army Corps of Engineers, but did not have measurements available, are shown as light gray circles. Source: DGGS 2018

Figure 4.1.3-20: Coastal Community Erosion

Riverine Erosion or scour occurs from high water flow forces and ice formations that wear away rock and soil along a riverbed and its embankments. This erosion also involves the breaking down of rock particles being carried downstream by the river. Eroded sediment is deposited in slower-moving sections of the river, such as the insides of river bends, places where the river widens, or where a river enters a lake or ocean. River erosion and deposition often lead to lateral stream movement, with the streams meandering across the valley bottom by alternately eroding the sediment on the outsides of curves (cut banks) and depositing sediment on the insides of curves (point bars). Over time, the entire stream can move great distances across its floodplain and even cut into areas beyond the floodplain.

People in Alaska are losing the ground beneath their feet because of erosion (Figure 4.1.3-21). Thawing permafrost and high river flow rates (such as during spring break up) contribute to increased erosive scour, and are being accelerated by climate change. Warmer air and water temperatures impact the

binding properties of permafrost rich soils while increased heavy rain events swell rivers and flood surrounding areas, which then washes away the no-longer intact soil. Riverine erosion threatens many Alaska villages and infrastructure throughout the state. Major mitigation measures are needed whether these communities and infrastructure remain in place or are relocated.



Newtok, Alaska's severely damaged bank reinforcement structures caused this steel shipping container to slide into the Ninglick River. Source: State of Alaska 2016 (<https://www.ktoo.org/2016/05/28/newtok-awaits-relocation-funding-30-years-flood-risk-documented/>)

Figure 4.1.3-21: Newtok Riverine Erosion

Wind Erosion moves soil from one location to another by wind power. Even a light wind can roll some soil particles along the surface, and strong winds can lift a large volume of soil particles into the air to create dust storms (Figure 4.1.3-22). Wind erosion is a relatively common occurrence in flat, bare areas; dry or sandy soils; or anywhere the soil is loose, dry, and finely granulated. The wind moves the finest particles (less than 0.1 mm in diameter) by suspending them in the air, and soil particles 0.1–0.5 mm in size are moved in a hopping or bouncing fashion, known as “saltation.” Soil particles greater than 0.5 mm in size are generally moved by rolling.

Windblown sand creates sand dunes along beaches and in dune fields, such as the great Kobuk Sand Dunes of northwestern Alaska. Windblown silt, called “loess,” can be carried many miles and redeposited on the ground as fertile loess soils, such as those covering large areas of Europe and North America (where highly productive farming has developed), and in the Matanuska-Susitna and Tanana River areas of Alaska.

While wind erosion is most common in deserts and coastal sand dunes and beaches, certain land conditions (e.g., bare soils) will exacerbate wind erosion in agricultural areas, where it can cause significant economic and environmental damage. Susceptibility to wind erosion is increased during drought periods, such as in the American and Canadian prairies in the 1930s during the Dust Bowl.



Source: NASA Earth Observatory, <https://www.earthobservatory.nasa.gov/images/40973/glacial-dust-off-alaska>

Figure 4.1.3-22: Satellite Image of Windblown Dust from the Copper River Floodplain

4.1.3.2.2 Locations of Erosion Hazards

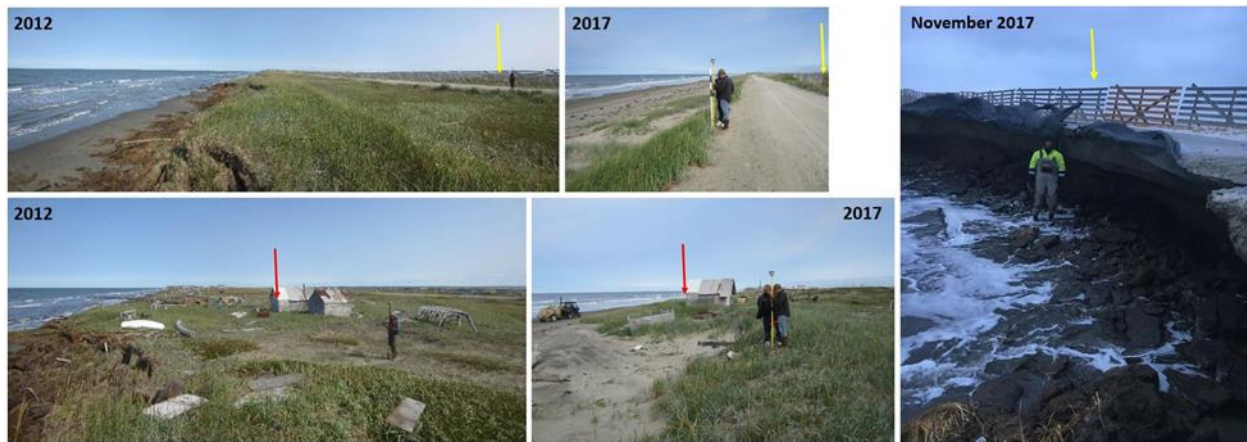
Erosion hazards impact many communities around the state. Figures 4.1.3-18 and 4.1.3-20 show the locations identified as being threatened by erosion throughout the state (Note that erosion does occur in southeast Alaska and additional data needs to be collected to determine the locations). As described in Section 4.2, the extent of erosion has been defined as a 0.5-mile buffer along community locations identified as experiencing coastal erosion (USACE), and a 0.25 mile buffer along riverine threatened communities (USACE).

4.1.3.2.3 History of Erosion Hazards Events

Coastal and riverine communities throughout the state have lengthy flooding and erosion histories. Rapid snowmelt, ice jams, heavy precipitation, ice-free oceans, and seasonal variations all increase the risk of coastal erosion. The first documentation effort for erosion in Alaska was conducted by the Alaska Division of Community and Regional Affairs in 1982 (DCRA 1982). At that time, 169 of 213 Alaska Native Villages were found to have experienced erosion, with the greatest impacts felt along coasts and tidally influenced rivers. The following list of events has been updated since the 2018 SHMP.

4.1.3.2.3.1 Coastal Erosion

2017 Coastal Erosion at Shishmaref: The community of Shishmaref, located on a barrier island on the Chukchi Sea coast, experienced an erosion event from a fall storm in 2017. The storm did not result in significant flooding, but storm waves caused erosion of the community dump access road and land fronting the community's only airstrip (Figure 4.1.3-23).



Occurring between 2012 and 2017 at two sites in Shishmaref, Alaska. Colored arrows point to the same locations in each of the two series of photos. Far right photo shows aftermath of November 2017 erosion event, which washed out the road to the dump. Source: Photos include staff from DGGs and the Native Village of Shishmaref

Figure 4.1.3-23: Coastal Erosion in Shishmaref

2020 November West Coast Storm: November 4–7, 2020, the west coast of Alaska was damaged by a strong coastal storm. This weather system brought blizzard conditions, elevated storm surge and significant coastal erosion into the region. On November 4, 2020, the storm moved into the western Bering Sea and then tracked northeast along the west coast of Alaska and impacted a large coastal area (over 600 miles) with gale force winds resulting in pushing a considerable storm surge across the region. Although many villages did experience damage along their respective coastlines, the village of Shishmaref took the brunt of this unusually long period of onshore winds, waves, and storm surge. Shishmaref was impacted by damaging erosion due to the combination of high winds, wind driven waves and storm surge ranging from five to six feet above the normal high tide line against a shoreline unprotected by sea ice. The storm surge overtopped and breached protective berms, flooding the low-lying coastal area within the community. As a result, the community sustained substantial damages to an approximately one-mile-long section of coastal beach berms and community roads. On November 9, 2020, the City, Native Village and Corporation of Shishmaref approved Resolution 21-03, declaring a local disaster emergency and requested State technical and financial assistance.

4.1.3.2.3.2 Riverine Erosion

2016 Ninglick River Erosion at Newtok: An erosion event along the Ninglick River at Newtok in the fall of 2016 resulted in approximately 150 feet of lateral erosion, damaging residences, and exposing a fuel header (Figure 4.1.3-24). Despite the amount of damage done in this and other events, FEMA denied the request for a major disaster declaration for the village.

Newtok has experienced many historic erosion events, with an average rate of erosion of 63 feet per year. The total amount of documented landward erosion between 1951 and 2015 is 3,680 feet; that is, in the last 66 years the riverbank has migrated almost 0.75 mile toward and into the town. Erosion has already claimed the community solid waste site, sewage lagoon, and barge landing site. The community anticipates the river will destroy the community water source, school, and airport by 2035 (Buzard et al. 2021).

Erosion is a particularly serious hazard in Newtok because the community is not only located on a riverbank and subject to typical riverine erosion, but coastal storms also enter the mouth of the river, raising water levels and winds and exacerbating the destruction.



Source: Romy Cadiente, Newtok Village Relocation Coordinator 2016

Figure 4.1.3-24: 2016 Ninglick River Erosion at Newtok

2018-2021 Napakiak School Erosion: In May of 2018, the Lower Kuskokwim School District identified the Napakiak School as being at serious risk from riverine erosion from the Kuskokwim River. In August 2019, the United States Coast Guard ordered the school's tank farm moved back from the shoreline due to erosion, and the National Resource Conservation Service provided funding to move several structures. In December 2021, after additional erosion forced the school to relocate students, over \$50 million was dedicated in the state budget to remove and relocate the school.

2021 October Southcentral AK Storm (DR-4638-AK): Beginning October 29 and continuing through November 1, 2021, an atmospheric river storm system, as defined by the NWS, brought heavy rain, snow, and strong winds to much of Southcentral Alaska. The subtropical system focused most of its moisture toward the Girdwood/Portage area within the MOA and eastern portions of the KPB, including the City of Seward and the community of Cooper Landing. At Portage, the rainfall amounts in the 2-day period alone corresponded to a 1 in 500-year event, while throughout the impacted areas rainfall levels reach recurrence intervals that ranged from a 1 in 25-year record to a 1 in 1,000-year record event. The storm's impacts were widespread and included numerous landslides and mudslides impacting state and local roads, including the Seward and Sterling Highways, eight locations along the ARRC tracks and right-of-way, and state-managed public-use trails. Significant flooding was reported in the Girdwood area, and runoff erosion washed out the sole road access to the Solid Waste Transfer and Wastewater Facility, an important and critical facility in Girdwood. High winds with measured gusts of over 100 miles per hour were measured in several areas resulting in widespread power outages. The most heavily damaged areas are within the MOA and the KPB.

4.1.3.2.4 Extent of Erosion Hazards

High water-flow storm surge floods scour (erode) coastal embankments, coastal protection barriers, and result in infrastructure and residential property losses. Additional impacts can include roadway embankment collapse, foundations exposure, and damaging impacts. Extreme extents of erosion impact in Alaska are up to 150 feet of lateral erosion in a single event and annual loss of over 60 feet. Erosion

hazards impact many communities around the state. As described in Section 4.2, the extent of erosion has been defined as community locations identified as experiencing coastal erosion (USACE 2022) and a 0.25-mile buffer along riverine threatened communities (USACE 2022). See Section 4.2 for detailed assessment.

4.1.3.2.5 Impact of Erosion Hazards

Erosion hazards impact many communities around the state and can range from negligible to catastrophic, from loss of shoreline under and supporting infrastructure from a single event to gradual changes over time due to discrete storm events. Rapid erosion rates have resulted in the relocation of entire villages, including Napakiak, Meshik, and Newtok. Communities with slow erosion rates may also be exposed if infrastructure exists near the coastline. Erosion can lead to roadway embankment collapse, exposure of foundations, and other infrastructure related damage.

4.1.3.2.6 Probability of Erosion Hazard Events

Alaska has historically experienced numerous erosion events. Many of these events are under-reported or not measured. Shoreline change has been evaluated based on past shoreline loss over time and predicted for some communities (Overbeck et al 2020). It is likely that those communities experiencing historic erosion may see continued erosion in the future. For this reason, recurrence probabilities are not easily computed for coastal erosion hazards.

4.1.3.2.7 Projected Changes in Locations of Erosion Hazards

Changes in erosion as a result of increased permafrost thawing will expand the area of erosion hazards, particularly in regions of ice-rich sediment and greater temperature increases. Riverine erosion will continue to occur and may expand into different areas as the river changes course and impacts the surrounding landscape. Coastal erosion may change as development continues along coastal areas and storms continue to impact areas less protected by nearshore and offshore sea ice.

4.1.3.2.8 Range of Anticipated Intensities of Erosion Hazard Events

Intensity (amount) of erosion is highly variable in space and time. Large flood or storm events can cause tremendous amounts of erosion in a very short period of time along rivers or the coast. Although Alaska's north coast experiences both erosion and accretion, it is predominantly erosional, retreating on average about 4.5 feet per year; very high rates of erosion—more than 65 feet per year—occur along some sections of coast, such as in Drew Point, Alaska. Bank erosion along the Matanuska River, a braided, glacial river in Southcentral Alaska, has damaged or threatened houses, roadways, and public facilities for decades. Erosion hazard data collected by the U.S. Geological Survey for the period 1949–2006 showed the river's braid plain expanded 861 acres, and erosion in the highest category ranged from 225 to 1,043 feet at reaches of bank an average of 0.5 mile long, affecting 8 percent of the banks but accounting for 64 percent of the erosion.

4.1.3.2.9 Frequency of Erosion Hazard Events

Erosion is an ongoing, regularly occurring phenomenon that may or may not be event specific. Significant erosion events are commonly linked to major weather, storm, and flood events.

4.1.3.2.10 Duration of Erosion Hazards

Erosion is ongoing and regularly occurring and may or may not be event specific. Significant erosion events may occur over a matter of hours and days, although significant erosion can occur over longer periods.

4.1.3.2.11 Future Conditions of Erosion Hazard Events, Including with Climate Change

Climate and weather are the two primary drivers of erosion in Alaska. Weather (the day-to-day state of the atmosphere) affects these hazards in the short term with individual episodes of rainfall, wind, and temperature that initiate or intensify individual episodes of erosion. Climate is the long-term weather

pattern in an area, typically averaged over an extended time period, typically 30 years. Climate is affecting the long-term incident rate and severity of erosion, especially in Alaska, which is particularly vulnerable due to its high northern latitude and the unique importance of snow, ice, and permafrost. Longer sea ice-free seasons, higher ground temperatures, and sea level rise are expected to exacerbate and accelerate erosion in many regions that ultimately increases risk.

Shorter periods of ice-free shorelines will result in a shorter period of protection of coastal regions from high energy fall storms. Shorter periods of ice extent will expose more coastal communities to ocean currents, wave action, and storm surge, leading to increased threats from erosion which has the potential to put more infrastructure at risk (UAF and others 2019).

4.1.3.2.11.1 Characteristics/Nature

Climate change will continue to impact and exacerbate erosion in developed and undeveloped areas of the state. Erosion will also affect the way people travel on the landscape and negatively impact existing infrastructure.

4.1.3.2.11.2 Locations

Climate change has widespread impacts on erosion throughout the state of Alaska. For example, erosion due to increased permafrost thawing will expand into new locations, particularly those with ice-rich sediment and greater increases in air and water temperatures.

4.1.3.2.11.3 Range of Anticipated Intensities

The intensity range of erosion can vary from minor to severe. Areas of ice-rich materials will be increasingly impacted by thawing, which can lead to increased erosion intensity. The impacts of climate change are increasing the severity of erosion, which then poses an increased risk to infrastructure.

4.1.4 Ground Failure

4.1.4.1 Characteristics/Nature/Type of Ground Failure Hazards

Ground failure results when rock and soil lose their mechanical stability, leading to failure, collapse, and/or material movement. “Mass wasting” and “mass movement” are terms used for events that include downslope movement from the originating location. Topography (i.e., slope), geologic setting, lithology (i.e., rock or sediment type), vegetation, and water content are important factors that influence the movement type (i.e., style) and speed as well as the amount and type of damage that may result from failure. Ground failure can occur due to natural processes, human activities, or a combination of the two.

4.1.4.2 Ground Failure Types

Landslide is a catch-all term that describes a wide variety of processes that result in the downward and outward movement of slope-forming materials including rock, soil, artificial fill, or a combination of these. “Landslide” is often used interchangeably with “slope failure” or “mass movement.” Anything that alters the slope gradient, vegetation cover, surface drainage, or groundwater infiltration can potentially destabilize vulnerable slopes and lead to landslides. In Alaska, degrading permafrost, steep slopes, heavy rain, retreating glaciers, wildland fires, and ground shaking from earthquakes are some of the important natural mechanisms that can trigger devastating landslides. Human activity—such as construction that undercuts or overloads dangerous slopes or redirects surface or groundwater flow—can trigger landslides, as can forest clearing or tundra vegetation disturbance.

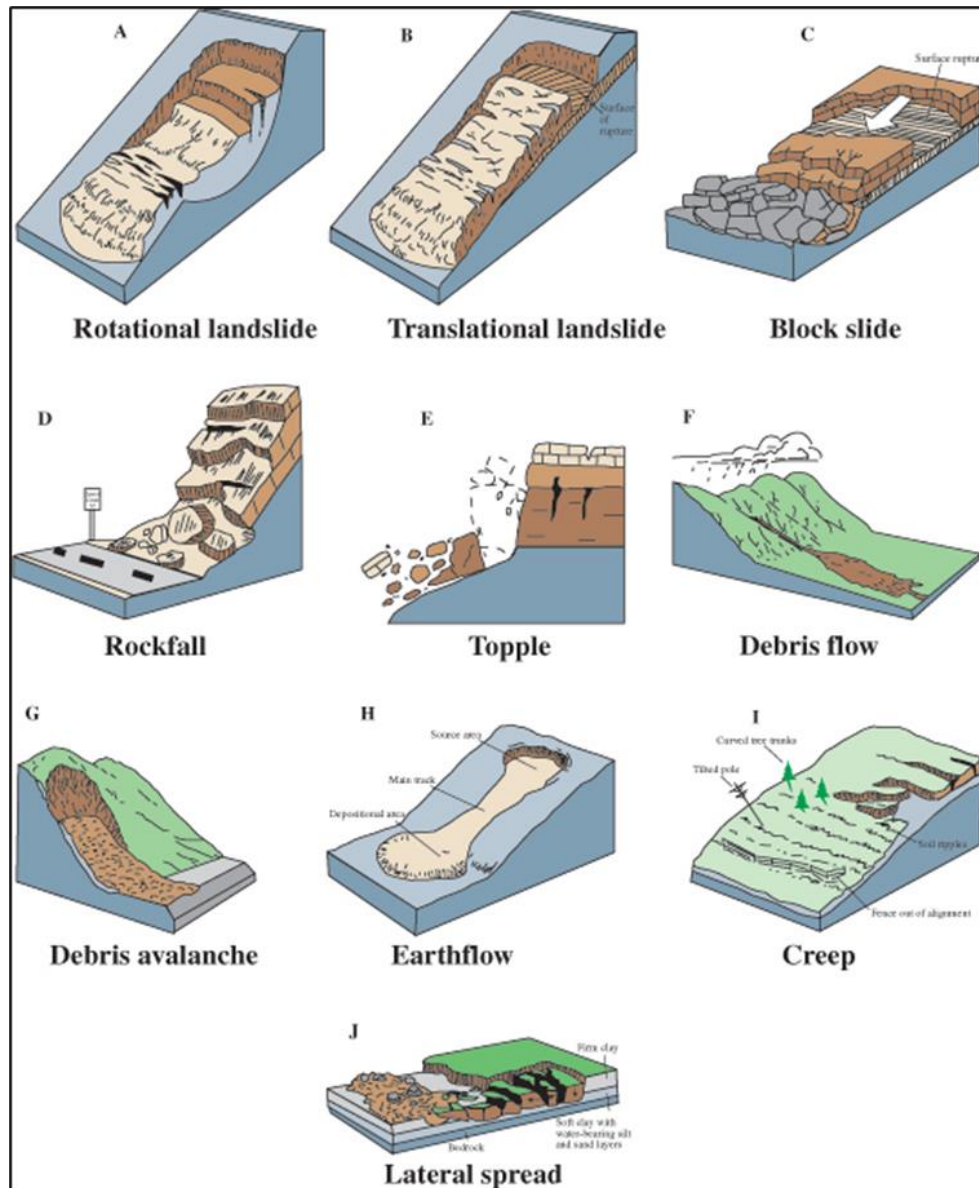
In general, landslides are classified based on the type of material being transported and the mechanics of material movement (Table 4.1.4-1). Transported materials include rock, soil (fine-grained material), and debris (coarse-grained materials). The materials may move by falling, toppling, sliding, spreading, or flowing.

Table 4.1.4-1: Landslide Classifications

Type of Movement		Type of Material	
		Bedrock	Engineering Soils
			Predominantly Coarse Predominantly Fine
Falls		Rock fall	Debris fall Earth fall
Topples		Rock topple	Debris topple Earth topple
Slides	Rotational	Rock slide	Debris slide Earth slide
	Translational		
Lateral spreads		Rock spread	Debris spread Earth spread
Flows		Rock flow (deep creep)	Debris flow (soil creep) Earth flow
Complex		Combination of two or more principal types of movement	

Landslides are often complex, involving multiple movement and material types, and they may begin as one mass movement type and evolve into another as materials collect and continue to move downslope. The most common landslide types can be categorized as listed below and shown in Figure 4.1.4-1:

- Rotational Landslide
- Translational Landslide
- Block Slide
- Rockfall
- Topple
- Debris Flow
- Debris Avalanche
- Earthflow
- Creep
- Lateral Spread



Source: USGS 2004

Figure 4.1.4-1: Diagram – Most Common Types of Landslides

A **Rotational Landslide** is a landslide in which earth material slides on a failure surface or thin failure zone that curves upward. The slide movement is more-or-less rotational about an axis that is parallel to the slope contour. Rotational landslides generally occur on steep slopes (greater than 20 degrees).

A **Translational Landslide** moves downslope along a relatively planar failure surface and has little rotational movement or backward tilting. Translational landslides commonly occur along geologic discontinuities such as faults, joints, bedding surfaces, or at the contact between rock and soil. If the failure surface slope is steep, these slides can have considerable run-out distances. In Alaska, the top of permafrost can form the failure surface for a translational landslide; the frozen layer is impermeable to water, which accumulates on top of the permafrost and acts as a lubricant that facilitates sliding of overlying unfrozen materials. These types of translational landslides are called “active layer detachments.”

Block Slides occur when material remains relatively coherent as it moves downslope, with little or no internal deformation. The sliding surface may be curved or planar.

A **Rockfall** is an abrupt, downward rock movement that detaches from a steep slope or cliff. Falling material may bounce or break on impact and then continue to roll downslope. Rockfalls can occur where natural processes (such as weathering and erosion) or human activities (such as digging or blasting) have resulted in an over-steepened slope.

A **Topple** describes the forward rotation of a mass of soil or rock about a pivot point that separates it from adjacent material. Toppling can be caused by natural processes, for example, stress from the weight of upslope material or freeze-thaw action in cracks or fractures. Columnar-jointed rocks are notably susceptible to toppling.

A **Debris Flow** is a rapid mass movement in which a saturated slurry of loose soil, rock, organic matter, air, and water flows downslope. Debris flows are commonly composed of a large proportion of silt- and sand-sized material, and are triggered by intense surface-water flow, due to heavy precipitation or rapid snowmelt, that erodes and mobilizes loose soil or rock on steep slopes. This landslide type is prevalent in areas with steep canyons and gullies, de-vegetated areas, and in volcanic regions with weak soils. Debris flows may develop from other types of landslides (such as rotational or translational) as they increase in velocity and the internal mass loses cohesion and/or gains water. A special form of debris flow that occurs on the slopes of volcanoes is called a “lahar” (see Volcano).

Debris Avalanches are very fast-moving debris flows. Debris avalanches occur in steep terrain from collapse of weathered slopes, or when bedrock disintegrates during a rotational or translational landslide as material moves downslope at high velocity.

Earthflows occur on moderately steep slopes, usually under saturated conditions, when earth materials lose shear strength and behave like a liquid. The flows are elongate and commonly occur in fine-grained soil (e.g., marine clay [quick clay] or silt) but granular materials or weathered bedrock with high clay content are also susceptible. Earthflows grow through a process known as “headscarp retrogression,” which is erosion of the upper portion of a failure surface and may evolve from slides or lateral spreads (described below) as they move downslope. Earthflows can destroy large areas and flow for several miles.

Soil Creep is a slow earthflow that is characterized by almost imperceptibly slow, steady, downslope movement of the uppermost few feet of soil or rock. Creep can pull apart or crack pipelines, highways, and other manmade structures. Creep is indicated by curved tree trunks, bent fences, or retaining walls, tilted poles or fences, and small soil ripples or ridges. Creep may be seasonal, where movement within the soil is affected by changes in moisture or temperature, or it may be continuous. In some cases, creep may progressively increase and produce other landslide types.

Solifluction is soil creep resulting from alternating cycles of freezing and thawing. It occurs when fine-grained soil thaws, becomes oversaturated due to poor drainage, and then begins to flow. If sufficient water is present, debris flows may develop. In areas of permafrost and deep seasonal freezing, the near-surface material (active layer) thaws seasonally and moves slowly downslope over the underlying frozen material; this process is called gelifluction.

Lateral Spread is the extension or disruption of a normally coherent upper rock or soil layer on top of a softer, weaker layer that has liquefied or flowed. During a lateral spread event the stronger upper unit may subside into the weaker lower unit, or material from the lower unit may be squeezed into the upper unit. This mass-movement type generally occurs on flat or very gentle slopes. Lateral spreads can be prevalent in seismically active areas with liquefiable soils (see Earthquake). For example, the Bootlegger Cove Clay (quick clays) in the Anchorage area is particularly susceptible to liquefaction, resulting in catastrophic lateral spreading during the 1964 Great Alaska Earthquake.

A **Slump** is a form of mass wasting that occurs when a coherent mass of loosely consolidated materials or rock layers moves a short distance down a slope. Slumps often occur as material drops off an eroding surface, for example, on the cutbanks of rivers or along undercut coastal bluffs.

Subsidence is any sinking or settling of the earth's surface, often due to removal of subsurface material. Subsidence is common in areas of thermokarst (see below). Other causes include underground mining; groundwater and petroleum extraction or movement; and degassing and other changes in hydrothermal systems. Tectonic subsidence occurs when the ground surface is lowered by sinking of the Earth's crust as crustal plates move during significant earthquakes. In Alaska, sediment compaction, thawing ice-rich permafrost, and earthquakes are common subsidence causes.

Thermokarst describes the land surface, landforms, and processes that result from thawing ice-rich permafrost. Ice-rich soil and ice lenses become exposed and thaw as surface material warms and erodes during summer, resulting in abundant water that mobilizes sediment to flow or slide downslope along the surface of the frozen permafrost; ice becomes exposed in steep headwalls, melting causes material to slump. **Retrogressive Thaw Slumps** and **Retrogressive Thaw Slides** form as permafrost ice continues to melt, scarps migrate upslope, and material continues to slump and slide (Figure 4.1.4-2). This process persists until displaced vegetation buries and insulates the ice-rich head scarp, slowing further degradation.



The top of the slump is 900 feet above the river. Source: NPS 2016

Figure 4.1.4-2: Large Retrogressive Thaw Slump on the Noatak River

Frozen Debris Lobes (FDLs) are a unique kind of slow-moving landslide found in permafrost-affected mountainous regions of Alaska, particularly the Brooks Range (Figure 4.1.4-3). Frozen debris lobes are lobate or tongue-shaped features consisting of soil, rock, organic debris, and massive ice from infiltrating water. The largest FDLs measured in Alaska are almost 300 feet wide and 1.75 miles long. Some are more than 80 feet high—as tall as an eight-story building. These masses of material move at rates of up to 165 feet per year.



Source: DGGs 2022

Figure 4.1.4-3: Frozen Debris Lobe Next to the Dalton Highway

4.1.4.2.1 Related Hazards

Ground failure is associated with many other hazards because these hazards can directly initiate mass movement, or else destabilize slopes, making them more susceptible to failure. For example:

- Rapid infiltration of water in soils leads to the loss of shear strength, which can trigger landslides
- Erosion can remove material at the base of a steep slope, resulting in loss of lateral support
- Thawing permafrost can leave voids in the ground, resulting in subsidence
- Ground motion (shaking) from earthquakes commonly initiates a variety of ground failures
- Lahars can form from the rapid melting of snow and ice during volcanic eruptions

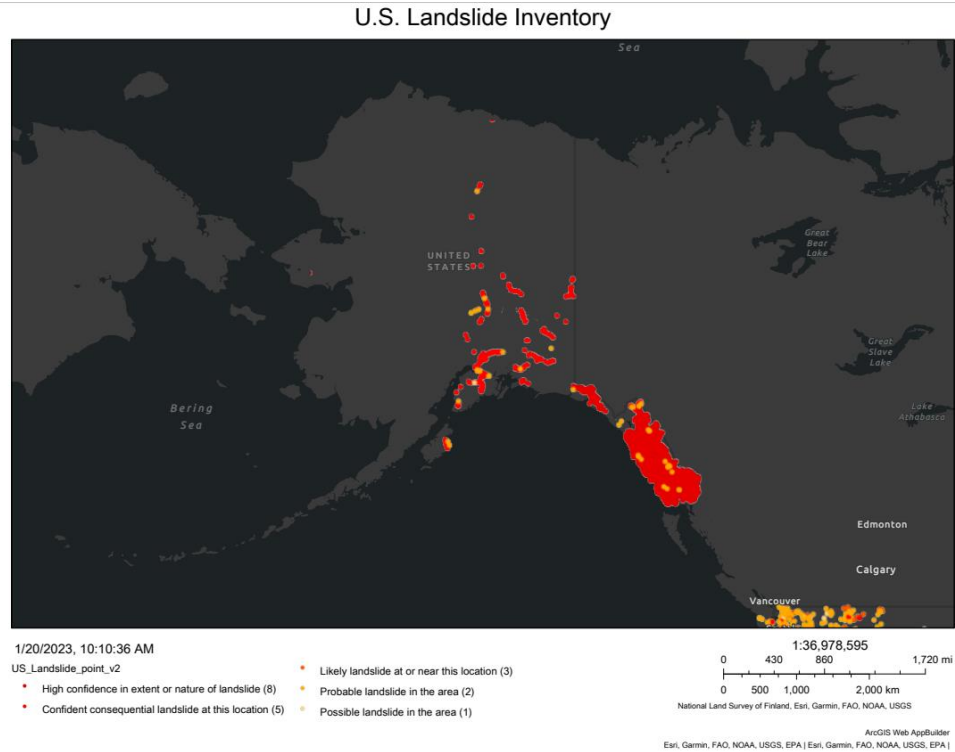
Landslides can also trigger other hazards; for example, large landslides that fall into water have the potential to cause tsunamis.

4.1.4.3 Locations of Ground Failure Hazards

Ground failures have many different triggering mechanisms; therefore, they can occur wherever soil conditions, geology, slope, and weather (especially rain events) combine to destabilize the ground. They occur in both bedrock and soils, on vegetated land and barren ground, on land and underwater, in humid areas and dry, and on both steep and gentle slopes. Degrading permafrost, steep slopes, heavy rain, retreating glaciers, wildfires, and ground shaking from earthquakes are some of the important natural mechanisms that can trigger landslides in Alaska. Human activity—such as construction that undercuts or overloads dangerous slopes or redirects surface or groundwater flow—can trigger landslides, as can forest clearing or tundra vegetation disturbance. As an example, the U.S. Forest Service has identified hundreds, if not thousands, of landslides within the Tongass National Forest area of Southeast Alaska.

Landslide hazard maps help raise awareness and promote public safety, but very few landslide hazard maps exist for the state.

The following figure shows the locations of landslide hazards in Alaska.



Source: USGS Landslide Hazard Program 2023

Figure 4.1.4-4: U.S. Landslide Inventory

4.1.4.4 History of Ground Failure Hazard Events

The following section provides examples of significant ground failure events in Alaska (updated since the 2018 SHMP):

Bluff Point Landslide. Located just north of Homer, the prehistoric Bluff Point landslide is the most massive known landslide of the Kenai Peninsula lowland (Figure 4.1.4-5). The body of the landslide is approximately 3.4 miles long, up to 1.6 mile wide, and has a scarp, or cliff relief, of 200–600 feet. A ponded area of the back-tilted landslide block formed as the mass slid along one or more spoon-shaped failure planes at depth. Bathymetry of the seafloor in this area suggests that the main body of the landslide could have extended up to 1.2 miles out from the modern shore. The landslide could have occurred any time since ~17,500 years ago, when glaciers retreated from the Bluff Point area back into Kachemak Bay, effectively de-buttressing the slope. Radiocarbon age estimates of vegetation from within one of these back-tilted soil layers suggest the slide occurred ~2,250 years ago, and the consensus is that a slide this massive was at least in part triggered by a major subduction-zone earthquake. The slide block has been extensively modified by coastal processes since deposition, and therefore it is not clear whether the Bluff Point landslide occurred as a single, catastrophic failure or as a series of progressive, smaller failures. The remnants of the original landslide headscarp are continuously eroding and collapsing, and there is evidence that reactivation of old slump blocks is possible. Deep-seated landslides fail progressively over time and—coupled with the potential for strong shaking in 1964-type subduction zone earthquakes—future failures of the headwall are likely.



Source: Alaska ShoreZone, NOAA Fisheries 2022

Figure 4.1.4-5: Prehistoric Bluff Point Landslide North of Homer

Ground Failures of the 1964 Great Alaska Earthquake. Some of the most dramatic ground failure events in Alaska were associated with the 1964 9.2M Great Alaska Earthquake, which triggered a wide variety of falls, slides, flows, and lateral spreads throughout Southcentral Alaska. Anchorage was heavily impacted because of failures in the Bootlegger Cove Clay Formation. Significant failure events occurred at Fourth Avenue, L Street, Government Hill, and Turnagain Heights, with several less-devastating slides in other areas, such as at Point Woronzof and Potter Hill.

The Government Hill Elementary School was severely damaged by a complex translational slide where the south wing of the school dropped ~30 feet while the east wing split lengthwise and collapsed. Part of this slide became an earth flow spreading 150 feet across the flats into the Alaska Railroad yards. The Turnagain Heights landslide was the largest and most complex translational slide, and likely began as a block slide that evolved to include lateral spreading, slumping, and possibly other movement types. This landslide caused serious damage to a housing development in which three people died.

The earthquake caused at least one rock avalanche. Rock avalanches are very large (typically >1.3 million cubic yards) landslides from rock slopes, which can travel much farther across the landscape than smaller events; the larger the avalanche, the greater the excess travel distance. A slab of rock became detached from the mountain peak overlooking Sherman Glacier. The rock slab disintegrated as it moved downhill, helping it achieve great velocities and extend a large distance over the glacier.

The 1964 Great Alaska Earthquake also caused extensive subsidence. The subsidence zone covered about 110,000 square miles, including the north and west parts of Prince William Sound, the west part of the Chugach Mountains, most of Kenai Peninsula, and almost all the Kodiak Island group. In some areas, subsidence exceeded 7 feet. Part of the Seward area is about 3.5 feet lower than before the earthquake, and portions of Whittier subsided more than 5 feet. The village of Portage, at the head of Turnagain Arm of Cook Inlet, subsided 6 feet, partly due to tectonic subsidence and partly due to sediment compaction during the earthquake.

Liquefaction of the soils beneath the Old Valdez waterfront caused an underwater landslide. The slide was estimated to be 98 million cubic yards of unconsolidated deposits, and it created a tsunami wave estimated to have been at least 30 feet high, which bounced back and forth in the bay repeatedly hitting the waterfront. Two other landslides were reported nearby in Shoup Bay. Thirty-two people are said to have died.



Source: USGS 1964

Figure 4.1.4-6: 4th Avenue Landslide

2009 Alaska Severe Storms, Flooding, Debris Flows, and Rockslides (DR-1865). In October 2009, the remnant of a typhoon brought the Kodiak Islands their second largest rainfall event ever recorded. More than 9.5 inches of rain fell in five days, resulting in debris flows and rockslides that damaged roads and infrastructure. The event was declared a federal disaster and included the Kodiak Island Borough and the Kodiak Electric Association.

2015 Sitka Landslides. On August 18, 2015, heavy rainfall resulted in more than 70 landslides in the vicinity of Baranoff Island, Southeast Alaska. Four debris flows impacted roads and infrastructure in Sitka, including one on Harbor Mountain that was more than 1,200 feet long and resulted in the death of three people and massive property damage on Kramer Avenue (Figure 4.1.4-7).



Source: DGGs 2015

Figure 4.1.4-7: South Kramer Landslide in Sitka, 2015

2018 Anchorage Earthquake (DR-4413 AK). A magnitude 7.1 earthquake hit Anchorage on November 30, 2018 and triggered multiple landslide events. Rockfalls and rockslides were the most common type of landslide that occurred, but slumps, earth flows, and lateral spreads were very damaging (Figure 4.1.4-8). The Seward Highway was closed due to rockfall on the road in several locations, and increased rockfall was observed along the highway for several months after the earthquake.



Source: DOT&PF 2018

Figure 4.1.4-8: Earthquake Damage on Vine Road Due to Shaking-Induced Soil Failure

2020 December Southeast Storm (DR-4585 AK). The record-breaking storm that hit Southeast Alaska on December 1–2, 2020, caused widespread and long-lasting disruption of daily life, property and structural

damage, and loss of life. Heavy rain and melting snow on already frozen and saturated ground led to flooding, road washouts, and landslides in several communities. The Beach Road landslide in Haines is the most well-known because it destroyed four homes and killed two people (Figure 4.1.4-9). The Beach Road slide originated in bedrock and turned into a debris flow as it incorporated soil and water. A landslide on Battery Hill destroyed another house. The Haines Highway was closed due to mudslides and debris flows that covered the road. Lutak Road was closed due to multiple debris flows and slope failures that impacted homes and sheds and damaged road embankments. There were numerous other landslides, rockfalls, and debris flows that also caused damage throughout Southeast Alaska communities. A landslide in Juneau broke a pipeline that supplies water to the Macauley Salmon Hatchery, and thousands of young fish perished.



Source: Alaska Public Media 2020- Alaska Army National Guard courtesy photos by 1st Lt. David Marshall

Figure 4.1.4-9: Beach Road Landslide in Haines

A disaster emergency was declared for the entire Southeast Region of Alaska, which included Haines Borough, Municipality of Skagway Borough, City and Borough of Juneau, City and Borough of

Wrangell, Petersburg Borough, City and Borough of Sitka, Ketchikan Gateway Borough and the Annette Island, Chatham, and Southeast Island Regional Education Attendance Areas (REAAAs).

2022 May Lowell Point Landslide (DR-4661 AK). On May 7, 2022, the City of Seward experienced a major landslide across Lowell Point Road that cut off road access to, and water/sewer service with, the Lowell Point community. The most severe impacts from the landslide, estimated at 200 feet high and 300 feet wide, and containing over 40,000 cubic feet of debris, included substantial cleanup and debris management to restore access, potential road surface and embankment damage, and disruption or damage to the water/sewer infrastructure through the slide area. The landslide stranded residents and disrupted normal travel to and from the Lowell Point community, requiring the use of commercial and contracted water taxi and barge service around the slide. The City of Seward, Kenai Peninsula Borough, and multiple state agencies engaged in a months-long response to this event. State agencies supported the community with response operations that included water-taxi and barge transport around the slide and road clearing. Geotechnical and slope stability assessments were ongoing in 2022. The landslide and adjacent mountainside remain unstable, and risk of further movement is possible.



Source: Anchorage Daily News/Loren Holmes 2022

Figure 4.1.4-10: Lowell Point Landslide

This event took place adjacent to a similar landslide that occurred on September 29, 2020. The 2020 landslide was triggered by a rainfall event, and it closed the road for several days. People used water taxis to shuttle around it.

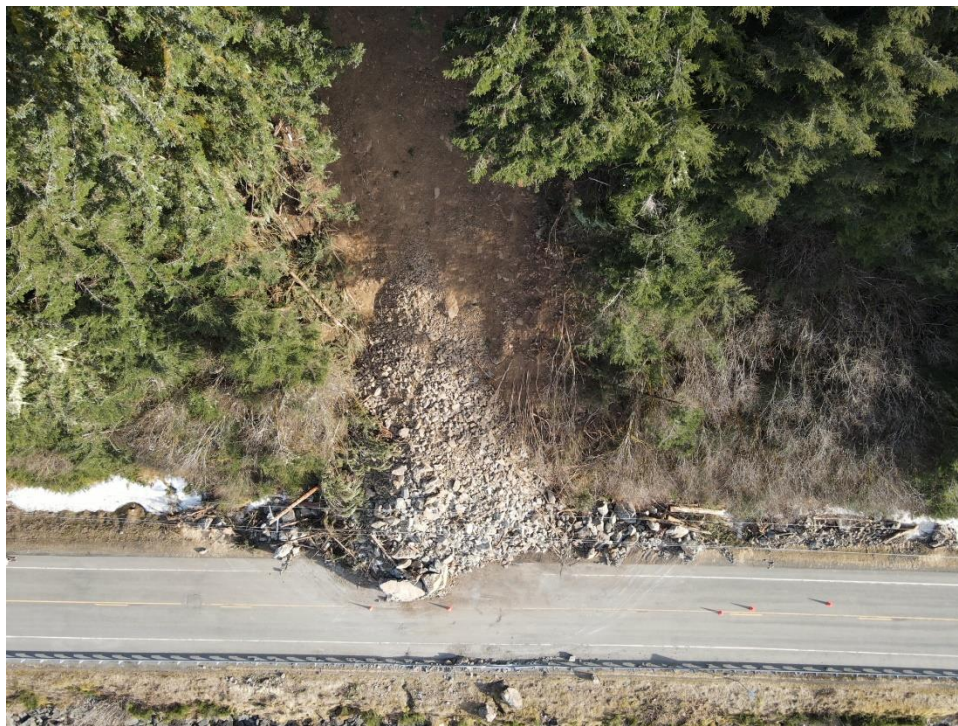
Ground Failure Events in Juneau. Multiple mass movements have affected Juneau in the past 100 years. A series of debris avalanches occurred in the area between Gastineau Avenue and South Franklin Street on January 2, 1920, that killed four people. Damage was caused by the impact of the debris slides as well as the relocation of structures that were pushed into other structures. A landslide on Gastineau Avenue on November 15, 1929, destroyed one home. A debris avalanche again struck between Gastineau Avenue and South Franklin Street on October 26, 1936. It destroyed several homes and killed one person.

One of the most destructive mass-wasting events occurred on November 22, 1936, when prolonged heavy rainfall triggered a debris flow that struck a residential area and caused numerous injuries and 15 deaths. The slide covered South Franklin Street to a depth of 10 feet.

On July 16, 1984, heavy rain fell on already-waterlogged soils and triggered a debris avalanche/flow that destroyed a small hydroelectric dam, damaged two houses, and left debris on the Glacier Highway and inside several local businesses.

Several ground failures occurred across the city after heavy rainfall on October 19 and 20, 1998. A mud slide collapsed Fritz Cove Road and destroyed one home. On North Douglas, at least five homes were damaged due to mass wasting and flooding.

On April 4, 2022, a sizeable rockslide occurred at Milepost 10.1 of North Douglas Highway. The road was fully closed, and local AKDOT&PF Maintenance and Operation staff responded with heavy equipment to begin debris removal operations. One lane was restored, and the trapped motorists were able to get past the rockslide. The rockslide took out enough trees and vegetation to expose an estimated 150-foot-high cliff band with significant overhanging blocks. An estimated 500 cubic yards of rock with several shattered tree trunks and minor colluvium soils hit the highway, filling the ditch, shoulder, inbound lane, and blocking the outbound lane with massive boulders, the largest measuring 11 feet across. On April 7, 2022, another rockslide occurred on the same cliff face, again covering the road. The massive overhanging blocks were dislodged from the cliff face during the event. One of the boulders, 16 feet across, bounced over the road and landed in the water. The road was closed to all but emergency vehicles and local traffic April 3–22, 2022.



Source: DOT&PF 2022

Figure 4.1.4-11: North Douglas Highway Landslide

On September 26, 2022, a mass-wasting event occurred on Gastineau Avenue that damaged some homes, knocked out power, and cut off road access. No injuries were reported. The event was a shallow channelized landslide that scoured down to bedrock with very little soil and bedrock involved. Homes, power, and the road system were mostly impacted by fallen trees. The area received over 2 inches of rain

over a 24-hour period and experienced unpredictable wind velocities and directions leading up to the event.



Source: DOT&PF-SR 2022

Figure 4.1.4-12: Gastineau Avenue Landslide

Other Ground Failure Events in Alaska. On June 9, 1958, an M8 earthquake triggered a landslide in Lituya Bay, which dislodged approximately 40 million cubic yards of material into the bay. This landslide triggered a tsunami with a wave that travelled up the opposite side of the bay to a height of 1,720 feet. Two people in a fishing boat in the bay were killed by the tsunami (see Section 4.1.5, Tsunami and Seiche).

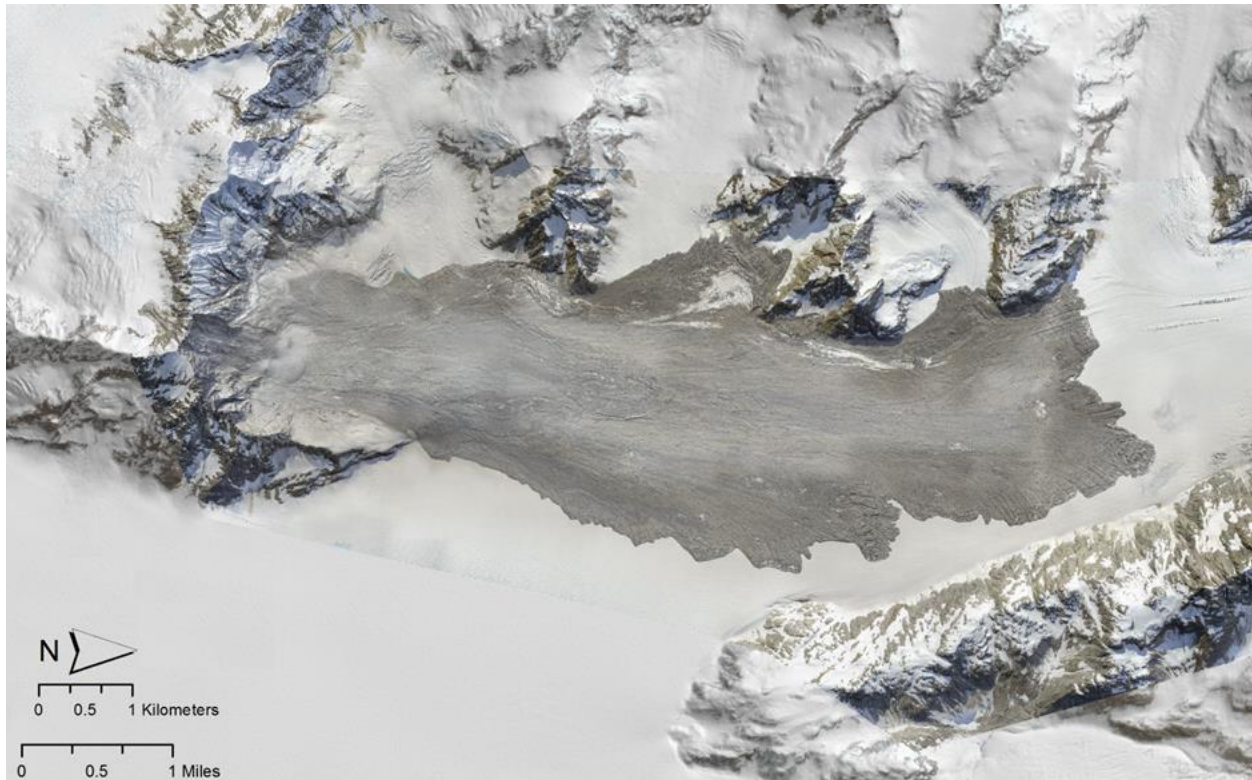
On November 29, 1969, a debris flow caused by the overflow of an emergency spillway destroyed Ketchikan's Upper Lake Silvis powerhouse, plunging the city into partial darkness.

An M7.9 earthquake of the Denali Fault in Interior Alaska triggered thousands of landslides on November 3, 2002. Landslides included widespread liquefaction within alluvial deposits, lateral spread, rockfall, and rockslides (see Section 4.1.2, Earthquake).

A rock avalanche on April 11, 2009, blocked the tunnel connecting the town of Whittier to the main highway system. The avalanche deposited a 300-foot-long by 30-foot-tall pile of rubble on the solitary access road, completely isolating Whittier. The town has no commercial airstrip, so the slide completely stopped all transportation and commerce until the rubble pile was removed days later. Falling rock inside the tunnel contributed to Whittier isolation in June 2014.

On October 17, 2015, a landslide at the Tyndall Glacier in Icy Bay sent an estimated 180 million tons of rock onto the glacier and into Taan Fjord and created a tsunami that reached elevations as high as 600 feet. The event was recorded by seismometers equal to an M4.9 earthquake. Aerial imagery shows that the glacier had retreated more than 10 miles since 1961. Glacial retreat is thought to have caused this event by removing the lateral support previously provided by the glacier.

On June 28, 2016, the collapse of a 4,000-foot rock face in Glacier Bay National Park was measured on seismometers as an M5.2 earthquake. The landslide collided with Lamplugh Glacier and spread out across more than 5 miles of the glacier. Glacial retreat is also thought to have caused this event.



Source: DGGS/Planet Labs 2016

Figure 4.1.4-13: Lamplugh Glacier Landslide

4.1.4.5 Current Landslide Monitoring and Mitigation

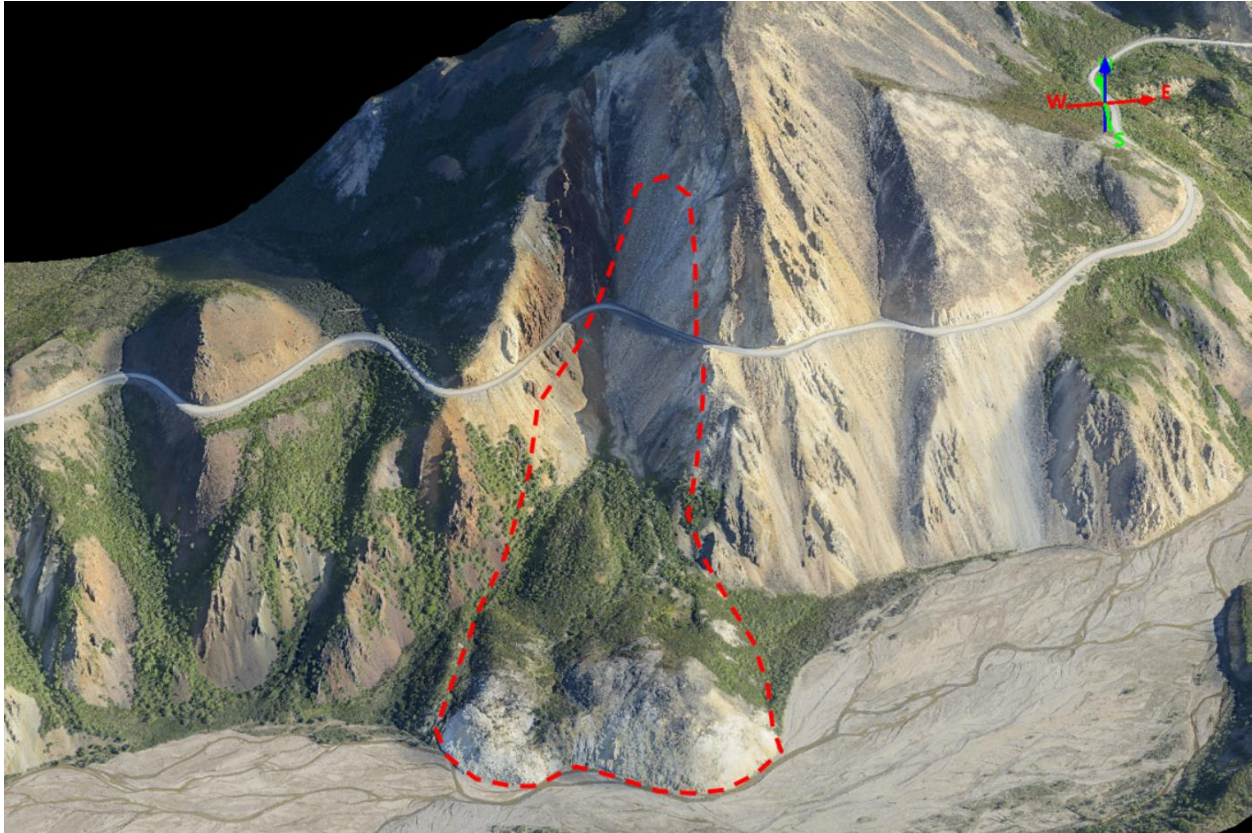
In 2018, the Department of Transportation and Public Facilities (DOT&PF) realigned a portion of the Dalton Highway around the closest frozen debris lobe (nicknamed FDL-A). Since there are so many other FDLs that could also reach the highway, the abandoned highway section remains in place so scientists can study what happens to it when the FDL encounters it, and in the summer of 2022, FDL-A came into contact with the toe of the embankment.



Source: AK RGB high resolution imagery 2022

Figure 4.1.4-14: FDL-A Nearing/Touching the Abandoned Section of the Dalton Highway

The Pretty Rocks landslide in Denali National Park has been active since at least the 1960s, and probably since before the road was constructed in 1930. Until recently, movement was estimated to be inches per year and only required maintenance every few years, but in 2014, road maintenance crews noticed a substantial acceleration. Movement was measured to be inches per month in 2017, inches per week in 2018, inches per day in 2019, and up to 0.65 inches per hour in 2021. The road was closed in August 2021 and is expected to remain closed until 2026 while engineers plan and construct a bridge that will span the landslide area.



Source: NPS 2015

Figure 4.1.4-15: Pretty Rock Landslide in Denali National Park

Several well-known, large debris flows originate in alpine permafrost high in the mountains above Haines. At least once each year, an overflow buries the Haines Highway with more than 10 feet of mud and rock (Figure 4.1.4-16). Numerous smaller events overflow the highway each year, causing significant disruption and cost to the State to maintain. Wide, vegetated debris fans are visible in aerial images, indicating this process has been ongoing for a long time. A portion of the highway has been reconstructed to bridge over the flow, and more construction is planned. This is further discussed in the Future Conditions section below.



Source: DOT&PF 2022

Figure 4.1.4-16: Haines Highway Debris Flow

Barry Glacier is located in the Barry Arm fjord of Prince William Sound. Analysis of airborne and satellite imagery reveals motion of a large landslide as early as 1957. Between 2009 and 2015, the landslide moved 600 feet toward the fjord at the same time as Barry Glacier was thinning and retreating below the landslide. Support of the valley walls degrades as the glacier melts and retreats, which leads to rockfall and landslides. This landslide has an estimated volume of 650 million cubic yards and has the potential to produce a tsunami comparable to what happened at Lituya Bay, with a potential tsunami reaching the town of Whittier and other communities throughout Prince William Sound. It is being actively monitored with installed instrumentation and via satellite imagery. This is not an isolated phenomenon; similar unstable slopes have been identified at several locations in Prince William Sound.

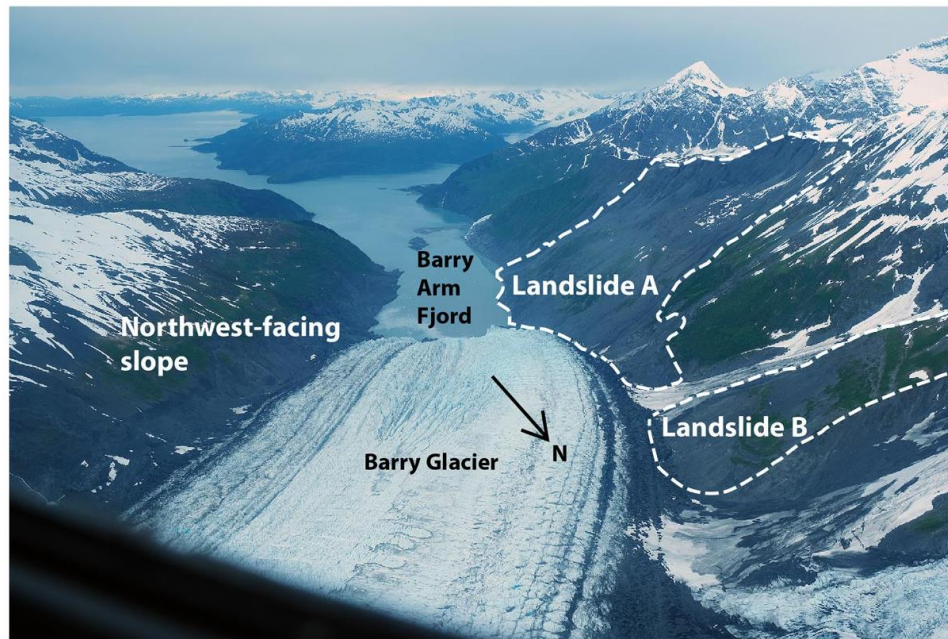
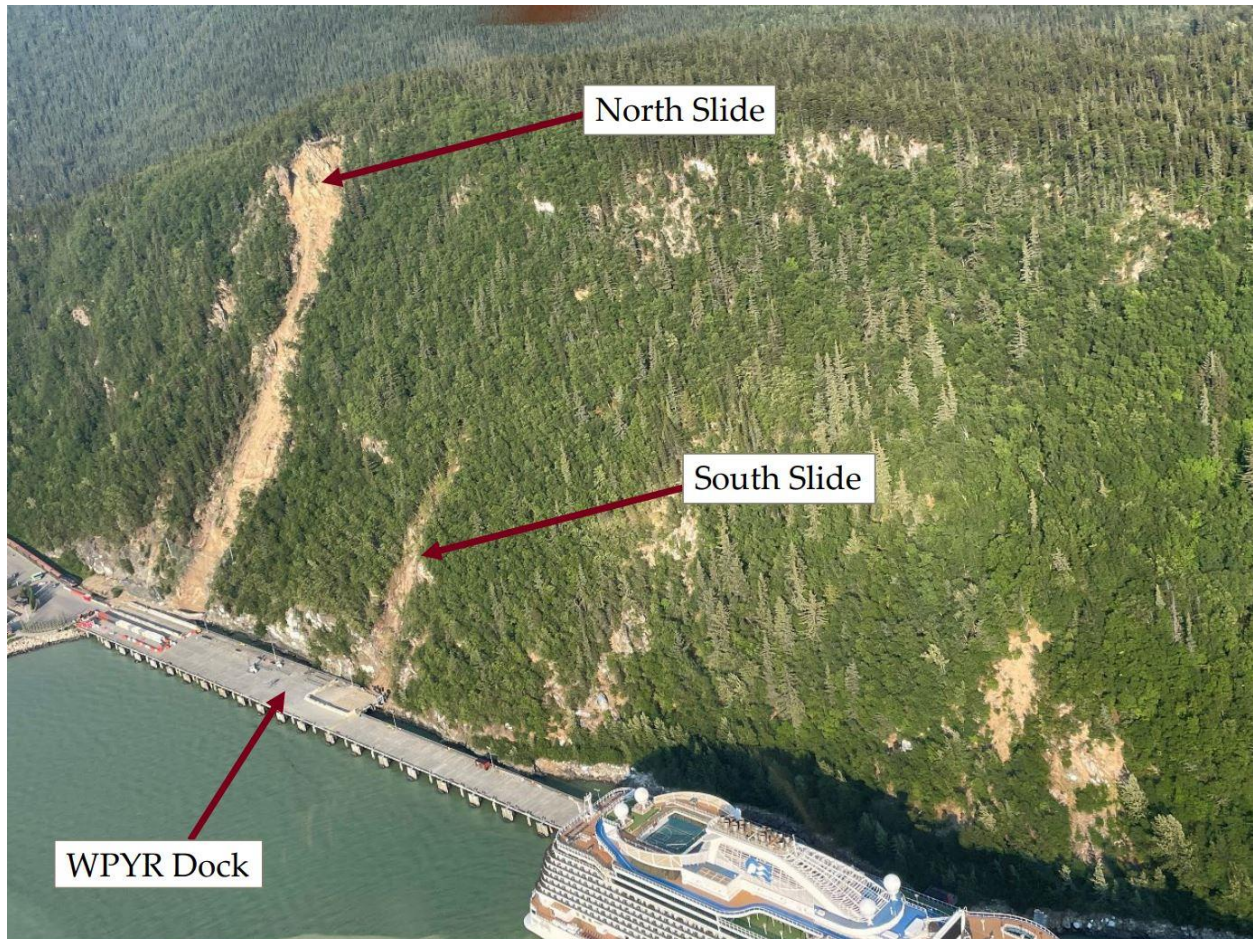


Photo by Gabe Wolken, June 26, 2020

Source: USGS/Gabe Wolken 2020

Figure 4.1.4-17: Barry Arm Landslide

Skagway has experienced recent rockfall from a tall, steep slope that is immediately upslope of the cruise ship dock (Figure 4.1.4-18). The “north slide” has been active for decades but has increased in activity over recent years. Rockfall barriers and attenuators were installed in 2017 after a large earthquake-induced rockfall event hit the dock. The fencing was destroyed during an event in September of 2022 and is no longer fully functional. A slide occurred to the south (“south slide”) on June 23, 2022 and released a boulder that punched a hole in the cruise ship dock, closing that dock indefinitely, resulting in substantial economic loss from cancelled cruise ship visits and dock fees. The Borough and engineers were working on a mitigation plan in 2022. Another notable event occurred in Skagway in 1994 when an underwater landslide collapsed a cruise ship dock that was being constructed and triggered a local tsunami that reached 6 feet in height on the opposite side of the harbor. (See also Section 4.1.5, Tsunami and Seiche.)



Source: Shannon & Wilson Railroad Dock Landslide, Initial Site Visit Trip Report, Skagway, Alaska 2022

Figure 4.1.4-18: Skagway Cruise Ship Dock Landslides

Pillar Mountain in Kodiak is an example of a historic landslide that was destabilized by human activity. The original road crossed the landslide roughly 130 feet higher than where the road is now, but continued rockfall and maintenance problems prompted the road to be moved. The road was realigned in the late 1950s to its current, lower location. In December 1971, rock was being excavated from the toe of the slope to be used as fill material when the landslide activated. Several days of rockfall followed that covered the road and resulted in an estimated 6 million cubic yards of deposited material. A gabion basket retaining wall was constructed to block rockfall from reaching the road, but rocks continued to reach and close the road, and it required frequent maintenance. The retaining wall was replaced in 2015.

On October 26–27, 2019, the Kodiak area received over 5 inches of rain that caused flooding, mudslides, collapsed culverts, and road embankment failures on the Chiniak Highway. Chiniak Highway remained closed to the public until the landslide debris was removed, collapsed culverts were replaced, and proper mitigation procedures were implemented at the road embankment failures.



Source: DOT&PF 2022

Figure 4.1.4-19: Chiniak Highway

On August 26, 2010, a rockfall occurred on South Tongass Highway in Ketchikan during the public morning commute to work and school. This site has experienced multiple slope failures that impact the road system.



Source: DOT&PF 2022

Figure 4.1.4-20: South Tongass Highway

4.1.4.6 Extent of Ground Failure Hazards

Ground failures occur throughout Alaska and can occur quickly or slowly over time. Damage from ground failure ranges from minor—with some repairs required and little to no damage to transportation, infrastructure, or the economy—to major if a critical facility (such as an airport) was damaged and transportation was affected. Historic Alaska ground failures have resulted in landslides more than 3 miles long, 1.5 miles wide, and 200 feet high. Subsidence has impacted up to 110,000 square miles and exceeded 7 feet.

4.1.4.7 Impact of Ground Failure Hazards

Impacts associated with ground failure range from negligible to catastrophic and include surface subsidence or upheaval and infrastructure damage. Landslides can cut off or restrict lifelines, isolate communities from necessary services, result in economic loss, and can also cause personal injury and death. Ground failure can pose a sudden and catastrophic hazard in the event of a large landslide. Most ground failure damage from man-made causes occurs from improperly designed and constructed buildings that settle as the ground subsides, resulting in structure loss or expensive repairs. To avoid costly damage to these facilities, careful planning and location and facility construction design is

warranted. The impact of a landslide varies from a minor road closure that is cleaned up in minutes or hours, to infrastructure damage that takes months or years to rebuild.

4.1.4.8 Probability of Ground Failure Hazards

Probability is the likelihood that an event will occur. Some landslides occur in places that are known hazard areas, while others are unexpected. Geologists cannot predict specific events but can make general estimations regarding the likelihood of an event happening based on historic activity and regional and local characteristics such as the underlying geology, soil conditions, slope angle, and meteorological and climatic conditions. Although the probability for ground failure is location-specific, the probability is likely, and increasing, due to a changing climate. Severe weather events such as precipitation and wind are a direct result of atmospheric warming. Atmospheric rivers are becoming increasingly common and increase the intensity and duration of precipitation events at regional and local scales. Landslide events are directly related to high intensity precipitation events, and those are likely to become more common over greater geographic regions of Alaska.

4.1.4.9 Projected Changes in Location of Ground Failure Hazards

Landslide probability is location specific, and numerous variables must be considered. It is common for debris flows to reoccur in the same channel or to shift slightly. Other types of landslides may reoccur in the same place or the area directly adjacent to a previous landslide. Ground failures related to thawing permafrost or changes in ground ice, including earthquake-induced liquefaction, are expected to appear in locations that were previously frozen and are now thawing. This includes areas that are immediately adjacent to recently thawed ground and where overlying vegetation has been removed. However, landslides also occur in areas with no prior known instabilities due to changing conditions such as increased rainfall, strong earthquake shaking, and human activities.

4.1.4.10 Range of Anticipated Intensities of Ground Failure Hazards

Landslides in Alaska have historically had a wide range of intensities, from a few fallen rocks that are barely noticed to catastrophic failures that block roads, destroy structures, and cause fatalities. We are becoming more and more aware of the changes in our environment even as we rely more on road systems as critical lifelines. Climate change has already affected the intensity of events in many areas within Alaska. Permafrost regions are experiencing increased lake drainage events and coastal erosion due to ground failures resulting from a warming climate, and landslides in permafrost are more common now due to warming ground and reduced soil strength.

4.1.4.11 Frequency of Ground Failure Hazards

The frequency of mass-wasting events and the significance of their effects are anticipated to increase as a result of population growth, development expansion, and continuous effects related to climate change. In Southeast Alaska, there are vulnerable communities located in coastal and mountainous environments. Landslides occurring in rural areas that do not impact a community and those that are of small volume are often not documented, so their frequency is uncertain. Those large enough to close a road and impact normal day-to-day life are better recorded, and they occur multiple times per year across the state.

Alaska has experienced several severe storms in recent years that have led to major landslides. Retreating glaciers are instrumental in causing large landslides in the state. Areas with ice-rich permafrost have also seen an increase in landslides. If these conditions continue, then it is expected the state will have more landslides. If the overall number of landslides increases, then it is likely that there will also be an increase in the number of major and catastrophic landslides that result in damaged infrastructure and fatalities.

4.1.4.12 Duration of Ground Failure Hazards

Landslides can happen suddenly, quickly, and without warning (for example, rockfall and debris flow events and seismically-induced events such as liquefaction and lateral spread) or very slowly (for example, soil creep). They may move slowly for a span of time and then rapidly gain speed. The duration

of ground failure events will depend on the nature and type of material and ground failure driving factors (earthquake, precipitation, etc.)

4.1.4.13 Future Conditions for Ground Failure Hazards, Including Climate Change

4.1.4.13.1 Characteristics/Nature

Studies show that changing climate conditions can increase the frequency of fast-moving, catastrophic landslides. At the same time, population growth and the expansion of settlements and lifelines over potentially hazardous areas are increasing the likelihood of landslide impacts.

Alaska is experiencing warming temperatures, which is causing glacial retreat, permafrost degradation, and changes to the active layer that freezes and thaws each year. Increased permafrost thaw causes thermokarst and subsidence due to loss of ground ice. Additionally, increased water from thawing ice amplifies potential for ground failure slides, flows, and creep. Increases in tsunami-producing landslides in Southeast Alaska can also be attributed to retreating glaciers and thawing permafrost. Rock-ice face collapse is most common in areas with glaciers and steep topography, frequently the same areas that attract tourists.

Alaska is experiencing an increase in rainfall and extreme rain events (e.g., atmospheric rivers). This is especially noticeable as an increase in coastal and river erosion but is also widely seen as rockfalls and debris flows. Rainfall can trigger landslides by loosening soils, lubricating rock joints, and mobilizing the material downslope. Faster-flowing water can carry larger soil particles and rocks.

4.1.4.13.2 Location

Historic events give us an idea of what might happen in the future, but changing conditions play an important role. Landslide location is dependent on factors such as the geology, slope, and rainfall of an area; therefore, it is expected that landslide location and risk will change along with changes to these factors, as well as other changing conditions. Alaska is experiencing an increase in air and ground temperatures, which is increasing glacial retreat, changing the seasonally frozen active layer, and thawing permafrost. Alaska is also experiencing more record-breaking rainfall and intense coastal storm events, which, coupled with a decline in winter sea ice, have caused an increase in landslides along the coast. Intense rainfall has triggered landslides that caused extensive damage and fatalities.

The Barry Arm, Taan Fjord, and Lamplugh Glacier described in the History section above are examples of glacial retreat leading to slope instability due to the loss of lateral support previously provided by the glacier. A warmer climate leads to glacier retreat by creating an environment where the glacier spends more time thawing and shrinking than it does freezing and growing. As more glaciers retreat, it is likely that we will see more of these types of landslides.

As warming accelerates there is likely to be an increase in landslides in many areas of the state. However, areas with abundant ice-rich permafrost are particularly susceptible to more landslide activities. Melting ground ice leads to subsidence and slumping. This tends to have a cascading effect as one area thaws and collapses, which exposes the adjacent area, which thaws and collapses, etc. As permafrost thawing accelerates, areas with ice-rich permafrost are likely to see an increase in landslides. Additionally, areas with retreating glaciers are likely to see an increase in landslide frequency as slopes become destabilized after ice removal. Degrading alpine permafrost in the Haines area is causing increased debris flow incidents that repeatedly inundate and block the highway, making it one of the most expensive maintenance stretches in the state for DOT&PF. Haines Highway construction in 2022 included raising the grade of the highway and installing four large culverts at the Mile 19 debris flow. This was designed to create a better catchment capacity and to allow maintenance equipment to move material through the culverts toward the river side with less disruption to highway traffic (Figure 4.1.4-21). Two October 2022 events proved this to be an effective strategy as the debris did not impact the highway at the Mile 19 slide, but the Mile 23 slide buried the road with 10 feet of debris. A future project is planned at the 23 Mile debris flow that will raise the grade of the highway and install the same engineered culverts.



Source DOT&PF 2022

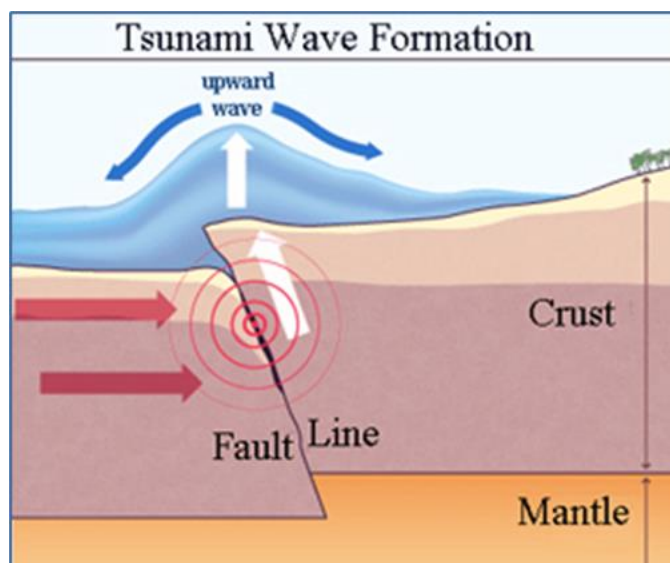
Figure 4.1.4-21: Construction at Mile 19 Debris Flow

4.1.4.13.3 Range of Anticipated Intensities

Alaska currently experiences a wide range of landslide intensities, from minor and barely noticeable to highly destructive and fatal. Changing conditions are expected to increase landslide frequency of all intensities, and as people expand across the landscape, including into hazardous areas, there will likely be an increase in catastrophic outcomes in the future. The intensity of ground failures can range from minor to severe. Increases in landslide activity can result in more intense ground failure events, especially with the potential for climatic warming which can increase water available to drive landslide activities. If the atmosphere continues to warm, a higher frequency of atmospheric river events that bring moisture in larger quantities and duration compared to regular frontal rain events can be anticipated. More weather data collection and better weather models can provide better warning for these events.

4.1.5 Tsunami and Seiche

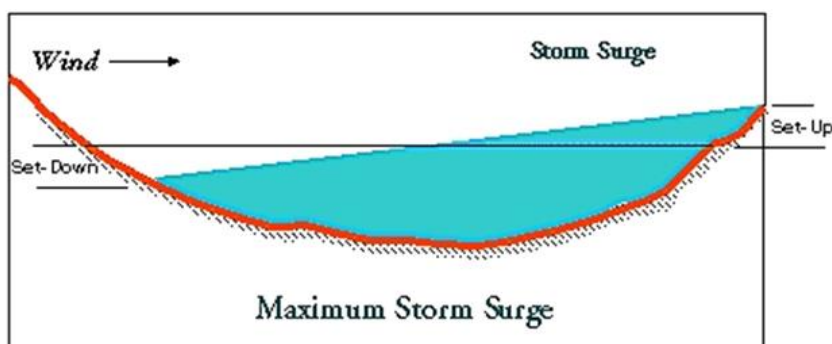
A tsunami is a series of waves in a water body caused by large, sudden water displacement (Figure 4.1.5-1). Subduction zone earthquakes, subaerial (land-based) and submarine landslides, volcanic eruptions, calving glaciers, underwater explosions, and even meteorite impacts have the potential to generate tsunamis. In Alaska, subduction zone earthquakes pose the primary tsunami threat.



Source: California Seismic Safety Commission, modified from How Stuff Works

Figure 4.1.5-1: Most Tsunamis Occur from Underwater Earthquakes

A seiche is a series of standing waves sloshing in a semi- or fully enclosed water body, typically caused when strong winds, rapid atmospheric pressure changes, earthquakes, tsunamis, or severe storm fronts “pile up” water on one end of the basin (Figure 4.1.5-2). When the driving force stops, the water rebounds to the other side of the enclosed area. The water then continues to oscillate back and forth for hours or even days. Because seiche waves are standing waves, they move vertically more than horizontally.



Strong storm winds blow across the lakes and “pile up” water on the downwind shore of the lake, resulting in wind set-up. On the opposing upwind shore, the storm surge lowers the water the exact amount that has risen at the downwind shore, resulting in a wind set-down. When the wind stops, the water sloshes back and forth.

Source: Michigan State University Department of Geography 2006

Figure 4.1.5-2: Storm Surges Can Cause Seiches in Large Lakes

Tsunamis are far more destructive than seiches in Alaska. In the last 60 years, Pacific plate subduction under the North American plate has resulted in numerous great earthquakes and is the source of locally generated tectonic tsunamis that have killed more than 100 people and destroyed entire towns. Some previously inhabited areas are now permanently abandoned because of this threat. Alaska has an enormous amount of coastline and, in addition to local and distant tectonic tsunamis, there are other tsunami triggers that may occur without warning.

4.1.5.0 Characteristics/Nature/Type of Tsunami and Seiche Hazards

Many potential tsunami causes are present in Alaska. For example, submarine landslide-generated tsunamis threaten numerous communities where nearby rivers deliver fine-grained sediment into the ocean (e.g., Valdez, Seward, Whittier, Skagway, Haines, Juneau, and Wrangell). These locally generated tsunamis can make community landfall within minutes.

The National Tsunami Warning Center (NTWC), University of Alaska Fairbanks, Geophysical Institute (UAF/GI), the Alaska Division of Geological & Geophysical Surveys (DGGS), and emergency management offices primarily focus on seismically-induced tsunami waves because there is typically sufficient time to warn communities of the potentially pending danger. Tectonic tsunamis originating in the vicinity of the Aleutian Islands, Alaska Peninsula, and the Gulf of Alaska are of particular concern to Alaskans because waves can reach coastal communities within minutes to hours after the earthquake that caused them.

Tsunamis generated by subsea earthquakes exhibit long wave periods, can have wavelengths extending up to several hundred miles, and travel at speeds that can exceed 500 miles per hour in the open ocean. In contrast, a typical wind-generated wave may have a period of ~10 seconds and a wavelength of ~300 feet. A main difference between the tsunamis and wind-generated waves is that the latter are only surface disturbances and do not cause movement of water at the ocean bottom. Rather than resembling normal sea waves, a tsunami is like a rapidly fluctuating tide and, depending on the area in question, the fluctuations can persist for more than 24 hours. In the open ocean, the amplitude (height) of a tsunami may only be a few feet and, combined with wavelengths of hundreds of miles, is imperceptible to boaters. The word “tsunami” is Japanese for “harbor wave” because fisherman on the open ocean would not perceive a tsunami but would return to their harbors to discover they had been destroyed.

The energy of a tsunami wave train affects the entire ocean column from sea surface to sea floor. As the tsunami enters shallow water, the wave is forced to slow down, resulting in increased amplitude (height). The two mechanisms by which tsunamis cause damage are:

- The smashing force of incoming water as land is inundated and
- The destructive force of water draining off the land while carrying tremendous debris (even knee-deep tsunami water contains enough debris to make walking impossible).

Note that it is also important to consider the natural tidal fluctuations in an area: a 3-foot tsunami on a very low tide may go unnoticed, but the same 3-foot tsunami on a very high tide may cause significant damage.

Tsunamis are categorized according to the distance from source mechanism to inundation zone:

- Local Tsunami;
- Regional Tsunami; and
- Distant Tsunami.

A **Local Tsunami** is any tsunami inundation that occurs near the source. The total elapsed time from the source event to the community is usually less than 1 hour. Alaska local tsunami event sources include:

- Subduction zone earthquakes;
- Volcanic eruption or edifice collapse;
- Landslides;
- Glacial calving;
- Rockfalls; and
- Any combination thereof.

Recall that strong earthquake shaking can increase gravity-driven mass movement potential. If the source event is not immediately observed (e.g., underwater slope failure), there may be no warning. A local tsunami is likely to reach coastlines before an official evacuation notice can be made by the NTWC or local authorities. If a causative source event is observed or experienced (such as an earthquake so strong residents can barely remain standing), coastal residents and visitors will need to quickly self-evacuate without any additional warning.

A **Regional Tsunami** may travel 1 to 3 hours before reaching the community. This tsunami type allows for more accurate and timely evacuation notices.

A **Distant Tsunami**, also referred to as tele-tsunami, trans-Pacific, or ocean-wide tsunami, usually takes more than 3 hours to arrive. In many cases, tele-tsunamis allow for sufficient warning time and evacuation. Most tele-tsunamis reaching Alaska are not severely damaging, but waves of just a few feet can cause currents that make maritime navigation difficult to impossible and damage harbors and other infrastructure. For example, Massacre Bay on Attu Island has historically received tele-tsunamis with amplitudes of less than 1 foot. In one rare instance, the 1960 Chilean earthquake, Massacre Bay recorded a tsunami wave more than 6 feet in amplitude. This same tsunami damaged docks and pilings at MacLeod Harbor, Montague Island, and Cape Pole, Alaska.

A **Seiche** is a temporary water level oscillation within a fully or partially enclosed water body (e.g., a lake or fjord). “Seiche” literally means “to sway back and forth.” Seismic seiches are typically caused by earthquakes that result in vertical motions. It may be difficult to isolate a specific causative mechanism near an earthquake epicenter, as seismic waves, landslides (submarine or subaerial), tsunamis, and tectonic tilting all may play a role in water level disturbance. At greater distances (i.e., over 600 miles), seiches are generated mainly by seismic surface waves.

Seismic waves from the 1964 Great Alaska Earthquake were so powerful that they caused water bodies to oscillate at many places in North America. Although they had rarely been reported following previous earthquakes, seiches were recorded at hundreds of surface-water gaging stations; in fact, four seiches were observed in Australia. Some of the 1964 seiches were very large, waves as high as 6 feet were reported on the Gulf Coast of the U.S., probably because they were generated in resonance with the seismic surface waves.

4.1.5.1 Locations of Tsunami and Seiche Hazards

Alaska has a long tsunami history, as documented by both the geologic and historic record. Tsunami threats vary by location along the coastline, by distance from the tsunami source, and according to the type of disturbance that generates the tsunami. Communities located on the open coast of Alaska Peninsula, Aleutian Islands, and Southcentral Alaska all may experience local, regional, and distant tsunamis. Local landslide-generated tsunamis are more likely to occur near mouths of rivers draining into the ocean, glacial moraines, and other areas with high sedimentation rates. Even if there is no significant over-land inundation, tsunamis can generate dangerous ocean currents in narrow passages, straits,

breakwaters, and near the tips of peninsulas. Tsunami and Seiche Inundation Mapping has been completed for the following areas by the Alaska Earthquake Center and DHS&EM:

Table 4.1.5-1: Alaska’s Inundation Mapped Communities

Adak	Gustavus	Nanwalek	Saint Paul
Akhiok	Haines	Nelson Lagoon	Sand Point
Akutan	Homer	Nikolski	Sawmill Bay
Anchor Point	Hoonah	Old Harbor	Saxman
Atka	Hydaburg	Ouzinkie	Seldovia
Chenaga Bay	Jakalof Bay	Pasagshak	Seldovia Village
Chignik	Juneau	Passage Canal	Seward
Chignik Lagoon	Kachemak Selo	Pelican	Shemya
Chiniak	Karluk	Perryville	Sitka
Cold Bay	Kasaan	Platinum	Skagway
Cordova	Ketchikan	Point Baker	Tatitlek
Craig	King Cove	Port Alexander	Unalaska
Dillingham	Klawock	Port Graham	Valdez
Dutch Harbor	Kodiak	Port Lions	Whittier
Elfin Cove	Larsen Bay	Port Protection	Yakutat
False Pass	Metlakatla	Resurrection Bay	
Fox Islands	Mountain Point	Saint George	

Source: DGS 2022

4.1.5.2 History of Tsunami and Seiche Hazard Events

Given the extent and dynamic Hazard Characteristics of Alaska’s coastline, there are far too many tsunamis and seiches to document here. This section has been updated since the 2018 HMP. Some of the most notable and destructive historical tsunamis and seiches are described below.

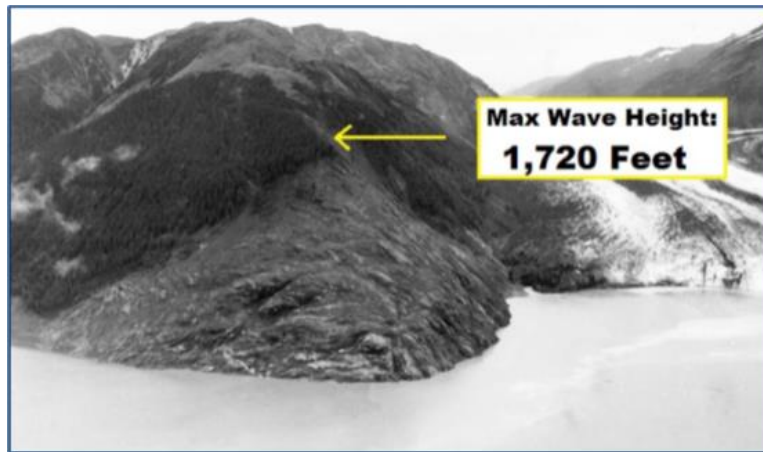
1883 Augustine Volcanic Tsunami. In 1883, the Augustine volcano erupted, causing a landslide and resulting debris flow-induced tsunami. The tsunami inundated Nanwalek (English Bay) and Port Graham with >20-foot tsunami waves.

1946 Unimak Island Earthquake Tsunami. An M8.6 earthquake occurred near Unimak Island on April 1, 1946. The resulting tsunami had a run-up of approximately 100 feet and destroyed the Scotch Cap lighthouse, a reinforced concrete structure. All five occupants and the lighthouse washed out to sea. The tsunami caused about \$250,000 in damages in Alaska, with widespread effects elsewhere. Relatively minor damage was reported in Washington and Oregon, as well as in French Polynesia and Chile. California suffered \$10,000 in damages and one death. Hawai’i was heavily impacted, with \$26 million in damages and 159 fatalities.

1957 Andreanof Islands Earthquake Tsunami. An M8.6 earthquake west of Unalaska generated <75-foot tsunami waves along Aleutian shores and a distant tsunami in Hawaii with maximum run-up of 53 feet. The tsunami event destroyed two bridges on Adak Island and damaged houses. On Unmak Island, tsunami waves destroyed part of the community dock. Additionally, Mount Vsevidof volcano erupted after being dormant for more than 200 years. The northwestern side of the Island of Kauai, Hawai’i, experienced more inundation and damage than the 1946 tsunami. The tsunami damaged boats and docks

in San Diego Bay, California, and reached Chile, El Salvador, and Japan. Although there were no reported fatalities from this event, the Hawaiian Islands suffered more than \$5 million dollars in damages.

1958 Lituya Bay Tsunami. A M 7.8 earthquake on the Fairweather fault triggered a landslide into the head of Lituya Bay in Glacier Bay National Park and generated a devastating tsunami. The wave traveled up the adjacent mountainside to a height of more than 1,720 feet (Figure 4.1.5-3). Two fishing vessels anchored in the bay were sunk, killing two people. A third boat was swept over the La Chaussee Spit and back into the bay, landing upright. Lituya Bay is a tsunami-prone area, and at least three other landslide-generated tsunamis have occurred there in the past. The 1958 earthquake triggered at least eight separate landslide-generated tsunamis, including the Yakutat Bay tsunami that caused three fatalities.



Trimlines along the bay that are still visible today. Source: USGS 1960

Figure 4.1.5-3: The 1958 Landslide-Generated Tsunami Wave in Lituya Bay

1964 Great Alaska Earthquake Tsunamis and Seiches. The 1964 Great Alaska Earthquake in Southcentral Alaska triggered several tsunamis, including one major tectonic tsunami and about 20 local submarine- and subaerial-landslide tsunamis. The tectonic tsunami hit 20–45 minutes after the earthquake, depending on location. The locally generated tsunamis struck between 1 and 5 minutes after earthquake initiation, arrived before the earthquake shaking had even stopped, and caused most of the deaths and damage. Tsunamis caused more than 90 percent of the deaths associated with this earthquake: 106 Alaskans and 16 California/Oregon residents were killed. Alaska’s damages were most extensive in Kodiak Island, Seward, Whittier, and Valdez, with significant tsunami damage throughout areas adjacent to the Gulf of Alaska.

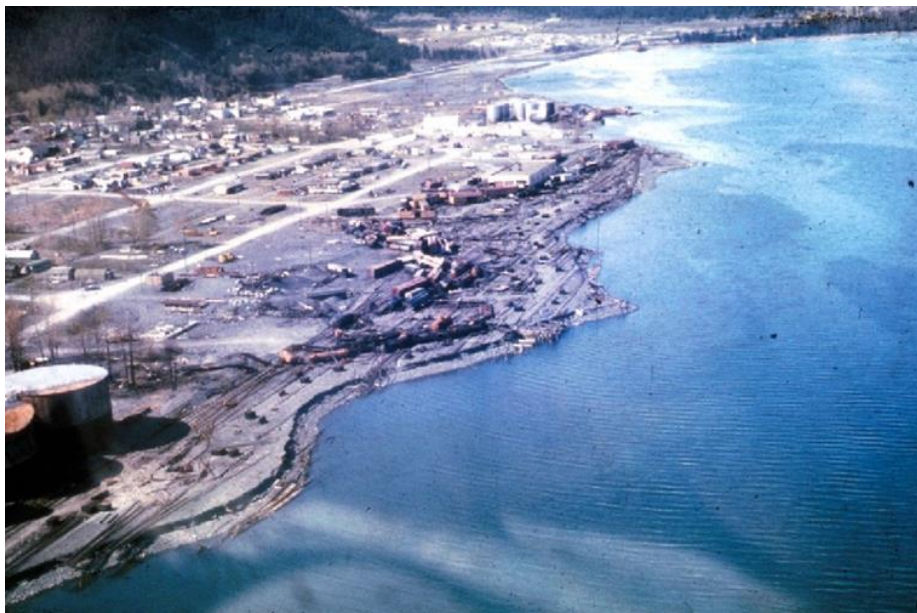
Kodiak: Witnesses to the Kodiak tsunami event observed ten waves that damaged or destroyed everything they reached, including the dock pier, roads, houses, and other facilities. They also destroyed the main electrical and water distribution systems. The tsunami caused \$31.3 million in damages, destroyed 80 percent of the city’s industrial base, and rendered 600 people homeless out of a population of 2,658. There were only six reported fatalities as most residents moved to high ground when they felt the earthquake (Figure 4.1.5-4).



Source: USGS 1964

Figure 4.1.5-4: 1964 Tsunami Damage Along the Kodiak Waterfront

Seward: The earthquake caused regional subsidence (approximately 4 feet) that exacerbated a local tsunami event. The local tsunami destroyed most of the facilities near the former shore, including a fuel tank farm that started the first of many fires. Additionally, the local tsunami spread floating, burning oil, which ultimately engulfed another large fuel tank farm further inland. The main dock collapsed with the waterfront and sank 30 fishing boats and 40 pleasure craft in the small boat harbor. The local tsunami also heavily damaged the railroad yards, moving a 120-ton locomotive 100 feet, and a 75-ton locomotive 300 feet (Figure 4.1.5-5). About 25 minutes after the earthquake and local tsunami event, the tectonic tsunami event arrived in Seward. The waves carried flaming oil and debris into Seward and set fire to a large section of the town. Overall, Seward lost about 95 percent of its industrial base and 15 percent of its residential properties. There were 12 fatalities, 200 injuries, and approximately \$14 million in damages.



A few months after the earthquake. Source: USGS 1964

Figure 4.1.5-5: 1964 Tsunami Damage in Seward

Whittier: A series of at least eight tsunami waves struck Whittier destroying two sawmills, the Union Oil Company, the Alaska Railroad depot, and several houses. The small boat harbor was also heavily

damaged. The tsunamis were responsible for 13 deaths and approximately \$10 million in damages in Whittier.

Chenega: The Native Village of Chenega was severely damaged by a tsunami. With 26 people killed, the community lost more than one-third of its population.

Valdez: Much like Seward, a portion of the Valdez waterfront slid into the bay during the earthquake, exacerbating a local tsunami. The earthquake and local tsunami heavily damaged or destroyed all structures near the former waterfront (Figure 4.1.5-6). Half of the downtown business district was destroyed, and fires burned uncontrolled for two weeks. Almost the entire town's fishing fleet (68 out of 70 boats) sank. The local tsunami swept away twenty-eight people gathered to watch a freighter unload. Shifting cargo in the freighter's hold caused additional fatalities.



The extent of inundation and destruction (dark area along the coastline) after the 1964 earthquake.
Source: USGS 1964

Figure 4.1.5-6: Aerial Image of Valdez, Alaska

1994 Skagway Tsunami and Seiche. On November 3, 1994, an underwater landslide collapsed a cruise ship wharf undergoing construction at the head of Taiya Inlet. The landslide generated a tsunami 9–11 meters high within the harbor, followed by a seiche, and resulted in one fatality and more than \$25 million in damages. The cause of the landslide is not definitively known, but extensive studies suggest that it was a result of several factors. Consensus is that an extreme low tide (1.2 meters below lower low water) triggered a submarine landslide in glacial sediments at the mouth of the Skagway River on the opposite side of the harbor, which had increased in volume due to recent flooding. This likely triggered the submarine failure of unstable sediments beneath the PARN dock, which at the time was undergoing major reconstruction and was storing 9,000 cubic yards of riprap material on the pier foundation.

Many Alaska communities are near historic tsunamigenic events that have occurred along the Aleutian Trench. The NTWC lists the following earthquake generated tsunamis with observed or measured tsunami waves that have occurred since 1996 with measurable inundation heights (Table 4.1.5-1).

Table 4.1.5-2: Alaska’s Tsunami Events Since 1996

Date	Location	Earthquake Moment Magnitude (MW)	Wave Height	Source	
			Ft/In M/Cm	Latitude	Longitude
June 10, 1996	Andreanov, Alaska	7.9	~ 3 Cm	51.593°	-51.593°
January 13, 2007	Kuril Islands	8.1	Undefined	46.230°	-154.550°
October 27, 2012	Queen Charlotte Island, (Haida Gwaii), BC	7.7	~6 Cm	52.788°	-132.101°
October 25, 2013	Honshu, Japan	7.1	<1 Cm	37.156°	-144.661°
January 23, 2018	Kodiak, Alaska	7.9	~10 Cm	56.046°	-149.073°

4.1.5.3 Extent of Tsunami and Seiche Hazards

The extent of tsunami and seiche impacts are dependent on the source, distance, and magnitude of original water displacement. Tsunami waves can travel thousands of miles, with speeds over 500 mph. Lituya Bay is the location of the world’s tallest tsunami recorded (1,720 ft). Additionally, tsunamis can travel inland as far as 10 miles, depending on the shape and slope of the shoreline. In January 2022, an undersea volcanic eruption in Tonga generated a tsunami that impacted Alaska’s coastline hours after the eruption, with waves up to 2.8 feet in King Cove and smaller waves in other communities.

Many communities believe their relatively protected location on the inward side of an island or at the head of a relatively shallow inlet—away from Aleutian Trench, Queen Charlotte Fault zone, or other open ocean created tsunami sources—would protect them from severe impacts. However, these perceived protected locations may be hit by significant waves propagating around the islands and through narrow channels. The 2011 Tohoku tsunami, originating in Japan, was registered both in Skagway and Juneau.

4.1.5.4 Impact of Tsunami and Seiche Hazards

Impacts associated with tsunamis and seiches can range from negligible to catastrophic and include injuries and deaths, disruption of power and services, disruptions of coastal fuel supplies, environmental damage from hazardous spills, and damages to buildings and infrastructure. Disruption to fresh water supplies, contaminated materials displacement, and damages associated with significant debris moving inland are also of concern. Alaska is subject to diverse tsunami impacts from a multitude of tsunamigenic sources. Potential impacts of tsunamis on Alaska communities are described in a series of modeling and mapping reports, which are available at the DGGs website (<https://www.dggs.alaska.gov/pubs/tsunami>). Digital data from these reports are available at (<https://dggs.alaska.gov/pubs/project/98>). Potential impacts span the entire range of possibilities from a barely detectable tsunami to completely destructive.

4.1.5.5 Probability of Tsunami and Seiche Hazards

Because tsunamis and seiches that affect Alaska’s coast can be generated by several phenomena, none of which themselves can be predicted, it is impossible to define a recurrence probability for tsunamis. However, due to the active geology of Alaska, it is highly likely that there will be tsunamis in the future.

4.1.5.6 Projected Changes in Locations of Tsunami and Seiche Hazards

Tsunami and seiche threats vary by location along the coastline, by distance from the tsunami source, and according to the type of disturbance that generates the tsunami. Communities located on the open coast of Alaska Peninsula, Aleutian Islands, and Southcentral Alaska all may experience local, regional, and distant tsunamis. Local landslide-generated tsunamis are becoming increasingly of concern and are more likely to occur near mouths of rivers draining into the ocean, glacial moraines, retreating glaciers, and other areas with high sedimentation rates.

4.1.5.7 Range of Anticipated Intensities of Tsunami and Seiche Hazards

Tsunami and seiche inundation are dependent on many factors, including the nature of the wave and the nature of the impacted shoreline. Inundation maps for many Alaska communities are available at the DGGS website (<https://www.dggs.alaska.gov/pubs/tsunami>). Tsunami and seiche events may result in little to no water displacement with barely recordable changes to wave height to catastrophic events with waves measuring over 1,000 feet in height, speeds up to 500 mph, and traveling inland up to 10 miles.

4.1.5.8 Frequency of Tsunami and Seiche Hazards

Tsunami and seiche frequency are dependent on many variables and cannot be predicted. There have been five notable earthquake-generated tsunamis recorded in Alaska since 1996 (Table 4.1.5-1).

4.1.5.9 Duration of Tsunami and Seiche Hazards

Tsunami and seiche modeling results for many Alaska communities are available at the DGGS website (<https://www.dggs.alaska.gov/pubs/tsunami>). The first wave may take hours to arrive at a location, and subsequent waves may continue to significantly impact a community for 12 hours or more.

4.1.5.10 Future Conditions for Tsunami and Seiche Hazards, Including Climate Change

4.1.5.10.1 Characteristics/Nature

Local tsunamis and seiches due to subaerial slope failures are expected to become more common with changing climate. Retreating glaciers, thawing alpine permafrost, and increased rainfall all contribute to unstable slopes that may cause a tsunami if landslides or rockfalls enter a body of water.

4.1.5.10.2 Location

Local tsunamis and seiches are anticipated to become more of a concern in Southeast Alaska due to glacier retreat in fjords associated with climate change. Glacier ice provides lateral support for over steepened, ice-scoured slopes; when glaciers retreat, these slopes can destabilize.

4.1.5.10.3 Range of Anticipated Intensities

Tsunami and seiche intensities are not anticipated to change due to climate change.

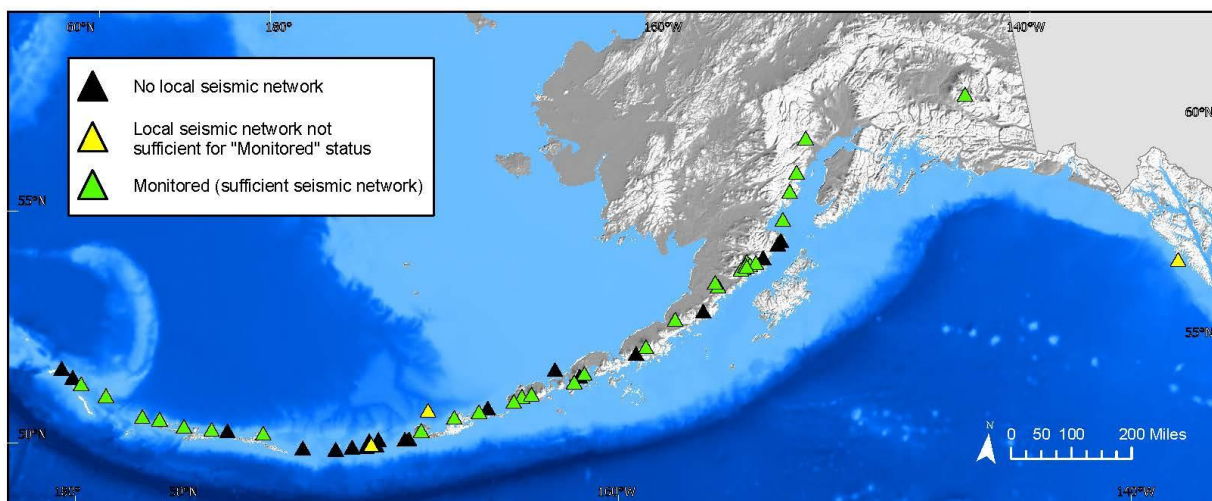
4.1.6 Volcano

4.1.6.1 Characteristics/Nature/Type of Volcano Hazards

Volcanoes are openings on the earth's surface where magma and gases escape from the subsurface. Lava flows and rock fragments (tephra) that erupt from the openings, or vents, build the landforms we know of as volcanoes.

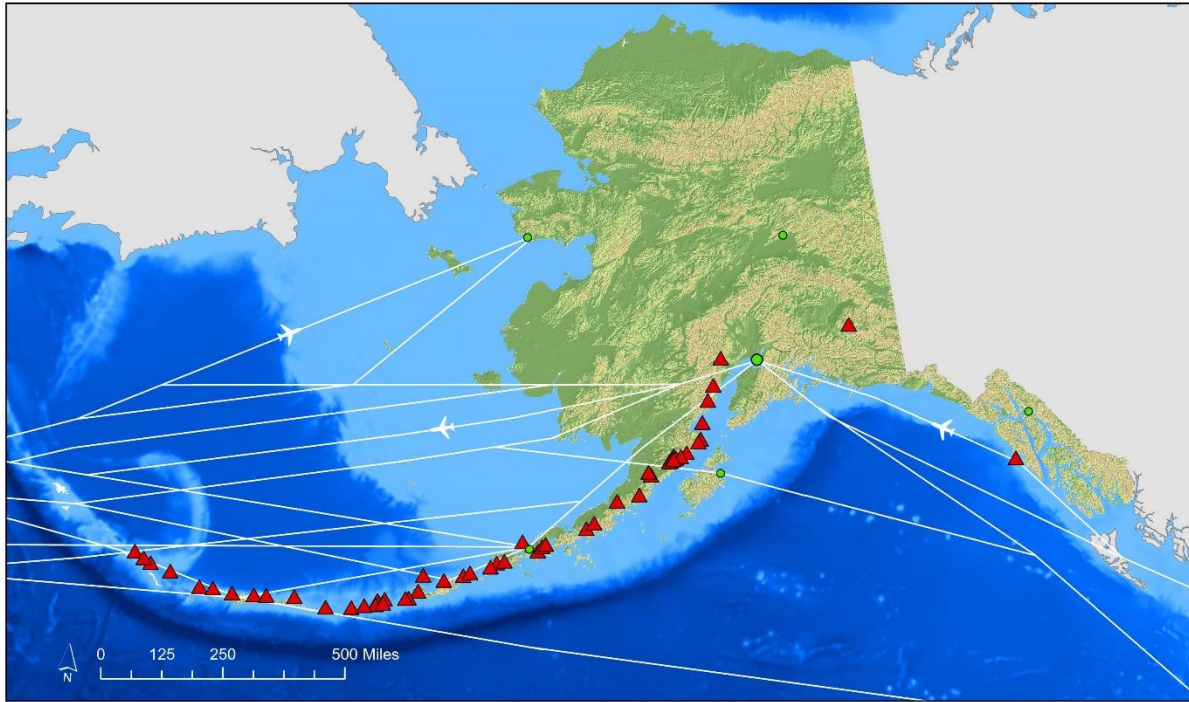
Volcanoes are surface expressions of larger systems of underground pathways and storage regions in the earth's crust containing hot (1,200–2,200°F) and variably molten rock called magma. In the deep crust, many tens of miles underground where magma originates, magma is less dense and more buoyant than the surrounding rock, which deforms plastically around the ascending magma. In shallower and cooler regions of the crust, magma ascent likely occurs within fractures of cooler rock forced open by pressure associated with escaping magmatic gases. Although volcanic eruptions represent the relatively rare arrival of magma to the earth's surface (Alaska averages about two eruptions per year), it is likely that underground pathways and storage regions are utilized for long periods of time, allowing some volcanoes to erupt similar compositions of magmas over their lifetimes.

The Alaska landscape continues to be profoundly shaped by volcanic processes. During the last 2 million years, at least 130 volcanoes or volcanic fields have been active within the state. Of these volcanoes, about 100 have been active within the last 10,000 years (and might be expected to erupt again), and at least 50 have been active since about 1760 (Figure 4.1.6-1). These youngest volcanoes stretch primarily from the Cook Inlet Region to the western Aleutian Islands but are also found in the Wrangell Mountains and in southeast Alaska (Mount Edgecumbe). In 1912, the largest eruption of the 20th century occurred at Novarupta-Katmai, located in what is now Katmai National Park and Preserve on the Alaska Peninsula. Volcanoes in Alaska have the potential to permanently displace entire communities and disrupt all modes of travel (Figure 4.1.6-2). In 2018, the US Geological Survey updated the national volcanic threat assessment as part of the National Volcano Early Warning System (NVEWS). The NVEWS threat ranking (<https://pubs.usgs.gov/sir/2018/5140/sir20185140.pdf>) places each volcano into one of five threat categories: Very High, High, Moderate, Low, and Very Low. Alaska has five volcanoes in the “Very High” threat category, 30 volcanoes in the “High” threat category, 30 in the “Moderate” threat category, 16 in the “Low” threat category, and 5 in the “Very Low” threat category.



Green triangles denote a volcano monitored by the Alaska Volcano Observatory with a ground-based seismic network; yellow indicates a volcano with at least one but fewer than four seismic stations; black volcanoes lack ground-based near-real time geophysical monitoring as of October 5, 2022. Source: DGGs/AVO 2022 (<https://www.avo.alaska.edu/>)

Figure 4.1.6-1: Alaska's Historically Active Volcanoes



Simplified illustration of approximate flights paths traveling over the historically active volcanoes of Alaska. Aircraft flying along these routes, some of the busiest in the world, carry more than 50,000 passengers and millions of dollars of cargo each day to and from Asia, North America, and Europe. Source: AVO 2022

Figure 4.1.6-2: Simplified Flight Paths of the North Pacific

The substantial amount of trans-Pacific and intrastate air traffic traveling directly over or near Alaska's volcanoes has necessitated developing strong communication and warning links between the Alaska Volcano Observatory (AVO), other government agencies with responsibility for aviation management, and the airline and air cargo industry. The Alaska Volcano Observatory coordinates an interagency plan for volcanic ash episodes for an integrated, multi-agency response to the threat of volcanic ash in Alaska. This plan details agency-by-agency roles and responsibilities during volcanic ash events and is supported by more detailed standard operating procedures maintained by each participating agency or operating unit. The plan is available here: <https://avo.alaska.edu/downloads/reference.php?citid=3996>.

As of October 2022, the Alaska Volcano Observatory (AVO) maintains monitoring networks on 33 of Alaska's active volcanoes (Figure 4.1.6-1). Data from these networks includes seismic, infrasound, and ground deformation information that is recorded and examined for precursory or ongoing signs of eruptive activity. In addition, AVO also examines satellite and webcam images of all Alaskan volcanoes at least once a day for signs of eruptive activity, ash clouds, or possible precursory ground heating. The combination of these methods is critical to AVO's capacity to assess volcanic activity accurately and continually.

4.1.6.2 Volcanic Landform Types

Volcanoes display a wide variety of shapes, sizes, and behavior. However, they are commonly classified among five main landforms: cinder cone (scoria cone), shield, lava dome, composite (stratovolcano or stratocone), and caldera (Figure 4.1.6-3).

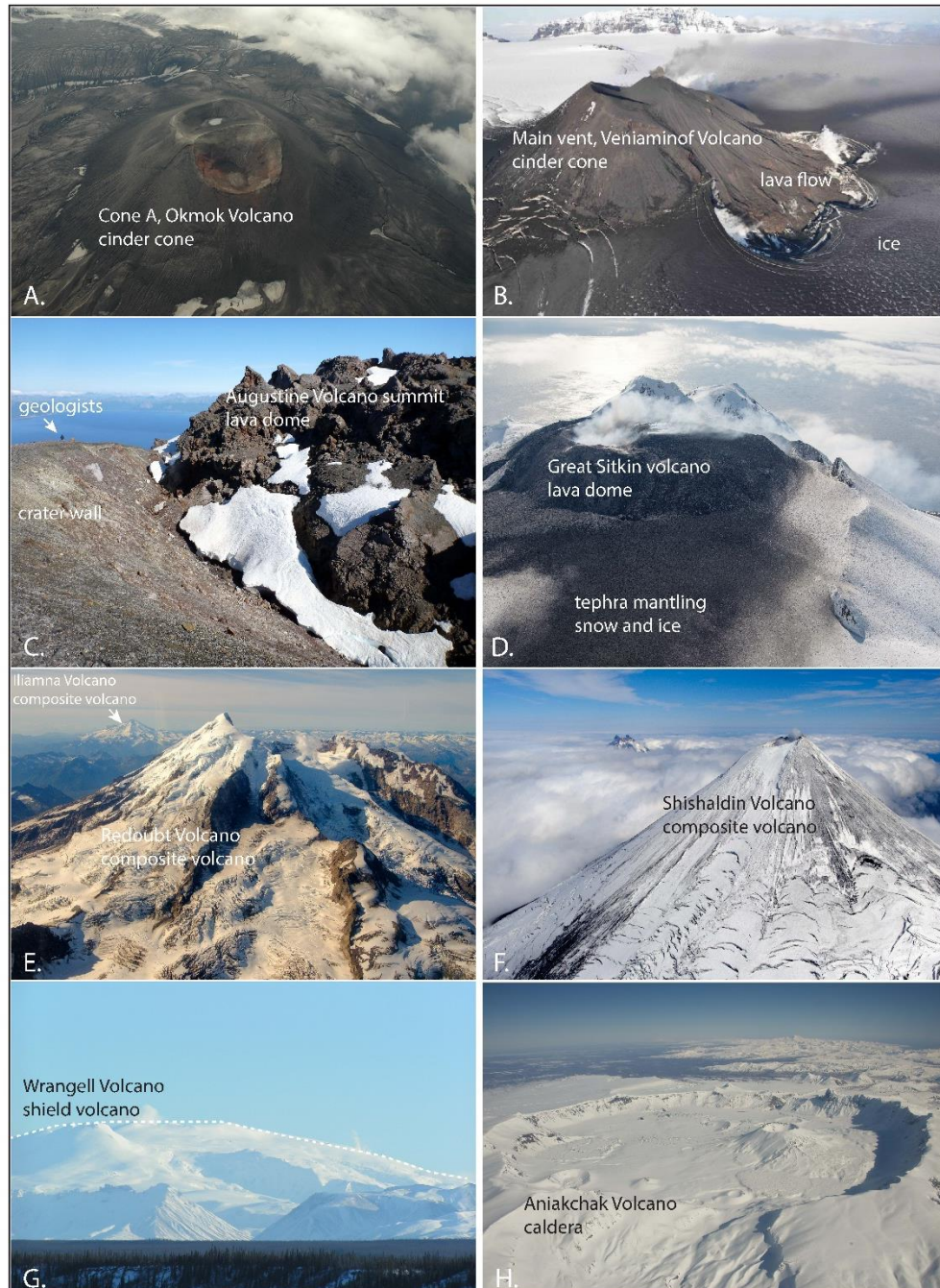


Figure 4.1.6-3: A: The Cone A cinder cone located within Okmok caldera, Umnak Island (Source: AVO/UAF-GI, URL: <https://www.avo.alaska.edu/images/image.php?id=25832>; B: the active cinder cone located in Veniaminof volcano, Alaska Peninsula (Source: AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=56231>; C: the 2006 lava dome at the summit of Augustine Volcano, Cook Inlet (Source: AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=110361>); D: the 2021 lava dome at Great Sitkin Volcano (Source: AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=170601>); E: composite volcanoes Redoubt and Iliamna, Alaska Peninsula (Source: AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=127911>); F: composite volcano Shishaldin on Unimak Island (Source: AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=118571>); G: shield volcano Wrangell (Source: Suzanne McCarthy, URL: <https://www.avo.alaska.edu/images/image.php?id=13214>); and H: the caldera of Aniakchak on the Alaska Peninsula (Source: Roy Wood, NPS, URL: <https://www.avo.alaska.edu/images/image.php?id=56664>).

Figure 4.1.6-3: Examples of Volcano Types in Alaska

Cinder cones (also called scoria cones) form when molten lava is ejected in poorly explosive and pulsatory eruptions from a single vent (Figures 4.1.6-3A and B). As the molten lava erupts and spews into the air, it disaggregates into smaller fragments that cool and solidify into volcanic ash, lapilli, and bombs that fall back and accumulate around the vent. Cinder cones are often circular or oval cones composed of unconsolidated tephra. Many cinder cones have a bowl-shaped crater at the summit and rise a few hundred feet above the surrounding ground surface. Cinder cones are rarely more than a thousand feet tall. Most cinder cones form during eruptions that last for days or weeks, although some cinder cone eruptions can last for months or even years. Cinder cones can form in groups of other cinder cones and associated lava flows called volcanic fields. Examples of volcanic fields dominated by cinder cones and lava flows in Alaska include the Ingakslugwat Hills volcanic field near Newtok, the St. Michael volcanic field near St. Michael, and the Imuruk volcanic field in the Bering Land Bridge National Preserve. Other cinder cones form within larger volcanoes, such as at Aniakhchak, Veniaminof, Okmok, and Wrangell volcanoes.

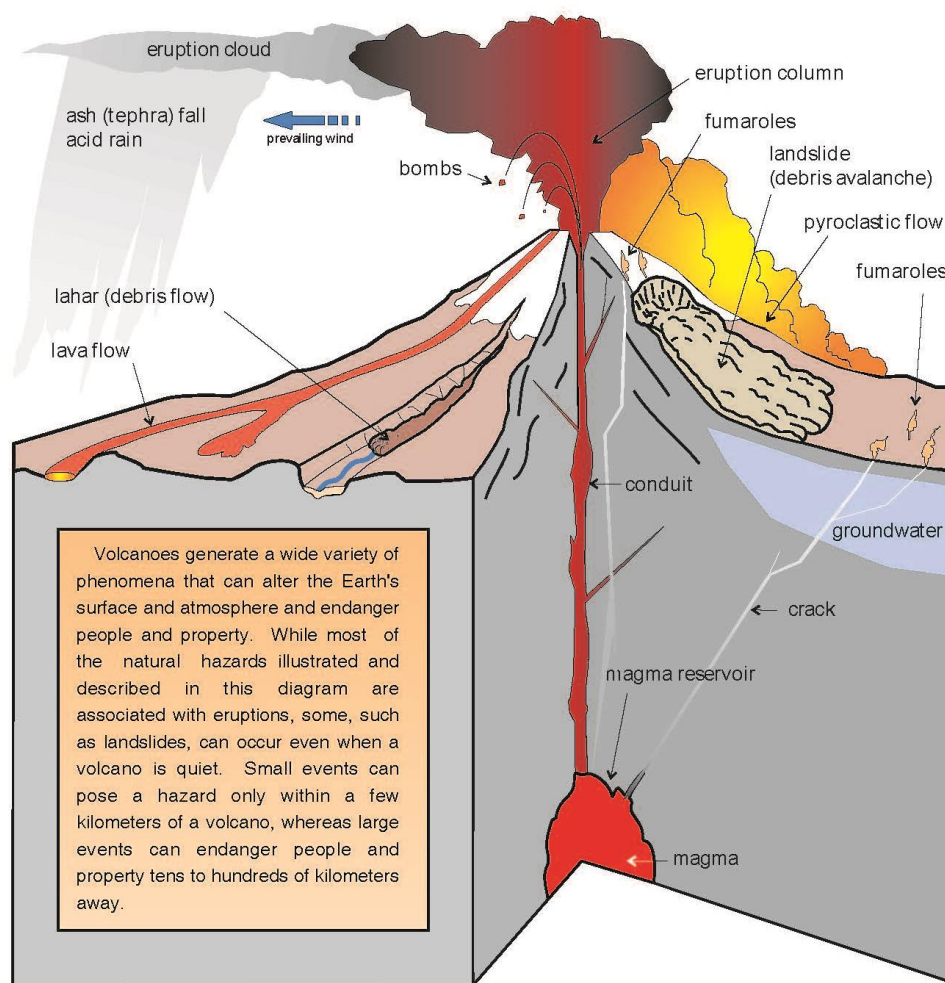
Lava domes form through the slow effusion of viscous lava from a vent (Figures 4.1.6-3 C and D). The high viscosity of the erupting lava, due to its high concentrations of silica, prevents it from flowing very far away from the vent. Instead, these sticky lavas pile up around the vent and form mound-like shapes that appear as a pile of unstable rubble. Lava domes often occupy summit craters of large composite volcanoes, such as Redoubt Volcano. Lava dome-building eruptions, like the 1989–1990 and 2009 eruptions of Redoubt, are dynamic in that the style of eruption can oscillate between periods of quiescent effusion of a viscous lava dome punctuated by periods of highly explosive eruptions capable of generating pyroclastic ash clouds and pyroclastic density currents. The 2009 eruption of Redoubt produced many lava domes, the largest one measuring 3,300 feet (1,000 meters) in length, 1,640 feet (500 meters) in maximum width, and at least 650 feet (200 meters) thick. The total volume of this 2009 Redoubt lava dome would fill more than 500 Conoco-Phillips buildings—at 300 feet (90 meters), the tallest structure in Anchorage. Augustine Volcano is an aggregate of multiple lava domes that emplaced and repeatedly collapsed over the past ~2,000 years. The Novarupta lava dome, measuring 800 feet (240 meters) across and 200 feet (60 meters) high, formed immediately after the explosive and voluminous June 6–9, 1912, Novarupta-Katmai eruption.

Composite volcanoes, sometimes called stratovolcanoes, are typically steep-sided, symmetrical cones of large dimension built by layers of lava, ash, and cinders (Figures 4.1.6-3 E and F). Composite volcanoes tend to erupt repeatedly from the same vent over hundreds of thousands of years. Eruptions from composite volcanoes vary in style, from effusive eruptions characterized by lava flows to explosive and violent eruptions that produce ash clouds and pyroclastic density currents. Factors like the viscosity of the erupting magma, the concentration of dissolved gasses in the erupting magma, and the rate that magma ascends to the surface prior to and during eruption all influence their eruptive style. Most Alaska volcanoes are the composite type, including those in Cook Inlet, like Iliamna Volcano, Redoubt Volcano, and Mount Spurr.

Shield volcanoes form gradually over long periods of time through voluminous eruptions of thin, fluid, and mafic lava flows (Figure 4.1.6-3 G). The low viscosity of these lava flows allows them to travel far from vent, which results in the broad and gently sloping shape of shield volcanoes. Many shield volcanoes have small cinder cones form on their flanks. The Hawaiian Islands are well-known examples of shield volcanoes. Mount Wrangell, Yunaska volcano, and Westdahl volcano are examples of shield volcanoes in Alaska.

Calderas are volcanic depressions that form when the ground surface that overlies a magma reservoir subsides during a volcanic eruption (Figure 4.1.6-3 H). They differ from craters, which form as material erupts out and away from a volcanic vent. Caldera-forming eruptions are among the largest and most destructive eruptions on earth, and many volcanoes in Alaska exhibit evidence of having explosive eruptions large enough to destabilize the underlying magma reservoir and form a caldera (Figure 4.1.6-3 H). Both Aniakhchak volcano and Veniaminof volcano, each located on the Alaska Peninsula, produced at least two caldera-forming eruptions over the past 10,000 years. The caldera at the summit of Mount Katmai is Alaska's youngest caldera owing to its formation during the 1912 Novarupta-Katmai eruption.

Volcano Hazards. Volcanoes produce a wide variety of hazards (Figure 4.1.6-4) that can kill people and destroy property. Large explosive eruptions can endanger people and property hundreds of miles away, and even affect global climate. Some volcanic hazards, such as landslides, can occur even when a volcano is not erupting.



Source: USGS 2018

Figure 4.1.6-4: Simplified Sketch of a Stratovolcano and Associated Eruption Hazards

The major volcanic hazards are shown in Table 4.1.6-1.

Table 4.1.6-1: Major Volcanic Hazards

Volcanic ash cloud	Lahar	Lava flow
Volcanic ashfall	Pyroclastic density current	Ballistics
Volcanic gases	Debris avalanche	Directed blast
Acidification	Rockfall and landslide	Tsunami

A **Volcanic Ash Cloud** (referred to as eruption cloud and eruption column in Figure 4.1.6-4) is created when volcanic ash is explosively blasted into the atmosphere during an eruption and then drifts away from the volcano with the wind (Figures 4.1.6-5 A and B). This is Alaska's principal volcanic hazard associated with explosive eruptions. Ash-rich clouds produced during large eruptions can reach heights of 30,000 to 65,000 feet or more above the volcano, although most Alaska eruptions are smaller (a few thousand feet to 20,000 feet). Prevailing North Pacific winds usually carry ash clouds eastward from the volcano, but dispersal in other directions is possible depending on wind patterns at the time of the eruption.

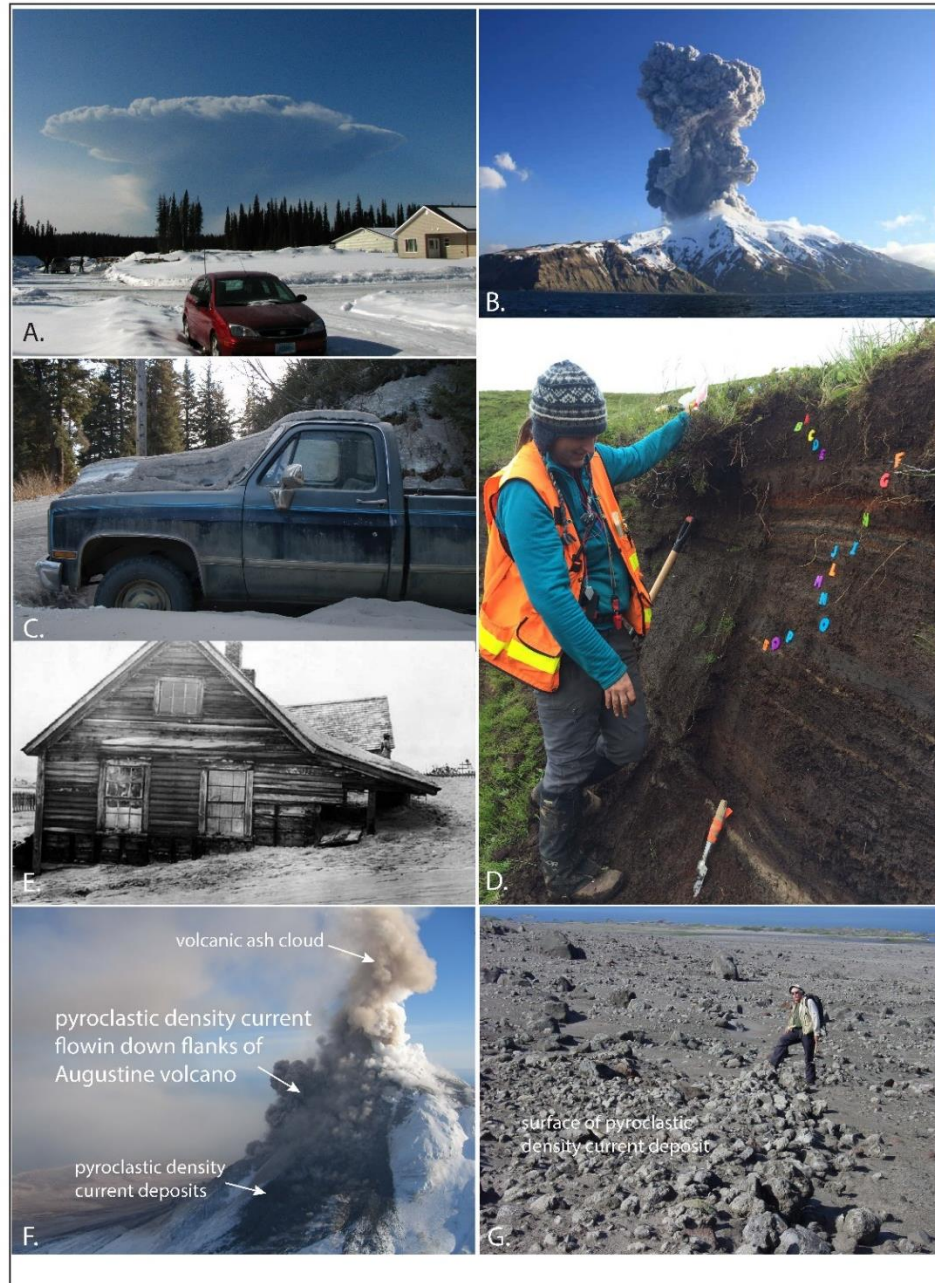


Figure 4.1.6-5 A: volcanic ash cloud from March 28, 2009 eruption of Redoubt volcano viewed from Soldotna (source: Tricia Jay Sadler, url: <https://www.avo.alaska.edu/images/image.php?id=17337>); B: volcanic ash cloud from May 25, 2021 eruption of Great Sitkin Volcano (Source: Lauren Flynn, U.S. Fish and Wildlife Service, url: <https://www.avo.alaska.edu/images/image.php?id=169841>); C: ashfall in Seldovia from March and April 2009 eruptions of Redoubt volcano (Source: AVO/USGS, url: <https://www.avo.alaska.edu/images/image.php?id=17927>); D: an exposure of numerous historic and prehistoric ashfall deposits north of Pavlof and Pavlof Sister volcanoes (Source: AVO/ADGGS, url: <https://www.avo.alaska.edu/images/image.php?id=118421>); E: a building in Kodiak partially buried by volcanic ashfall following the 1912 eruption of Novarupta/Katmai (Source: Amelia Elkinton Collection, accession number UAF-1974-175-399, Archives, Alaska and Polar Regions Collections, Rasmuson Library, UAF; <https://vilda.alaska.edu/u/?cdmg11,1191>); F: Photo of a volcanic ash cloud and a pyroclastic density current flowing down the northeast flank of Augustine volcano acquired during an observation flight on March 6, 2006 (Source: G. Tytgat, AVO/UAF-GI, url: <https://www.avo.alaska.edu/images/image.php?id=8374>); G: Surface of a deposit emplaced by a pyroclastic density current on the north flank of Augustine volcano during the 2006 eruption (Source: K. Bull, AVO/ADGGS, url: <https://www.avo.alaska.edu/images/image.php?id=11914>).

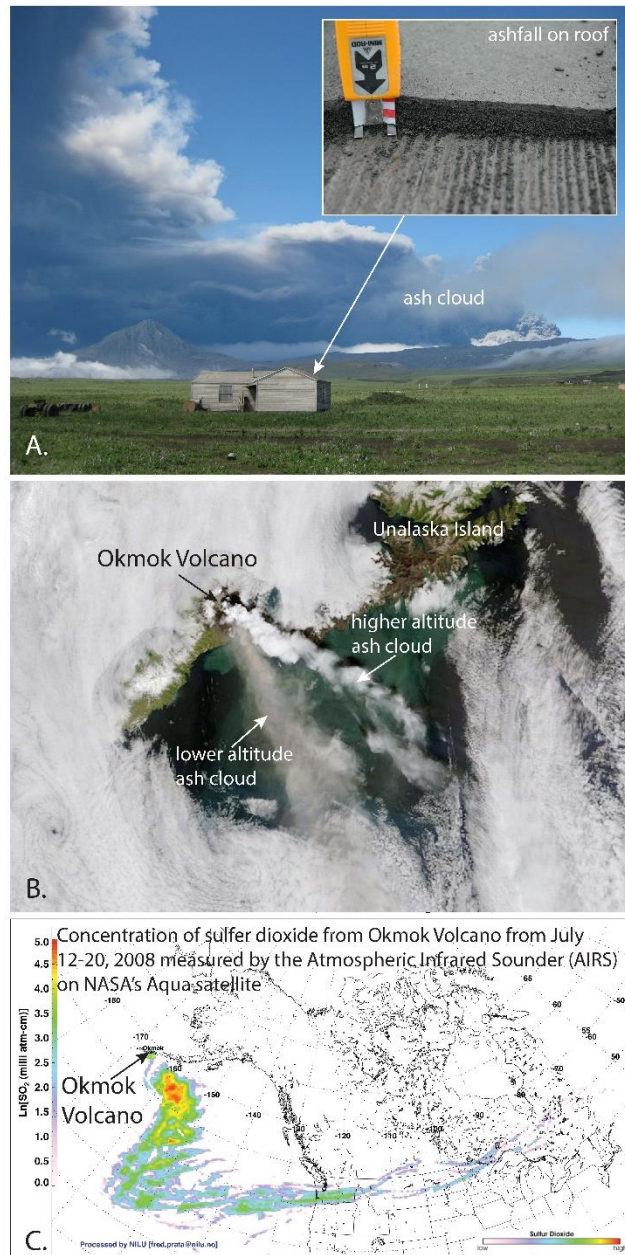
Figure 4.1.6-5: Hazards Associated with Volcanic Ash Clouds in Alaska

Alaska airspace is extremely busy with long-range, wide-body aircraft, as well as smaller aircraft like regional and bush planes. The Ted Stevens Anchorage International Airport is the fourth-busiest cargo airport in the world. More than 50,000 people fly over or very near Alaska volcanoes as they travel the North Pacific (NOPAC) and Russian Far East air routes. Alaska's unique geographic location generates high air traffic volume—all direct air routes between the U.S. (even Los Angeles and New York) and Asian cities, such as Tokyo and Hong Kong, pass along the NOPAC routes. Most of the aircraft carrying freight between Europe and Asia come through Alaska for refueling, so a considerable percent of all air freight on earth passes near Alaska's many volcanoes (Figure 4.1.6-2).

Encounters between aircraft and volcanic ash are serious because the ash can cause severe damage to the engines as well as other parts of the airplane. Volcanic ash is abrasive and melts at the high operating temperatures of modern jet engines. When ingested into a jet engine, volcanic ash erodes turbine blades, and the melted ash can adhere to critical parts, causing engine failure. Any forward-facing surface of an airplane engulfed in a volcanic ash cloud is likely to be eroded, including the cockpit and forward cabin windows and landing-light covers. Cockpit windows may be abraded enough to diminish forward visibility, and ash entering sensitive electronics can interfere with navigation and other onboard systems. As a result of electrical disturbances within the ash cloud, a flight crew may additionally lose the ability to transmit a distress call. Sulfur and other gases released in large eruptions also affect aircraft and their occupants. Acidic aerosols formed by the hydration of these volcanic gases produce a corrosive mist that may cause respiratory problems for passengers and flight crews and accelerate deterioration of vulnerable aircraft components. More than 80 aircraft-volcanic ash encounters worldwide have resulted in damage to aircraft since 1953. Nine of these encounters resulted in engine shutdown during flight.

Alaska's most serious ash-aviation incident took place on December 15, 1989, when a Boeing 747-400 aircraft temporarily lost power to all four engines after encountering an ash cloud from Redoubt volcano as the airplane descended for a landing in Anchorage. After steeply gliding through a descent of more than 14,000 feet, the pilot was able to restart the engines and land safely in Anchorage. While there were no injuries to passengers, the damage to engines, avionics, and aircraft structure from this encounter was estimated at \$80 million in 1990 dollars. Recent eruptions of Alaska volcanoes have resulted in numerous flight delays and cancellations for regional and international flights, including eruptions of Augustine Volcano in 2005, Kasatochi volcano in 2008, Redoubt Volcano in 2009, multiple Pavlof Volcano eruptions, and Bogoslof Volcano in 2016 and 2017.

Another example in Alaska that illustrates aviation impact was the 2008 Okmok Volcano eruption on Umnak Island in the Aleutian Islands. On July 12, 2008, Okmok erupted explosively, sending ash to 50,000 feet (Figure 4.1.6-6). During successive eruptions over five and a half weeks, the residents of Nikolski were stranded due to flight cancellations. Unalaska/Dutch Harbor (65 miles northeast) was dusted with ash on several occasions, causing outbound flights to be grounded and inbound flights to be diverted elsewhere. This eruption also produced a plume of sulfur dioxide that reached altitudes of around 10 miles and drifted south over the Pacific Ocean before moving east over the northern regions of the contiguous United States and southern Canada (Figure 4.1.6-6 C).



A: August 3, 2008 volcanic ash cloud viewed from Fort Glenn, Bering Pacific Ranch, on the eastern flank of Okmok volcano (Source: J. Larsen, AVO/UAF-GI, url: <https://www.avo.alaska.edu/images/image.php?id=15391>) with inset image showing July 12, 2008 ashfall on roof of building near the dock east of Fort Glenn ranch house (Source: C. Neal, AVO/USGS, url: <https://www.avo.alaska.edu/images/image.php?id=15457>); B: Image of the volcanic ash cloud from Okmok volcano on July 13, 2008, captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite (Source: NASA image courtesy of MODIS Rapid Response Team, url: <https://earthobservatory.nasa.gov/images/20230/okmok-volcano-erupts>); C: Composite image showing the intensity and location of the sulfur dioxide plume from Okmok volcano between July 12-20, 2008 (Source: Fred Prata, NILU, url: <https://earthobservatory.nasa.gov/images/8939/sulfur-dioxide-from-okmok->)

Figure 4.1.6-6: Volcanic Ash Cloud Hazards from the 2008 Eruption of Okmok Volcano

Volcanic Ashfall is ash that falls to earth from an eruption cloud. The fragments in the ash cloud vary in size, and the heavier particles fall near the source while finer particles travel farther downwind. Transported ash will fall out of the cloud and accumulate on surfaces and structures, contaminate water sources, and infiltrate electronics and motors. The weight of significant accumulations may collapse structures and cause other damage. Chronic exposure to ash may be a significant public health hazard. Essential items, including dust masks, clean water, non-perishable food, and eye protection, are key in preparation, as significant ashfall may keep people housebound for extended time periods (Figures 4.1.6-5 and 4.1.6-6).

During the most recent eruptions in Alaska, communities have received no more than minor to trace amounts of ashfall (<1/4 in). Even small amounts of volcanic ash can have a significant impact. During the recent eruptions of Augustine, Spurr, and Redoubt volcanoes, in Cook Inlet, trace amounts of ash severely impacted Southcentral Alaska, especially the Kenai Peninsula, resulting in transportation delays; airport, school, and business closures; ash cleanup costs; degradation of power and water systems; and stockpiling of emergency supplies. Other recent impactful ashfalls include the 2008 eruption of Kasatochi, which deposited a small amount of ash on Adak, and the 2008 eruption of Okmok and the 2016–2017 eruption of Bogoslof, which both deposited trace amounts of ash on the community of Unalaska. Looking further back in time, the geologic record clearly shows that many Alaska communities are underlain by layers of volcanic ash from prehistoric eruptions.

The largest eruption of the twentieth century was the 1912 Novarupta-Katmai eruption on the Alaska Peninsula. This eruption produced ashfall as far away as Dawson City (Yukon, Canada), Ketchikan (Southeast Alaska), and Puget Sound in Washington. During the 3 days of the eruption, darkness and suffocating conditions caused by falling ash and sulfur dioxide gas immobilized the population of Kodiak, Alaska. Sore eyes and respiratory distress were rampant, and water became undrinkable. Radio communications were totally disrupted, and with visibility near zero, ships could not dock. Roofs in Kodiak collapsed under the weight of more than a foot of ash (Figure 4.1.6-5 E), buildings were wrecked by ash avalanches that rushed down from nearby hillslopes, and other structures burned after being struck by lightning from the ash cloud. Similar conditions prevailed elsewhere in southern Alaska, and several villages were abandoned forever. Within 50 miles of the erupting vent, animal and plant life was decimated by ash and acid rain. Bears and other large animals were blinded by ash and starved when large numbers of the plants and small animals they lived on were wiped out. Millions of dead birds that had been blinded and coated by volcanic ash littered the ground. Aquatic organisms, such as mussels, insect larvae, and kelp, as well as the fish that fed upon them, perished in ash-choked shallow water. Alaska's salmon-fishing industry was devastated, especially from 1915 to 1919, because of the starvation and failure of many adult fish to spawn in ash-choked streams. Even today, more than 100 years after this eruption, ash from the 1912 eruption is remobilized by winds and poses a potential problem to aviation, as well as a possible health hazard to people living on Kodiak Island.

Volcanic Gases are released by both historically active and older volcanoes (e.g., Figure 4.1.6-7 C). Volcanic gases are dissolved in the magma when stored under pressure but are released to the atmosphere during eruptions or through passive degassing activity. The gases consist largely of water vapor (>80% by volume) and carbon dioxide (CO₂) (~10% by volume). Smaller concentrations of sulfur dioxide (SO₂), hydrogen sulfide (H₂S), and chlorine compounds are also emitted to the atmosphere from volcanoes.

Large explosive eruptions can deliver volcanic gases, aerosol droplets, and ash to stratospheric altitudes, often in a short period of time, causing a variety of atmospheric perturbations. One example is acid rain, which is produced when high concentrations of volcanic gases are leached out of the atmosphere. Acid rain can affect vegetation, livestock, humans, infrastructure, and machinery. Another example is the release of SO₂, which oxidizes to form sulfuric acid within a few weeks of eruption and, together with atmospheric water vapor, produces sulfate aerosol. These aerosols increase the reflection of radiation from the Sun back into space, cooling the earth's lower atmosphere while warming the stratosphere. Some large volcanic eruptions result in minor climatic or chemical effects. Gases can also collect and concentrate in topographic lows where they form corrosive acidic mists that irritate eyes and respiratory systems.



Photos showing effects of acidification. A: View of Indecision creek downstream of Chiginagak volcano flowing from the right side of the image has a pH of 1.2. Note damaged brown vegetation along valley margins resulting from 2005 acidic lake floor from Chiginagak Volcano (Source: Cyrus Read, AVO/US Geological Survey image URL: <https://www.avo.alaska.edu/images/image.php?id=10589>). B: Aerial view of iron oxide plume in Mother Goose Lake, which Indecision Creek flows into (Source: Paul Tickner, AVO-UAF image URL: <https://www.avo.alaska.edu/images/image.php?id=4258>). C: Orange colloidal iron-oxides found along the shore of acidified Mother Goose Lake, August 2005. (Source: Paul Tickner, AVO-UAF image URL: <https://www.avo.alaska.edu/images/image.php?id=4262>).

Figure 4.1.6-7: Photos Showing Effects of Acidification

Acidification occurs when a large amount of volcanic gas is dissolved in a water body, producing a highly acidic water volume. Vegetation and wildlife can be greatly affected by this contaminated water source. Acidified water may be transported great distances from the original source.

Between November 2004 and early May 2005, magmatic heat within Chiginagak volcano melted ice and snow on the summit, filling the crater with acidified water. In early May 2005, the water overtopped the crater wall at the base of the summit glacier, and the acidic water and sulfurous debris flowed 17 miles downslope and into Mother Goose Lake, the headwaters of the King Salmon River. The flow killed all

vegetation in its path and all aquatic life in the lake, preventing the annual salmon run (Figure 4.1.6-7). Fishing lodges and guide services in the area lost revenue. Scientists from various government agencies studied the event, and the Alaska Volcano Observatory deployed a data-logging seismometer for about 1 month but recorded no significant seismicity.

Lahar is an Indonesian term describing a mixture of water and rock fragments flowing down the slopes of a volcano and/or river valleys. Sometimes called volcanic mudflow, a moving lahar looks like a mass of wet concrete consisting of rock debris ranging in size from clay to boulders more than 30 feet in diameter. Lahars vary in size and speed. Small lahars less than a few yards wide and several inches deep may flow a few feet per second. Large lahars hundreds of yards wide and tens of feet deep may flow several tens of feet per second; much too fast for people to outrun. They form in a variety of ways but are routinely associated with volcanic eruptions (Figure 4.1.6-8). Lahars may also form from intense rainfall on loose volcanic rock deposits, breakout of a lake dammed by volcanic deposits, or water-saturated debris avalanches.



A: Gray mud, boulders, and debris from the April 4, 2009, lahar and flood in Drift River Valley, downslope of Redoubt Volcano. Note prominent tree scars, and diffuse mud line (arrow) that is up to 3 feet higher than the tree scars (Source: Chris Waythomas, AVO-UAF 2009. Image URL: <https://www.avo.alaska.edu/images/image.php?id=18367>).
B: Lahar and flood deposits spreading across the fan at the mouth of Drift River Valley near Redoubt Volcano on March 23, 2009 (Source: Cyrus Read AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=17011>).
C: View west of the runway, helipad, and service buildings at the Drift River Oil Terminal near Redoubt Volcano on March 23, 2009. The lahar deposit is at least half a meter thick at the buildings. (Source: Cyrus Read AVO/USGS, URL: <https://www.avo.alaska.edu/images/image.php?id=16988>)

Figure 4.1.6-8: Photos of Lahar Deposits in Alaska

Lahars are common in Alaska due to the abundance of volcanoes capped with snow and ice. When there is thermal activity at a volcano (either above or below the surface), there is potential for substantial melting, producing large water volumes. This water can cause floods or can mix with sediment, ash, and other deposits to form lahars, debris flows, and mud flows.

Pyroclastic Density Currents, or “pyroclastic flows” are hot ground-hugging mixtures of gas, ash, and rock that typically travel at speeds of more than ~50 mph (~80 km/hr) and at temperatures ranging from ~400°F to 1300°F (200°C to 700°C). They are among the most hazardous of volcanic phenomena. Pyroclastic density currents can form from explosions at a volcanic vent, collapse events on steep lava dome flanks, and collapse events of eruption columns. The velocity and flow behavior of pyroclastic density currents depend largely on their ratio of gas to solid particles (e.g., ash, crystals, rock). Pyroclastic density currents characterized by low gas to solid ratios tend to be slower and hotter, causing them to follow valleys and other low-lying terrain while incinerating and smothering everything in their path. These pyroclastic density currents can generate a tsunami if emplaced into lakes or the ocean. Pyroclastic density currents characterized by higher gas to solid ratios can travel at higher velocities (up to ~400 mph/650 km/hr) and surmount topographic obstacles such as ridges and hills.

Debris Avalanches occur when a mass of volcanic rock fragments and soil moving down a steep mountain slope or hillside behaves like a snow avalanche because of its high water content. They can happen without warning and travel quickly. The mass moves as a fluid and can attain speeds of 100 to 180 mph (160 to 290 km/hr). Their runout may extend many miles, and their high velocity and momentum allow them to cross valleys and run several hundred feet up the opposite slopes. Debris avalanches that occur near the coast can generate tsunamis if the debris advances into the water. Washington’s 1980 Mount St. Helens eruption began as the largest debris avalanche in recorded history. Large debris avalanche deposits are seen in the geologic record at several Alaska volcanoes, including Tanaga Volcano, Shishaldin Volcano, Okmok volcano, Yantarni Volcano, Augustine Volcano, Mount Spurr, and Iliamna Volcano.

Rockfalls and Landslides are volcanic hazards because many volcanoes, and especially caldera walls, are steep-sided and constructed of accumulated products from previous eruptions. This material can be poorly consolidated, heavily weathered, or altered due to volcanic gases, creating unstable slopes that are susceptible to collapse. Earthquakes near or associated with volcanoes can lead to increased rockfall, as well as increased landslide frequency and size.

Lava Flows, moving outpourings of molten rock (i.e., lava), commonly erupt from volcanoes in Alaska; however, due to their chemistry, they are typically slow moving and usually pose little hazard to humans. Explosions can occur when lava interacts with water, producing ash and other ballistics (e.g., lava or rock projectiles). Lava flows that encounter snow and ice can cause melting and result in lahars that travel down volcano flanks at high speeds.

Ballistics, lava or rock projectiles ranging in size from a few inches to tens of feet in diameter, can be produced by explosive volcanic eruptions. These objects usually land within about 3 miles of the vent. Ballistics can pose a substantial threat to humans and can cause considerable damage. Eruptions that involve magma and water interaction are especially capable of producing ballistics. As hot material comes into contact with water, violent steam explosions will shatter rocks and throw ballistics into the air.

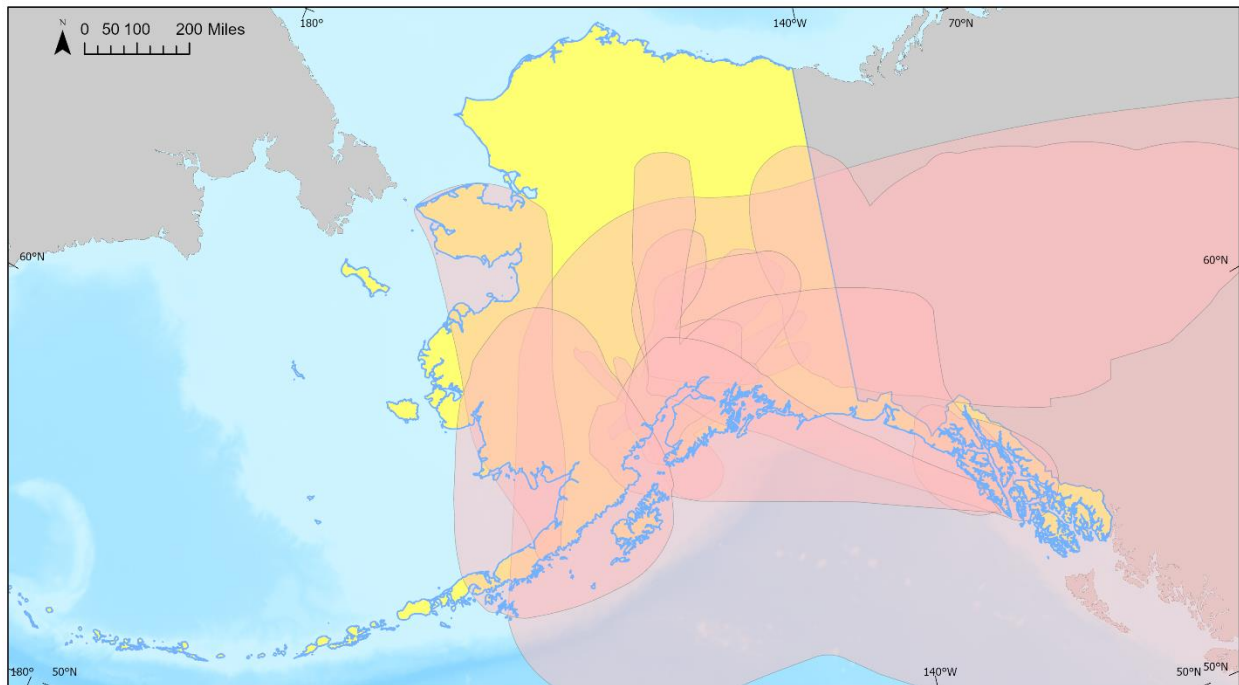
Directed Blasts (or lateral blasts) are eruptions radiating primarily outward from a volcano, as opposed to upward. The shock wave flattens forests and structures, while the super-heated blast debris and gases disperse over the local area, incinerating and burying everything in their path. The deadly May 18, 1980, Mount St. Helens, Washington, eruption was a lateral blast. Calculations have shown that the blast’s initial velocity of about 220 mph quickly increased to about 670 miles per hour. The blast was heard hundreds of miles away in the Pacific Northwest, including parts of British Columbia, Montana, Idaho, and northern California, and caused widespread devastation as far as 19 miles from the volcano.

Volcanic Tsunamis can be created by underwater eruptions, volcanic flank collapses that send large amounts of debris into a water body, or pyroclastic density currents entering a body of water.

Communities surrounding Cook Inlet may be at an increased risk for volcanic tsunamis generated by activity from volcanoes near shore. Prehistoric debris avalanche activity from Augustine Volcano in Cook Inlet generated at least one tsunami with deposits found near Homer. Pyroclastic density current activity from Aniakchak volcano on the Alaska Peninsula also generated a tsunami with deposits found up to 50 ft (15 m) above mean high tide along the northern Bristol Bay coastline of Alaska.

4.1.6.3 Locations of Volcano Hazards

Alaska is at continual risk for volcanic eruptions (Figure 4.1.6-1). Most of Alaska's volcanoes are far from settlements that could be affected by near-field (within 50 miles) hazards such as pyroclastic density currents, lahars, and lava flows; however, ash clouds and ashfall have historically caused significant impact to Alaska's human populations.



Selected Holocene and historical tephrafall distribution in Alaska, including tephra (volcanic ash) layers from Aniakchak II caldera-forming eruption, Aniakchak 1931, Augustine 1976, Crater Peak 1992, Mount Edgecumbe dacite, Hayes Oshetna tephra, Hayes tephra set H, Mt. Churchill White River Ash, Novarupta-Katmai 1912, and Redoubt 1989-90. Data from Mulliken, K.M., Schaefer, J.R., and Cameron, C.E., 2018, Geospatial distribution of tephra fall in Alaska: a geodatabase compilation of published tephra fall occurrences from the Pleistocene to the present: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 164, 46 p. <https://doi.org/10.14509/29847>

Figure 4.1.6-9: Geospatial Distribution of Selected Holocene and Historical Tephrafall Distribution in Alaska

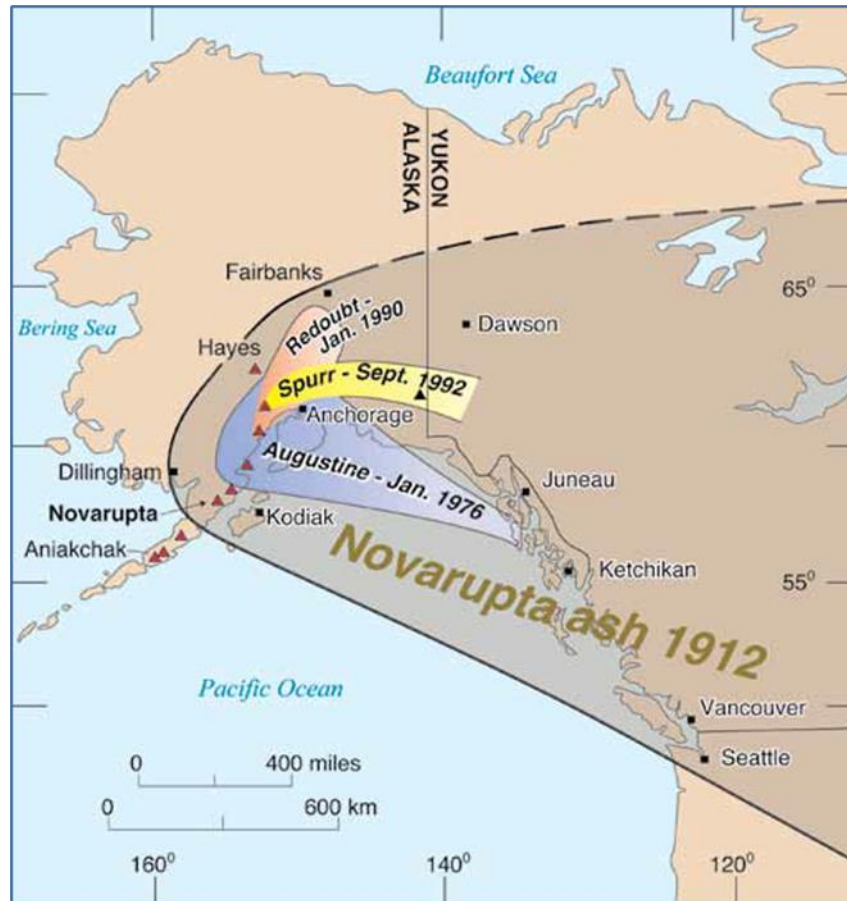
4.1.6.4 History of Volcano Hazard Events

This section describes a brief history of select eruptions in Alaska. For a more comprehensive look at the eruptive history of select volcanoes, the Alaska Volcano Observatory has published detailed hazard reports for some of the highest-threat volcanoes. Each report contains a description of the eruptive history of the volcano, the hazards it poses, and the likely effects of future eruptions to populations, facilities, and ecosystems. The reports can be freely downloaded from the Alaska Volcano Observatory website

www.avo.alaska.edu, or by direct link at:

<https://www.avo.alaska.edu/downloads/classresults.php?pregen=haz>. Information on individual Alaska eruptions is also available by volcano at <https://www.avo.alaska.edu/volcanoes/>.

The largest volcanic eruption of the 20th century occurred at Novarupta and Mount Katmai in June 1912. The 3-day event generated an ash cloud extending thousands of miles (Figure 4.1.6-5). Within 4 hours of the eruption, the ash reached Kodiak and paralyzed the city (Figure 4.1.6-5 F). Many structures eventually collapsed under the weight of the ash, and some buildings were destroyed by ash avalanches; ash tainted the drinking water and the air. Entire villages on the Alaska Peninsula evacuated, including Katmai and Savonoski. The volcanic ash and acid rain also killed animals and plants; many animals starved to death. The amount of ashfall from this eruption (Figure 4.1.6-5) was far greater than the recent eruptions of Redoubt, Spurr, and Augustine volcanoes. Fourteen earthquakes greater than M6 were associated with this event. An event of similar magnitude is possible at several volcanoes along the Aleutian Arc in the future.



Source: USGS/J. Fierstein 2017

Figure 4.1.6-10: 1912 Novarupta-Katmai 1912 Eruption Ash Distribution Compared to Ash Footprints from Other, Smaller Recent Alaska Eruptions: Redoubt 1990, Spurr, 1992, and Augustine 1976.



As a result of the 1912 Novarupta-Katmai eruption, volcanic ash fell on Kodiak Island, ~100 miles to the east. Decades later, this ashfall remains as a roughly 1.5-foot thick unit under just a few inches of organic material developed since 1912.

Source: Jennifer Adleman; AVO image URL:

<https://www.avo.alaska.edu/images/image.php?id=13227>

Figure 4.1.6-11: 1912 Ashfall Remains as a ~1½ Foot Thick Unit Under Organic Material

Archaeological and geologic evidence suggests that an eruption of Aniakchak Volcano 3,500 years ago spread ash over much of Bristol Bay and generated a tsunami which washed up onto the tundra around Nushagak Bay. Within the past 10,000 years, Aniakchak has had at least 20 substantial eruptions.

Recent examples include eruptions of Augustine Volcano in 1986 and again in 2005–2006. In both instances, ash plumes repeatedly rose to 30,000 feet above sea level or higher, disrupting air traffic and dusting Cook Inlet communities with ash. A lava dome formed in the summit crater towards the end of each of these eruptions. A concern during both eruptions was the possibility of a flank collapse and debris avalanche into Cook Inlet. Such an event could trigger a tsunami along lower Cook Inlet, as happened in 1883 when a debris avalanche flowed down the north flank of Augustine and into the ocean on the morning of October 6. Sea level rise of up to 20 feet was reported at English Bay across Cook Inlet.

Redoubt Volcano erupted most recently in 1989–1990 and again in 2009, each time producing voluminous lahars that temporarily closed the Drift River Oil Terminal 27 miles downstream (Figure 4.1.6-12). As described earlier, the 1989 eruption of Redoubt resulted in an ash encounter with a commercial aircraft, causing a temporary loss of all four engines and an estimated \$80 million in damage to the aircraft. In Alaska, disruption of air transportation is a major issue with volcanoes due to the numerous flight routes across the North Pacific downwind of historically active volcanoes (Figure 4.1.6-2).



View west of the runway, helipad, and service buildings at the Drift River Oil Terminal, inundated by lahars from Redoubt Volcano's 2009 eruption. The lahar deposit is at least 20 inches thick at the buildings. Source: Game McGimsey (AVO/UAF); AVO image URL: <https://avo.alaska.edu/images/image.php?id=16988>

Figure 4.1.6-12: Runway, Helipad, and Service Buildings at the Drift River Oil Terminal

The 1989–1990 eruption of Redoubt seriously affected daily community life, commerce, and oil production and transportation throughout the Cook Inlet region.

Mount Spurr's 1992 eruption of its Crater Peak vent brought business to a halt and forced a 20-hour closure of Anchorage International Airport. Communities as much as 400 miles away reported light ash dustings.

Eruptions from Crater Peak on June 27, August 18, and September 16–17, 1992, produced ash clouds (fig. 11) that reached altitudes of 13 to 15 kilometers [8-9 miles] above sea level. These ash clouds drifted in a variety of directions and were tracked in satellite images for thousands of kilometers beyond the volcano (Schneider and others, 1995). One ash cloud that drifted southeastward over western Canada and over parts of the conterminous United States and eventually out across the Atlantic Ocean (fig. 12) significantly disrupted air travel over these regions but caused no direct damage to flying aircraft (USGS 2002).

The March 27, 2016, eruption of Pavlof Volcano generated an ash cloud to 37,000 ft which extended more than 500 miles in a narrow band over interior Alaska. Minor (1/32–1/4 in) to trace (<1/32 in) ashfall was reported in several communities, including Nelson Lagoon, Port Heiden, and Dillingham. The March 27–28 ash plume also caused the cancellation of more than 40 Alaska Airlines flights to and from Utqiavik, Bethel, Anchorage, Fairbanks, Kotzebue, Nome, and Prudhoe Bay, Alaska, as well as numerous flight cancellations by regional air carriers PenAir and Ravn.

The 2016–2017 eruption of Bogoslof Volcano included 70 explosive events and at least two episodes of subaerial dome building. Three events produced ashfall on nearby communities and mariners east and south of Bogoslof. The eruption resulted in dozens of flight cancellations and flight diversions around the volcano and its ash clouds.

Since the 2018 SHMP, there have been 12 eruptions or questionable eruptions reported by the Alaska Volcano Observatory.

Great Sitkin	Semisopchnoi	Veniaminof	Cleveland	Shishaldin	Pavlof
2018	2018	2018	2019	2019	2021
2019	2019	2021	2020		
2021	2021				

4.1.6.5 Extent of Volcano Hazards

Geographic ashfall extent, along with a record of ashfall layers found in stratigraphic sections, illustrate at-risk areas for this hazard. Eruptive activity during the last approximately 2 million years produced ash clouds that have covered nearly the entire state with at least one significant ash layer. The 1912 Novarupta/Katmai eruption was widespread and primarily impacted the communities of Katmai Village, settlements on the Ukak and Savonoski Rivers, and Douglas Village; the eruption resulted in 1 foot of ash in Kodiak 100 miles away. A series of eruptions from the Mount Edgumbe Volcanic Field during the late Pleistocene between 13,000 and 14,500 deposited more than 3 feet of ash on Sitka, about 16 miles from Mount Edgumbe.

Geologic deposit investigations across the state have identified locations where more than 30 individual ashfall events have occurred. This record is a significant “at-risk indicator” for future ash events. For example, there are locations near Dutch Harbor that have received over 40 separate ashfall events over the last 8,000 years as indicated by separate layers of tephra preserved in the soil. Small communities along the Alaska Peninsula and Aleutian Islands are at risk from volcanic eruptions, and these volcanic eruptions may consist of extended periods of intermittent ash emissions, resulting in significant disruption for months. Large eruptions, though less frequent, may severely impact seasonal and subsistence lifestyles over broad regions.

Alaska residents will likely experience ashfall during any large volcanic eruption. A tsunami is possible if the eruption includes a pyroclastic flow that enters the open ocean or other large water body. A much more likely impact would be caused by drifting ash clouds that could result in prolonged traffic disruptions (air, land, or rail), preventing essential community resupply (for example, food and medicine delivery) and medical evacuation service capabilities to full-service hospitals. Alaska is also subject to airborne ash disruptions from active volcanoes in Japan and the Kamchatka Peninsula of Russia, that frequently erupt and produce ash that travels into Alaskan airspace.

A massive eruption anywhere on earth could severely affect the global climate, radically changing everyone’s long-term weather event risks for weeks, months, or years.

4.1.6.6 Impact of Volcano Hazards

Over the last few hundred years, an average of about two eruptions occurs each year in Alaska. Eruptions in the western Aleutian Islands impact local and trans-Pacific aircraft. Eruptions near or within Cook Inlet have the potential to impact a large part of the state’s population and infrastructure. A larger ashfall event would undoubtedly be devastating to Alaska residents by straining Alaska’s infrastructure and supply chain and disrupting transportation (air, ocean, land, and rail routes), especially if other hub communities are also significantly affected. Residents would likely experience respiratory problems from airborne ash, personal injury, and potential residential displacement or lack of shelter. Other effects could include general property damage (electronics and unprotected machinery), structural damage from ash loading, state/regional transportation and power generation/transmission interruptions, loss of commerce, and water supply contamination.

These ashfall impacts can range from negligible, being an inconvenience, perhaps with no transportation capability for a few days at most, to critical, in the case of heavy, debilitating ashfall throughout the state, forcing residents to be completely self-sufficient.

4.1.6.7 Probability of Volcano Hazards

Geologists can make general long-term forecasts associated with individual volcano activities by carefully analyzing past activity, but these are based on trends and likelihood, rather than specific events or timelines. Short-range forecasts are often possible with greater accuracy, especially for volcanoes with ground-based geophysical monitoring. Signs of increasing activity, such as elevated seismicity, rapid ground-surface deformation, or changes in heat or gas output, can indicate that an eruption will follow within weeks or months. Magma moving upward into a volcano often causes a significant increase in small, localized earthquakes, and measurable carbon dioxide and compounds of sulfur and chlorine emissions increases. Shifts in magma depth and location can cause ground level elevation changes that can be detected through ground instrumentation or remote sensing observations.

Based on the number and location of active volcanos in Alaska combined with the history of volcanic activity, it is highly likely that volcanoes will continue to present hazards to Alaska, and the state can anticipate approximately two eruptions per year.

4.1.6.8 Projected Changes in Location of Volcano Hazards

The locations of youthful volcanoes in Alaska are not expected to change on human timescales.

4.1.6.9 Range of Anticipated Intensities of Volcano Hazards

Volcanic eruptions are often measured on a Volcanic Explosivity Index (VEI) scale, which runs from 0–8 (<https://www.usgs.gov/media/images/volcanic-explosivity-index-vei-a-numeric-scale-measures-t>) and incorporates the volume of erupted products, eruption cloud height, and qualitative observations to determine the explosivity value of a volcanic eruption. Historical eruptions in Alaska have been assigned VEI levels ranging from 0 (non-explosive) to 6 (very large). Prehistoric eruptions of Alaska volcanoes include some of the largest Holocene eruptions on Earth. In general, smaller eruptions are much more common than large eruptions.

4.1.6.10 Frequency of Volcano Hazards

The advent of modern air travel in the 1950s has enabled more frequent observations of Alaska volcanoes. Because of this, we now know that Alaska averages about two eruptions per year.

4.1.6.11 Duration of Volcano Hazards

Individual explosions from eruptions at Alaska volcanoes often last only minutes, although an eruptive period may last for many months or years, consisting of intermittent explosions, lava dome or flow growth, and periods of quiescence.

4.1.6.12 Future Conditions for Volcano Hazards, Including Climate Change

4.1.6.12.1 Characteristics/Nature

The characteristics and nature of Alaska volcanoes and their eruptions is not expected to change, including from the effects of climate change.

4.1.6.12.2 Location

The location of Alaska volcanism is not expected to change.

4.1.6.12.3 Range of Anticipated Intensities

The range of expected intensities is not expected to change.

4.1.7 Severe Weather

4.1.7.1 Characteristics of Severe Weather Hazards

This section defines Alaska's weather-related hazard threats, which influence Alaska's weather, and defines or explains each weather event's characteristics, location, extent (impact areas), actual or potential impacts or damage, and their general recurrence probability. Damaging weather impacts occur from seasonal, as well as sudden, climate change related conditions.

Extreme Cold varies according to a region's normal climate; near freezing temperatures are considered "extreme" in areas unaccustomed to winter weather. Extreme cold usually involves temperatures between -20 to -50°F in Alaska. Excessive cold may accompany winter storms or can occur without storm activity during clear skies with high barometric pressure. Extreme cold accompanied by wind exacerbates exposure injuries such as frostbite and hypothermia. Because of Alaska's varying average temperatures per region, the National Weather Service differentiates between an "extreme cold warning" and a "cold weather advisory." Communities on the North Slope and the interior are more accustomed to colder temperatures than those in southcentral or southeast Alaska, for example, and thus the temperatures required to release a cold weather advisory will differ.

Extreme cold interferes with infrastructure across Alaska for days or sometimes weeks at a time. Liquid fuels may congeal or freeze denying motorized transportation, heat, and electricity generation. In desperation, some people choose to burn propane stoves indoors, increasing their risk to carbon monoxide poisoning. Aircraft may be grounded, delaying the resupply to remote villages. Water and sewer pipes often freeze and rupture, flooding occurs later when they thaw.

Winter Storms include a variety of phenomena described above and as previously stated may include several components such as wind, snow, and ice storms. Ice storms include freezing rain, sleet, and hail can be the most devastating of winter weather phenomena; often causing automobile accidents, power outages, and personal injury. Freezing rain coats every surface it falls on with an icy glaze. Freezing rain is produced when a warmer mass of air flows over the top of a denser mass of freezing air closer to the surface. Rain then falls from the warmer mass down through the freezing mass of air, producing ice crystals (NWS, 1999).

Heavy or Excessive Snow is capable of immobilizing a community and bringing transportation to a halt. Airports and major roadways may close, disrupting supply flow and emergency response service access. Excessive accumulation can collapse roofs, knock down trees and power lines, damage parked light aircraft, and capsize small boats. Heavy snow dramatically increases avalanche and flooding risks. Snow removal, damage repairs, and business loss will financially impact communities. Heavy snow is associated with vehicle accidents, overexertion, hypothermia, and lost travelers. In regions of the state characterized by tundra, high winds can blow large volumes of snow back into the air. An estimated 10–50 percent of seasonal snowfall is returned to the atmosphere where this snow is redistributed, functioning as new snowfall. This blowing snow can also accumulate in topographic depressions or against structures (McFadden et al., 2001).

High Winds in excess of 60 miles per hour (mph) occur frequently over the coastal areas along the Bering Sea and the Gulf of Alaska. They can also combine with loose snow to produce blizzards. High winds occur when there are winter low-pressure systems in the North Pacific Ocean and the Gulf of Alaska, and in the interior due to strong pressure differences.

Down-slope wind storms created by temperature and pressure differences on mountainous terrain can produce winds in excess of 120 mph. Areas like the Brooks Range, the Alaska Range, and coastal mountain slopes experience down-slope winds.

Localized downdrafts, downbursts, and microbursts are also common wind hazards in Alaska. On rare occasions, downbursts and microbursts may be generated by thunderstorms. Downbursts are areas of

rapidly-falling, rain-cooled air. Upon reaching the ground, the downburst spreads out in all directions, at much slower speeds than those found in the Lower 48. Microbursts are smaller scale, more concentrated downbursts. Both types of wind, commonly lasting 5 to 7 minutes, are hazardous to aviation. These winds can reach hurricane force and have the potential to seriously damage port facilities, impact the fishing industry, and cause damage to community infrastructure (especially above ground utility lines) while disrupting vital marine transportation.

Ice Storms occur when excessive ice accumulations are expected during a freezing rain event. They are a particularly hazardous winter weather phenomena and often cause numerous automobile accidents, power outages, and personal injury. Ice storms form from freezing rain when it passes through a thin layer of cold air just above the ground and cools to below freezing. The drops remain in a liquid state until they impact a surface and freeze on contact. Additionally, when freezing rain combines with a top layer of snow which melts and refreezes, as when there is a brief warm spell and then temperatures drop back below freezing, it creates a thick layer of ice on top of the compacted lower layer of snow, creating dangerous conditions that can lead to vehicle accidents and slip-and-fall injuries on sidewalks. It may also cause telecommunications and power outages by damaging lines (Groisman et al., 2016). Freezing rain is hazardous to large mammals, as it can make winter forage inaccessible, leading to decreased populations available for subsistence hunting (Wilson et al., 2012).

Thunderstorm hazards are lightning, heavy rain, snow, updrafts, downdrafts, severe aircraft turbulence and icing, damaging hail, high winds, and, in rare cases, flash flooding in certain regions of the state. Lightning exists in all thunderstorms. It is formed from built-up charged ions within the thundercloud. Lightning is hazardous to humans and frequently starts wildfires. Most thunderstorms in Alaska are usually of the single-cell or pulse variety, developing from a combination of atmospheric instability and moisture and triggered by surface heating from the sun. The storms generally last only 20–30 minutes and do not usually produce severe weather. Pulse thunderstorms occasionally produce high winds, hail, or weak tornadoes. Multi- or super-cell thunderstorms and squall line tornadoes are rare events in Alaska. A thunderstorm is considered severe if winds reach or exceed 58 mph, it produces a tornado, or it generates surface hail at least 1 inch in diameter. Thunderstorms affect relatively small areas, as the average thunderstorm is about 15 miles in diameter and lasts less than 30 minutes in any given location. Thunderstorms may produce hail in ball or irregular shapes greater than 0.75 inches in diameter. The size and severity of the storm determine the size of the hailstones. Unlike the hail in midwestern states, Alaskan hail is small (pea-sized) and fairly rare. The extreme atmospheric conditions necessary to generate damaging sized hail (greater than 0.75 inches in diameter) are highly unusual in Alaska.

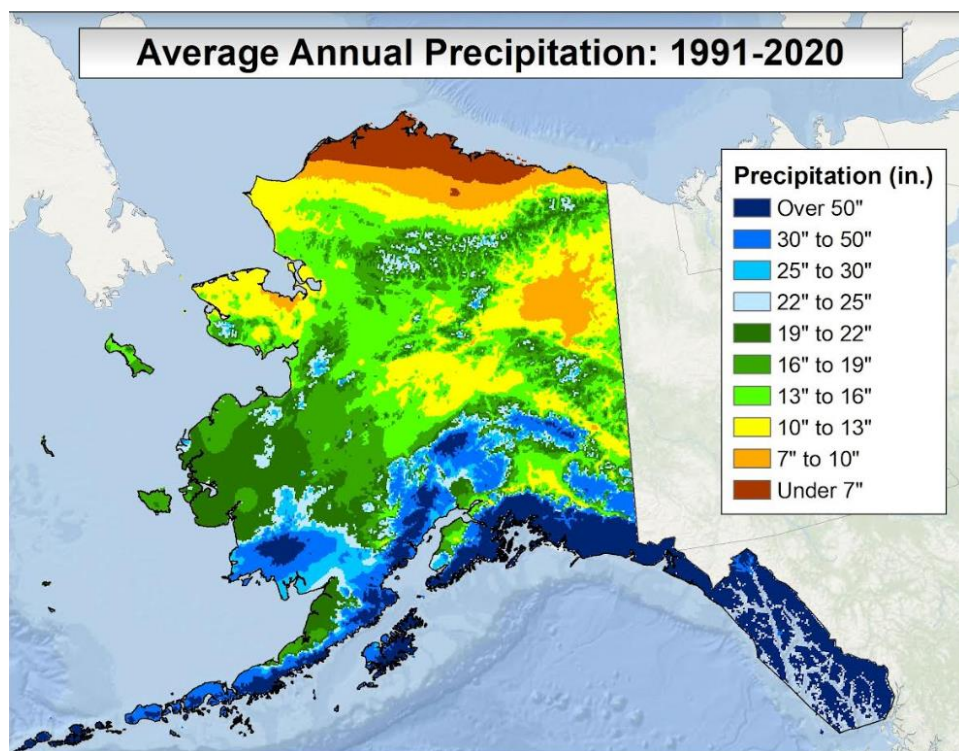
One of the most common hazard impacts from thunderstorm activity in Alaska is wildland fire in the interior's northern boreal forests. In Alaska, the peak thunderstorm season occurs from end of May to the beginning of August, and tens of thousands of lightning strikes may occur over that period. According to the Bureau of Land Management (BLM), there were approximately 47,500 lightning strikes in Alaska in 2022 (BLM, 2022). In one 48-hour period, from July 2 to July 4, 2022, Alaska experienced a total of 17,774 lightning strikes (AICC, 2022). Lightning strike wildfires are much less prevalent in the coastal region than in the interior because the frequency of storms is smaller, and the climate is much wetter. In a typical year, Alaska has fewer than 40 days with thunderstorms, and they do not occur uniformly over the state. Thunderstorms primarily occur between the Brooks Range and the Alaska Range, but all parts of Alaska experience occasional thunderstorms (BLM, 2022).

Thunderstorms are also observed along the southern coastal areas, with a higher frequency along the eastern Gulf of Alaska coast between Cordova and Craig. Interestingly, these storms occur during the winter months as well as during summer. Lightning-caused injuries and deaths are unusual in Alaska; however, in 1986, one person was killed, and three others injured near Tok when they took shelter under a tree that was struck by lightning.

Tornadoes are rare in Alaska. They most frequently occur in the Yukon-Kuskokwim Delta. Of the five tornado damage potential categories (Fujita Scale 0-5), Alaska tornadoes rarely exceed the lowest level, but they have the potential to cause damage or casualties when they touch down in developed areas. Waterspouts, the spinning upward movement of water through wind action, are more common in Alaska and occur in all southern maritime areas of the state. Damage occasionally results from the vortices' action on property.

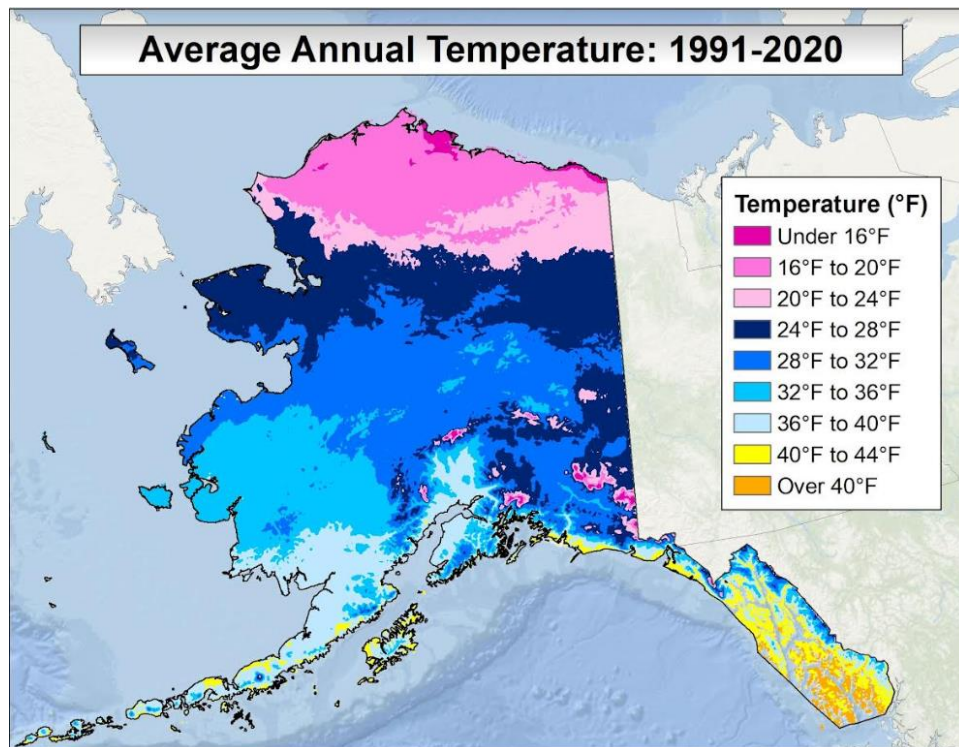
Heavy Rain occurs when the amount of rainfall in a particular location over a short period of time exceeds normal volume to a substantial degree and varies by season and location. What constitutes heavy rain in southeast Alaska would vary from what is considered heavy rain in a part of the state which sees less intense rainfall. The potential impacts of heavy rain include crop damage, erosion, and an increased flood risk. Flooding triggered by heavy rain can result in injuries/loss of life, road washouts, and damage to property and other infrastructure. In recent years, a larger percentage of precipitation has come in the form of intense single-day events, according to the EPA (EPA, 2021).

Alaska's annual rainfall based on Parameter-elevation Regressions on Independent Slopes Model (PRISM) that combines climate data from NOAA and Natural Resources Conservation Service (NRCS) climate stations with a digital elevation model can generate annual, monthly, and event-based climatic element estimates such as seasonal as well as anomaly precipitation and temperature. Alaska's average annual precipitation for 1991-2020 is shown in Figure 4.1.7-1 and Alaska's average annual temperature for 1991-2020 is shown in Figure 4.1.7-2.



Source: NOAA NCEI Gridded Normals

Figure 4.1.7-1: Statewide Average Historical Annual Precipitation, 1991–2020



Source: NOAA NCEI Gridded Normals

Figure 4.1.7-2: Statewide Average Annual Temperature, 1991–2020

Storm Surge is a significant cause of property damage in Alaska. Storm surges are a coastal flood that occurs when the sea travels inland past the high-tide level often accompanied by high winds increasing the destructive force of the water. Conditions that have a high possibility of resulting in flooding in coastal areas include low atmospheric pressure, strong winds (blowing directly onshore or along the shore with the shoreline to the right of the direction of the flow), and consistent winds persisting from a consistent direction over a long distance across the open ocean (fetch).

Communities that are most susceptible to coastal flooding typically have gradually sloping bathymetry near the shore and exposure to strong winds with a long fetch over the water. Communities and villages along the west coast areas of Alaska have experienced significant damage from coastal floods. These locations will usually experience coastal flooding during the late summer or early fall. There is a decreased potential for ground failure as shore-fast ice (ice that is “fastened” to the coastline) forms along the coast before winter, but later freeze-ups and earlier fall/winter storms increase the potential of erosion, storm surge flooding and ice override events.

4.1.7.2 Locations of Severe Weather Hazards

All of Alaska is vulnerable to severe weather effects. Each location experiences diverse severe storm conditions, snow depths, wind speeds, and extreme temperature ranges.

4.1.7.3 History of Severe Weather Hazard Events

Alaska is continually impacted by severe weather events such as hurricane force/straight line wind, excessive rain, sea storms, winter storms, and extreme cold. Severe weather events can be devastating and costly, especially in smaller, coastal communities throughout Alaska. Table 4.1.7-1 lists historical severe weather events from the Alaska Disaster Cost Index. Table 4.1.7-1 has been updated since the 2018 SHMP. Narratives of the most recent disasters follow the table.

Table 4.1.7-1: Historical severe weather events statewide from the Alaska Disaster Cost Index

Disaster	Date	Location
Kodiak Winter Storm	1/28/1978	Kodiak Island; Karluk
Campbell Creek Flood	2/10/1978	Anchorage
Wrangell & Craig Winter Storm	11/6/1978	Craig, Wrangell
Matanuska-Susitna Winter Storm	2/9/1979	Matanuska-Susitna Borough
West Coast Storm	11/23/1979	Dillingham census area, Bethel Census Area, Kusilvak Census Area
Willow Creek Flood	12/20/1979	Willow
Kodiak Island Winter Storm	2/5/1980	Kodiak Island: Port Lions, Ouzinkie, Old Harbor, Akhiok
Anchorage High Wind Storm	4/4/1980	Anchorage
Bristol Bay High Wind & Storm Surge	9/2/1980	Bristol Bay, Dillingham Census Area, Bristol Bay Borough, Lake and Peninsula Borough
Copper River Extreme Cold & Flood	12/11/1980	Copper Center
Southcentral Alaska Rainstorm	7/22/1981	Southcentral Alaska
Fort Yukon Flood	5/17/1982	Fort Yukon
Russian Mission, Akiak, Akiachak, High Wind & Storm Surge	10/1/1982	Russian Mission, Akiak, Akiachak
Kipnuk Ice Flow Flood	4/1/1983	Kipnuk
Aniak Ice Jam Flood	6/15/1983	Aniak
Cordova Flash Flood	9/16/1983	Cordova
Unalakleet & Mountain Village Extreme Cold	3/5/1984	Unalakleet
Elim Extreme Cold	3/9/1984	Elim
Kotzebue Extreme Cold	4/30/1984	Kotzebue
Alakanuk Ice Jam Flood	6/13/1984	Alakanuk
Emmonak Ice Jam Flood	6/15/1984	Emmonak
Southeast Alaska High Wind & Storm Surge	11/26/1984	Juneau, Sitka, Kake, Angoon, Tenakee Springs
Haines Heavy Rain	1/25/1985	Haines
Savoonga Extreme Cold	2/26/1985	Savoonga
Buckland Flood	5/30/1985	Buckland
Kobuk Flood	5/30/1985	Kobuk
Anvik Yukon River Flood	6/5/1985	Anvik
Emmonak Flood	6/11/1985	Emmonak
Pilot Station Yukon River Flood	6/18/1985	Pilot Station
Upper Kuskokwim River Flood	6/18/1985	McGrath, Sleetmute, Red Devil
Pitka's Point Flood	7/9/1985	Pitka's Point
Bethel Flood	7/10/1985	Bethel
Cordova Heavy Rain	10/31/1985	Cordova
Thorne Bay Extreme Cold	12/5/1985	Thorne Bay
Unalaska High Wind	12/13/1985	Unalaska
Pelican High Wind	3/19/1986	Pelican
North Slope Windstorm Major Disaster	9/20/1986	North Slope Borough
Southcentral Alaska Flood	10/10/1986	Seward, Matanuska-Susitna Borough, Corova

Disaster	Date	Location
Kotzebue Extreme Cold	2/5/1987	Kotzebue
Aniak Flood	5/19/1987	Aniak
Sleetmute/Red Devil Ice Jam Flood	5/28/1987	Sleetmute, Red Devil
Buckland Flood	6/16/1987	Buckland
Richardson Highway Heavy Rain	7/24/1987	Richardson Highway
Haines Flood	2/29/1988	Haines
Crooked Creek Flood	5/12/1988	Crooked Creek
Napakiak/Napaskiak Flood	5/24/1988	Napakiak, Napaskiak
Kaltag Flood	5/26/1988	Kaltag
Shishmaref High Wind & Storm Surge	8/5/1988	Shishmaref
Northwest Arctic Borough Extreme Cold	1/15/1989	Kotzebue, Buckland, Northwest Arctic Borough
St. George High Wind	2/9/1989	St George
North Slope Borough Winter Storm	2/24/1989	North Slope Borough
Spring Flood	5/1/1989	Kusilvak census area, Bethel Census Area, Northwest Arctic Borough
Circle Yukon River Flood	5/6/1989	Circle
Ft. Yukon Flood	5/6/1989	Fort Yukon
Klawock Heavy Rain	6/19/1989	Klawock
Fairbanks/North Star Borough Flash Flood	8/1/1989	Fairbanks, North Star Borough
Matanuska-Susitna Borough Flood	8/4/1989	Matanuska-Susitna Borough
Municipality of Anchorage Heavy Rain & Flood	8/30/1989	Anchorage
Seward/Kenai Peninsula Borough Heavy Rain & Flood	8/30/1989	Seward, Kenai Peninsula Borough
Richardson Highway Heavy Rain	9/13/1989	Richardson highway, Copper River highway
Moose Feeding Project Heavy Snow	3/28/1990	Interior
89 Spring Floods Hazard Mitigation	4/14/1990	Statewide
McGrath Ice Jam Flood	5/16/1990	Mcgrath
Kobuk Ice Jam Flood	5/17/1990	Kobuk
Lower Kuskokwim Storm	9/4/1990	Bethel Census Area, Bristol Bay Borough
Kotzebue High Wind Storm	9/4/1990	Kotzebue
Nome Storm	9/10/1990	Nome
Diomedes Winter Storm	11/21/1990	Diomedes
Southcentral Heavy Snow	12/1/1990	Southcentral Alaska
Larsen Bay Extreme Cold	2/14/1991	Larsen Bay
Fairbanks/North Star Borough, Aniak, McGrath, Red Devil, Anvik, Grayling, Emmonak, Holy Cross, Alakanuk, Shageluk, Galena Heavy Snow & Flood	5/3/1991	Fairbanks, North Star Borough, Aniak, McGrath, Red Devil, Anvik, Grayling, Emmonak, Holy Cross, Shageluk, Galena
Yukon River Flood Breakup Flood	6/17/1991	Fort Yukon, Beaver, North Pole, Stevens Village
New Koliganek Flood	10/14/1991	New Koliganek
Kodiak Heavy Rain	11/2/1991	Kodiak
Eagle Village & City Ice Jam Flood	5/19/1992	Eagle City
Galena Flood	5/26/1992	Galena
Upper Yukon Breakup Flood	6/9/1992	Yukon-Koyukuk Census Area

Disaster	Date	Location
Nome Highway High Wind & Heavy Rain Disaster	10/5/1992	Nome Census Area, Nome, Council
Galena Breakup Flood Disaster	5/10/1994	Galena
Cummings Road Flood	7/13/1994	Delta Junction, Cummins Road
94 Fall Flood	8/8/1994	Kobuk, Kiana, Kotzebue, Allakleet, Alatna, Hughes, Bettles, Wiseman
Metlakatla Sea Storm	11/10/1994	Metlakatla
Aniak Ice Jam Flood	6/5/1995	Aniak
Yukon Kuskokwim Delta Flood	9/5/1995	Akiak, Kwethluk, Napaskiak, Emmonka, Alakanuk
Southcentral Fall Flood	9/18/1995	Kenai Peninsula Borough, Matanuska-Susitna Borough, Anchorage, Chugach, Copper River REAA, Whittier, Cordova, Richardson, Copper River, Edgerton Highway
'96 Southeast Storm	9/25/1996	Pelican, Elfin Cover
Eastern Tanana River Heavy Rain & Flood	8/26/1997	Taylor Highway, Alaska highway, Nebesna Road, Tok Cutoff, Richardson Highway, Copper Valley Highway, Northway Road, Village of Northway
Shishmaref Sea Storm	10/6/1997	Shishmaref
Endicott Mountains Flood	6/18/1998	Allakleet, Huslia, Wiseman, Evansville, Dalton Highway, (Coldfoot, Atigun)
Southeastern Storm	10/19/1998	Haines (city and borough), Juneau (City and Borough) Chilkat Indian Village (Klukwan)
Central Gulf Coast Storm	12/21/1999	Whittier, Valdez, Kenai Peninsula Borough, Matanuska-Susitna Borough, Anchorage, Aleutian East, Bristol Bay, Denali, Fairbanks North Star, Kodiak Island, Lake and Peninsula borough, Dillingham census area, Bethel, Wade Hampton, Southeast Fairbanks
Middle Yukon Flood	5/24/2001	Koyukuk, Nulato
Shishmaref High Wind	10/5/2001	Shishmaref
Interior Flood	5/30/2002	Fairbanks North Star Borough, McGrath, Lime Village, Sleetmute, Red Devil, Crooked Creek, Aniak, Kwethluk, Ekwok, New Stuyahok, Chase, Talkeetna, Montana Creek, Emmonak,
Northwest Fall Sea Storm	10/8/2002	Kotzebue, Kivalina, Shishmaref
Kenai Peninsula Borough Flood	10/23/2002	Kenai Peninsula Borough, Kodiak Borough, Chignik Bay, Chignik Lake, Chignik Lagoon,
Southcentral Wind Storm	3/6/2003	Matanuska-Susitna Borough, Kenai Peninsula Borough, Municipality of Anchorage
Salcha Flood	4/29/2003	Salcha
Denali Borough River Flood	7/14/2003	Denali Borough
2003 Fall Flood	9/26/2003	Lake and Peninsula Borough, Kenai Borough, Kodiak Island Borough
Fall Sea Storm	11/1/2003	Unalakleet, Diomed, Port Heiden
Bering Strait Storm	10/18/2004	Bering Strait REAA, Elim, Koyuk, Shaktoolik, Unalakleet, Northwest Arctic Borough, Kivalina, Kotzebue, Mekoryuk
Kaktovik Winter Storm	1/7/2005	Kaktovik

Disaster	Date	Location
Spring Flood	5/3/2005	Emmonak, Alakanuk, McGrath
Bristol Bay Storm	8/23/2005	Bristol Bay, Clark's Point, Ekuk, Togiak, Lake and Peninsula Borough, Bristol Bay Borough, Dillingham
West Coast Storm	9/22/2005	Northwest Arctic Borough, Bering Strait REAA, Kashunamiut REAA, Lower Yukon REAA, Lower Kuskokwim REAA, Nome, Kivalina, Unalakleet, Golovin, Tununak, Hooper Bay, Chevak, Mekoryuk, Napakiak
Southeast Storm	11/18/2005	Juneau Borough, Sitka Borough, Pelican, Hoonah, Skagway
Southcentral Winter Storm	2/5/2006	Seward, Kenai Peninsula Borough
Spring Flood	5/5/2006	Yukon river, Kuskokwim River, Koyukuk River, Hughes, Koyukuk, Kwethluk, Alakanuk, Emmonak
Southcentral Flood	8/18/2006	Matanuska-Susitna Borough, Cordova, Copper River Highway, Chugach REAA, Richardson Highway, Copper River REAA, Delta/Greely REAA, Denali Highway, Alaska Railroad and Parks Highway, Denali Borough
Southern Alaska Storm	10/8/2006	Kenai Peninsula Borough, Seward, Seldovia, Chugach REAA, Cordova, Valdez, Copper River REAA, Richardson Highway, Glennallen, McCarthy
Kivalina Storm	10/11/2006	Kivalina
Kenai River Ice Jam Flood	1/25/2007	Kenai River, Sterling, Soldotna, Kenai Peninsula Borough, Big Eddy, Poacher's Cove, River Quest
Kivalina Storm	9/12/2007	Chukchi Sea Coast, Kivalina, Shishmaref, Point Hope
Tanana Basin Flood	7/27/2008	Fairbanks North Star Borough, North Slope Borough, Wainwright, Kaktovik, Yukon-Koyukuk REAA, Nenana, Denali Borough
Spring Flood	4/28/2009	Eagle, Alaska Gateway REAA, Copper River REAA, Chistchina, Matanuska-Susitna Borough, Yukon Flats REAA, Circle, Fort Yukon, Chalkyistik, Beaver, Stevens Village, Rampart, Yukon-Koyukuk REAA, Tanana, Ruby, Galena, Koyukuk, Nulato, Kaltag, Iditarod REAA, Bethel, Kwethluk, Napakiak, Napaskiak, Oscarville, Yupiit REAA, Akiak, Akiachak, Tuluskak, Kuspuk REAA, Aniak, Upper Kalskag, Lower Kalskag, Stony River, Sleetmute, Red Devil, Crooked Creek, Napaimute, Fairbanks North Star Borough, North Pole, Salcha, Bering Strait REAA, Nome
Kodiak Storm	10/9/2009	Kodiak Island Borough
Seward Storm Surge	12/1/2009	Seward
Interior Flood	7/10/2010	Alaska Gateway REAA, Copper River REAA
Red Devil Spring Flood	5/8/2011	Red Devil, Crooked Creek
Kenai Peninsula Wind Storm	11/1/2011	Kenai Peninsula Borough
West Coast Storm	11/7/2011	Kusilvak Census Area, Nome Census Area, Northwest Arctic Borough, North Slope Borough,

Disaster	Date	Location
		Bering Strait REAA, Lower Kuskokwim REAA, Lower Yukon REAA, Southwest Region REAA
2012 September Storm	9/4/2012	Matanuska-Susitna Borough, Alaska Gateway REAA, Chugach Census Area
Kuskokwim Delta Flood	10/5/2012	Kuskokwim Delta, Napaskiak
Prince William Sound Winter Storm	12/15/2012	Cordova, Prince William Sound, Valdez, Yakutat
Spring Flood	5/17/2013	Alaska Gateway REAA, Eagle, Copper River REAA, Chisotchina, Gulkana, Yukon Flats REAA, Circle Fort Yukon, Yukon-Koyukuk REAA, Galena, Lower Yukon REAA, Emmonak, Alakanuk
Kenai Peninsula Borough Heavy Rain & Flood	10/27/2013	Kenai Peninsula Borough, Prince William Sound, Seward, Homer, Kenai, Anchor Point, Tyonek
November Storm Disaster	11/5/2013	Bering Strait REAA, Lower Yukon REAA, Lower Kuskokwim REAA, Fairbanks North Star Borough
Dalton Highway Flood	3/13/2015	Dalton Highway, Deadhorse
North Slope Borough Flooding	3/13/2015	Dalton Highway, Fairbanks, Deadhorse, Dalton Highway
Fort Yukon Flood	5/19/2015	Fort Yukon
Southeast Heavy Rain	8/14/2015	Sitka Borough, Sitka
North Slope Borough Sea Storm	8/27/2015	North Slope Borough, Barrow (Utqiagvik), Wainwright
Bering Sea Storm	12/12/2015	Aleutians West Census Area, Bethel Census Area, Pribilof Islands, Adak, St. George, Kipnuk, Atka, Kwingillingok
Togiak Winter Storm	12/24/2015	Togiak
West Coast Storm Disaster	12/28/2016	St. Lawrence Island, Bethel Census area, Nome Census area, Norton Sound, Seward Peninsula, Kotzebue Sound, Savoonga, Gambell
North Slope Borough Storm Disaster	9/28/2017	Utqiagvik (Barrow), North Slope Borough
Gulf of Alaska Winter Storm	12/4/2017	Kenai Peninsula: Seward, Lowell Point, Homer, Anchor Point, Happy Valley, Ninilchik, Cohoe, Kenai
Susitna River Flood	5/11/2018	Susitna River, north of Talkeetna, MP 235-252 AKRR
Kenai Peninsula Borough Flood	10/12/2018	Kenai Peninsula Borough, City of Seward
Kenai Peninsula Borough Winter Storm	11/27/2019	Kenai Peninsula Borough, Nikiski, Seldovia, Seward
Spring Flood	4/21/2020	Yukon, Kuskokwim, Tanana, Koyukuk Rivers, Nikolai, Crooked Creek, Napaimute, Kolmokof River, Kwethluk, Nunapitchuk
West Coast Storm	11/4/2020	Alaska west coast; Shishmaref
Southeast Winter Storm	12/1/2020	Southeast Alaska; Haines, Skagway, Juneau, Wrangell, Petersburg, Sitka, Ketchikan, and Annette Island, Chatam, and SE Island REAA
Buckland Spring Flood	5/13/2021	Buckland
Southcentral Alaska Storm	10/29/2021	Southcentral Alaska, MOA, Girdwood/Portage, Kenai Peninsula Borough, Seward, Cooper Landing

Disaster	Date	Location
Wrangell High Wind Storm	11/30/2021	Wrangell
Matanuska-Susitna & Copper Wind Storm	1/1/2022	Matanuska-Susitna Borough
Southeast Storm	1/8/2022	Alaska Panhandle, Yakutat, Haines, Skagway, Juneau
Tanana & Kuskokwim Spring Flood	5/6/2022	Tanana & Kuskokwim River; Sleetmute, Red Devil, McGrath, Manley Hot Springs, Glennallen
Typhoon Merbok Remnants	9/15/2022	West Coast of Alaska
Interior Winter Storm	12/25/2022	Fairbanks North Star Borough, Denali Borough, Yukon-Koyuk census area

2018 October KPB Flooding. On October 12, 2018, and continuing, numerous areas of the Kenai Peninsula Borough and the City of Seward have suffered widespread flooding and related damages as a result of an unusually heavy and persistent rainfall event; and the City of Seward and the Kenai Peninsula Borough are political subdivisions of the State of Alaska; and, both the City of Seward and the Kenai Peninsula Borough have issued local declarations of disaster emergency in response to this event. The following conditions exist as a result of this disaster: widespread flooding of community roads, the Seward airport, and other facilities; and severe threat to life and property; and, these conditions have required local emergency protective measures to protect life and property, including activation and staffing of emergency operations centers; emergency debris clearance of roads and stream channels to protect critical infrastructure and maintain access; placement of road barricades and sandbagging to protect roads and bridges; school closures. The flooding in this area has the potential to cause substantial damage to the highway, community infrastructure, the Seward airport, and homes; and, the severity and magnitude of the emergency is beyond the timely and effective response and recovery capability of local resources, and repairs and emergency assistance are required.

2019 December KPB Storms. On December 6, 2019, the State Emergency Operations Center (SEOC) was contacted by the Kenai Peninsula Borough (KPB) Office of Emergency Management (OEM) concerning storm-related damages to several areas of the Borough resulting from a severe winter storm that began November 27. The storm produced strong winds and heavy snowfall that caused trees to topple onto power lines resulting in multi-day power outages and transportation delays in the communities of Nikiski and Seldovia. Over 3,100 homes in Nikiski were reportedly without power due to heavy snowfall. The Borough was also concerned about potential heavy rainfall and snowmelt flooding in Seward. KPB activated their Emergency Operations Center to monitor and manage the power outage and flooding threat. At the end of the workday, the SEOC received a local declaration from KPB, dated December 6, that included a local declaration from the City of Seldovia, each seeking public and individual assistance, emergency resources, and other assistance. Poor weather continued through December 10, 2019. The SEOC contacted KPB and the City of Seldovia for damage estimates and response costs. Additional damages and costs were reported by the Alaska Department of Transportation and Public Facilities (DOT&PF), Department of Natural Resources, Division of State Parks (DNR State Parks), and the Homer Electric Association, Inc (HEA).

2020 Spring Floods. The National Weather Service (NWS) Alaska Pacific River Forecast Center (APRFC) forecasting a “dynamic” break up on the State’s major river systems such as the Yukon, Kuskokwim, Tanana, and Koyukuk Rivers with a corresponding above-average flood potential for rivers south of the Brooks Range. The high water along the Kuskokwim River in late April/early May 2020 was due initially to a warm up that caused break up on the Kuskokwim River that began on April 21 with Nikolai, and generally worked its way downriver. The river ice broke at Crooked Creek, 34 miles upriver of Napaimute, on April 29 and moved downriver toward Napaimute. A large ice jam formed at the mouth of the Kolmokof River approximately 10 miles downriver of Napaimute and caused unprecedented

flooding of the old village of Napaimute and surrounding areas. On May 4, the Napaimute Traditional Council (NTC), declared a disaster emergency for the village due to the flooding. On May 6, the Organized Village of Kwethluk (OVK) contacted the SEOC verbally declared a disaster emergency caused by rising floodwaters that had inundated roads and entered two homes. APRFC considered this flooding related to snowmelt runoff and not an ice jam. On May 11, the SEOC was contacted by the Native Village of Nunapitchuk reporting high water up to five-feet-deep in town due to snowmelt and tidal surge, but no impact to homes or community infrastructure. On May 14, the SEOC received a signed tribal declaration of local disaster from both the City and Native Village of Nunapitchuk.

2020 December Southeast Storm (DR-4585 AK). A very strong atmospheric river impacted Southeast Alaska from December 1-2 with a series of other strong and moist weather fronts through December 8th. The atmospheric river produced historic extreme precipitation in particular over the far northern inner channels including Haines Alaska. The rainfall and snowmelt caused massive road infrastructure damage from runoff coming from Ripinsky Ridge that overwhelmed culverts and flooded areas away from steep terrain including portions of the Haines airport. There were also multiple debris flows along the Haines Highway, Lutak Rd, Mud Bay Rd, Mosquito Lake area and a deadly landslide along Beach Rd where 2 people lost their lives. A large avalanche came down into Chilkat Lake that damaged a few homes. Residents were evacuated from numerous locations across the Haines area. Eight homes were destroyed, and at least 21 will be inaccessible in the long term. On December 1, precipitation moved into the region with snow level slowly rising through the day with some minor accumulations at sea level but much more at higher elevations (34-59") and along the Haines Highway (17.8"). The 24hr precipitation amount of 5.49" on December 1 from the Haines Airport broke the all-time daily record from 1946 and was a 25 to 50-year return period for rainfall frequency. Looking at a rolling 24hr rainfall total from December 1 through the 2 at 12pm the max was 7.12" with a 100-150-year return interval (RI). The downtown Haines COOP station reported 6.62" which broke its all-time daily precipitation record from 2005 on December 2 (taken at 8am). The Haines40NW COOP reported 5.23" and broke its all-time daily precipitation record from 1999 and was a 25-year RI. Under the authority granted by Alaska Statute 26.23.020(c), Governor Dunleavy declared that a condition of disaster emergency exists in the entire Southeast Region of Alaska to include Haines Borough, Municipality of Skagway Borough, City and Borough of Juneau, City and Borough of Wrangell, Petersburg Borough, City and Borough of Sitka, Ketchikan Gateway Borough and the Annette Island, Chatham, and Southeast Island Regional Education Attendance Areas (REAA's), and this condition is of sufficient severity and magnitude to warrant a disaster declaration in order to provide assistance. In addition, as an appropriate life safety decision, the Governor suspended compliance with all state environmental permitting requirements and other specific State requirements pertaining to the Department of Transportation and Public Facilities in accordance with the authority granted by AS 26.23.220 (g)(1), for the duration of the effective date of this proclamation.

2020 November West Coast Storm. November 4 – 7, 2020, the west coast of Alaska was damaged by a strong coastal storm. This weather system brought blizzard conditions, elevated storm surge and significant coastal erosion into the region. On November 4, 2020, the storm moved into the western Bering Sea and then tracked northeast along the west coast of Alaska and impacted a large coastal area (over 600 miles) with gale force winds resulting in pushing a considerable storm surge across the region. While many villages did experience damage along their respective coastlines, the village of Shishmaref took the brunt of this unusually long period of onshore winds, waves and storm surge. Shishmaref was impacted by damaging erosion due to the combination of high winds, wind driven waves and storm surge ranging from five to six feet above the normal high tide line against a shoreline unprotected by sea ice. The storm surge overtopped and breached protective berms, flooding the low-lying coastal area within the community. As a result, the community sustained substantial damages to an approximately one-mile-long section of coastal beach berms and community roads. On November 9, 2020, the City, Native Village and

Corporation of Shishmaref approved Resolution 21-03, declaring a local disaster emergency and requested State technical and financial assistance.

2021 October Southcentral AK Storm. On October 29 and continuing through November 1, 2021, an “atmospheric river” storm system, as defined by the National Weather Service (NWS), brought heavy rain, snow, and strong winds to much of Southcentral Alaska. The subtropical system focused most of its moisture toward the Girdwood/Portage area within the Municipality of Anchorage (MOA), and eastern portions of the Kenai Peninsula Borough (KPB), including the City of Seward and the community of Cooper Landing. The NWS Alaska Region reported the four-day storm produced preliminary rainfall amounts as follows: Portage 23.88 inches, Girdwood 16.28 inches, and portions of the Kenai Peninsula, between six and 10 inches. At Portage, the rainfall amounts in the two-day period alone corresponded to a 1 in 500-year event, while throughout the impacted areas rainfall levels reach recurrence intervals that ranged from a 1 in 25-year record to a 1 in 1,000-year record event. At higher elevations above Girdwood, the Chugach National Forest measured almost 20 feet of snow in a 24-hour period. The rainfall continued into November 2, when a second albeit smaller, storm entered the areas further saturating soils and contributing additional runoff to already swollen streams. The storm’s impacts were widespread and included numerous landslides and mudslides impacting state and local roads, including the Seward and Sterling Highways, eight locations along the Alaska Railroad (ARRC) tracks and right-of-way, and state-managed public-use trails. Significant flooding was reported in the Girdwood area, and runoff erosion washed out the sole road access to the Solid Waste Transfer and Wastewater Facility, an important and critical facility in Girdwood. MOA engineers estimated temporary and permanent repairs exceed \$2.5 million. Several locations of ARRC rail were heavily damaged; engineer estimates for one location (ARRC Milepost 52.24) exceeds \$3.6 million. A more accurate damage estimate quantifies closer to \$4 million in total ARRC costs. High winds with measured gusts of over 100 miles per hour were measured in several areas resulting in widespread power outages. It is expected that following a full damage assessment of all impacted areas, the total damages from the storm will exceed \$6 million. The Alaska Division of Homeland Security and Emergency Management (DHS&EM) continues to receive damage assessment and repair cost estimates from local communities and state agencies. The most heavily damaged areas are within the MOA and the KPB. Although a complete damage assessment has not been prepared, the initial damages compiled so far exceed \$6 million; thus, they likely far exceed the minimum statewide per capita threshold required by the Stafford Act of \$1,195,427.30 calculated by multiplying 733,391 Alaska residents (2020 Census) by the Federal Fiscal Year 2022 per capita indicator of \$1.63.

2021 November Wrangell Wind Storm. Beginning on November 30, 2021, the City and Borough of Wrangell experienced a sudden exceptionally strong windstorm with wind gusts up to 118 mph, that toppled power poles and trees, damaged homes and personal property, and caused widespread power, cellular telephone, and internet outages affecting thousands of residents, disrupted normal community functions, and damaged community utility and other critical infrastructure. The windstorm damaged or downed numerous trees which fell onto local and regional power transmission lines, interrupting electrical service and requiring backup generators to be deployed at the Wrangell Medical Center, radio station, airport runway lighting, municipal water and wastewater treatment plants, and other critical facilities. The high winds also damaged the city park shelter requiring extensive repairs and approximately 120 homes were without power for over 30 hours in near-freezing temperatures, prompting local officials to open an emergency community shelter for affected residents, threatening power lines and/or blocking roads, and to remove those hazardous trees posing a public risk to residents, personal property, and public infrastructure. The City and Borough of Wrangell, a political subdivision of the State of Alaska, has declared a local disaster emergency and requested State disaster assistance, including technical and financial assistance, to recover from this event. The severity and magnitude of this emergency are beyond the timely and effective response and recovery capability of local resources, immediate and emergency

assistance is needed, and there are insufficient regularly appropriated local funds to cover these requirements. On December 17, 2021, the SEOC received a financial impact summary for this disaster from the city and Borough of Wrangell. The total estimated disaster-related emergency response, temporary and permanent repair costs for this disaster are \$255,372, with another \$807,500 in ineligible mitigation costs. These costs do not exceed the minimum state threshold of \$1,195,427.30 to request a federal disaster declaration, thus, a request for federal disaster assistance through the Federal Emergency Management Agency was not submitted.

2021 December Interior Alaska Winter Storms. During the final week of December, the interior of Alaska was hit by back-to-back severe winter storms, which brought heavy snow, freezing rain, high winds, and snow drifts to Fairbanks and several other communities, causing several days of power outages, considerable accumulation of snow and ice on roads, and shut downs of Fairbanks North Star Borough services such as libraries and recreation. On December 26, Fairbanks received a total of 1.93 inches of precipitation, the third highest daily fall on record. The Golden Valley Electric Association had 18 crews in the field, and required another 9 crews from Anchorage, working around the clock to restore power to the community. It took several days for snowplows to clear roads in cities from Fairbanks to Circle further north. December 2021 also received the second highest amount of precipitation on record for the city of Fairbanks, with the community receiving a total of 47 inches.

2021 & 2022 Alaska Severe Winter Storm and Straight-line Winds (DR-4648 & 4646 AK). Beginning on or around December 15, 2021, the State of Alaska experienced an atypical change in the strength and location of the jet stream that steered a series of low-pressure storm systems into the Bering Sea, through the West Coast, and into Interior Alaska. This unusual weather pattern produced an atmospheric river, bringing warm and moist air from the Pacific Ocean. Over the Christmas holiday weekend, this weather system produced record precipitation in the Fairbanks area and across other regions in Interior Alaska. These highly unusual winter storms produced extreme cold temperatures, strong winds, wind chills to 45 degrees below zero, freezing rain (resulting in ice accumulation), and heavy snowfall. Impacts from this severe weather included downed power lines, widespread power outages involving over 14,000 residents, road closures (including major highways), hazardous driving conditions, water in building crawl spaces and basements, and building damage across much of Interior Alaska. The National Weather Service (NWS) – Fairbanks Office reports this storm produced 1.93 inches of liquid precipitation on December 26, 2021, the wettest December day on record and third wettest day on record for Fairbanks. Also, NWS measured 4.75 inches of precipitation in December, the wettest December on record, and the second wettest winter month on record. On December 29, 2021, the Fairbanks North Star Borough mayor requested disaster assistance from the State Emergency Operations Center (SEOC) to support the Borough transporting residents to shelter who were unable to leave their homes due to access and power issues. The Alaska National Guard deployed eight personnel with vehicles to Fairbanks on January 1 – 4, 2022 to meet this request. The total estimated disaster-related response and recovery costs for this disaster have not been fully quantified; expenditures for this disaster were limited to \$1 million from the Disaster Relief Fund pursuant to Alaska Statute (AS) 26.23.020(i) and (k), and per AS 26.23.025(a). The current balance of the Disaster Relief Fund is \$3,435,998.60 and a supplemental appropriation is not required at this time.

Beginning January 1, 2022, strong cold northerly air brought extreme cold weather and sustained strong winds to the Matanuska-Susitna Borough and Copper River Basin. Wind gusts over 80 miles per hour, with wind chills to 40 degrees below zero were recorded. Impacts from this storm included multi-day power disruption to over 18,000 Matanuska-Susitna residents, windblown storm debris, overturned vehicles on highways, downed trees, wind and freeze damage to homes, schools, government structures, commercial businesses, and other property. The Matanuska-Susitna Borough declared a local declaration of disaster emergency for this storm on January 3, 2022 and requested state disaster assistance. The total estimated disaster-related response and recovery costs for this disaster have not been fully quantified; expenditures for this disaster were limited to \$1 million from the Disaster Relief Fund pursuant to Alaska Statute (AS)

26.23.020(i) and (k), and per AS 26.23.025(a) this letter serves as the initial finance plan. The current balance of the Disaster Relief Fund is \$3,435,998.60 and a supplemental appropriation is not required at this time.

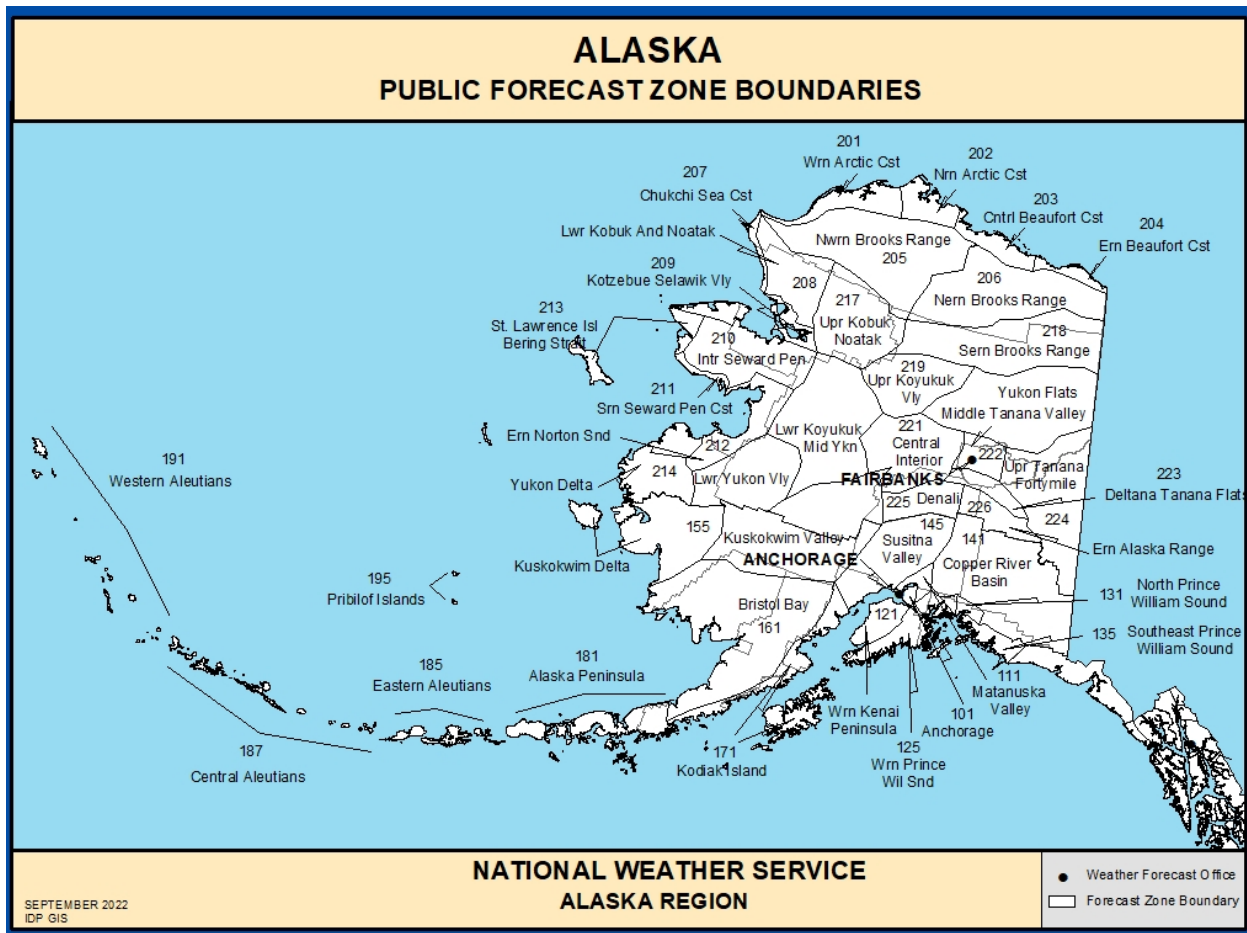
2022 January Southeast Storm. Beginning January 8 and continuing through January 11, 2022, a strong winter storm brought extraordinary heavy snow and rainfall over the northern portions of the Alaska Panhandle. This recent cold weather pattern produced over five feet of snow in some areas, followed by heavy rain and additional snow that significantly added to the structural loads on public facilities and infrastructure, residential homes, personal property, and commercial structures. The heavy snow loading on two commercial buildings in the City and Borough of Juneau caused them to collapse, and similar heavy snow loading on the Yakutat Health Center damaged the roof structure resulting in water leakage into the facility. The heavy snow and rain, ice accumulation, and cold temperatures caused similar roof damage and/or frozen water and wastewater pipelines in other public buildings and private property in the City and Borough of Yakutat, Haines Borough, and Municipality of Skagway Borough requiring emergency response. Community efforts to remove snow, while ongoing since the start of the storm, are challenged by continuing extreme weather and limited local or regional resources. Local officials were concerned about additional damages that may occur if emergency snow removal is not completed rapidly, have requested immediate state support, including the Alaska National Guard, for labor, equipment, and supplies for snow removal from community structures and critical facilities. The City and Borough of Yakutat, City and Borough of Juneau, Haines Borough, and Municipality of Skagway Borough are each political subdivisions of the State of Alaska, and the City and Borough of Yakutat has declared a local disaster emergency and requested state disaster assistance for this event. The severity and magnitude of this emergency are beyond the timely and effective response and recovery capability of local resources, immediate and emergency assistance is needed, and there are insufficient regularly appropriated local funds to cover these requirements.

2022 February Galena Fire Hall Collapse. On February 24, 2022, the City of Galena sustained a severe loss and threat to life safety from the collapse of the city fire hall due to a combination of ice buildup and excessive layer of snow. This region of the state experienced near record breaking, or record-breaking snow and rain accumulation, which significantly added to the structural load and caused the collapse of the structure. The following conditions exist as a result of the disaster emergency: temporary relocation for the emergency response vehicles to include the rescue truck, ambulance, fire truck, all of the volunteer firefighter equipment and support items, as well as the water delivery truck; alternative water distribution and transportation methodologies, straining the potable water system located near the Galena Interior Learning Academy school; and, failure of water pipe and valve structures supporting the community piped water system, including the Sidney Huntington School. The City of Galena is a political subdivision with the State of Alaska; and the severity and magnitude of the emergency is beyond the timely and effective response and recovery capabilities of local resources, immediate and emergency assistance is needed, and there insufficient regularly appropriated local funds to cover these requirements. On the 13th day of May 2022, under authority granted by Alaska Statute 26.23.020(c), it was declared that a condition of disaster emergency exists in the City of Galena and this condition is of such severity and magnitude to warrant a disaster declaration in order to provide assistance.

2022 September Typhoon Merbok Remnant Storm Event (DR-4672). On September 16-18, 2022, the strongest storm to enter the Bering Sea in 70 years hammered communities along the western coast of Alaska. Typhoon Merbok transitioned into a Pacific storm pushing northward, bringing severe storm surge flooding, 90 mph winds, and 50-foot seas to several small communities, prompting a disaster declaration from Governor Mike Dunleavy. The U.S. Department of Transportation released \$9 million in quick-release emergency funding to repair damage from the storm. President Joe Biden approved a request from the state for the federal government to cover 100% of eligible recovery costs for 30 days following the event, as well as a reimbursement to the state for 75% of total disaster recovery costs. Over 1,000 miles of coastal Alaska was impacted by the flooding. Nome, Golovin, Koyuk, and Unalakleet were among the hardest hit, suffering road washouts, homes being moved off their foundations, sand and

sewage being deposited along roads and into peoples' homes, broken windows and doors, damaged bridges, telecommunications and power outages, and displaced residents. Residents in White Mountain lost personal property as it was washed down the Niukluk River, and \$25,000 in frozen food was lost when power outages caused freezers to fail (Native Village and City of White Mountain MJHMP planning team, 2022). In the village of Elim, flood waters disrupted their water treatment and sewage systems, allowing e. coli to contaminate their drinking water and causing an intake of salt water into their water lines (Native Village and City of Elim MJHMP planning team, 2022). The village of Golovin was among the hardest hit, losing the entirety of its winter food supply and one third of its residences due to the hurricane-force winds and severe flooding.

The NOAA, Alaska Region's 2018 "Alaska Public Forecast Zone Boundaries" map (Figure 4.1.7-3), displays inclusive weather zone boundaries and numbering. Both features will assist communities with locating current, forecast, or historic weather and climate change related events or conditions for diverse locations throughout the state.



Source: NOAA, Alaska Region, 2022

Figure 4.1.7-3: Alaska Public Forecast Zone Boundaries

4.1.7.4 Extent of Severe Weather Hazards

All of Alaska is vulnerable to severe weather effects. Each location experiences diverse severe storm conditions, snow depths, wind speeds, and extreme temperature ranges. Extreme events include 159 mph winds recorded at Attu (12/7/50), largest one-day snowfall of 5 feet, 2 inches in Valdez (12/29/1955), and one-day rainfall events with over 5 inches in a 24-hour period (1-in-1,000-year event).

4.1.7.5 Impact of Severe Weather Hazards

The intensity, location, and topography influence severe weather event impacts. Hurricane force winds, rain, snow, and storm surge can be expected to impact the entire area.

Extreme weather events such as rain, snow, wind, or a combination of these conditions causes transportation to become immobilized (e.g., all transportation: air, boat, road; even snow machine, and ATV traffic stops). Impacts can range from negligible to catastrophic. Essential supply deliveries, emergency response, medical transport, and critical subsistence activities cannot resume until the weather clears and populations can move about safely. Disaster response and recovery is delayed and disrupted by ongoing and repeated severe weather impacts to road, aviation, and maritime transportation.

Heavy snow accumulations can cause roof collapse and knock down trees and power lines. Heavy snow can also damage light aircraft and sink small boats. A quick thaw after a heavy snow can cause substantial flooding. Snow removal, damage repairs, and business disruptions can have severe economic impacts to individuals, villages, and cities.

Weather injuries and deaths usually occur from vehicle and/or snow machine accidents as well as overexertion and hypothermia caused by overexposure to severe weather events.

Aircraft may be grounded due to extreme cold and ice fog conditions, cutting off access and delaying community supply deliveries. Long cold spells can cause rivers to freeze, disrupt shipping, and increase the likelihood of ice jams and associated flooding or overflow threats.

Extreme weather interferes with community infrastructure and its proper functions. It can cause fuel to congeal in storage tanks and supply lines and stop electric power generation, which in-turn causes heaters and furnaces to stop and water and sewer pipes to freeze or rupture. If extreme cold conditions are combined with low or no snow cover, the ground's frost depth can increase, disturbing buried pipes. The greatest danger from extreme cold is the effect on people. Prolonged exposure to the cold and high winds can cause frostbite or hypothermia and become life-threatening; infants and elderly people are most susceptible. Carbon monoxide poisoning is also a possible effect as people will use supplemental heating devices not intended for indoor use during extreme weather events.

Although the scope, severity, and pace of future climate change impacts are difficult to predict, it is clear that potential changes could affect our agencies' ability to fulfill their respective missions. The challenges posed by climate change, such as more intense storms, frequent heavy precipitation, heat waves, drought, extreme flooding, and higher sea levels could significantly alter the types and magnitudes of hazards faced by communities and the emergency management professionals serving them. Some specific areas where climate change could influence response, recovery, and mitigation are:

- Coastal regions, which are becoming increasingly populated and developed. More frequent severe storms may increase the necessity of increased emergency services and associated response and recovery capacity.
- Critical infrastructure resiliency is necessary to ensure operational continuity service delivery is essential and may experience task priority challenges.

4.1.7.6 Probability of Severe Weather Hazards

It is highly likely that Alaska will continue to experience diverse and seasonal severe weather events. The state has a 1 in 1 year (1/1=100 percent) chance for severe weather to occur within any given year.

4.1.7.7 Projected Changes in Location of Severe Weather Hazards

Alaska is experiencing a shift in precipitation, temperature, and storm patterns, and most regions are experiencing milder winters and warmer summers. According to the Fourth National Climate Assessment, the arctic is warming faster than southern regions of the state. Interior Alaska, which is accustomed to temperatures which stay below freezing all winter, is beginning to witness winter warm spells and

temperature swings like those more commonly found in southeast and southcentral Alaska. These winter warm spells create thaw-and-refreeze events, which bring heavy snow and freezing rain, and cause accumulations of ice on the surface, such as during the December 2021 winter storms. Additionally, the permafrost regime in Alaska is shifting. Communities built on thick layers of permafrost are beginning to witness foundation shifts and infrastructure damage due to permafrost degradation, with residents reporting that where there was once permafrost found directly below the surface, they now find saturated soils and a permafrost layer beginning much deeper in the ground. Precipitation regimes are also projected to shift. While southeast Alaska receives more precipitation than any other region of the state, by mid-century much of southcentral, western Alaska, the interior, and the arctic are anticipated to experience a 15% or greater increase in precipitation, according to NOAA (Stewart et al., 2022).

4.1.7.8 Range of Anticipated Intensities of Severe Weather Hazards

Many regions of the state are witnessing milder winters and decreased winter snowpack, but an increased severity of winter storms and an increased frequency of thunderstorms during the summer. As relative humidity increases due to loss of winter sea ice, it enables more unstable thermodynamic environments, increased low-level buoyancy, and weaker downdrafts. These conditions increase the frequency of, and energy available to, organized convection, which can produce hazards such as hail, flash floods, heavy snow, heavy rain, and thunderstorms (Poujol et al., 2021). Severe weather events in all seasons are thus projected to intensify due to the effects of climate change. Milder winters will also lead to an increase in severity of thaw-and-refreeze events, which affect large mammal populations by restricting the amount of winter forage available (Wilson et al., 2012). This will impact subsistence hunting in rural Alaska and may lead to a change in availability of some traditional foods (Not all resources will decline. For example, moose populations are increasing in numbers and range at the same time that caribou populations are shrinking). These events can also impact larger communities in the state, by increasing the risk of vehicle accidents and slip-and-fall injuries. Finally, thaw-and-refreeze events can increase the severity of freezing rain events. If temperatures swing above freezing during the winter, freezing rain can mix with existing melting snow cover, creating thick layers of ice on roads and walkways when temperatures dip back below freezing.

4.1.7.9 Frequency of Severe Weather Hazards

The frequency of future storms and severe weather are anticipated to increase in Alaska, with regions south of the Yukon River expected to see severe storms nearly once a month during the summer (Poujol et al., 2021). Heavy precipitation and thunderstorm events will be more frequent, increasing the magnitude and frequency of summertime flash floods, and increasing the frequency of wildfires in the summer. Winter storms are also projected to increase in frequency. Additionally, as the climate continues to warm, thaw-and-refreeze events are anticipated to increase in frequency (Wilson et al., 2012). These temperature swings can also lead to freezing rain and ice storms.

4.1.7.10 Duration of Severe Weather Hazards

Climate change may lead to an increased frequency and intensity of storms, but of shorter durations. As organized convection increases, the intensity of precipitation increases faster than the atmosphere's water-holding capacity (Berg et al. 2013). Precipitation may fall faster and harder, leading to an increased risk of flash floods in some regions, but these storms may also burn themselves out quickly.

4.1.7.11 Future Conditions for Severe Weather Hazards, Including Climate Change

Climate change is a phenomenon of warming caused by greenhouse gases such as water vapor, carbon dioxide, and other gases in the earth's atmosphere acting like a blanket over the Earth, trapping additional heat of the sunlight-warmed surfaces instead of allowing it to escape into space. The more gasses, the thicker the blanket, the warmer the earth. The increased buildup of greenhouse gases changes precipitation patterns; increases storms, wildfires, and flooding frequency and intensity; and substantially changes flora, fauna, fish, and wildlife habitats.

In contemporary usage, climate change commonly refers to the change in global or regional climate patterns that spans from the mid- to late 19th century to the present. Evidence collected by scientists and engineers from around the world tells an unambiguous story: the planet is warming, and per the Intergovernmental Panel on Climate Change (IPCC), humans are largely responsible. Climate change at high northern latitudes, such as Alaska, is causing rapid and severe environmental change.

Since the late 1970s, statewide annual average temperatures in Alaska have increased with an average rate of 0.7°F per decade, with 2016 being the warmest year in historical records (USGCRP 2018). This included considerable annual and regional variability and was accompanied by a greater number of extremely warm days and fewer extremely cold days (CCSP 2008). The statewide average annual precipitation during this same period has increased by about 10 percent, with recent decades showing amounts largely above normal throughout Alaska, but with substantial annual and regional variability (Shulski and Wendler 2007; ACRC 2018). Figure 4.1.7-4 shows the annual average temperature normals from 1991 through 2020.

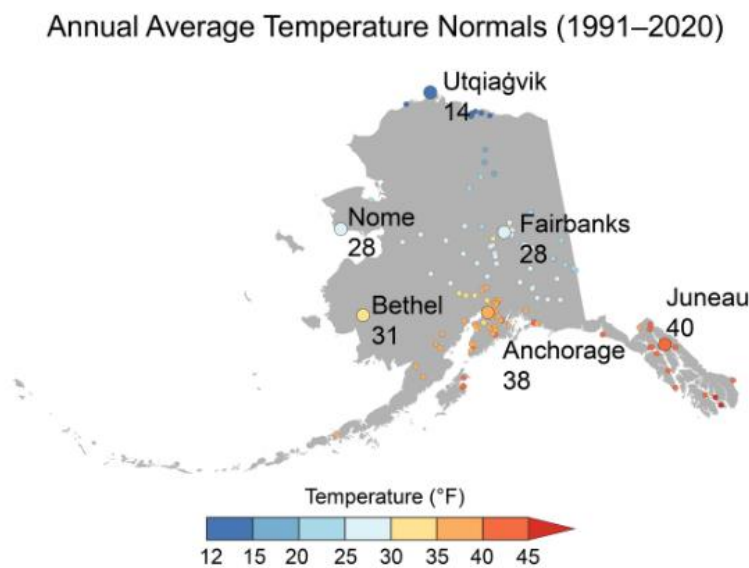


Figure 4.1.7-4: State Climate Summary (NOAA National Centers for Environmental Information, State Climate Summaries 2022)

Global climate is projected to continue changing over this century, and changes to Alaska's climate are expected to be unprecedented. Due to polar amplification, Alaska is warming at twice the rate of the rest of the globe, with the North Slope warming considerably faster than the rest of the state (Bekryaev et al., 2010; USGCRP 2018). According to the Fourth National Climate Assessment, highest daily maximum temperatures in Alaska are projected to rise by 4–8%, and lowest daily maximum temperatures are projected to rise by 10% by 2045–2065; additionally, the annual maximum one-day precipitation may see an increase of 15% in most of the state (USGCRP 2018).

Climate change is also impacting the world's oceans. Ocean acidification is an increase in the acidity of ocean waters by the uptake of carbon dioxide, a greenhouse gas. This issue could impact subsistence as well as Alaska's commercial fishing industry, as acidifying oceans will have significant implications for the food web in the oceans. Acidification has negative implications for corals, crustaceans, crabs, mollusks, and any other calcium carbonate-dependent organisms (USGCRP 2018).

The state's rapidly changing climate impacts are already pronounced and will intensify as average temperatures continue to trend upward. The societal impacts of a changing climate are exacerbated as the frequency and magnitude of the physical processes that control climate-related natural hazards are

amplified, threatening community resilience, and increasing natural hazard vulnerability of infrastructure and property. In Alaska, damaged roads from flooding, along with damaged infrastructure and buildings due to permafrost degradation, are projected to be the largest climate change-driven damages, with costs estimated to reach \$5.5 billion by 2099 unless the state invests in adaptations to the changing climate (Melvin et al., 2016).

Climate Change: The UAF Arctic Climate Impact Assessment (ACIA) describes recent weather changes and how they impact Alaska:

Alaska experienced an increase in mean annual temperature of about 2 to 3 °C between 1954 and 2003... Winter temperatures over the same period increased by up to 3 to 4 °C in Alaska and the western Canadian Arctic, but Chukotka experienced winter cooling of between 1 and 2 °C...

The entire region, but particularly Alaska and the western Canadian Arctic, has undergone a marked change over the last three decades, including a sharp reduction in snow-cover extent and duration, shorter river- and lake ice seasons, melting of mountain glaciers, sea-ice retreat and thinning, permafrost retreat, and increased active layer depth. These changes have caused major ecological and socio-economic impacts, which are likely to continue or worsen under projected future climate change. Thawing permafrost and northward movement of the permafrost boundary are likely to increase slope instabilities, which will lead to costly road replacement and increased maintenance costs for pipelines and other infrastructure. The projected shift in climate is likely to convert some forested areas into bogs when ice-rich permafrost thaws. Other areas of Alaska, such as the North Slope, are expected to continue drying. Reduced sea-ice extent and thickness, rising sea level, and increases in the length of the open-water season in the region will increase the frequency and intensity of storm surges and wave development, which in turn will increase coastal erosion and flooding...

Impacts on people's lives

Traditional lifestyles are already being threatened by multiple climate-related factors, including reduced or displaced populations of marine mammals, seabirds, and other wildlife, and reductions in the extent and thickness of sea ice, making hunting more difficult and dangerous. Indigenous communities depend on fish, marine mammals, and other wildlife, through hunting, trapping, fishing, and caribou/reindeer herding. These activities play social and cultural roles that may be far greater than their contribution to monetary incomes. Also, these foods from the land and sea make significant contributions to the daily diet and nutritional status of many indigenous populations and represent important opportunities for physical activity among populations that are increasingly sedentary... (ACIA 2015)

The University of Alaska Geophysical Institute's Alaska Climate Research Center (ACRC) provided 2017 Alaska Statewide mid-winter and mid-summer summaries. The planning team determined that spring and fall weather, although different, can be viewed as transition periods between the winter and summer extremes. These data are 2017-centric and used as historical representations only. Future global climate change conditions will affect future weather patterns and events. Actual community temperatures and depths may vary due to their relative proximity to their respective locations and identified weather zones.

4.1.7.11.1 Characteristics/Nature

Climate change affects all severe weather-related events such as:

- **Extreme Cold:** Extreme cold events are projected to become less frequent due to climate change, as average low temperatures are projected to rise more than average high temperatures, and winters will become milder. In Alaska, the average lowest daily maximum temperatures are projected to rise by 10% by 2045-2065 (USGCRP 2018).
- **Winter Storms:** Winter storms are projected to increase in frequency and severity due to climate change. Climate scientists have suggested that warming temperatures, caused by the increase of greenhouse gases in the atmosphere, may be enabling longer and more intense cycles of winter storms (Dixon et al. 2018). The additional heat trapped in the atmosphere by greenhouse gases provides more energy to power storms, and Bering Sea communities such as St. Michael are already witnessing these effects, according to the St. Michael HMP planning team.
- **Heavy or Excessive Snowfall:** The projected increase in precipitation across the state cited above will also lead to more snowfall, and an increase in severity and frequency of excessive snowfall events. According to the EPA, Alaska has experienced an 11% increase in the amount of precipitation falling in very heavy events from 1958 to 2012 (EPA 2016).
- **High Winds:** Over a historical period spanning 1980-2014, there has been an increase in the frequency of high wind events in the northern and western coastal region of Alaska. High-wind events are projected by models to become more frequent, especially in the northern and western coastal regions of Alaska (Redilla et al. 2019).
- **Ice Storms:** Freezing rain and ice storms are anticipated to increase in frequency and severity due to climate change. As relative humidity is increased due to lack of sea ice and warmer air, more water vapor is present in the air to potentially fall as freezing rain during seasonal transitions and Alaska's warmer winters. Climate change may also increase polar jet stream meandering, increasing the frequency of near-freezing temperatures and increasing the likelihood of freezing rain (Groisman et al., 2016; Poujol et al., 2021).
- **Thunderstorms:** Thunderstorms and lightning storms are anticipated to become more frequent due to the increase in organized convection. Alaska is projected to see a tripling of the frequency of thunderstorms by the end of the century (Poujol et al., 2021). As organized convection and precipitation are both projected to increase in Alaska, an increase in frequency and severity of hail events is anticipated. (Poujol et al., 2021).
- **Tornadoes:** Tornadoes are very rare in Alaska, and there is no research to date that has looked at future trends.
- **Heavy Rain:** Precipitation is projected to increase across Alaska due to climate change. According to the Fourth National Climate Assessment, the annual maximum one-day precipitation in most of Alaska may see an increase of 15%, while southeast Alaska may see an increase of 10% (USGCRP 2018). Some regions of the state will see dramatic increases in precipitation. For example, White Mountain may see an increase of 37% of rain in the fall (UAF/SNAP 2022). These increases in precipitation will lead to an increase in frequency and severity of heavy rain events. According to the EPA, Alaska has already experienced an 11% increase in precipitation during heavy rain events (EPA, 2016).
- **Storm Surge:** Storm surge events are projected to increase in frequency and severity due to climate change. El Niño events are impacting the Aleutian Low, a low-pressure system which is located near the Aleutian Islands during winter. As the climate continues to warm, the Aleutian Low is shifting

eastward, creating an increase in the frequency and severity of storm surges in the Bering Sea region (Callaway et al., 1999).

4.1.7.11.2 Probability of Location Changes

Although the effects and their severity will vary from region to region, climate change is not a localized event, but one that is taking place across the entire planet. Alaska has been referred to as a “climate canary,” as northern and arctic regions are projected to see the most dramatic changes the most quickly, and Alaska’s climate is indeed seeing the effects of global climate change. According to the Fourth National Climate Assessment, Alaska is warming at twice the rate of the rest of the globe (USGCRP 2018).

The effects of climate change are making traditional subsistence hunting and gathering more difficult and will reduce the amount of food available in remote Indigenous communities. Additionally, many coastal communities are witnessing a decrease in shore-fast ice during winter. Shore-fast ice protects the coastline from erosion and ice override events during severe winter storms, and communities such as Gambell are witnessing an increase in ice override events, which pose a hazard to infrastructure, as the winter Bering Sea ice cover continues to retreat every year. Fall storms are also occurring later and later in the year. Other regions of Alaska, such as the interior of the state, are witnessing an increased frequency and severity of wildfires.

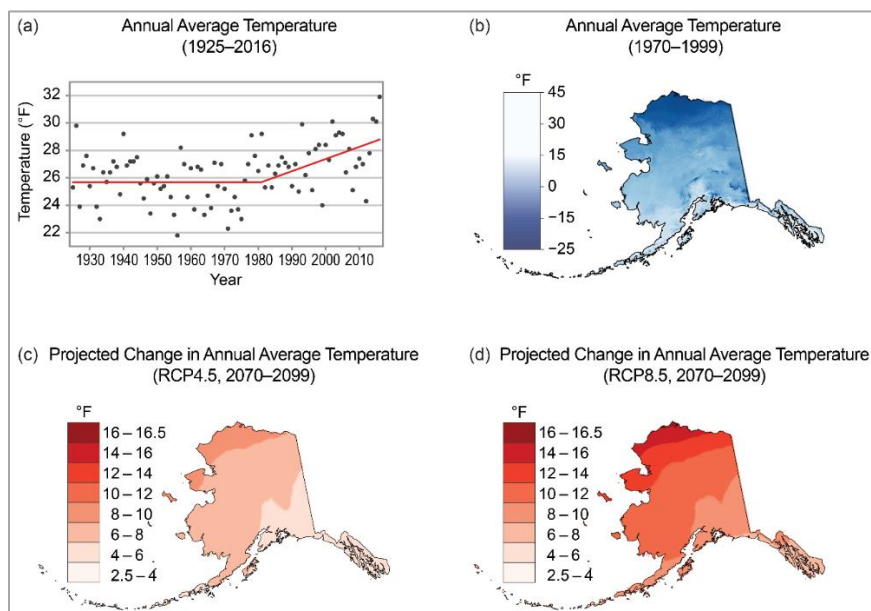
Climate change is impacting quality of life and subsistence hunting and fishing in rural Alaska. Small, mostly-Indigenous communities in western Alaska are reporting permafrost degradation as well as increases in frequency and magnitude of storm surges, both of which are leading to building and critical infrastructure damage, along with changes in marine mammal and fish migratory patterns, decreased crab populations, toxic algal blooms and seabird die-offs, decreases in seaweed and other aquatic plants to harvest, an increased intensity of winter storms, a rapid decline in Bering Sea ice cover, and increased precipitation (Kawerak Region, 2023). Additionally, the increased precipitation is making the drying of fish catches more difficult. In western Alaska, residents are reporting milder winters, leading to thinner ice cover on rivers during the winter combined with a need to cross more frequently in order to travel further from the community to find large game. These factors make subsistence hunting far more hazardous due to the potential of breaking through the thin ice and drowning. The community also reports that rivers are widening, and water temperatures are increasing, leading to die-offs of local fish populations (Kawerak Region, 2023).

A study published in the Bulletin of the American Meteorological Society by Partain and colleagues found that the 2015 wildfire season, the second most widespread on record, which included the Sockeye Fire that burned over 7,000 acres in the Matanuska-Susitna Valley, destroying dozens of structures and displacing residents, occurred during fire conditions which were 34-60% more likely to exist due to anthropogenic climate change (Partain et al., 2016). Due to the loss of winter sea ice and increased relative humidity fueling organized convection, Alaska is projected to see a threefold increase in severe storms, including thunderstorms which often ignite wildfires (Poujol et al., 2021). According to the University of Alaska, Fairbanks Scenarios Network for Alaska + Arctic Planning (SNAP), southeast communities, such as Sitka, are projected to see an increase of 7°F of average annual temperatures by the end of the century, whereas Utqiagvik (formerly known as Barrow) on the north slope may see an increase as high as 18°F of average annual temperatures (UAF/SNAP 2022). Climate change will affect, and is affecting, all of Alaska to varying degrees.

4.1.7.11.3 Range of Anticipated Intensities

Due to compounding factors such as the decline of arctic sea ice, increased organized convection, polar jet stream meandering, polar amplification, and the continued emissions of greenhouse gases, climate change and its effects are projected to continue to intensify across Alaska. Most projections for these effects are compiled and tabulated according to potential levels of emissions, according to a low, medium, or high level of greenhouse gases produced by society. Under all three scenarios, Alaska is expected to see drastic changes. According to the Fourth National Climate Assessment, if society successfully curbs greenhouse gas emissions significantly, Alaska is projected to warm by 8–10°F in the northern region, 6–8°F in the interior, and 4–6°F in the southern regions of the state, whereas a continued increase in global emissions

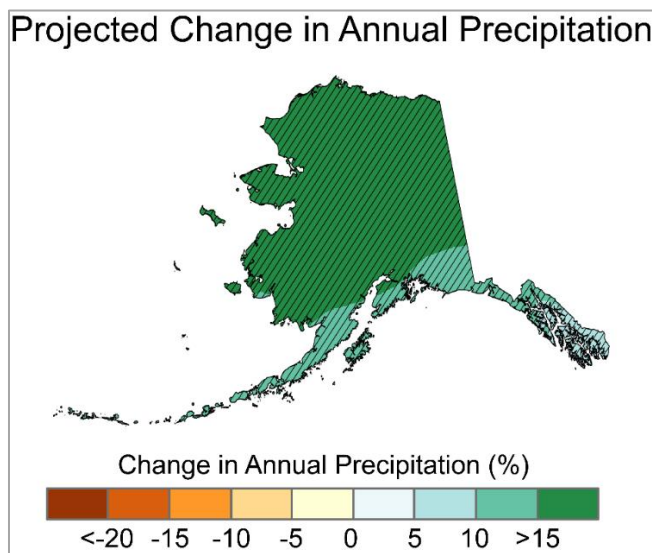
may lead to a rise of 12–16°F in the north, 10–12°F in the interior, and 6–10°F in the southern regions of the state by the end of the century (USGCRP 2018). These scenarios are illustrated in Figure 4.1.7-5 below.



Source: 2018 United States Fourth National Climate Assessment

Figure 4.1.7-5: Statewide Annual Average Temperatures, 1925-2016, and Projections, 2070-2099

Figure 4.1.7-6 depicts current projections for increases in annual precipitation by the middle of the century.

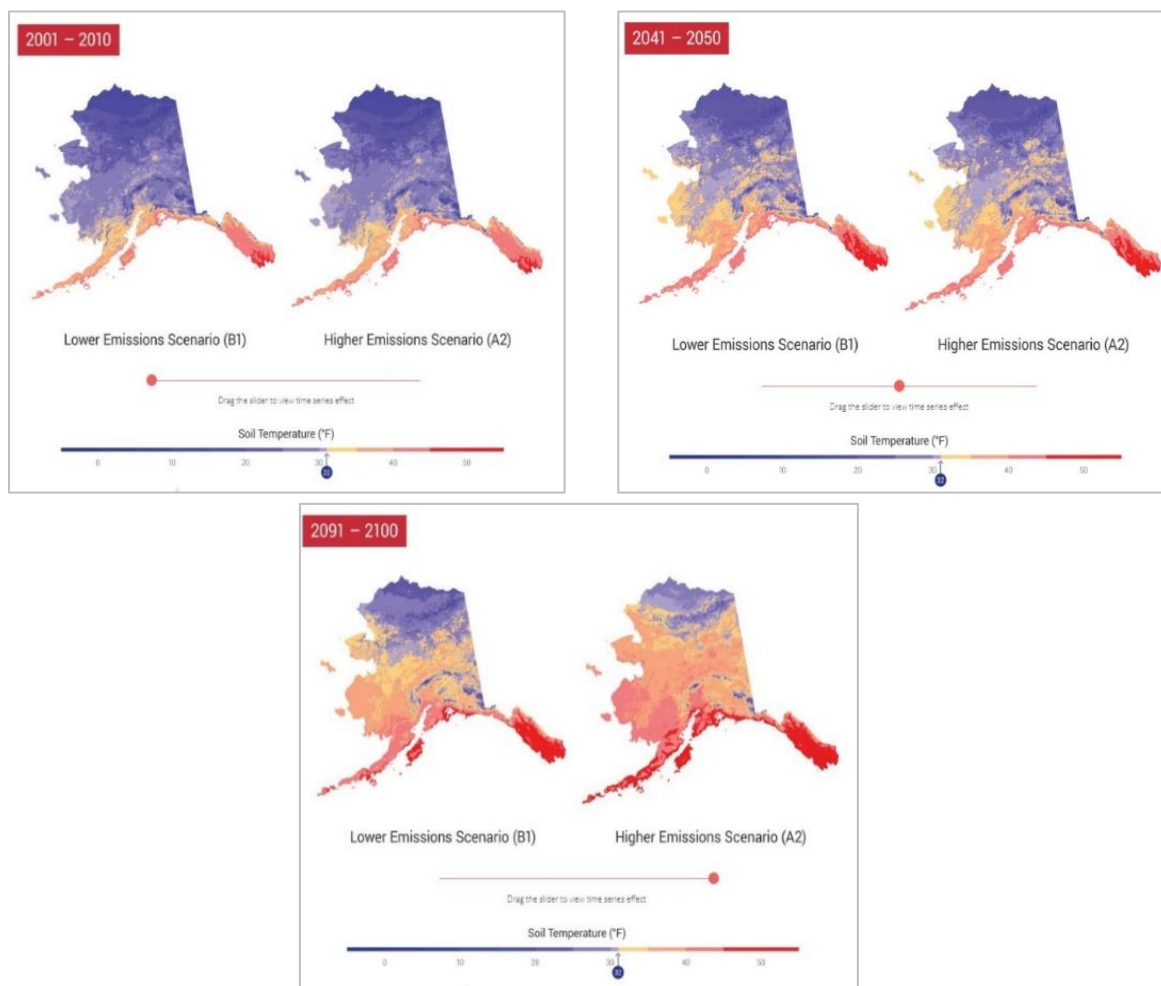


Source: CISESS, NEMAC, and NOAA, 2022

Figure 4.1.7-6: Projected Change in Annual Precipitation from the 20th Century to the Mid-21st Century

Figure 4.1.7-7 below indicates statewide projections for average annual ground temperature at a depth of 3.3 feet over time if emissions of heat-trapping gases continue to grow (higher emissions scenario, A2), and if they are substantially reduced (lower emissions scenario, B1). Blue shades represent areas below freezing at a depth of 3.3 feet, and yellow and red shades represent areas above freezing at that depth.

These scenarios have profound implications for communities and infrastructure built on permafrost and may lead to costly repairs for many small Indigenous communities throughout Alaska.



Source: 2018 United States Fourth National Climate Assessment (<https://nca2018.globalchange.gov/chapter/26/>)

Figure 4.1.7-7: Statewide Ground Temperature Projections, 2001–2100

4.1.8 Wildland Fire and Community Fire

While a part of the natural ecosystem, fires in Alaska are a dangerous hazard when they involve local communities. During the 5-year period spanning 2017 through 2022, there were 106 fire-related fatalities recorded in Alaska from structure fires. Over that same period of time, 2,728 fires have burned more than 7 million acres in Alaska (AICC, 2022).

For the purposes of profiling the hazard in Alaska, fires in this section are characterized by their primary fuel source into two categories:

- Wildland fire, which originates in or consumes natural vegetation as a key component of the fire; and
- Community fire, which propagates among structures and infrastructure.

Fire is a natural wildland management force in Interior Alaska. It is a key environmental factor in cold-dominated ecosystems. Without fire, organic matter accumulates, the permafrost table rises, and ecosystem productivity declines. Fire rejuvenates an ecosystem by removing decaying matter and returning their nutrients to the soil, preserving vegetative diversity and wildlife habitat unique to Alaska. In the absence of wildland fires, many plant and animal species would no longer thrive.

While fire is critical for maintaining the viability of Alaska's ecosystems, it must be tempered with the need to protect human life and property. This is particularly true of fires burning in "wildland urban interface" areas, where structures and other human development meet or intermingle with undeveloped wildland. Wildland urban interface (WUI) has gained importance throughout Alaska with increased development adjacent to wild lands.

Firefighter and public safety are the primary concerns of each local and wildland response agency. In Alaska, thousands of acres burn every year in 300 to 800 fires primarily between the months of March and October. According to the Alaska Interagency Coordination Center (AICC), Alaska lost 6,544,207 acres from 2018 through 2022. This figure consisted of the 2,375 wildland fires that started throughout that same time period. This is an average of 2,755 acres per wildland fire.

4.1.8.0 Fire Management in Alaska

Wildland fire management in Alaska is a joint effort among federal, state, local, and tribal governments, native organizations, local fire departments, communities, and landowners. The land management agencies, also known as jurisdictional agencies, have the overall land and resource management responsibilities as provided by federal, state, or local law.

The "Alaska Master Cooperative Wildland Fire Management and Stafford Act Response Agreement" improves Alaskan fire management agencies' efficiency in responding to wildland fire by facilitating the coordination and exchange of personnel, equipment, supplies, services, and funds while sustaining activities such as prevention, preparedness, communication and education, fuels treatment and hazard mitigation, fire planning, response strategies, tactics and alternatives, suppression, and post-fire rehabilitation and restoration. Exhibit C of this agreement, the "2022 Alaska Statewide Operating Plan," addresses statewide issues affecting cooperation, working relationships, protocols, sharing of resources, financial arrangements, and joint activities and projects. Table 4.1.8-1 lists statewide fire dispatch centers demonstrating their commitment to effective firefighting resource allocation and coordination throughout the state.

Table 4.1.8-1: Alaska Fire Dispatch Centers

Dispatch Center	Location	Managing Agency
Alaska Interagency Coordination Center (AICC)	Fort Wainwright	BLM/AFS
Upper Yukon/Tanana/Military Zone Dispatch Center (YTDC)	Fort Wainwright	BLM/AFS
Galena Zone Dispatch (GADC)	Galena	BLM/AFS
Northern Forestry Dispatch Center (FASC)	Fairbanks	DNR
Matanuska-Susitna Dispatch Center (MSSC)	Palmer	DNR
Kenai Interagency Dispatch Center (KIDC)	Soldotna	DNR
Copper River Dispatch Center (CRSC)	Copper Center	DNR
Chugach National Forest Dispatch (CGFC)	Anchorage	USFS
Tongass National Forest Dispatch (TNFC)	Ketchikan	USFS

Source: 2022 Alaska Statewide Annual Operating Plan

(<https://fire.ak.blm.gov/content/aicc/Alaska%20Statewide%20Master%20Agreement/2.%20Alaska%20Statewide%20Operating%20Plan/Alaska%20Statewide%20Operating%20Plan.pdf>)

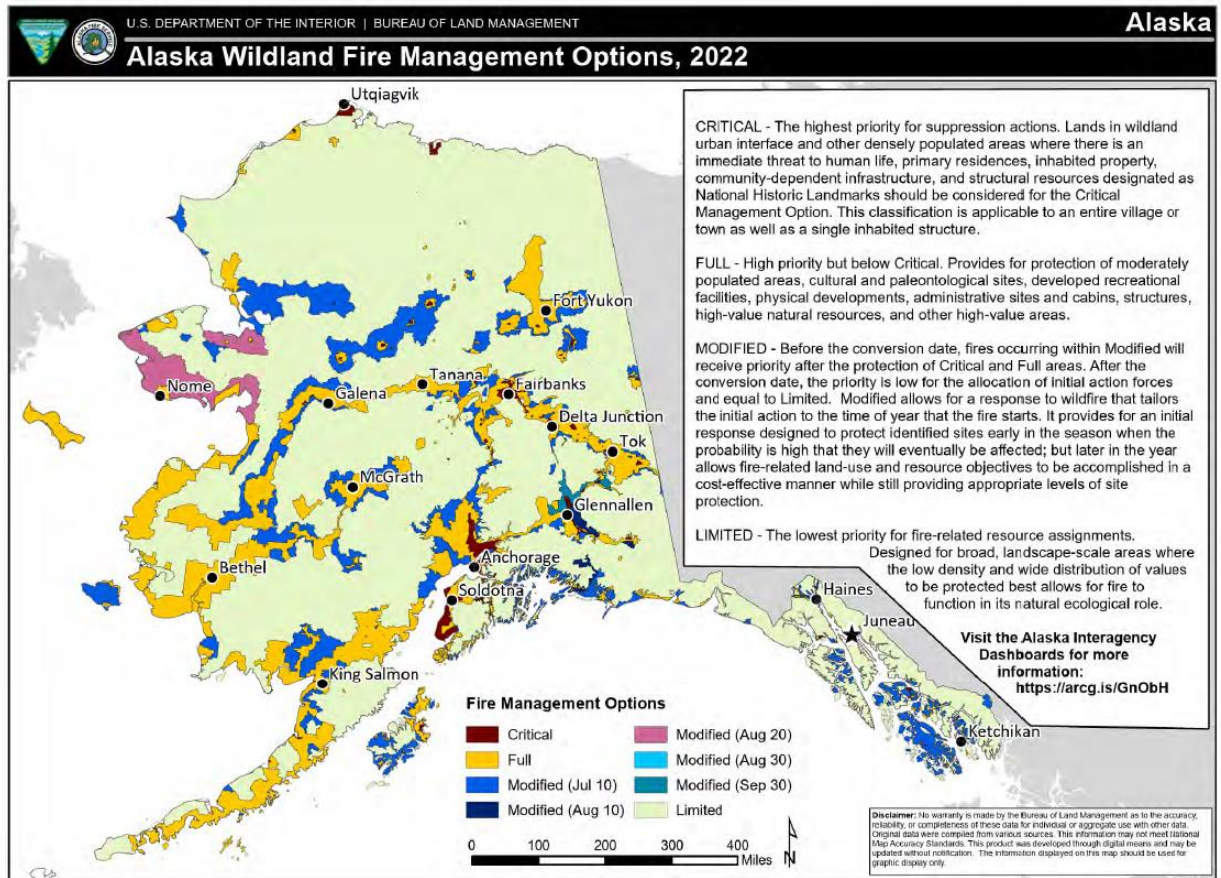
4.1.8.1 Fire Management Options

Prior to the planning efforts in the 1980s, decisions regarding wildland fire management were based upon available resources. In 1988, interagency planners established four fire management options (Critical, Full, Modified, and Limited) and defined response priorities for each wildland fire option. Standard responses ranged from aggressive suppression to surveillance. In 1998, the 1988 management option definitions were incorporated into the Alaska Interagency Wildland Fire Management Plan update; the plan guides wildland fire response within Alaska.

Alaska wildland fire suppression agencies have developed and implemented the 2022 Alaska Interagency Wildland Fire Management Plan (<https://fire.ak.blm.gov/administration/asma.php>). The plan establishes response options and priorities. The range of responses provides an opportunity for agencies to achieve both protection and natural resource management goals and objectives, as well as essential fuels and vegetation management resources.

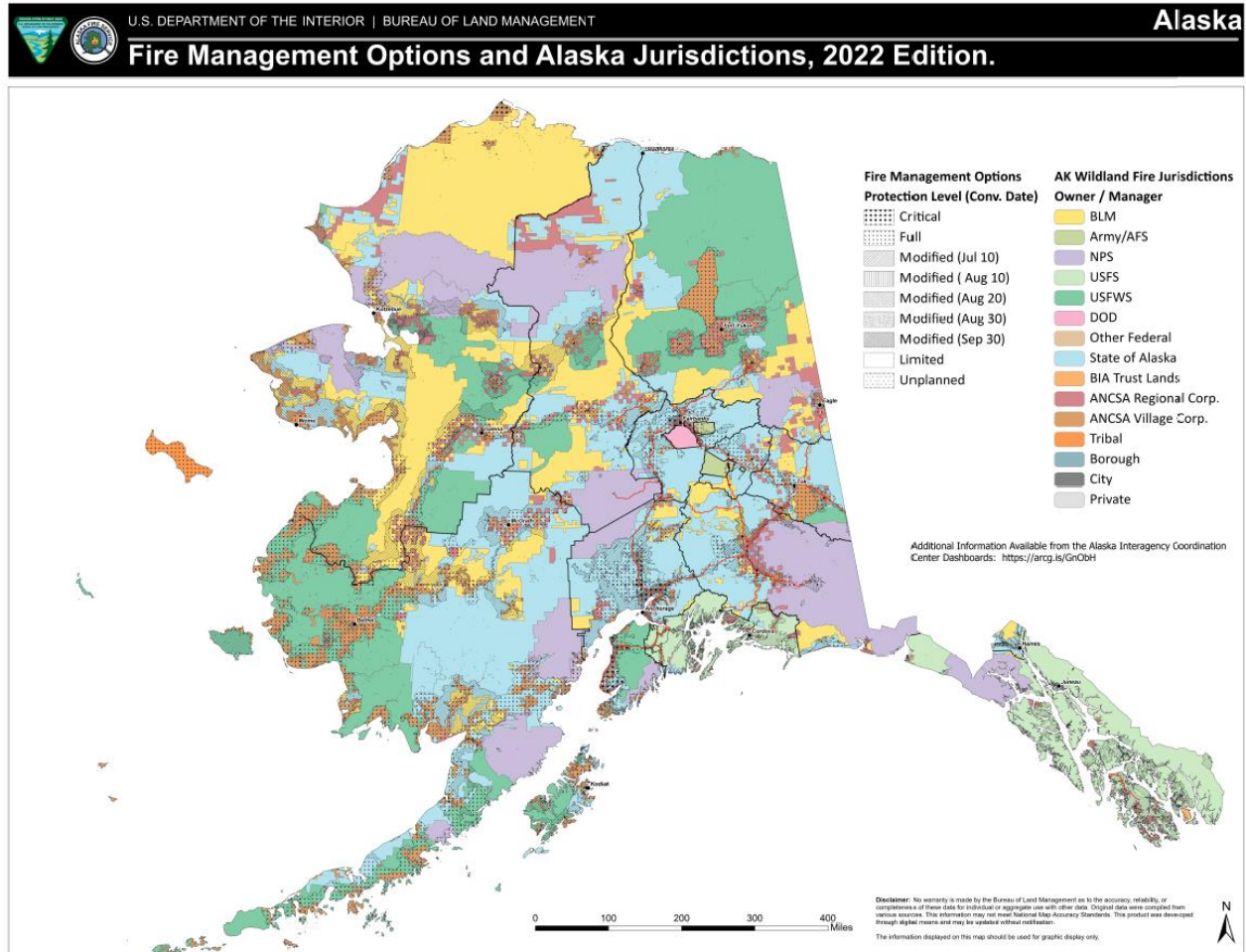
BLM, in coordination with the AICC, provides the BLM Alaska Fire Management Plan Interactive Web Maps to support their fire mitigation initiatives. The following maps and associated tools depict Alaska Fire Management Plan components available to guide mitigation planning efforts and initiatives.

Figure 4.1.8-1 displays Alaska's wildland fire management options: Critical, Full, Modified, Limited and Unplanned, and Figure 4.1.8-2 depicts Alaska's 2022 fire management options and responsible jurisdictions.



Source: AICC 2022

Figure 4.1.8-1: Alaska Fire Management Options

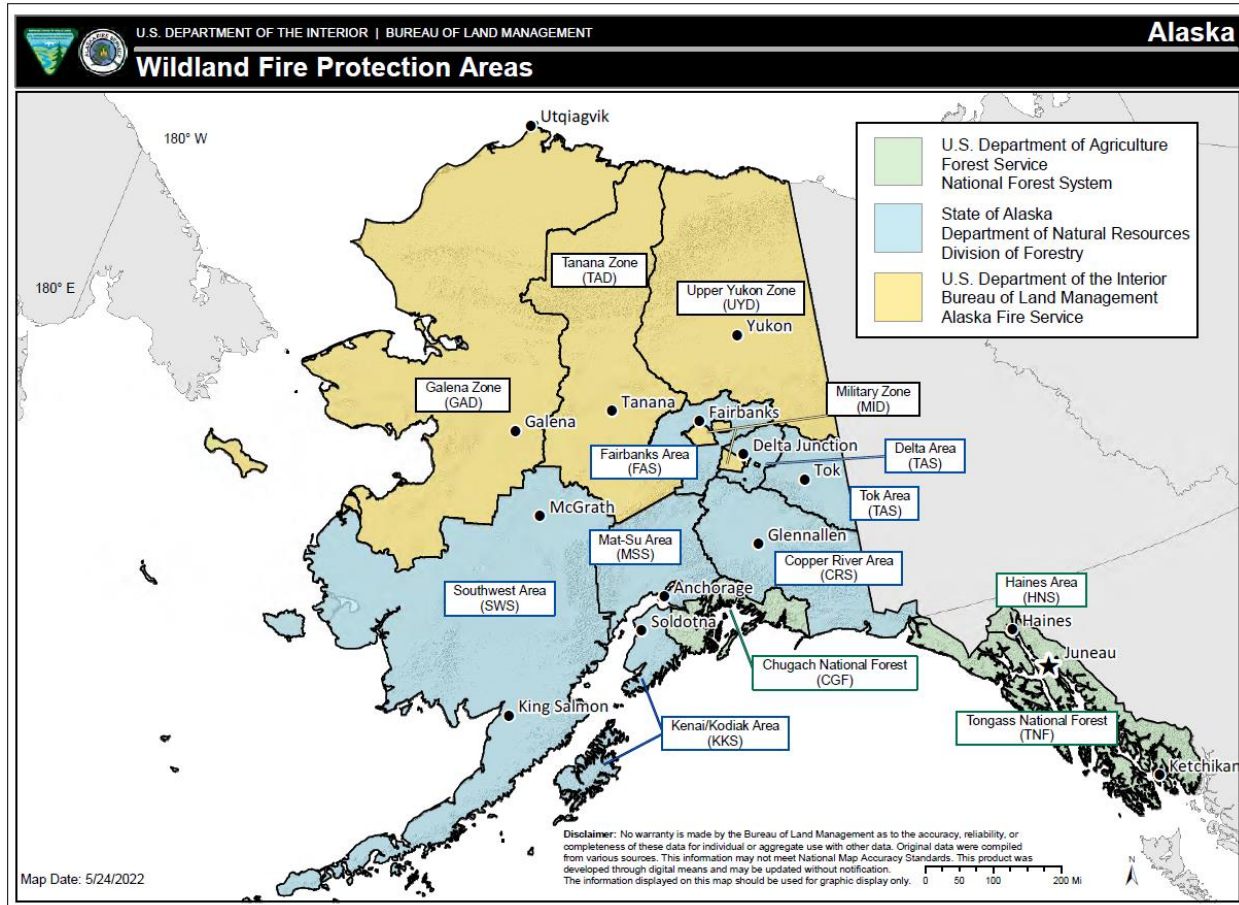


Source: AICC 2022

Figure 4.1.8-2: Alaska Fire Management Options with Jurisdictional Responsibilities

Alaska is divided into three protection areas supported by diverse agencies as specified in the Alaska Statewide Master Agreement: (<https://fire.ak.blm.gov/administration/asma.php>) (Figure 4.1.8-3):

- U.S. Department of Agriculture, Forest Service, and National Forest System;
- Alaska Department of Natural Resources, Division of Forestry; and
- U.S. Department of Interior, Bureau of Land Management, and Alaska Fire Service.



Source: AICC 2022

Figure 4.1.8-3: Alaska Fire Protection Areas

4.1.8.2 Wildland Fire

4.1.8.2.1 Characteristics/Nature/Type of Wildland Fire Hazards

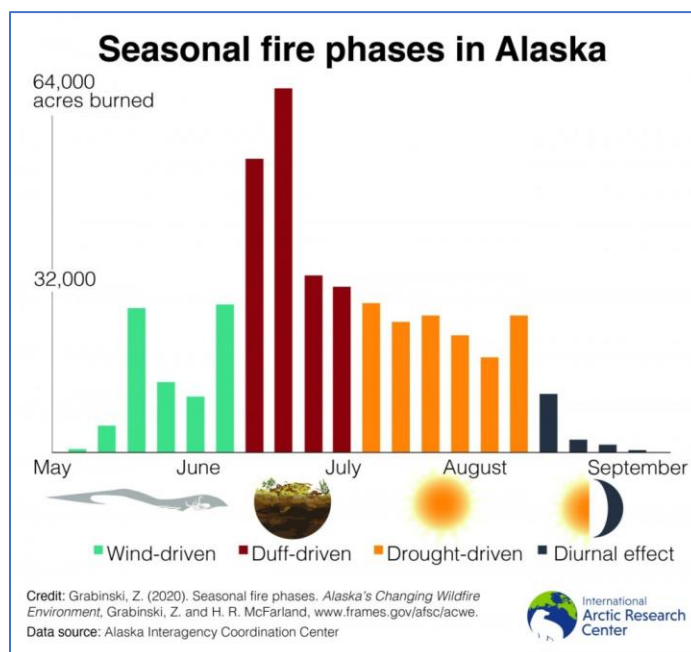
A wildland fire spreads through the consumption of vegetation and other organic matter that is available to burn, which are known as wildland fire fuels. Fire often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible from miles around. Wildland fires can be caused by human activities (e.g., such as unattended burns or campfires) or by natural events such as lightning.

The Alaska fire season, particularly in the interior region of the state, has four phases. Early fire season begins in April, typically before full green-up when the below ground soil is still frozen. The most readily available fuels are dead grasses and surface litter. With these limited fuels, wind is the key driver of fire activity. Fire can spread and grow rapidly, but usually with low severity because it cannot burn deeply into the moist and frozen duff. Early season fire is often the result of human-caused ignitions when outdoor recreation activities and debris burning lead to unintentional fire starts. These preventable fires are usually close to human communities and receive aggressive suppression response.

The peak of the fire season is driven by long warm days around solstice, which dry out subsurface fuels. In northern latitudes, a surface layer of slowly decomposing moss, lichen, and litter, called duff, is often about a foot deep. Duff in boreal and tundra landscapes generally accounts for more biomass below ground than available above ground. This duff layer creates a unique fuel bed where wildfire can burn deep below the surface and smolder for days or weeks, reigniting fuels at the surface when weather

conditions become favorable. Lightning is most common during the duff-driven phase. In most years, and all years with a substantial fire season, the majority of acres burned are caused by lightning ignitions. These fires are often in remote locations where managers can allow fires to serve their ecological role without directly impacting human life or property.

Later in July, if temperatures remain high and precipitation is low, drought may extend and expand the fire season. Finally, as the season winds down in fall, the cooler nighttime temperatures normally slow fire activity.



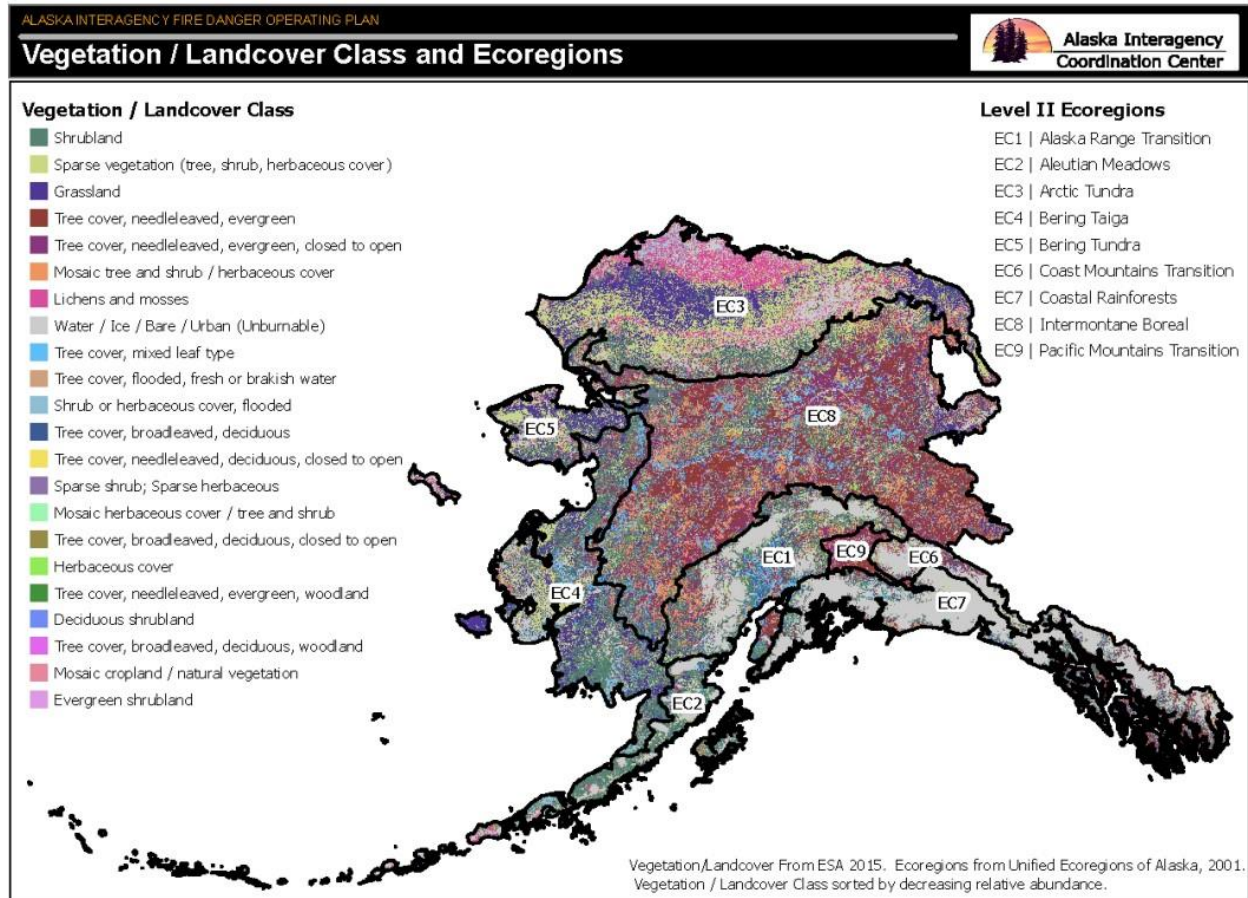
Source: UAF-IARC (<https://uaf-iarc.org/alaskas-changing-wildfire-environment/>)

Figure 4.1.8-4: Seasonal Fire Phases in Alaska

The frequency and severity of wildland fires is also dependent on other hazards, such as lightning, drought, and infestations (e.g., the damage caused by spruce-bark beetle infestations). If not promptly controlled, wildland fires can grow into an emergency or disaster. Even small fires can threaten lives and resources and destroy improved properties; they can also impact transportation corridors and/or infrastructure. In addition to affecting people, wildland fires may severely affect livestock and pets. Such events may require emergency water/food, evacuation, and shelter.

4.1.8.2.2 Locations of Wildland Fire Hazards

Wildland fires may occur anywhere in Alaska when weather, fuel availability, topography, and ignition sources combine to form the most favorable wildland fire conditions. All of Alaska is considered to be vulnerable to wildland fire, which includes various vegetation such as grasses and tundra.



Source: BLM 2020

Figure 4.1.8-5: Type II Ecoregions of Alaska

- **EC1 – Alaska Range Transition** – Much of this region is in the high elevations of the Alaska Range and Talkeetna Mountains. It contains mainly black spruce, standing dead white spruce due to a recent bark beetle infestation, and mixed hardwoods. Fire load on the Kenai Peninsula is significantly higher than in the Matanuska-Susitna Valley. Since 2014, two fires large fires have burned over 350,000 acres on the Kenai Peninsula (Funny River 2014 and Swan Lake 2019).
- **EC2 – Aleutian Meadows** – Primarily tundra fuels with a low fire load.
- **EC3 – Arctic Tundra** – North Slope tundra that usually does not have weather conditions to support large fire growth. However, in 2007, the 250,000+ acre Anaktuvuk River fire burned late in the season and prompted fire managers to reassess the idea that the North Slope does not have large fires.
- **EC4/EC5 – Bering Taiga, Bering Tundra** – Low fire load, but fires do happen under favorable conditions. Mainly short lived as moisture frequently impacts the west coast.
- **EC6/EC7 – Coastal Mountain Transition/Coastal Rainforest** – The area is normally quite wet, but fires can occur in the Panhandle under dry conditions, which may be becoming more frequent.
- **EC8 – Intermontane Boreal** – Most flammable region in Alaska. Black spruce and mixed hardwood are broken up by numerous large fire scars from a varied fire history.

- **EC9 – Pacific Mountains Transition** – Fire activity in the Copper River Basin is mainly restricted to valley floors and usually requires more severe conditions to sustain fire spread than the Interior.

4.1.8.2.3 History of Wildland Fire Hazard Events

The Alaska Division of Forestry and Fire Protection, and the Alaska Fire Service identified the following human-caused “High Profile Fires.” These included the McHugh Creek, Sockeye, Funny River, Hasting, Caribou, and Parks Highway fires (Table 4.1.8-2). This information has been updated since the 2018 SHMP.

Table 4.1.8-2: High Profile State Agency Managed Wildfires

Fire Name	Fire Number	Year	Area Burned (Acres)	Location	Forestry Office	Estimated Cost	Residences Destroyed	Outbuildings Destroyed	Buildings Damaged
Parks Highway	611163	2006	130,000	Nenana	FAS	9,654,725	2	14	--
Caribou	703278	2007	56,000	KPB	KKA	7,124,524	88	109	--
Hastings	111271	2011	54,000	FNSB	FAS	18,476,249	1	1	--
Funny River	403140	2014	195,858	KPB	KKS	14,319,380	--	--	--
Sockeye	501282	2015	7,220	Willow	MSS	7,347,213	55	--	44
McKinley	901738	2019	3288	MSB	MSS	8,923,725	50	80	--
Shovel Creek	911319	2019	22487	FNSB	FAS	22,841,423	--	--	--
Swan Lake	903181	2019	167,181	Kenai	KKS	43,632,546	--	--	--
Lime Complex	204899	2022	865,620	SW Alaska	SWS		--	54	--
Clear	211346	2022	73,284	Clear, AK	FAS	~20,00,000	2	51	--

DHS&EM tracks State and federal disaster declarations within their Disaster Cost Index (DCI). The DCI listed the following fire events that lists affected communities and agencies under state or federal declarations of disaster as applicable within each event (spanning 2013 through present).

AK-15-249 2015 Sockeye Wildfire declared by Governor Walker on June 15,

2015: Beginning on June 14, 2015 and continuing, a large urban interface wildfire exacerbated by record high temperatures caused widespread damage to the community of Willow and surrounding areas of the Matanuska Susitna Borough. The response to the wildfire is hampered by red flag warnings for record warm temperatures, strong winds, low humidity, and dry thunderstorms this month that affects the entire central portion of the state, including the Matanuska Susitna Borough. The wildfire has damaged or destroyed at least 50 private homes and/or secondary structures and damaged several more and resulted in 175 residents seeking refuge in temporary shelters, although these numbers are expected to rise. The following conditions exist as a result of this disaster: a robust emergency response and management operation requiring substantial additional labor, equipment, and support costs to combat the fire; activation of the emergency operations center; damage or destruction of at least 50 homes and other structures; evacuation and sheltering of 175 residents and hundreds of pets/work animals to date; severe damage to personal and real property; disruption of power, natural gas, communications, and other utility infrastructure requiring temporary and permanent repairs. A federal Fire Management Grant (FMAG) has been authorized to assist in the cost of suppression.

AK-15-250 2015 Kenai Wildfire declared by Governor Walker on June 19, 2015: Beginning on June 15, 2015 a series of wildfires have occurred in the Kenai Peninsula Borough as a result of prolonged hot, dry weather and human error. The most significant of these is the Card Street Wildfire which began on June 15 and damaged 11 buildings in Sterling, including 3 primary residences. The fire moved away from residences into the Kenai Wildlife Refuge... The Alaska Division of Forestry, local firefighters, and national wildland firefighter teams are currently working to gain control of the Card Street fire and numerous other fires within the Borough. A federal Fire Management Grant (FMAG) has been authorized to assist in the cost of suppression. The SEOC has been fully activated to support firefighting efforts. In addition, the AK National Guard and DOD are providing fire suppression support with troop and resource deployments as well as supporting SEOC operations.

AK-15-251 2015 Summer Alaska Wildfires declared by Governor Walker on June 26, 2015: Beginning on June 14, 2015 and continuing, wildland fires have impacted multiple communities throughout the state requiring emergency response, evacuations, and sheltering. Due to ongoing fire growth and new fire starts, the number of communities that will be impacted or threatened and the extent of community fire damage is unknown. Current and forecasted weather including warm temperatures, strong winds, low humidity, and dry thunderstorms indicate a continued wildland fire threat to the state. The following conditions exist as a result of this disaster: a robust emergency response and management operation requiring substantial additional labor, equipment, and support costs to combat the fire; activation of the emergency operations center; evacuation and sheltering of over 200 residents from five different communities.

AK-19-266 2019 August Southern Wildfires declared by Governor Dunleavy on August 23, 2019: Beginning on August 17, 2019 and continuing, multiple large wildland fires, exacerbated by extreme drought, caused widespread damage to the communities of Willow, Caswell, and surrounding areas of the Matanuska Susitna Borough. The Swan Lake Fire, burning since June 5, 2019, escaped containment lines and crossed portions of the Sterling Highway, threatening the communities of Sterling and Cooper Landing in the Kenai Peninsula Borough. Two additional wildland fires near Homer ignited on August 17-18, 2019, and continue to threaten structures in the vicinity of Anchor Point and Homer in the Kenai Peninsula Borough.

The response to the wildland fires is hampered by drought and record dry fuels, strong winds, and low humidity that affect the entire southcentral portion of the state, including the Matanuska Susitna Borough. The wildland fires in the Matanuska Susitna Borough have damaged or destroyed multiple homes and structures, resulting in the mandatory evacuation of approximately 400 residents, many who have sought refuge in temporary shelters. The scope of the damage is not yet fully realized due to active fire suppression efforts and substantial damage to private homes, public facilities, and communications and utility lines are anticipated.

The following conditions exist as a result of this disaster: a robust emergency response and management operation requiring substantial additional labor, equipment, and support costs to combat the fire; damage or destruction of multiple homes and other structures; evacuation of hundreds of residents and hundreds of pets/work animals; the sheltering of 84 residents in temporary shelters; severe damage to personal and real property; significant delays and closures of major highways roads, disruption of power, natural gas, communications, and other utility infrastructure requiring temporary and permanent repairs.

AK-22-286 2022 Summer Wildfires declared by Governor Dunleavy on June 10, 2022: Beginning in late May 2022 and continuing, unusual hot and dry weather, accompanied by dry lightning, caused multiple wildfires in southwest Alaska threatening communities and necessitating a local, state, and federal fire, emergency management, and mass care response. On May 31, during Red Flag conditions, lightning started the East Fork fire north of St. Mary's on the Yukon River. The fire has grown to become the largest fire in the state at over 125,000 acres and is threatening the communities of St. Mary's, Pitkas Point, Mountain Village, and Pilot Station, all within the Lower Yukon Regional Educational Attendance Area (REAA). On June 9, fire progression near St. Mary's prompted local community and fire officials to recommend voluntary relocation of over 100 elderly, medically-fragile, and vulnerable residents to two shelters in Bethel. Along with the field fire suppression effort, shelter operations continue in Bethel, along with feeding and evacuee support, until fire conditions allow evacuees to return. The following conditions exist as a result of this disaster: emergency response and management operations with personnel, equipment, and logistical support costs to combat the fire and protect community structures and infrastructure; and temporary relocation, sheltering, and mass care support for over 100 residents from four different communities. There is ongoing growth to current fires, new fires starting, forecasted fire danger, and an unknown number of communities potentially threatened or damaged by fire. The severity and magnitude of this emergency are beyond the timely and effective response and recovery capability of local resources, and there are insufficient regularly appropriated local funds to cover these requirements. On the 10th day of June 2022, under authority granted by Alaska Statute 26.23.020(c), it was declared that a condition of disaster emergency exists in the Lower Yukon REAA, including the communities of St. Mary's, Pitkas Point, Mountain Village, and Pilot Station, and this condition is of sufficient severity and magnitude to warrant a disaster declaration in order to provide assistance.

(DHS&EM 2022)

The State Division of Forestry provided the following details for the Kodiak Twin Creek Fire that started on August 27, 2015 (Figure 4.1.8-6):

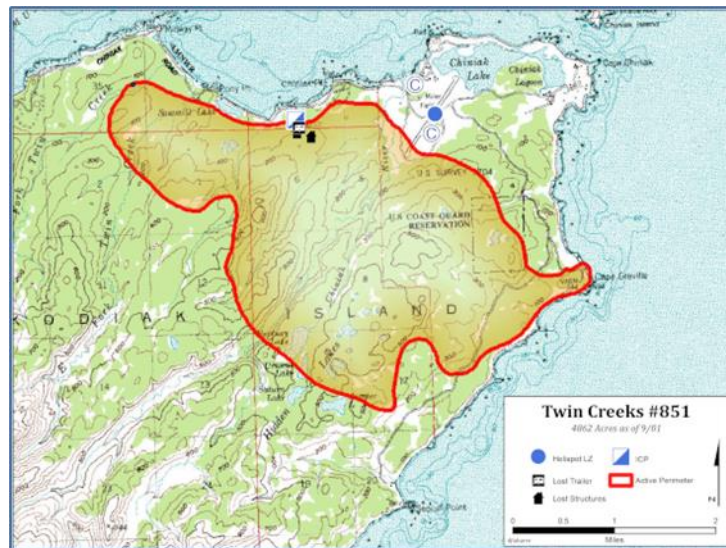
The Twin Creeks Fire, also known locally as the Chiniak Fire, started near the Kodiak Island community of Chiniak on Thursday evening, August 27. overnight and the next day strong winds quickly spread this fire through 5,000 acres of grass, timber, and logging slash on Leisnoi, Incorporated lands. The Chiniak Library, one home, and a cabin were destroyed by the fire.



Source: DOF Kodiak, Alaska 2015

Figure 4.1.8-6: Twin Creek Fire

The Twin Creek Fire involved a large portion of the island, threatening the entire Chiniak Community as depicted in Figure 4.1.8-7.



Source: DOF 2015

Figure 4.1.8-7: Map of Twin Creek Fire

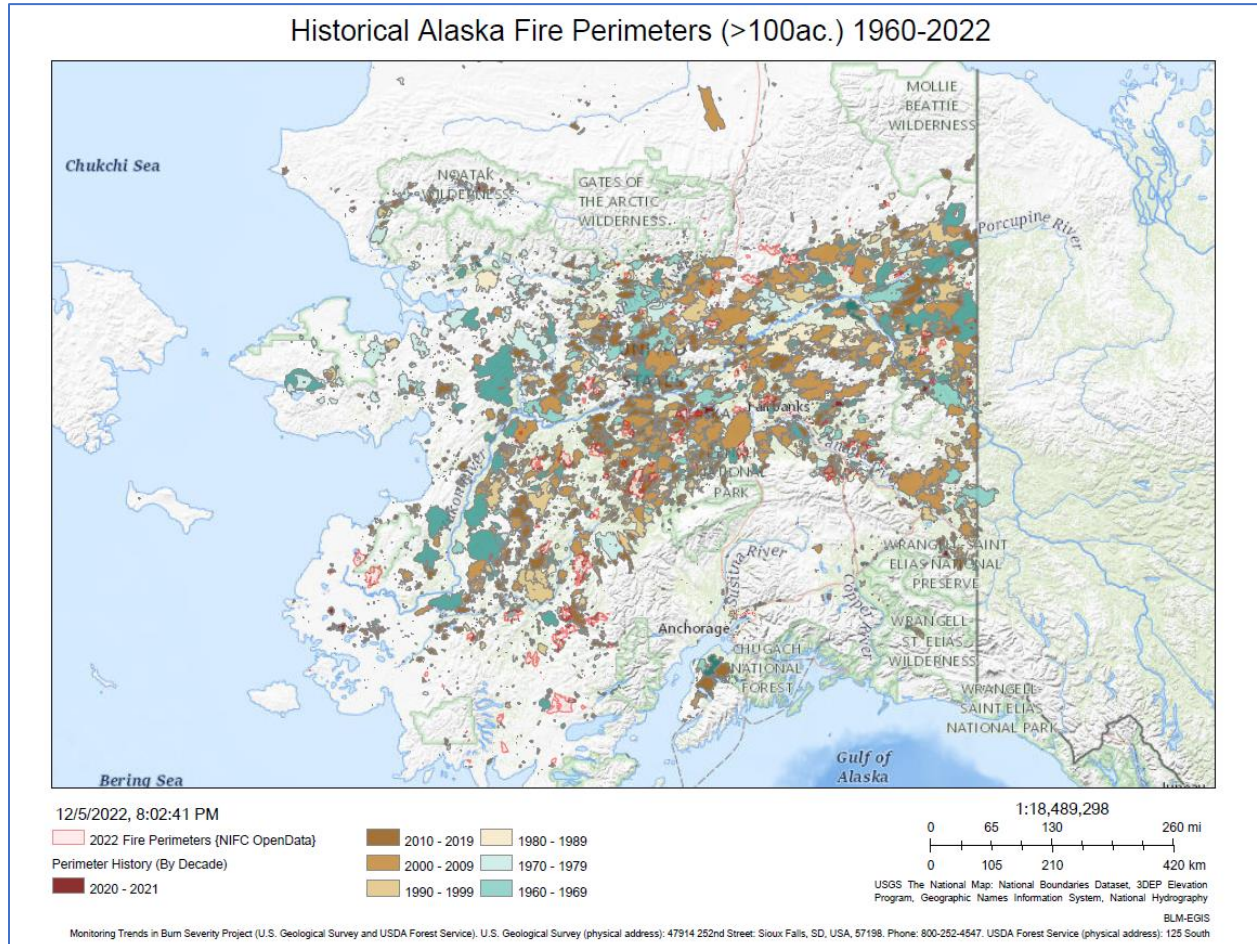
The following Fire Management Assistance Declaration fires occurred between 2019-2023:

- Alaska Clear Fire (FM-5442-AK), June 21, 2022
- Alaska Deshka Landing Fire (FM-5290-AK), August 17, 2019
- Alaska McKinley Fire (FM-5287-AK), August 17, 2019
- Alaska Shovel Creek Fire (FM-5282-AK), June 22, 2019

4.1.8.2.4 Extent of Wildland Fire Hazards

Wildland fires may occur anywhere in Alaska when weather, fuel availability, topography, and ignition sources combine to form favorable wildland fire conditions. Alaska's boreal forest is a fire adapted

ecosystem, and all of Alaska that is not rock or covered by permanent snow or water is vulnerable to wildland fire. This includes vegetation types such as black spruce, mixed-hardwoods, tundra, grasses, and beetle-kill. Historically, most large wildland fires occur in the central interior (between the Alaska Range and Brooks Range), due to the susceptibility of the boreal forest to large fire growth, lack of summer precipitation, and frequent dry lightning storms that pass through this area (see Figure 4.1.8-8). When weather and fuel conditions align, fires can happen in less likely areas such as the Aleutian peninsula, Southeast panhandle, and on the North Slope.



Source: AICC 2022 (<https://fire.ak.blm.gov/>)

Figure 4.1.8-8: Alaska's Historic Wildfire Perimeters Greater than 100 Acres

4.1.8.2.5 Impact of Wildland Fire Hazards

Wildland fire impacts range from negligible to catastrophic. The indirect effects of wildland fires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance river and stream siltation, thereby enhancing flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards.

Wildfires in the far north have the potential to release extreme amounts of carbon into the atmosphere because of surface fuels and permafrost. Boreal forest floor contains large amounts of biomass in compacted layers of undecomposed moss and litter (known as duff), which can be hundreds of years old.

Estimates of forest floor biomass in the range of 180 tons per acre for black spruce forest are comparable to combined slash/duff loadings for mixed conifer stands in the intermountain west. Even upland tundra contains 30–60 tons per acre of biomass.

Population centers in Alaska range from large cities such as Anchorage and Fairbanks, down to small villages with populations under 100 people located off the major road systems, and only accessible by river or air. Alaska's cities and boroughs are expanding into the wildland/urban interface, and each year there are additional properties, homes, recreational sites, and people put at risk of being impacted by wildland fire. Many homesites are bordered by Black Spruce and other flammable vegetation. One of the Alaska Division of Forestry and Fire Protection's primary missions is to protect human life and private property from wildland fire, but with fast-moving fires, this cannot always be safely accomplished. Almost every year there are impacts to property from wildland fire, and in years when conditions align to create significant fire growth, there can be significant damage to primary and secondary structures. In three recent years (2015, 2019, and 2022), large fire activity across the State burned from 50 to over 100 structures during the summer and caused evacuations and significant disruption to communities.

Alaska is seeing expansion in tourism, mining, and military and government facilities into the wildland/urban interface. In 2022, the Clear Space Force station was threatened by wildland fire, several mining operations were suspended with workers evacuated, and significant infrastructure damage occurred to a mine in Southwest Alaska. The Trans-Alaska pipeline, which runs 700 miles from the North Slope to Valdez, also has vulnerable equipment and pump stations which are at risk. Alaska is a major destination for recreational tourism, and fire often threatens high-dollar lodges, remote cabins, and campgrounds, and smoke from fire can seriously affected the income generated from tourism that Alaska's communities depend on.

Smoke from wildfires also has detrimental health consequences for residents. Some summers see weeks on end of hazardous air quality due to large fire activity. Often, at-risk, or elderly residents from villages that are off the road system have needed to be evacuated due to smokey conditions. Smoke also hampers air-travel which communities in Alaska rely on.

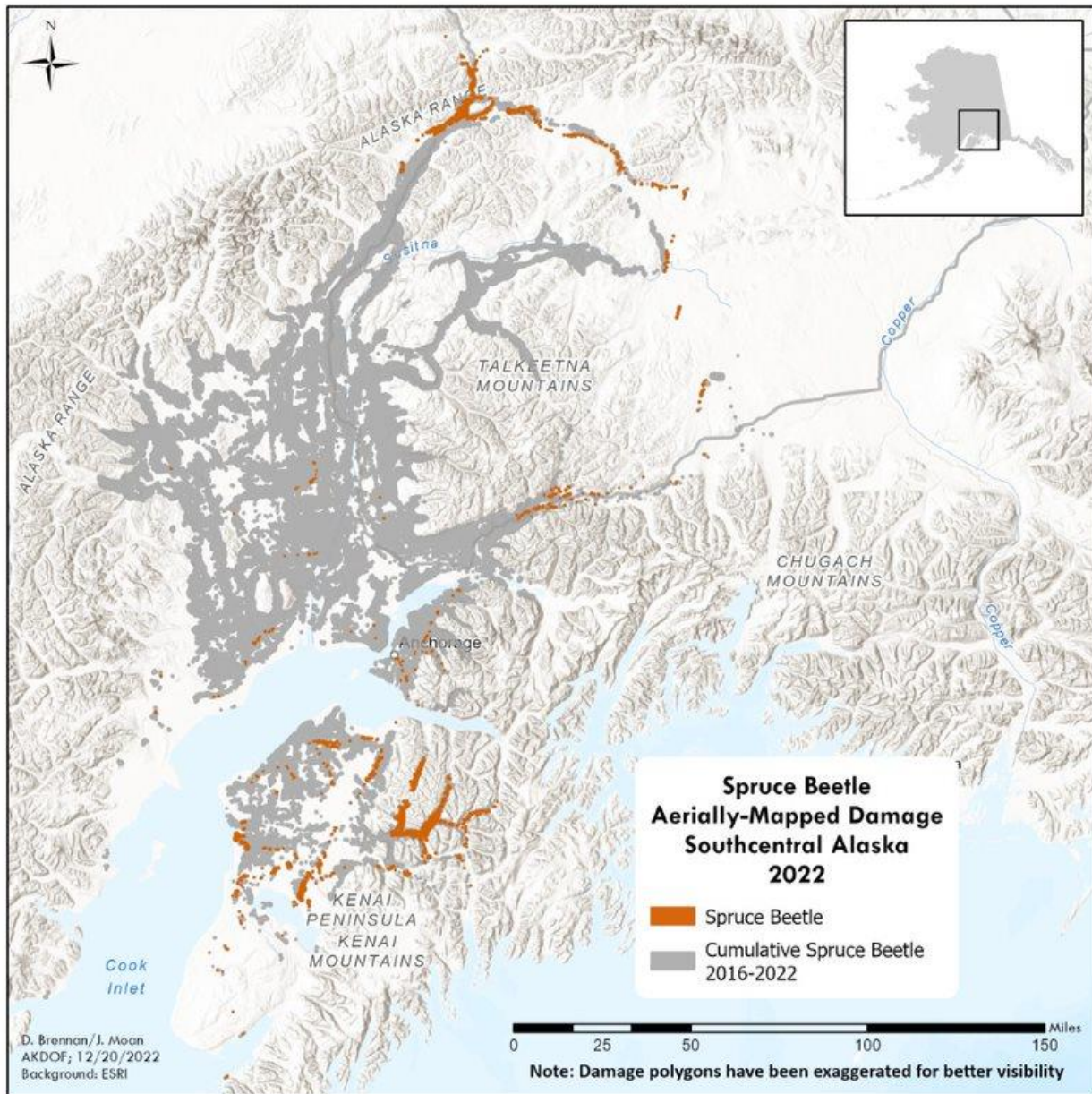
In 1971, the Alaska Native Claims Settlement Act (ANCSA) granted individual Native Alaskans 40–120-acre allotments around the state. The federal government is by law bound to protect these allotments from wildland fire, which creates more challenges for the protection agencies to prioritize firefighting resources. Many Native communities within Alaska are reliant on hunting, berry picking, and trapping to help support their families. Fires in the vicinity of these villages can have detrimental effects on the subsistence lifestyle, affecting hunting lands, berry gathering spots, and even fishing due to siltation after the fire.

4.1.8.2.6 Probability of Wildland Fire Hazards

As expansion of communities, businesses, and infrastructure into the wildland/urban interface continues, the probability of threats to these values will continue to increase. Not only are there additional values which will need to be protected but increasing human traffic into the wildlands will create more chances for human-caused ignitions. Based on historical events, it is highly likely that wildland fires will occur annually in Alaska.

4.1.8.2.7 Projected Changes in Location of Wildland Fire Hazards

Significant beetle killed Spruce Forest in Southcentral and interior Alaska is increasing the chance for catastrophic wildland fires in areas with standing dead fuels. See Figure 4.1.8-9.



Source: DOF 2022 (<https://www.fs.usda.gov/detailfull/r10/forest-grasslandhealth/?cid=FSEPRD536861&width=full>)

Figure 4.1.8-9: Beetle Killed Damage in Southcentral Alaska

4.1.8.2.8 Range of Anticipated Intensities of Wildland Fire Hazards

Not including the effects of climate change, fire intensity would be expected to range between smoldering to active large fire growth in old growth boreal forested areas. Areas of beetle killed spruce from the last 10 years would be an exception, creating a fuel susceptible to intense fires which would be difficult to suppress.

4.1.8.2.9 Frequency of Wildland Fire Hazards

Alaska historically has from 400–700 wildland fires in a season. Fire frequency will continue to rise, as has been the trend, due to the increase in human activity in the wilderness creating more chance for

human caused ignitions. Planned new road systems into interior Alaska will introduce two major sources of fire ignition: vehicles and hunters.

4.1.8.2.10 Duration of Wildland Fire Hazards

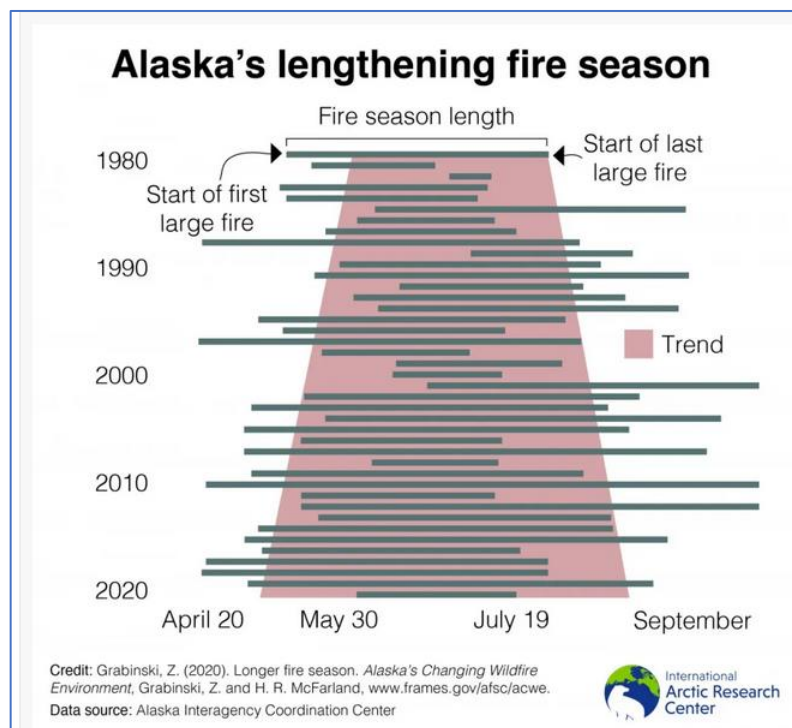
The typical Alaskan fire season starts in May and continues through August. During the last decade, fire season has been starting earlier (often in April) and continuing later (September/October) due to the effects of climate change, which are addressed below.

4.1.8.2.11 Future Conditions for Wildland Fire Hazards, Including Climate Change

An intensified pattern of wildfire is emerging in Alaska as rapidly increasing temperatures and longer growing seasons alter the state's environment.

Both tundra and boreal forest regions are seeing larger and more frequent fires. The impacts of these fires are felt across the state. In response to changing wildfire patterns, Alaska's fire management agencies are adapting quickly. The use of remote sensing tools, such as data from satellites, and science-based decision making have been a critical component in responding to intensified wildfire seasons.

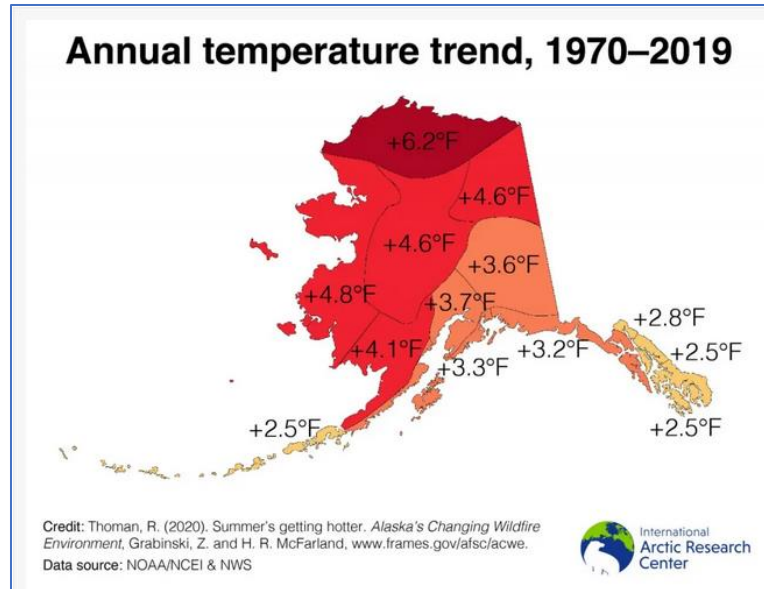
Alaska's wildfire season is getting longer. Over the past 40 years, the first large fire (1000+ acres) of the season starts earlier, and the last large fire of the season starts later. Fire managers responded by changing the official start date of the fire season. Since 2006, Alaska's official fire season has started on April 1. This reduces accidental ignitions by requiring permits to burn debris and allows agencies to begin training personnel and allocating resources earlier. In busy fire seasons, such as 2019, the fire season may be extended into the fall.



Source: UAF-IARC 2020

Figure 4.1.8-10: Alaska's Lengthening Fire Season

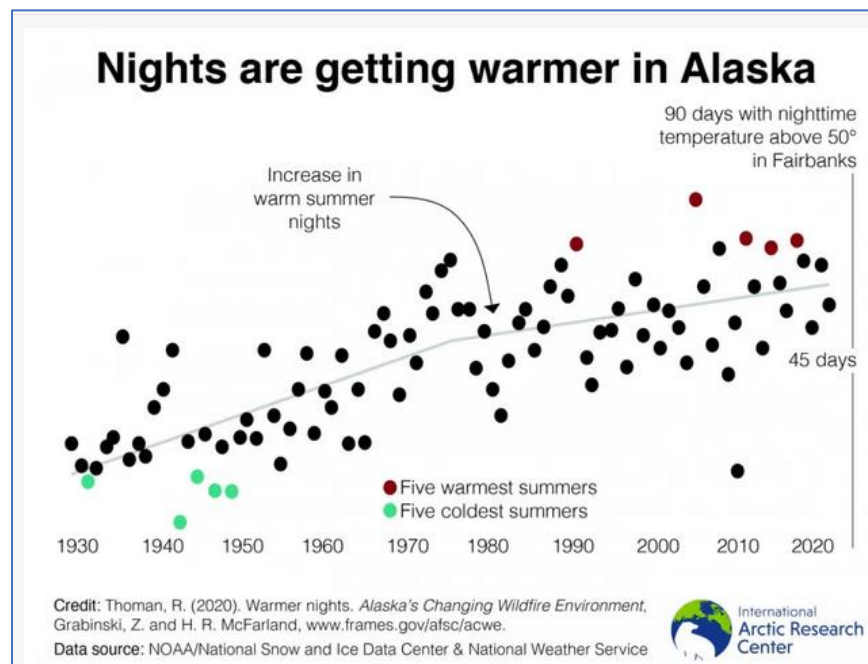
Summer temperatures across Alaska have been increasing since 1970. A typical summer nowadays is close to what the warmest summers were prior to the 1970s. When comparing the average June to August temperatures over the last 95 years, nine of the ten warmest summers occurred in the past 20 years, whereas the ten coldest summers all occurred before 1975.



Source: UAF-IARC 2020

Figure 4.1.8-11: Alaska's Annual Temperature Trend, 1970–2019

Daily low temperatures are increasing. Alaska now experiences many more warm nights compared to the early part of the 20th century. This is especially true for Interior communities like Fairbanks. The five summers with the warmest nights (the red dots on the graph) all occurred in the past 20 years, whereas the five summers with the coldest nights (blue dots) occurred before 1950. Warming nighttime temperatures are especially impactful in Alaska, where the long days of midsummer can allow fires to burn around the clock.

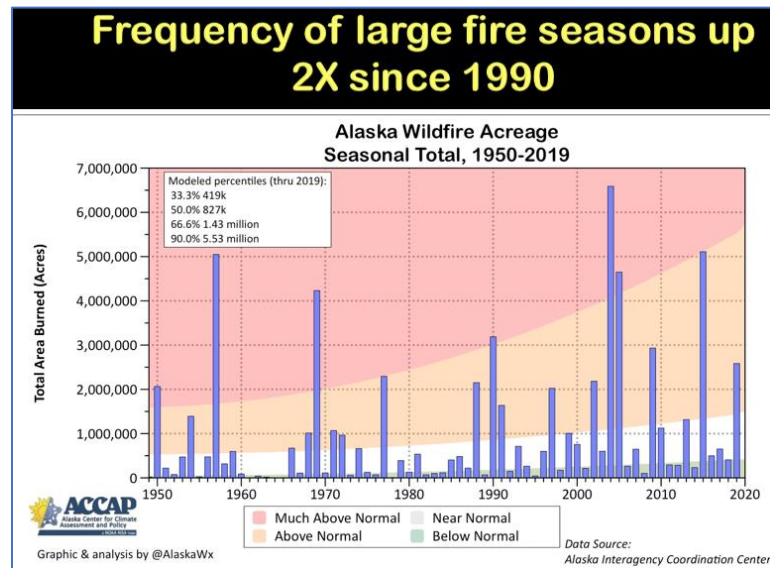


Source: UAF-IARC 2020

Figure 4.1.8-12: Nights in Alaska Are Getting Warmer

4.1.8.2.11.1 Characteristics/Nature

Since 1990, Alaska has experienced nearly twice the number of wildfires per decade compared to periods 1950 through 1980. Additionally, the sparsely populated Arctic region experienced only three wildfires over 1,000 acres from 1950 to 1970. Since 2000, there have been over 33 large wildfires.



Source: AICC Predictive Services Unit 2019

Figure 4.1.8-13: Alaska Wildfires Have Increased Dramatically Since 1990

4.1.8.2.11.2 Location

Changes in climate have altered the tundra landscapes of Alaska. Thanks to recent decades of warmer springs and summers, there is more vegetation (and more fuel). In 2022, southwestern Alaska experienced the two largest tundra wildfires on record for the Yukon Kuskokwim Delta region. Burning primarily in June, the East Fork fire and the nearby Apoon Pass fire burned a combined 257,000 acres. Almost all wildfire activity in this region has occurred in the past 7 years.

Similarly, in the far north of Alaska, large wildfires have become a new phenomenon. In 2007, the largest ever tundra fire in the North Slope region of Alaska, the Anaktuvuk River Fire, burned over 250,000 acres, more than doubling the total area that has burned in the region since the 1950s. Unlike the boreal forest, wildfire in arctic tundra has been a rare occurrence over the past 11,000 years and increasing fire frequency has the potential to induce shifts in vegetation (and wildfire fuel) cover—especially by promoting shrub growth. Tundra fires are also a factor in adding to climate-induced permafrost thawing and ground subsidence.

4.1.8.2.11.3 Range of Anticipated Intensities

The intensity of the Alaska fire season recently and increasing trend over the past few decades coincide with a rapidly changing climate. From 2001 to 2020, wildfires in Alaska burned 31.4 million acres, which is more than 2.5 times as many acres as burned from 1961–1980 or 1981–2000. Changes in environmental factors such as lightning, temperature, and precipitation are contributing to more fire on the landscape in Alaska. Since the 1970s, summer temperatures in Alaska have risen over 4 degrees Fahrenheit in regions where wildfire is prevalent. As the air temperature rises, the air holds more moisture, leading to more convective storms. Lightning ignited fires make up the vast majority of burned acres in Alaska and are reaching into places where they have rarely occurred before. Average summer lightning strikes have increased statewide by 17 percent over the past 3 decades, but several regions have more than doubled in that same time. When weather conditions over the state are suitable for convection, the magnitude of storms and lightning ignitions can be overwhelming for fire response. For example, an incredible 18,000 lightning strikes were recorded in two days in interior Alaska in July 2022.

June 2022 in Alaska was a remarkable month for wildfire. An incredible 1.84 million acres burned, nearly tying the all-time record for June. Notably, 1.2 million acres burned in southwestern Alaska, more than doubling the area burned in that region since the 1950s in a single year.

4.1.8.3 Community Conflagration

4.1.8.3.1 Characteristics/Nature/Type of Community Fire Hazards

Community fire is a large destructive fire that is widespread throughout an urban area or community involving one or more developed areas in the community. In contrast to the commonly destructive individual property fire, community fire involves a larger portion of the community's built environment. In small communities, fires frequently overwhelm resources and damage infrastructure. In rural Alaskan communities, the loss of a critical building, such as a school, may warrant a local disaster declaration.

Community fires are very difficult to control. Complicating factors are wind, temperature, slope, proximity of structures, and community firefighting capability, as well as building construction and contents. Additional factors facing response efforts are hazardous substance releases, structural collapse, water service interruptions, unorganized evacuations, and loss of emergency shelters. Historical national community fire examples include the Chicago City Fire of 1871 and the San Francisco City fire following the 1906 earthquake.

4.1.8.3.1.1 Structural Fire Spread

The leading causes of structural fires is cooking, heating, electrical systems, candles, smoking, and intentional/arson. For example, a cigarette that is not properly extinguished may start a fire in a garbage can or along the roadway and quickly spread from there. If unnoticed or not extinguished quickly, these fires may spread throughout the structure and can become devastating. The spreadability of a fire is dependent on many factors but is largely influenced by the construction type of a building and materials used.

4.1.8.3.1.2 Types of Construction

There are five basic groups of building construction used throughout the United States. All buildings in America can be associated with one of the five basic types of construction, identified by Roman numerals in building codes and by engineering schools throughout the nation and listed in order from least combustible to most combustible:

Type I (fire resistive) – Least combustible

Type II (non-combustible)

Type III (ordinary)

Type IV (heavy timber)

Type V (wood frame) – Most combustible

Fire-resistive (type I) construction was originally designed to contain fire inside the building to one floor. This concrete and steel structure, called "fire resistive" when first built at the turn of the century, was supposed to confine a fire with its construction. Faults in modern construction allow fire to spread over several floors in a fire-resistive building despite its steel-and-concrete structure by spreading through air-conditioning and heating ducts as well as from lower windows to windows above in a multi-story building.

Non-combustible (type II) buildings have steel or concrete walls, floors, and structural framework. When a fire occurs inside a type II building, flames rising to the underside of the steel roof deck may conduct heat through the metal and ignite the combustible roof.

Ordinary (type III) construction is also called brick-and-joist construction. It has masonry bearing walls but the floors, structural framework and roof are made of wood or other combustible material. Ordinary construction has been described by some firefighters as a "lumberyard enclosed by four brick walls."

Heavy-timber (type IV) construction is sometimes called "mill construction" because it was the type of structure used at the turn of the century to house textile mills. These buildings have masonry walls like type III buildings, but the interior wood consists of large timbers that can create large, radiated heat waves after the windows break during a blaze. A fire in a heavy-timber building can produce a tremendous conflagration with flames coming out of the windows, spreading fire to adjoining buildings.

Wood-frame (type V) construction is the most combustible of the five building types. The interior framing and exterior walls may be wood. A wood-frame building is the only one of the five types of construction that has combustible exterior walls.

Source: Structural Fire Spread – Vincent Dunn, Deputy Chief FDNY (retired)
(<https://inspectapedia.com/roof/Structural-Fire-Spread-Dunn.pdf>).

4.1.8.3.1.3 Structural versus Wildland Firefighting

Structural and wildland fires differ on the nature of the fire, but both require different firefighting techniques and have different roles and responsibilities to fight and extinguish the fire. Wildland firefighters typically have to cover large amounts of area to combat a wildfire as well as establish fire lines or breaks to properly contain a spreading fire. When wildland firefighters encounter structure, vehicle, dump, or other non-vegetative fires during the performance of their wildland fire suppression duties, firefighting efforts are often limited to wildland areas. Wildland fire suppression largely attempts to keep a fire from spreading beyond its current location as wildland fires can change directions at any point. Typically, wildland firefighters are neither equipped nor trained to combat structure fires.

Structural fire suppression within defined service areas is the responsibility of volunteer, city, or borough fire departments. Structural firefighters must work quickly to extinguish a fire before it spreads to other surrounding infrastructure. Many smaller communities across Alaska, particularly those off the road system, have very limited or no structural fire suppression capability.

4.1.8.3.2 Locations of Community Fire Hazards

Under certain conditions, wildland fires may occur anywhere in Alaska when weather, fuel availability, topography, and ignition sources combine to form the most favorable wildland fire conditions. Most of Alaska's community centers could potentially experience a wildland/urban interface fire because of the state's extensive spruce bark beetle infestation and excessive dry fuels surrounding residential neighborhoods.

The Municipality of Anchorage's (MOA) Anchorage 2004 "Wildfire, Dare to Prepare" Program Report describes their efforts to reduce fire threats to the community.

Managing for fire and forest health

Anchorage Fire Department (AFD) uses science to make management decisions for fuel treatment projects. AFD Foresters work cooperatively with State Forestry fire behavior experts to assign prescriptions to forested areas. In addition, mitigation strategies focus on the home ignition zone for residential areas. This 100–200-foot radius around a structure has been proven time and again to be the most influential zone determining a home's ignition potential. Case studies from across America, Canada, and Australia show repeated accounts of homes burning to the ground while trees and surrounding vegetation remain green. Furthermore, documented research conducted by Jack Cohen of the Missoula Fire Sciences Laboratory substantiates efforts to reduce home ignitions through extending vegetation treatment and landscape management to the 100-foot radius.

Source: https://www.muni.org/Departments/Fire/Wildfire/Documents/ANCHORAGE_WILDFIRE_May_2004_Program_Report.pdf

Figure 4.1.8-8 depicts historical wildfire perimeters, which could be used as an indicator of community fire potential.

4.1.8.3.3 History of Community Fire Hazard Events

DHS&EM tracks State and Federal disaster declarations within their Disaster Cost Index (DCI). The DCI listed the numerous remote locational wildland fire events, many of which burned residential properties and could be called community fire events (Section 4.1.8.3).

Substantial community infrastructure can be damaged or destroyed from a single fire event. These fires can cripple remote communities when they lose basic utilities (e.g., power, water, stores, clinics) and structure uses by any hazard event. Structure fires are more likely to threaten human life.

Table 4.1.8-3 provides a representative sample of historical Alaska community fires:

Table 4.1.8-3: Historical Community Fires

Location	Date	Impacts
Sleetmute	12/20/2001	A fire destroyed the community building in Sleetmute. The building housed the clinic, Council Office, Village Public Safety Officer (VPSO) office, washeteria, and the TV equipment for the Alaska Rural Communication Service (ARCS) satellite station.
Hooper Bay Fire	08/03/2006	The fire continued through the next day and resulted in the destruction of the community's elementary school, high school, school support facilities, community store, and 14 homes – nearly 10% of the entire community.
Birch Creek Fire	05/26/2011	The tribal office building fire spread and destroyed the community's power plant, tribal office, potable watering point, and telephone building.
Dot Lake Fire	08/28/2011	The village utility building provided water and heat for several homes in the community through an underground utilidor and is utilized as a watering point for other residents in the area.
Stuart Creek Fire	06/14/2013	The fire started during an Army artillery training exercise, burned more than 87,000 acres required evacuating of 1,200 residents and many sled dog teams from the area. It was one of the largest wildfires in the U.S. in 2013. This fire cost \$21 million to fight the fire.
Alatna Multi-Purpose Building Fire	04/15/2015	The Multi-Purpose Building in Alatna caught fire in the boiler room. The building houses the water treatment facility, Washeteria, and clinic.
Kenai Wildfire	06/05/2015	Card Street Wildfire which began on June 15 and damaged 11 buildings in Sterling, including 3 primary residences.
Sockeye Fire	06/15/2015	A large urban interface wildfire exacerbated by record high temperatures caused widespread damage to the community of Willow and surrounding areas of the Matanuska Susitna Borough.
Kotlik Structure Fire	08/16/2016	A structural fire destroyed the old school facility and several nearby buildings.
Cook Inlet Earthquake	11/30/2018	A major earthquake measured at magnitude 7.0 produced strong seismic shaking that caused widespread and severe damage primarily within the Municipality of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough. The disaster resulted in widespread and severe seismic shaking, causing damage to structural collapse, and resulting fires to several community buildings; and severe damage to private homes and personal property.

Location	Date	Impacts
Kaktovik School Fire	02/06/2020	A fire destroyed much of the Harold Kaveolook School in Kaktovik. The building was initially reported to be completely destroyed but local firefighters overcame extremely cold ambient temperatures with wind chills down to 70 degrees below zero to save the elementary wing and teacher housing, however, the secondary grade levels and gymnasium were destroyed.
Jan Tuluksak Washeteria Fire	01/16/2021	The Washeteria and Water Plant in Tuluksak caught on fire. Firefighting efforts were led by community members carrying buckets of water from the river in an attempt to extinguish the fire. The cause of the fire was unknown at the time but is now believed by the Fire Marshall to be accidental.
Tununak Washeteria Fire	02/15/2022	The building was discovered aflame following electrical work conducted earlier that day. Firefighting efforts by the community were unsuccessful, hampered by limited equipment, poor weather, and very high winds. As a result, the washeteria was completely destroyed.
Stebbins Store Fire	11/29/2022	A fire of unknown origin burned down the only store in Stebbins. Residents of Stebbins travelled to the nearby community of Saint Michael to purchase food and essential supplies, wiping out their store of nearly all supplies.

Alaska community fires that resulted in disaster declarations are listed in the DCI. These historical events include:

02-199 Sleetmute Core Service Facility Fire (Admin Order 196): At approximately midnight December 20th, 2001, a fire destroyed the community building in Sleetmute. The building housed the clinic, Council Office, VPSO office, washeteria and the TV equipment for the ARCS station. The Disaster Policy Cabinet recommended that disaster assistance be provided to Sleetmute for, “full recovery or temporary measures only as appropriate for the parameters that will provide for a safe, secure and sanitary community by measures that are unable to be addressed through other State (non-DRF), and federal and non-profit agency’s emergency funding resources.” On May 24, 2002, the Governor signed AO 196 and provided funding not to exceed \$150K. This was the unfunded balance after all other grant sources were exhausted. Total recovery costs for the village were estimated to be \$2.26M. Disaster Relief Funds provided were an “improved project” category. Sleetmute was funded for the entire \$150K.

07-219 2006 Hooper Bay Fire (AK-07-219) declared August 6, 2006 by Governor Murkowski then FEMA declared (DR-1666) on October 27, 2006: Beginning on August 3, 2006 and continuing through August 4, 2006, the Second Class City of Hooper Bay, Alaska sustained severe losses and threats to life and property from a community structure fire that has destroyed the elementary school, the high school, school support facilities, and 14 homes. As a result of this disaster the homes and personal property of 17 families consisting of 66 people are lost and 400 students do not have educational facilities. There are also potential water contamination and air quality issues. The eligible damage estimate is \$10 million.

12-234 2011 Birch Creek Fire declared by Governor Parnell on August 9, 2011: On May 26, 2011 the tribal office building in Birch Creek caught fire. The fire spread and destroyed the community’s power plant, tribal office, potable watering point, and telephone building. On June 2, 2011, The Division of Homeland Security & Emergency Management (DHS&EM) received a local disaster declaration and request from the Tribe seeking State disaster assistance for emergency protective measures, temporary and permanent repairs to village infrastructure, and technical and funding assistance needed to repair or replace damaged facilities. Since the fire, temporary power

has been restored to the village. Alaska Energy Authority (AEA) has delivered and installed a 28kw generator at the old school that is providing power for the community. A satellite telephone was provided to the community as United Utilities attempts to restore some local and long-distance telephone service. Arctic Resources Group, LLC, and Tanana Chiefs Conference Division of Environmental Health have provided bottled water for the community and are working on a temporary water source.

12-235 2011 Dot Lake Fire declared by Governor Parnell on October 4, 2011: At approximately 11:00 PM, August 28, 2011, a fire at the village utility building occurred. Local efforts to suppress the fire with available equipment were unsuccessful and the entire building and its contents were destroyed. The building housed the local washeteria and showers. The facility also provided water and heat for several home homes in the community through an underground utilidor and is utilized as a watering point for other residents in the area. Due to the fire, electrical power has been lost to the local community building and the clinic. Six families are without water and five families are without adequate heat. Two families have Toyo stoves, and two families have wood stoves as back up, these backup systems will not prevent their water lines from freezing nor is there any method of preventing the water lines in the underground system from freezing. This facility served 55 people in Dot Lake Village and the immediate area.

AK-15-247 2015 Alatna Washeteria Fire declared by Governor Walker on April 25, 2015: On the morning of April 15, 2015, the Multi-Purpose Building in Alatna caught fire in the boiler room. The building houses the water treatment facility, Washeteria, and clinic. The fire was extinguished, but not before it caused substantial damage to the water treatment facility and heating components, rendering both inoperable. The Washeteria and clinic sustained substantial smoke damage. Extensive damage to the electrical wiring in the Multi-Purpose Building has been reported and the entire building is without power. Damage to the water treatment facility has cut off the supply of potable water to the village. The cause of the fire is unknown at this time. Currently, village residents are able to drive across the Koyukuk River to Allakaket, five miles away on the other bank, and access potable water and the clinic; however, this option will not be viable for long as break-up is imminent.

AK-15-249 2015 Sockeye Wildfire declared by Governor Walker on June 15, 2015: Beginning on June 14, 2015 and continuing, a large urban interface wildfire exacerbated by record high temperatures caused widespread damage to the community of Willow and surrounding areas of the Matanuska Susitna Borough. The response to the wildfire is hampered by red flag warnings for record warm temperatures, strong winds, low humidity, and dry thunderstorms this month that affects the entire central portion of the state, including the Matanuska Susitna Borough. The wildfire has damaged or destroyed at least 50 private homes and/or secondary structures and damaged several more and resulted in 175 residents seeking refuge in temporary shelters, although these numbers are expected to rise. The following conditions exist as a result of this disaster: a robust emergency response and management operation requiring substantial additional labor, equipment, and support costs to combat the fire; activation of the emergency operations center; damage or destruction of at least 50 homes and other structures; evacuation and sheltering of 175 residents and hundreds of pets/work animals to date; severe damage to personal and real property; disruption of power, natural gas, communications, and other utility infrastructure requiring temporary and permanent repairs. A federal Fire Management Grant (FMAG) has been authorized to assist in the cost of suppression.

AK-16-259 2016 Kotlik Fire Disaster declared by Governor Walker on October 4, 2016: On August 18, 2016, a structural fire destroyed the old school facility and several nearby buildings in the Lower Yukon River community of Kotlik. Since construction of a new school in Kotlik in 2003, the old school was boarded up and utilities shut off to preserve it for future use. The fire also destroyed: a small city building used by the Native Village of Hamilton as their tribal office; a 100-foot section of boardwalk; and the teacher housing, a generator building, and two storage buildings owned by the Lower Yukon School District (LYSD).

The City of Kotlik Local Government submitted a local Disaster Declaration with Request for State Assistance, dated September 9, 2016 which was received by the DHS&EM on September 12, 2016. In their declaration, the City of Kotlik specifically requested disaster relief for debris removal/clean up, technical assistance and funding to reconstruct the City gymnasium, public disaster assistance for emergency protective measures, temporary and permanent repairs to school water and sewer pipe lines and electrical systems.

AK-18-265 2018 November Cook Inlet Earthquake declared by Governor Walker on December 2, 2018 then FEMA declared an Emergency Declaration on November 30, 2, 2018 (EM-3410) then declared a Major Declaration on January 31, 2019 (DR-4413): On November 30, 2018, a major earthquake measured at magnitude 7.0 produced strong seismic shaking that caused widespread and severe damage primarily within the Municipality of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough. The Municipality of Anchorage and Matanuska-Susitna Borough have each issued local declarations of disaster emergency in response to this event.

The disaster resulted in widespread and severe seismic shaking damage to: major highways and critical community roads, bridges, and other transportation infrastructure; undermining of road embankments and railroad tracks, and loss of track base; widespread power, water, and communication disruption; structural collapse and resulting fires to several community buildings; and severe damage to private homes and personal property.

These conditions have required local emergency protective measures to protect life and property, including activation and staffing of emergency operations centers; emergency debris clearance of roads and railroad tracks to protect critical infrastructure and maintain access; placement of road barricades to protect roads and bridges; operation of mass shelters for affected residents; school, business, and government office closures.

AK-20-268 2020 February Kaktovik School Fire declared by Governor Dunleavy on March 6, 2020: On February 7, 2020 the State Emergency Operations Center (SEOC) was contacted by the Emergency Manager for the North Slope Borough in regards to a fire that destroyed much of the Harold Kaveolook School in Kaktovik on the night of February 6, 2020. The building was initially reported to be completely destroyed but local firefighters overcame extremely cold ambient temperatures with wind chills down to 70 degrees below zero to save the elementary wing and teacher housing, however, the secondary grade levels and gymnasium were destroyed. It was confirmed later that day with the North Slope Borough (NSB) attorneys that the school was insured. There were no injuries or fatalities associated with this event to either first responders or to the public.

On February 7, 2020 the North Slope Borough (NSB) declared a local disaster emergency for Kaktovik that included a request for state disaster assistance for this event. This local declaration and request for state assistance was received at the State Emergency Operations Center (SEOC) on February 7, 2020.

The SEOC, Department of Environmental Conservation, Department of Education and Early Development, and Public Safety, and other state agencies worked together to address immediate and short-term needs. The initial focus had been on addressing the education needs of the students using temporary classrooms and other structures in Kaktovik. The remote nature of this Inupiat community restricts what local structures can be utilized immediately, or retrofitted quickly, to meet this critical need.

AK 21-274 Jan Tuluksak Washeteria Fire declared by Governor Dunleavy on February 8, 2021: On Saturday, January 16, 2021 the State Emergency Operations Center (SEOC) received a report that the Washeteria and Water Plant in Tuluksak was on fire. Subsequent reports indicated that the structure was a total loss. The Washeteria in Tuluksak serves as the only public watering point for potable water in the entire community, including the school. The SEOC was in contact with multiple community members and organizations (Village Safe Water, Remote Maintenance Workers, (RMW) Yukon-Kuskokwim Health Corporation, (YKHC), and the State Fire Marshall's Office) in the days following the fire to ensure a coordinated and organized response to the incident. YKHC and the RMWs helped with planning and establishing a temporary non-potable water source for the community while working with all of the involved parties to plan for both temporary and long-term solutions to the water supply issues in the community. The initial response to this incident was hampered by blizzard conditions in the area at the time and the fact that the community has no organized fire department. The firefighting efforts were led by community members carrying buckets of water from the river in an attempt to extinguish the fire. The cause of the fire was unknown at the time, but is now believed by the Fire Marshall to be accidental.

On Thursday, January 21, 2021 the Tuluksak Native Community signed a local disaster declaration requesting state assistance. In their declaration, "The Tuluksak Water Plant and Washeteria sustained a fire with total devastation, resulting in residents no longer having access to potable drinking water for consumption and/or washeteria facilities for washing clothes and bathing. The declaration also stated, "it is requested that the governor of the State of Alaska declare a disaster emergency to exist... and provide disaster assistance to the Tuluksak Native Community in its response and recovery from this event. The Tuluksak Native Community specifically requests individual assistance for water accessibility for residents, public disaster assistance for temporary and permanent construction of water sanitation facilities, technical assistance, and funding to evaluate the extent of the damage.

AK-22-280 2022 February Tununak Washeteria Fire declared by Governor Dunleavy on February 17, 2022: On February 16, 2022, the NVT (2020 population: 368) contacted the State Emergency Operations Center (SEOC) to report their washeteria had been destroyed by a fire the previous night. On the evening of February 15, 2022, the building was discovered aflame following electrical work conducted earlier that day. Firefighting efforts by the community were unsuccessful, hampered by limited equipment, poor weather and very high winds. As a result, the washeteria was completely destroyed. On February 17, 2022, the NVT IRA Council sent the SEOC a signed local disaster declaration, with a request for state assistance.

The loss of the washeteria did not impact community access to drinking water because the public watering point is located at the school. However, the washeteria did provide water to the health clinic and these functions are now disrupted. The community primarily used the washeteria for cleaning, bathing, and laundry; no homes have piped water or sewage systems. According to the local Tribal Administrator, the building had been closed for repairs since December 2021 and needed new electrical infrastructure,

washers, dryers and other general repairs. The absence of this infrastructure has historically caused hygiene concerns, made worse by the ongoing Coronavirus (SARS-Co V-2) pandemic. Since the fire, residents obtain their water for drinking, washing and other uses from either the public watering point at the school or from a nearby creek.

On November 29, 2022, the rural community of Stebbins lost its only store due to a structural fire (Figure 4.1.8-14).



Source: Alaska Public Media/Linda Greta Camillus 2022

Figure 4.1.8-14: 2022 Stebbins Store Fire

Figure 4.1.8-15 provides an aerial view of the July 2013 Stuart Creek Fire, Pleasant Valley, Alaska.



Source: Photo Courtesy InciWeb; Pleasant Valley Area 2013

Figure 4.1.8-15: July 2013 Stuart Creek Wildland Community Interface Fire

Sleetmute experienced a community fire in 2001 (Figure 4.1.8-16) that destroyed its tribal office, Village Public Safety Office, washeteria, and TV equipment for the ARCS satellite station.



Source: DHS&EM 2001

Figure 4.1.8-16: 2001 Sleetmute Community Fire

4.1.8.3.4 Extent of Community Fire Hazards

Community interface fires generally follow similar patterns as a wildland fire; however, the fire engages with close proximity to infrastructure, utilities, and residential properties.

Fire-susceptible fuels (e.g., slash, dry undergrowth, flammable vegetation) in close proximity to residences and infrastructure, coupled with weather and topography, influence fire behavior, potential threat, and community impact extent.

The Alaska State Fire Marshal’s Office provided the following loss estimations of top structure fires from 2018–2021.

Table 4.1.8-4: Loss Estimations from Top Structure Fires, 2018–2021

Year	Loss Estimation
2021	\$15,853,141
2020	\$28,780,000
2019	\$27,592,202
2018	\$16,660,295

4.1.8.3.5 Impact of Community Fire Hazards

Community fires threaten Alaska’s population centers if not properly controlled, with impacts that range from negligible to catastrophic. A small fire can threaten lives and resources and destroy property. In addition to impacting people, these fires may severely threaten livestock and pets. Such events may require owners to consider evacuation and emergency shelter or determine how they will be able to provide emergency watering and feeding if their structures are destroyed or substantially damaged. Rebuilding after a fire loss is challenged by Alaska’s short construction season and limited transportation resources.

4.1.8.3.6 Probability of Community Fire Hazards

Increased community development, fire fuel accumulation, and weather pattern uncertainties indicate that seasonal wildfires will continue into the future. Based on historical events, it is likely that a community fire will occur once every three years (33%). The probability of community fires will be dependent on multiple factors including weather conditions (season, fuel potential), building density, and community-specific building or fire codes. A structure fire in a community that has higher building density, such as Diomedes or Juneau, can be devastating as a fire is able to quickly spread from one building to another, potentially impacting the entire community.

Communities and individuals need to develop plans to address this ever-increasing threat. Communities may utilize land use planning to protect their community from future community fire events. The potential for a fire to devastate a community can be reduced by adopting proper building and fire codes as well as spacing out further construction projects from existing structures. A lower building density reduces the potential of a structure fire spreading from one building to another.

4.1.8.3.7 Projected Changes in Location of Community Fire Hazards

Community interface fires can occur in any community and can begin independently or as a result of a nearby wildfire.

4.1.8.3.8 Range of Anticipated Intensities of Community Fire Hazards

The range of anticipated intensities for community fires will be dependent on multiple factors including weather conditions (season, fuel potential), building density, and community-specific building or fire codes. A structure fire in a community that has higher building density, such as Diomedes or Juneau, can be devastating as a fire is able to quickly spread from one building to another, potentially impacting the entire community.

4.1.8.3.9 Frequency of Community Fire Hazards

Community fires can occur during any season. Fires can quickly spread during drier, warmer months of the year. The typical Alaskan fire season starts in May and continues through August.

4.1.8.3.10 Duration of Community Fire Hazards

Community fires can last for varying periods of time and will greatly depend on construction materials used in the affected building as well as the season. Larger communities such as Anchorage, Fairbanks, and Juneau have the resources available to combat structure fires and can respond quickly once the fire is reported. However, the majority of rural Alaskan communities do not have the equipment nor resources available to fight large structure fires and the loss of a critical building, such as a school, may warrant a local disaster declaration.

4.1.8.3.11 Future Conditions for Community Fire Hazards, Including Climate Change

4.1.8.3.11.1 Characteristics/Nature

Due to climate change, the nature of community interface fires may increase. Climate change within Alaska is likely to result in increased drought and longer fire seasons, as well as increases in the severity and frequency of fires as the spring season in Alaska is projected to become warmer and drier.

4.1.8.3.11.2 Location

Due to climate change, the location of community interface fires may increase as tundra landscapes and forest compositions across the state are changing from coniferous to deciduous. Climate change has resulted in worsened insect damage to forests across much of the state, which may increase the area of standing dead, highly flammable trees that are especially vulnerable to wildfire. Additionally, spring and summer seasons are becoming warmer and drier, increasing the potential for fires in different regions of the state.

4.1.8.3.11.3 Range of Anticipated Intensities

Community interface fires are not a natural hazard event but may begin as a result of a nearby wildfire. Therefore, the effect of climate change on wildland fires will impact community interface fires. Climate change within Alaska is likely to result in increased drought and longer fire seasons as well as increases in the severity and frequency of wildfires.

4.1.9 High Hazard Potential Dams

4.1.9.1 Characteristics/Nature/Type of High Hazard Potential Dams

Alaska Statute 46.17.900(3) defines a dam as “an artificial barrier and its appurtenant works, which may impound or divert water.” To be regulated as a dam under state jurisdiction, a barrier must meet at least one of the following three descriptions listed in the statute:

1. Have an impounding capacity at maximum water storage elevation of 50 acre-feet and be at least 10 feet tall measured from the lowest point at either the upstream or downstream toe of the dam to the crest of the dam;
2. Be at least 20 feet tall measured from the lowest point at either upstream or downstream toe of the dam to the crest of the dam regardless of its storage capacity; or
3. Pose a threat to lives and property in the event of a failure or improper operation of the dam or barrier.

Alaska dams exist for many purposes that include:

- Hydroelectric,
- Water supply,
- Flood control and storm water management,
- Recreation,
- Fish and wildlife habitat,
- Fire protection,
- Mine tailings and contact water storage, and
- Wastewater containment and treatment.

4.1.9.1.1 Dam Hazard Potential Classification

All dams are classified according to their potential impacts from catastrophic failure; referred to as their “hazard potential” classification. The hazard potential only describes dam failure consequences but provides no information on the condition of a dam or its failure likelihood. The hazard potential classification assigned to a structure in Alaska is based on one of three categories (Table 4.1.9-1) described in the current dam safety regulations (11 AAC 93.157):

Table 4.1.9-1: Dam Hazard Potential Classifications

Classification	Threat Level	Defined
Class I	High	If the department determines that the failure or improper operation of the barrier will result in probable loss of human life
Class II	Significant	If the department determines that the failure or improper operation of the barrier will result in
		(A) A significant danger to public health;
		(B) The probable loss or significant damage to homes, occupied structures, commercial property, high-value property, major highways, primary roads, railroads, or public utilities, other than losses or damage limited to the owner of the barrier; or
		(C) Other probable significant property losses or damage, other than losses or damage limited to the owner of the barrier; or

Classification	Threat Level	Defined
		(D) Probable loss of or significant damage to waters identified under 11 AAC 195.010(a) as important for the spawning, rearing, or migration of anadromous fish.
Class III	Low	If the department determines that the failure or improper operation of the barrier will result in
		(A) Limited impacts to rural or undeveloped land, rural or secondary roads, and structures;
		(B) Property losses or damage limited to the owner of the barrier; or
		(C) Insignificant danger to public health.

An artificial barrier that is assigned a Class I (high) or Class II (significant) hazard potential is considered to “pose a threat to lives or property” and meet the statutory definition of a dam regardless of its geometry.

This plan currently requires a risk assessment for Class I, or “High” Hazard Potential Dams (HHPD), those whose failure may result in loss of life. It is recognized that Class II, or “Significant” Hazard Potential Dams also pose risk to people and structures, as well as to the environment. For instance, failure of some water supply dams in remote areas could cause a public health crisis.

Alaska dam’s hazard potential classification is based on jurisdictional status as shown in Figure 4.1.9-1. In general, the Class I dams are located in major urban areas of Alaska such as Anchorage, Juneau, Ketchikan, Wrangell, and Kodiak. Class II dams are located across the state and serve various purposes such as water containment, hydroelectric, and tailings storage.

The Alaska dam safety regulations require Class I and Class II dams to have an emergency action plan (EAP), which includes a map of the potential inundation zone in the case of a dam breach. At a minimum, the hazard potential classification is determined based on a preliminary investigation that includes conservative observations from ground reconnaissance, aerial photos, or other investigations of downstream threats to life and property.

Conducting a numerical dam break analysis is expensive, and the input data readily available to many dam owners is outdated, too imprecise, or non-existent. For example, TP-47, which is commonly used to determine probable maximum precipitation for most of the state, was last updated in 1963 and was based on limited historical records available at the time and does not anticipate forecasted predictions of changing climate. The vast majority of the state lacks precise digital elevation modelling to route flood waters. While existing inundation map quality is limited, emergency action planning by dam owners is expected to compensate for these deficiencies (by, for example, expanding areas of evacuation where location, depth, and velocity of flow have low confidence).

4.1.9.2 Locations of High Hazard Potential Dams

There are currently 110 dams in Alaska listed in the National Inventory of Dams (NID), which documents all known dams in the United States that meet certain criteria. The NID is maintained by the U.S. Army Corps of Engineers and works in close collaboration with federal dam regulating agencies, including FEMA and state and federal dam regulating agencies, to obtain current and accurate information.

Of the 110 total dams in Alaska, 30 of them are classified as High Hazard Potential Dams (HHPDs) (Figure 4.1.9-1 and Table 4.1.9-2). Note that the size of the circles in Figure 4.1.9-1 relates to the volume capacity of the dam, not level of risk.

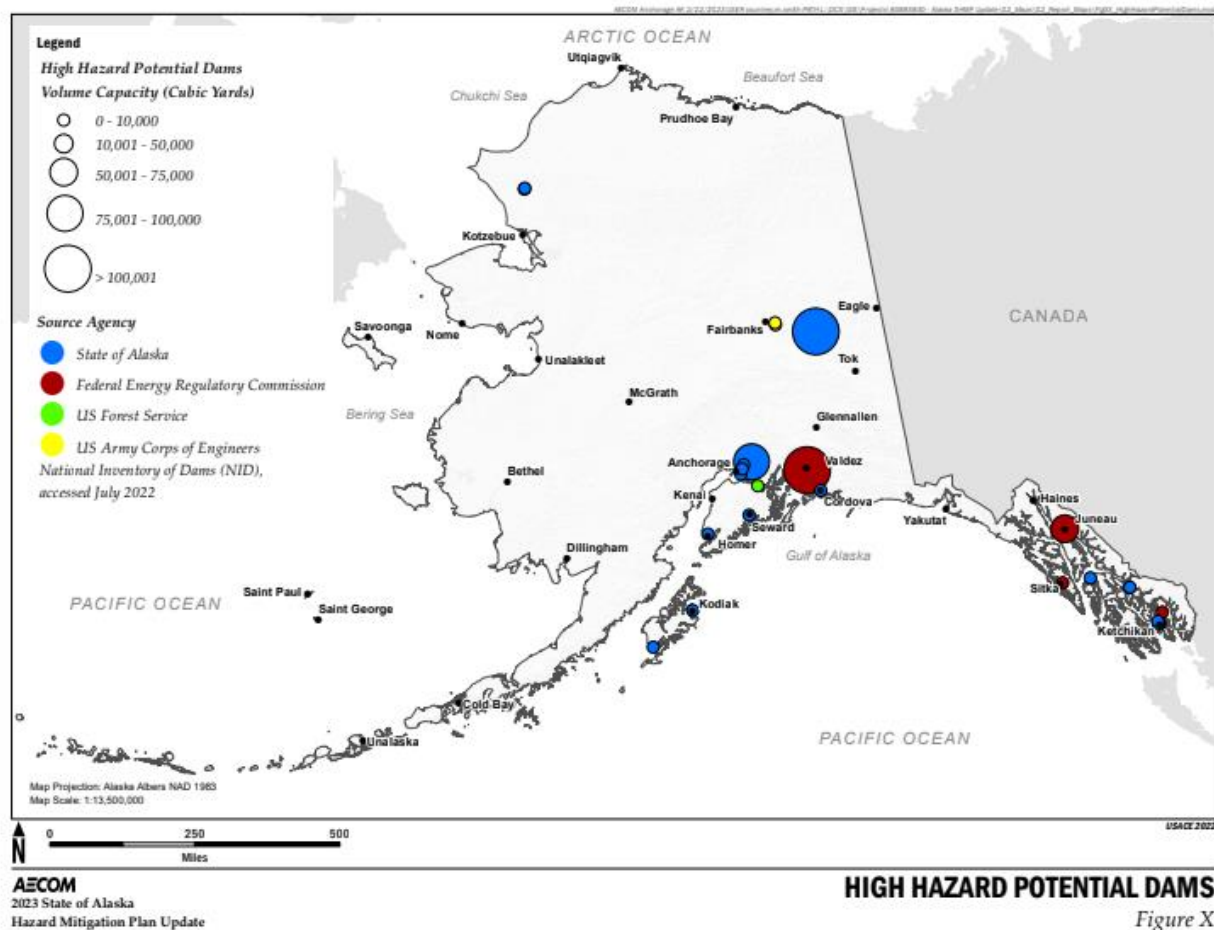


Figure 4.1.9-1: High Risk Dams in Alaska

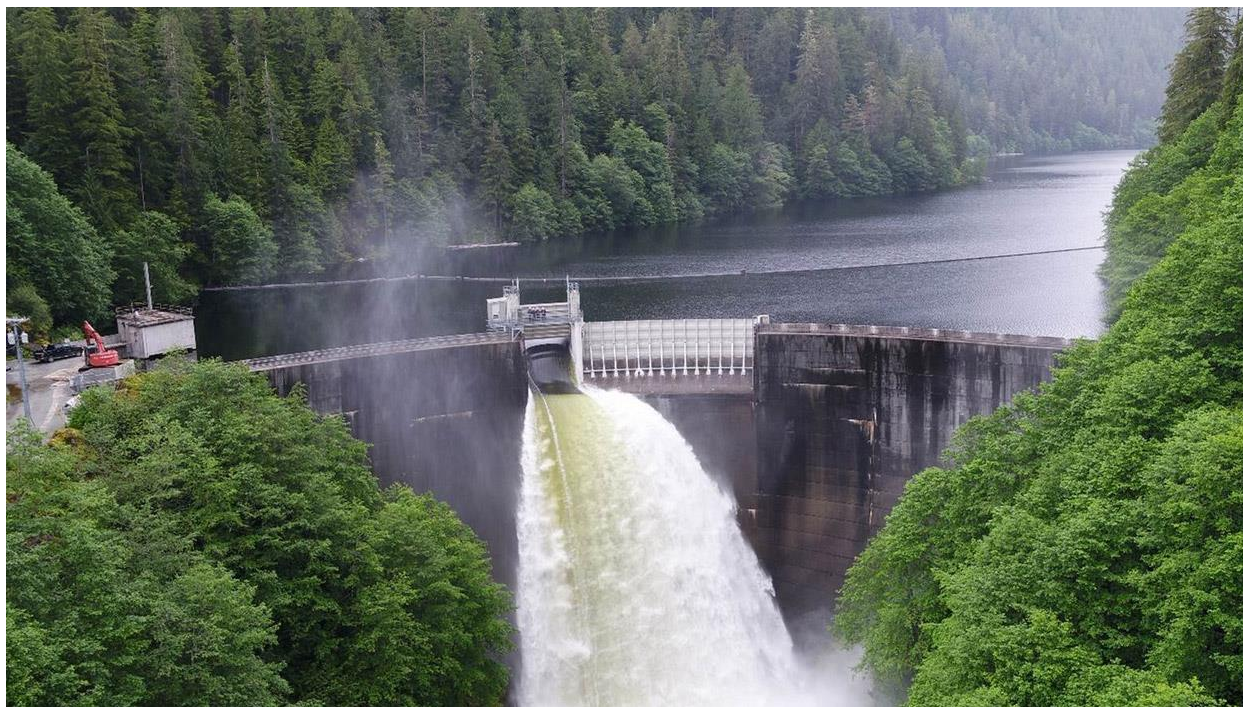
Table 4.1.9-2: List of High Risk Dams in Alaska

Dam Name	NID ID	Location	Agency	Primary Purpose
Cooper Lake	AK00001	Cooper Landing	Federal Energy Regulatory Commission	Hydroelectric
Blue Lake	AK00002	Sitka	Federal Energy Regulatory Commission	Hydroelectric
Salmon Creek	AK00003	Juneau	Federal Energy Regulatory Commission	Hydroelectric
Crystal Lake	AK00005	Petersburg Borough	Federal Energy Regulatory Commission	Hydroelectric
Ketchikan Lakes	AK00006	Ketchikan	Federal Energy Regulatory Commission	Hydroelectric
Lake Connell	AK00010	Ketchikan	State of Alaska	Water Supply
Carlanna Lake	AK00011	Ketchikan	State of Alaska	Water Supply
Whitman Lake	AK00012	Ketchikan	Federal Energy Regulatory Commission	Hydroelectric
Wrangell Upper	AK00013	Wrangell	State of Alaska	Water Supply
Wrangell Lower	AK00014	Wrangell	State of Alaska	Water Supply
Meals Lake Dam	AK00018	Cordova	State of Alaska	Water Supply
Bettinger Upper Reservoir Dam	AK00022	Kodiak	State of Alaska	Water Supply
Solomon Gulch Spillway	AK00027	Valdez	Federal Energy Regulatory Commission	Hydroelectric
Solomon Gulch	AK00027	Valdez	Federal Energy Regulatory Commission	Hydroelectric
Eklutna Dam	AK00033	Eklutna Village	State of Alaska	Hydroelectric
Lake "O" The Hills	AK00034	Anchorage	State of Alaska	Other
Ship Creek Dam	AK00035	Anchorage	State of Alaska	Water Supply
Lowell Creek	AK00060	Seward	State of Alaska	Flood Risk Reduction
Douglas Island Dam	AK00077	Douglas	State of Alaska	Flood Risk Reduction
Moose Creek Dam – East Cutoff Dike	AK00085	Fairbanks	U.S. Army Corps of Engineers	Flood Risk Reduction
Moose Creek Dam	AK00085	Fairbanks	U.S. Army Corps of Engineers	Flood Risk Reduction
Alitak Cannery Dam #1	AK00092	Alitak Cannery	State of Alaska	Water Supply
Bridge Creek Dam	AK00101	Homer	State of Alaska	Water Supply
Lower Fire Lake Dam	AK00189	Eagle River	State of Alaska	Fish and Wildlife Pond
Red Dog Tailings Main Dam	AK00201	Kivalina	State of Alaska	Tailings
Red Dog Tailings Back Dam	AK00303	Kivalina	State of Alaska	Other
Pogo R.T.P. Dam	AK00304	Fairbanks	State of Alaska	Contact Water Collection for Water Treatment or Discharge
New Kake Dam	AK00305	Kake	State of Alaska	Water Supply
Explorer Glacier Pond Dam	AK82401	Portage	U.S. Forest Service	Fish and Wildlife Pond
Swan Lake	AK83013	Ketchikan	Federal Energy Regulatory Commission	Hydroelectric



Source: <https://www.peri-usa.com/projects/civil-engineering/blue-lake-dam.html>. Date taken, unknown.

Figure 4.1.9-2: Blue Lake Dam in Sitka



Source: <https://pacificpile.com/swan-lake-hydroelectric-expansion-utilized-after-record-rainfall/>. Date taken, November 2020

Figure 4.1.9-3: Swan Lake Hydroelectric Dam in Ketchikan



Source: <https://dawson.com/whitman-lake-hydroelectric/>. Date taken, unknown.

Figure 4.1.9-4: Whitman Lake Hydroelectric Dam in Ketchikan



Source: <https://www.arctictoday.com/alaskas-red-dog-mine-plans-expansion-new-territory/>. Date taken, unknown.

Figure 4.1.9-5: Red Dog Mine Tailings Dam in Red Dog

4.1.9.2.1 Dam Owners and Dam Regulators

Dam owners are responsible and liable for a dam under their ownership and are responsible for complying with state and federal regulations. Dams can be owned by private citizens or companies, quasi-governmental bodies, state or local governments, or federal agencies. The majority of Alaska's dams are owned by local governments or privately owned, and the remaining are owned by state or federal agencies and utility companies (Figure 4.1.9-6).

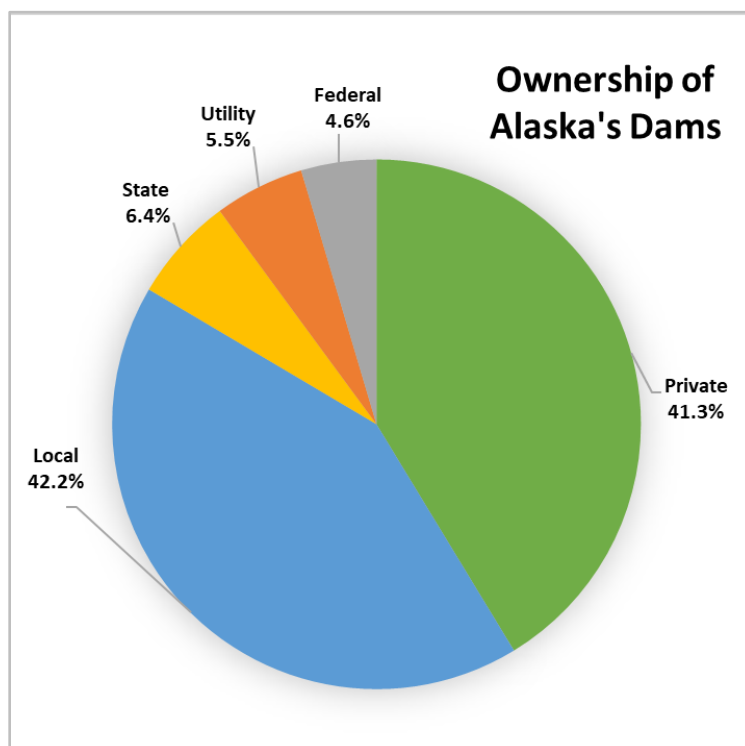


Figure 4.1.9-6: Ownership of Alaska's Dams

Dam regulators are responsible for reviewing dam construction plans, performing and reviewing safety inspections, and enforcing dam safety policies. State and federal agencies regulate most dams; however, some dams are unregulated due to state or federal exemptions.

Dams that are exempt from state jurisdiction include dams owned and operated by the federal government, those regulated by the Federal Energy Regulatory Commission, and artificial barriers that fail to meet the statutory definition of a dam. Federally-owned high hazard dams are also required to have EAPs by federal regulations.

The Alaska Dam Safety Program (ADSP) is responsible for supervising the safety of the 80 dams under state jurisdiction, which includes issuing Certificates of Approval for new dam construction and for existing dams' operation, repair, modification, removal, or abandonment.

The ADSP is also responsible for:

- Adopting regulations and issuing orders necessary for ensuring dam safety;
- Providing routine administration of the ADSP and the Dam Safety and Construction Unit (Dam Safety) of the ADNRR;
- Classifying dams based on the potential hazard to lives and property created by the dam;
- Approving the design, construction, operation, and inspection of dams through “certificates of approval,” which are issued based on specific information submitted to Dam Safety for review;
- Identifying unsafe dams that compromise the mission of the ADSP and taking the necessary steps to mitigate those risks;
- Raising the level of compliance for jurisdictional dams that are out of compliance with state dam safety regulations;
- Enforcing the dam safety statutes and regulations through appropriate legal actions, if necessary, including issuing injunctions, assuming operational control of the dam, breaching the dam, or other activities necessary to mitigate the risk; and
- Providing information and educational material about dams in Alaska and dams in general, including the Alaska Dam Inventory, Training Aids for Dam Safety, conference proceedings, and other resources.

Table 4.1.9-3 lists the regulation jurisdiction of Alaska's state, federal, and other owner managed and regulated dams.

Table 4.1.9-3: Agency Regulated Dams with Hazard Classifications

Regulating Jurisdiction	Class I High Hazard	Class II Significant Hazard	Class III Low Hazard	Total Each Jurisdiction
State of Alaska	18	40	24	80
FERC	9	a	a	a
USACE	2	a	a	a
USFS	1	a	a	a
Total	30	45	111	<u>110</u>

Source: NID, Alaska Dam Safety Office

^a Unknown

4.1.9.3 History of Dam Failure Events

This section has been developed for the new FEMA 2022 State HMP requirements.

4.1.9.3.1 Dam Failure Events in the United States

Table 4.1.9-4 describes some significant historical dam failure events in the United States.

Table 4.1.9-4: Historical Dam Failure Events in the United States

Date of Failure	Dam Name	Cause of Failure	Description of Failure	Magnitude of Damages
May 31, 1889	South Fork Dam (Johnstown, PA)	Culvert collapsed, heavy rain, and poor maintenance	The worst man-made disaster in the United States prior to September 11, 2001, occurred in 1889 when the South Fork Dam catastrophically failed and sent 3.6 billion gallons of water towards the town of Johnstown.	2,209 fatalities \$17 million in damages (over \$550 million value in 2022)
March 12–13, 1928	St. Francis Dam (Santa Clara, CA)	Poor engineering	The “worst American civil engineering disaster of the 20th century” occurred in 1928 when the St. Francis Dam in Los Angeles County failed as a result of a series of human error and poor engineering judgment. As a result, a landslide occurred at a portion of the dam, and over 12 billion gallons of water rushed down the Santa Clara River Valley.	432 fatalities Over \$7 million in damages
February 26, 1972	Buffalo Creek Dam (Buffalo Creek Valley, WV)	Unknown	Coal Slurry Impoundment #3 at the Buffalo Creek coal mine in Logan County, West Virginia gave way, sending millions of gallons of water and millions of cubic yards of coal slurry down the Buffalo Creek.	125 fatalities Over \$400 million in damages, including the destruction of over 500 homes
June 9, 1972	Canyon Lake Dam (Rapid City, SD)	Overtopping	Extreme rainfall within a few hours led to the overtopping of the Canyon Lake Dam.	238 fatalities Over \$160 million in damages, including the destruction of 1,335 homes
June 5, 1976	Teton Dam (Teton, ID)	Poor engineering, internal erosion	The Teton Dam catastrophically failed after its first filling.	11 fatalities Over \$400 million in damages
July 19–20, 1977	Laurel Run Dam (Laurel Run, PA)	Breached embankment, inadequate spillway	The Laurel Run Dam failed after torrential storms hit the Johnstown area, dropping up to 11.8 inches of rain in just 8 hours. This equated to approximately a 500-year storm.	40 fatalities \$5.3 million in damages
November 6, 1977	Kelly Barnes Dam (Toccoa Falls, GA)	Poor engineering	The Kelly Barnes Dam failed after 4 days of heavy rainfall.	39 fatalities \$2.5 million in damages

Source: Association of State Dam Safety Officials (<https://damfailures.org/case-study/>)

The 1970s was a monumental decade for dam failure events in the United States as five dams failed and resulted in almost \$2 billion in damages. However, most states had no substantive dam safety laws prior to this series of dam failures, and these events ultimately led to the creation of dam safety laws and programs in the United States.

4.1.9.3.2 Dam Failure Events in Alaska

There have been several dam failure and non-failure events in Alaska's history, but only one has resulted in a fatality. Additionally, in 1983, the Hess Creek Reservoir Dam low-level outlet was being inspected and resulted in two divers drowning (not as a result of dam failure). FEMA classifies a dam failure as "any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function" and a non-failure event as "an event at a dam that will not, by itself, lead to a failure, but that requires investigation and notification of internal and/or external personnel." Non-failure events can lead to flooding of upstream and/or downstream areas.

Table 4.1.9-5 provides a representative list of dam failure and non-failure events in Alaska.

Table 4.1.9-5: Alaska's Historical Dam Failure and Non-failure Events

Date	Structure Name and Hazard Potential	Incident Type	Incident Driver	Incident Mechanism	Damage Description
1964	Campbell Lake Dam (L) Old Eklutna Dam (H) Lake o' the Hills Dam (H)	Failure	Earthquake	Unknown	Following the 1964 Great Alaskan Earthquake, these dams failed due to seismic activity.
	Lower Fire Lake Dam (H) Lower Eklutna Dam (S)	Non-failure			Following the 1964 Great Alaskan Earthquake, these dams were damaged due to seismic activity, but they did not fail.
1972	Lake o' the Hills Dam (H)	Failure	Seepage/ Internal Erosion	Piping	Dam failed due to piping failure at a low-level outlet. This failure event resulted in one fatality of a 10-year-old boy who was swept into a culvert.
1973	Carlanna Lake Dam (H)	Failure	Flooding	Unknown	Dam failed after a flood. No fatalities were reported.
1978	Monashka Lake Dam (S)	Failure	Flooding	Unknown	Dam failed after a flood. No fatalities were reported.
1980s	Alitak Cannery Dam #2 (L)	Failure	Flooding	Inadequate Spillway	These dams failed for various reasons in the 1980s.
	Alitak Cannery Dam #4 (L)	Failure	Unknown	Unknown	
	Larson Bay Cannery Dam	Failure	Unknown	Degraded Concrete	
	Campbell Lake Dam (L)	Failure	Flooding	Inadequate Spillway	
1983	Hess Creek Reservoir Dam (S)	Non-failure	Unknown	Unknown	Two divers that were inspecting the lower-level outlet got sucked into an outlet and drowned.
1990s	Valdez Creek Mine Dam	Failure	Unknown	Piping	Unknown.
1992	Willow Creek A5 Dam	Failure	Unknown	Unknown	Dam failed less than 1 month after completion.
1999	Shotgun Diversion Dam (L)	Failure	Unknown	Overtopping	Unknown.
2000–2007	Gunnuk Creek Dam (New Kake Dam is H)	Failure	Unknown	Unknown	Structural failure caused reservoir drainage and severe economic impact to the community.

Date	Structure Name and Hazard Potential	Incident Type	Incident Driver	Incident Mechanism	Damage Description
2014–2017	Mahoona Dam (L)	Non-failure	Unknown	Unknown	Structure became degraded to the point that an emergency replacement occurred in 2014. In 2014, a stump frozen into the reservoir surface ice was pushed through the timber face as the reservoir was drawn down for hydroelectric power, effectively failing the dam as it was unsafe to operate at that point. Ice damaged the new dam's low-level outlet, causing the reservoir to drain completely, and additional emergency repairs were completed in 2017 (also related to the drawdown of the reservoir after it ices over.).
2015	Long Lake Dam (L)	Non-failure	Hydrologic/Flooding	Gate/Valve Failure	Heavy rain event (7.73 inches in 24 hours and 2.8 inches earlier in the week) resulted in a rainfall induced flood event during which a section of the wooden flashboards failed.
2018–2023	Hydaburg Water Supply Dam (S)	Non-failure	Unknown	Unknown	Dam was experiencing progressive failure in recent years and was at risk of collapse. The dam was severely damaged by flooding in January of 2022 and was removed in May 2022. ANTHC is expected to start construction on the replacement in summer 2023.
2020	Hess Creek Dam (S)	Non-failure	Deterioration or Poor Condition	High Reservoir Level/Debris Clogging	Satellite imagery on 4/25/2020 appears to show the dam is impounding a significant amount of water. There is no serviceable spillway. The low-level outlet does not appear to be functioning. Wildfires the previous year burned area and likely increase runoff and erosion, potentially clogging low level outlet causing impoundment. The dam owner breached the dam in 2021. ADSP visited the site in summer 2022 to observe the breach. It does not appear to be able to impound water anymore. After another observation following breakup spring 2023, this structure will be decommissioned and removed from the NID.
2021	Long Lake Dam (L)	Non-failure	Malfunction of Equipment/Gate	Gate/Valve Failure	A log damaged flashboards causing an overtopping event.

Source: Alaska Dam Safety Office, Association of State Dam Safety Officials (<https://damsafety.org/Incidents>)

4.1.9.3.2.1 Great Alaskan Earthquake (1964)

Following the M9.2 earthquake that occurred in the Prince William Sound region of Alaska, the following dams failed:

- Campbell Lake Dam
- Old Eklutna Dam
- Lake o' the Hills Dam

The following dams were damaged but did not fail:

- Lower Fire Lake Dam
- Lower Eklutna Dam

4.1.9.3.2.2 Lake o' The Hills Dam Failure in Anchorage (1972)

In 1972, Anchorage's Lake o' the Hills Dam failed and resulted in the fatality of a 10-year-old boy. The inundation map for this dam includes the grounds adjacent to O'Malley Elementary School.

4.1.9.3.2.3 Gunnuk Creek Dam Failure in Kake (2000)

The failure of the Gunnuk Creek Dam in Kake in 2000 significantly impacted the community. After the City's main water supply dam failed, the small reservoir quickly drained, and the city was forced to find a temporary and long-term solution to provide water to the 800-person community.

The water supply loss had impacts throughout the entire community as the local seafood processor lost production for the next 2 weeks, at the peak of the fishing season, and the hatchery experienced an increased egg and fry mortality rate due to water quality problems. No one was injured when the dam failed, but the hatchery experienced some damage to their access road. After the dam failure, a child was severely scalded by boiling water in a kitchen accident later in the week while trying to make the water safe to use.

The response to this disaster included local residents and government entities, businesses, state agencies, and the federal government. The initial economic impact to the community was estimated at approximately \$2 million, not including dam replacement. The budget for a new, replacement dam planned by the Army Corps of Engineers was approximately \$10 million, and construction of the new dam was completed, and operations began in April of 2007.

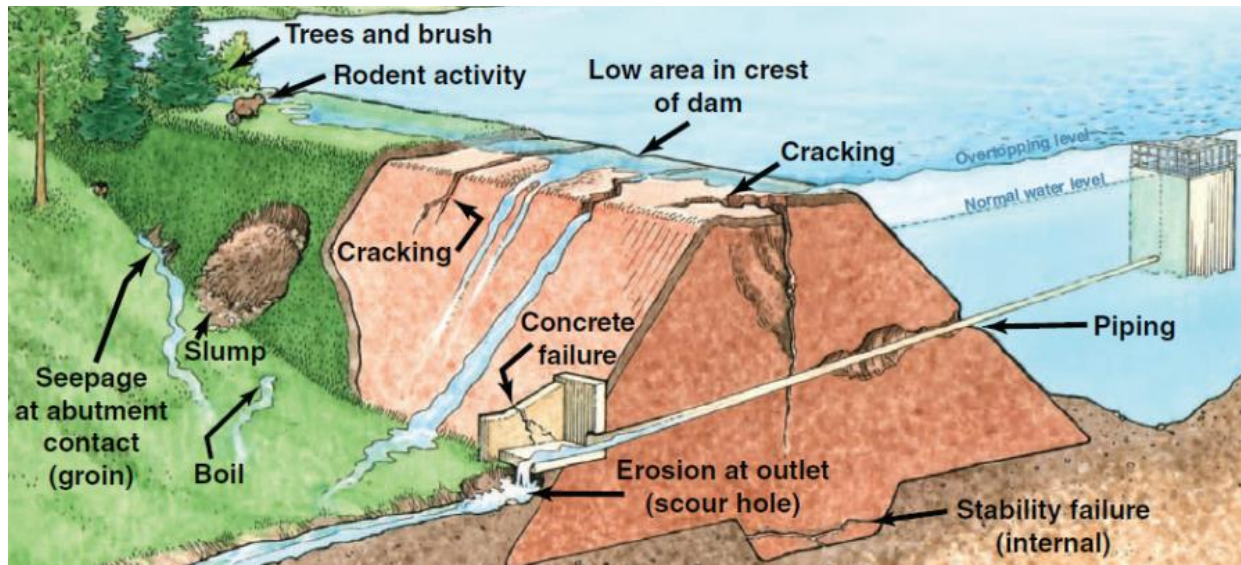
4.1.9.4 Extent of Dam Failure Events

According to the Association of State Dam Safety Officials (ASDSO), the common causes of dam failure include overtopping, foundation defects, cracking, inadequate maintenance and upkeep, and piping (Figure 4.1.9-7). Additionally, dams may fail due to natural hazards such as landslides or earthquakes.

- **Overtopping** is often a precursor of dam failure and is caused by water spilling over the top of a dam.
- **Foundation defects** include settlement and slope instability.
- **Cracking** is caused by movements such as natural settling of the dam or from earthquakes.
- **Inadequate maintenance and upkeep** may lead to dam failure if structural defects are not detected and quickly resolved.
- **Piping** occurs when seepage through a dam is not properly filtered, and soil particles continue to progress and form sink holes in the dam.

Dam failure can result in slow spilling or complete failure with water flooding the inundation area resulting in damage to residences, critical facilities, infrastructure and potentially loss of life. All HHPDs have documented EAPs with various levels of inundation mapping on file with the State Dam Safety Engineer.

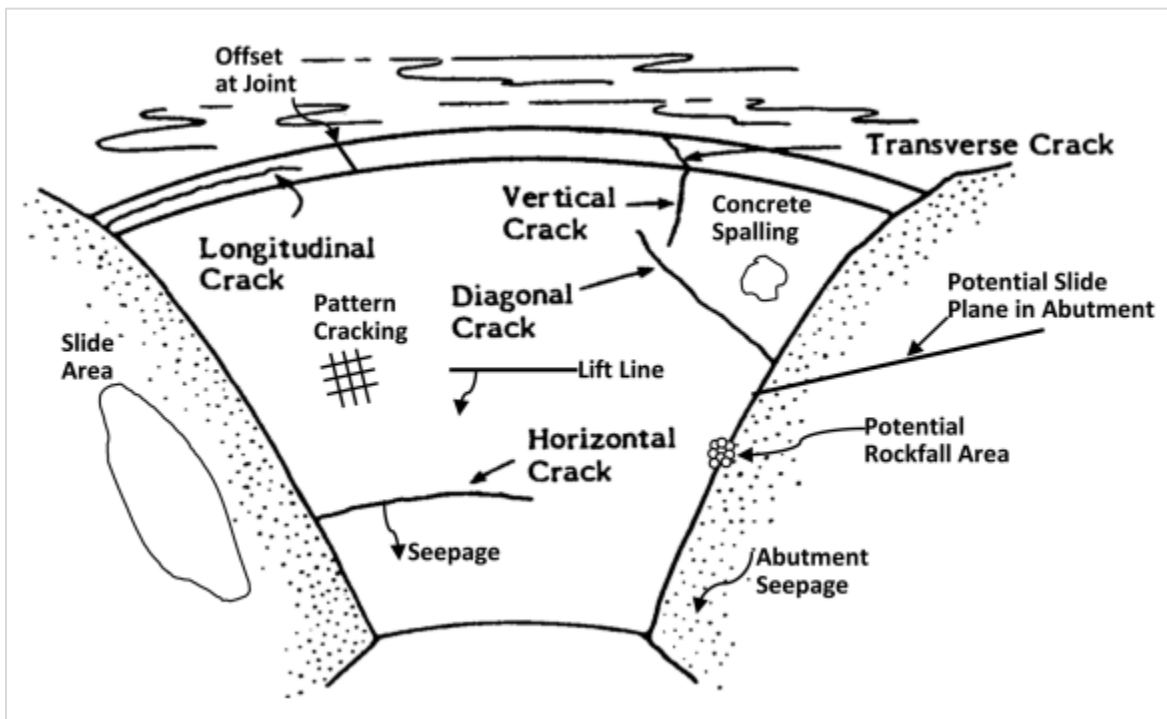
Unsafe maintenance practices have resulted in fatalities, as in the case of the Hess Creek Reservoir Dam that killed two inspectors. There is also the issue of public safety around dams, such as keeping recreational users away from spillways, low level outlets, and low head dams. Dams can be an attractive nuisance. These cause casualties and fatalities but are not considered disasters.



Source: FEMA Pocket Safety Guide for Dams and Impoundments- FEMA P-911/October 2016

Figure 4.1.9-7: Causes of Dam Failure

Figure 4.1.9-8 shows the visible signs of potential failure mechanisms of concrete dams.



Source: FEMA Pocket Safety Guide for Dams and Impoundments- FEMA P-911/October 2016

Figure 4.1.9-8 Noteworthy Observations at a Concrete Dam

4.1.9.5 Impact of Dam Failure Events

Future potential impacts from a dam failure event can be catastrophic incidents that result in substantial economic impacts and loss of life. There are varying degrees of failure that can contribute to uncontrolled water release from the reservoir, ranging from improper gated spillway operation to the partial or full breach of the dam's main structural components. Lesser degrees of failure often occur in advance of a catastrophic failure and are generally amenable to mitigation if detected and properly addressed. Dam failures can occur wherever the structures are located from several general causes, including:

- Inadequate spillway capacity which results in dam overtopping during extreme rainfall-runoff events;
- Internal erosion or piping caused by seepage through the embankment or foundation or along conduits;
- Improper or insufficient maintenance leading to decay and deterioration;
- Inadequate design, improper construction materials, and poor workmanship;
- Operation issues;
- Failure of upstream dams on the same river system;
- Landslides into a dam's reservoir, creating a wave that overtops the dam;
- Seismic instability;
- Vandalism; and
- Terrorism.

The State Dam Safety Engineer states that Alaska's informal population risk estimate for state and federal, Class I (High) hazard potential dams in Alaska is approximately 4,000 people.

4.1.9.6 Probability of Future Failure Events

Dam engineering and regular safety inspections may be able to predict if/when a dam will fail. Early detection through periodic safety inspections and regular maintenance can help dam owners identify and resolve an issue before it leads to a partial or complete failure.

Following the Kelly Barnes Dam failure event in 1977, President Jimmy Carter directed the USACE to inspect the nation's non-federal HHPDs. This program lasted from 1978-1981 and dam safety programs were then established in most states, eventually leading to the National Dam Safety Program which supports dam safety programs in all states (ASDSO). Modern dam safety laws combined with advanced engineering and construction techniques, as well as stricter permitting requirements, have resulted in the number of dam failure events significantly decreased since the 1970s.

Periodic Safety Inspections (PSI), Emergency Action Plans (EAP), and inundation maps are tools and resources that dam owners and dam regulators use to identify the potential for affected hazard areas if a dam were to fail.

4.1.9.6.1 Periodic Safety Inspections

The Alaska Administrative Code Section 11 AAC 93.159 outlines the periodic safety inspection requirements for all dam classifications in the State. It states:

- (a) The owner of a Class I (High) or Class II (Significant) dam shall provide for a periodic safety inspection of the dam at least once every three years. The owner of a Class III (Low) dam shall provide for a periodic safety inspection of the dam at least once every five years. The department may order a dam owner to provide for a periodic safety inspection more often than required by this subsection if the department determines that the dam might be unsafe or that more frequent inspections are necessary to protect public safety. Each periodic safety inspection and other work required by this section is at the owner's sole expense. Each periodic safety inspection must be detailed and

comprehensive and must meet the department's guidelines for periodic safety inspections. Those guidelines, set out in Chapter 10, Section 10.4 of the department's Guidelines for Cooperation with the Alaska Dam Safety Program, dated September 26, 2003 are adopted by reference. The most current version of the Guidelines is dated July 2017 and will continue to be in draft until the regulations are updated.

The Association of State Dam Safety Officials provides the following graph of the condition ratings for the 18 state-regulated high hazard potential dams as well as rating criteria (Table 4.1.9-6).

Satisfactory: No existing or potential dam safety deficiencies are recognized.

Fair: No existing or potential dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in dam safety deficiency.

Poor: A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficient. Further investigations and studies are necessary.

Unsatisfactory: A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

Not rated: The dam has not been inspected or has been inspected but, for unknown reasons, has not been rated.

Table 4.1.9-6: 2021 Condition Ratings of Alaska's State Regulated HHPDs*

NID ID	Dam Name	Condition Rating	Date of Condition Assessment
AK00010	Lake Connell	Satisfactory	7/21/2015
AK00011	Carlanna Lake	Satisfactory	11/5/2020
AK00033	Eklutna Dam	Satisfactory	12/12/2018
AK00201	Red Dog Tailings Main Dam	Satisfactory	3/4/2021
AK00303	Red Dog Tailings Back Dam	Satisfactory	2/26/2021
AK00304	Pogo R.T.P. Dam	Satisfactory	10/2/2019
AK00305	New Kake Dam	Satisfactory	10/15/2020
AK00018	Meals Lake Dam	Fair	5/18/2018
AK00022	Bettinger Upper Reservoir Dam	Fair	9/1/2020
AK00034	Lake o' the Hills Dam	Fair	1/7/2020
AK00035	Ship Creek Dam	Fair	1/31/2019
AK00077	Douglas Island Dam	Fair	10/26/2016
AK00101	Bridge Creek Dam	Fair	10/31/2019
AK00189	Lower Fire Lake Dam	Fair	12/10/2019
AK00013	Wrangell Upper	Poor	10/3/2019

NID ID	Dam Name	Condition Rating	Date of Condition Assessment
AK00014	Wrangell Lower	Poor	10/3/2019
AK00092	Alitak Cannery Dam #1	Poor	11/1/2019
AK00060	Lowell Creek	Not Rated**	N/A

*Does not include federally regulated dams as most data for those is not available.

**The Lowell Creek Dam has known dam safety deficiencies for loading conditions. The dam is regulated by the state, but USACE performs the maintenance and inspections, and the condition has not been assessed. The USACE has the funding and is working on the mitigation for this project.

4.1.9.6.2 Emergency Action Plans and Inundation Mapping

An EAP is another form of emergency preparedness for dam owners and dam regulators. An EAP identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to help prevent loss of life and minimize property damage if a failure event occurs. The EAP is developed by the dam owners, but the purpose is to prepare owners, operators, and emergency management personnel for an emergency event. The dam owner is responsible for keeping the document up to date, exercising it, and activating it. 11 AAC 93.164(b)(4) requires HHPD dam owners to prepare EAPs in accordance with FEMA P-64.

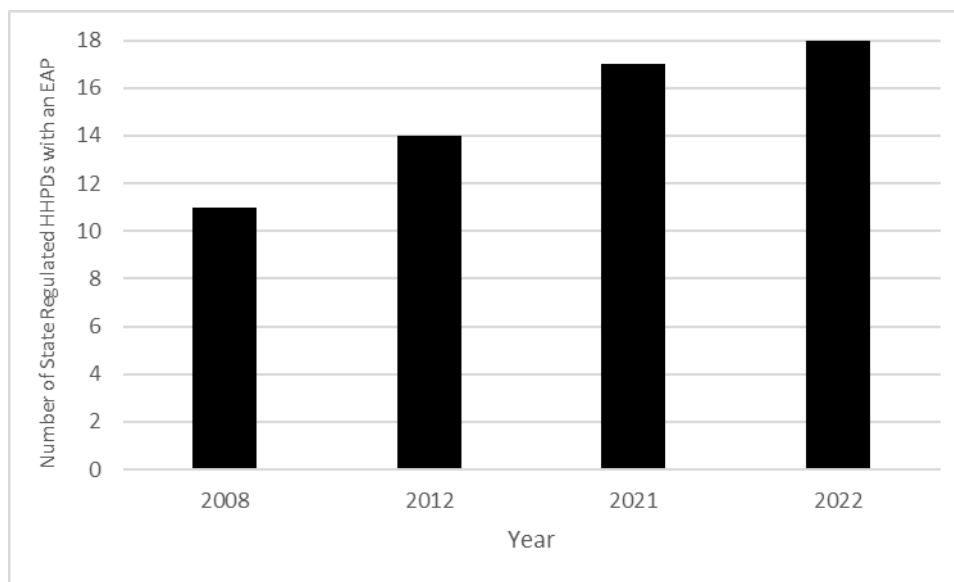
All HHPDs in the state are required to have EAPs with downstream hazard analysis, inundation mapping, notification flowcharts, dam classification, roles and responsibilities of dam owners and key personnel, emergency preparedness, and supporting appendices. Dam owners coordinate with emergency management authorities to develop the EAP and tailor the plan to the dam site conditions.

The minimum requirements for the state to approve an EAP are outlined in 11 AAC 93.164(b):

11 AAC 93.164. Owner's emergency action plan.

- (b) The department will approve an emergency action plan if
 - (1) the plan adequately protects life and property, given the particular risks presented to life or property if the dam fails or in anticipation of imminent dam failure;
 - (2) the plan provides adequately for the coordination of emergency responders in the community;
 - (3) the plan contains information that the department considers necessary to minimize danger to life and property; that information must include, if required by the department;
 - (A) a detailed inundation map, prepared in substantial accordance with 11 AAC 93.195;
 - (B) dam break analysis; and
 - (C) schedule for exercise and revision of the plan; and
 - (4) for a Class I dam, the plan is developed and maintained in accordance with
 - (A) the Federal Emergency Management Agency's Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners (FEMA 64), as revised as of October 1998 and adopted by reference; or
 - (B) other requirements that the department determines are necessary to protect life or property.

As of 2023, all 18 state-regulated HHPDs have an EAP.



Source: Association of State Dam Safety Officials 2022, Alaska Dam Safety Office

Figure 4.1.9-9: Number of Alaska’s State Regulated HHPDs with an EAP as of 2023

Inundation maps show the areas that would be flooded or affected if a dam failure event occurs. The State of Alaska State Dam Safety Engineer states that all 18 of the state regulated HHPDs have inundation maps of variable quality and detail. In addition, many of the state regulated Class II (Significant) dams also have inundation maps of variable quality and detail.

4.1.9.6.3 Alaska Dam Safety Program Metrics

Adequate staffing is an important aspect to program performance. In 2021, the State of Alaska had two full time employees in the Dam Safety Office, and the overall state budget for dam safety was \$325,000 (Association of State Dam Safety Officials 2021). The State Dam Safety Engineer states that AS 46.17 allows the office to utilize consultants when necessary to execute the Alaska Dam Safety Program.

Dam owners are responsible for the safe operation, maintenance, and emergency action planning for their respective dams. Many dam owners would welcome additional resources to support the safety of their dams (i.e., EAP development, infrastructure rehabilitation, additional engineering analysis, etc). Many industries would benefit from more accurate/precise survey data, updated seismic mapping, and an updated PMP/AEP hydrologic study. These tools would benefit more than just dam owners.

The graphs below compare State of Alaska Dam Safety program metrics to the national average. State metrics significantly above the Regulated Dams per FTE (full-time equivalent) and Regulated HHPDs per FTE national averages can be indicators of the need for additional staffing resources (Association of State Dam Safety Officials 2021).



Source: Association of State Dam Safety Officials 2022

Figure 4.1.9-10: 2021 Alaska Dam Safety Program Metrics

While Alaska has a comparatively low FTE per HHPD dam ratio, the state is significantly larger than any other state in the country, and it can be logistically challenging to get to many of the dams in the state. Related travel costs to many dams in Alaska significantly increase the budget per regulated dam.

4.1.9.6.4 Dam Failure Data

The probability of dam failure varies greatly, because historic dam failures represent a wide range of engineering, construction, and operations quality from different types of dams across the world. The probability of failure of water retention dams is generally considered to be very low, on the order of 1 in 10,000 per year, while the historical average failure rate of tailings dams is 1 in 1,000 per year (Marr 2019).

4.1.9.7 Projected Changes in Location of High Hazard Potential Dams

There are no current projected changes in location of the HHPDs in Alaska. The location of HHPDs may change in the future if dams are reclassified from different hazard classifications or new dams are constructed that meet the HHPD classification.

4.1.9.8 Range of Anticipated Intensities of Dam Failure Events

The range of anticipated intensities during dam failure events will be dependent on many factors such as location, dam type, volume of contents, and failure mechanism.

Some historical dam failure events in the United States have resulted in no fatalities, while others have resulted in thousands of fatalities. Additionally, historical dam failure events in the United States have resulted in damages ranging from a few thousand dollars to multi-million dollars.

4.1.9.9 Frequency of Dam Failure Events

Dam failure events have not been common in Alaska; there have been 23 recorded dam failure and non-failure events in Alaska in a 58-year time period (1964–2022). The frequency of dam failure will likely increase if proper maintenance and inspections are not regularly conducted.

4.1.9.10 Duration of Dam Failure Events

The duration of a dam failure event will depend on many factors such as the structure type, incident driver and/or mechanism, location, and availability of resources to respond to the failure. The duration of a failure event may be hours, multiple days, or even months.

With the implementation of EAPs, it is easier to record incident duration. It starts when the owner activates the EAP, and it ends when the owner notifies that the event is over.

Table 4.1.9-7 outlines the duration of Alaska’s historical failure and non-failure events.

Table 4.1.9-7: Duration of Alaska’s Historical Dam Failure and Non-Failure Events

Date	Structure Name	Incident Duration
1972	Lake o’ the Hills Dam	Unknown
2000–2007	Gunnuk Creek Dam	Unknown
2014/2017	Mahoona Dam	Unknown
2015	Long Lake Dam	Unknown
2018	Hydaburg Water Supply Dam	Unknown
2020	Hess Creek Dam	Unknown
2021	Long Lake Dam	Unknown

(Source: ASDSO, 2022)

4.1.9.11 Future Conditions of High Hazard Potential Dams, Including Climate Change

4.1.9.11.1 Characteristics/Nature/Type

The characteristics/nature/type of potential failures from HHPDs in the State of Alaska may change due to climate change. HHPDs are designed to pass a probable maximum flood (PMF) unless an incremental

hazard assessment determines a lower event is more appropriate. With predicted increases in precipitation and rain on snow events in some areas, it is possible that the PMF in some areas will increase. An increased PMF could overwhelm the system's ability to attenuate the flood, leading to a revised dam break analysis and change in the inundation zones.

Another potential threat to dams in Alaska is the degradation or loss of permafrost due to climate change. Landsat satellite imagery and empirical modeling project that near-surface permafrost will be lost entirely from large parts of Alaska (16–24%) by the end of the century (USGCRP 2018; Pastick et al. 2015). Thermosiphons or similar technology to maintain permafrost beneath dams have not been used in Alaska.

The following dams were constructed on permafrost soils:

- Hess Creek Dam (Significant hazard dam, not HHPD)
 - Construction of this dam was completed in 1946. Initial assessments during this time estimated the underlying permafrost depth to be 66.5 feet to 200 feet (USACE 1972). Permafrost beneath the dam has degraded since the dam's construction and is no longer present directly beneath the dam. Dam breached in 2021 and is currently being decommissioned.
- Vortac Lake Reservoir, Kotzebue Water Supply Dam (Significant hazard dam, not HHPD)
 - Vortac Lake Dam has permafrost in the embankment that is degrading due to wind/wave erosion.
- Itasigrook Dam and Isatkuaq Lagoon Dam, Utqiagvik (Significant hazard dams, not HHPD)
 - Impacts to the Itasigrook dam from coastal erosion are of concern. The dam has a “seawall” barrier in the spillway to protect from storm surges. The seawall is not vital to the integrity of the dam, but the city does not want sea water to surge into the reservoir.
- Nixon Fork Tailings Dam (Significant hazard dam, not HHPD)
 - Slumping at the dam over the years is likely due to local melting of permafrost beneath the dam. The Nixon Fork Tailings Dam is in a state of long-term care and maintenance. It is still considered operational although there are no mining operations currently on the site.
- Red Dog Tailings Dams (HHPD)
 - This is the only HHPD constructed on permafrost in Alaska. The addition of tailings over the years may have caused degradation of permafrost beneath the dam.

4.1.9.11.2 Location

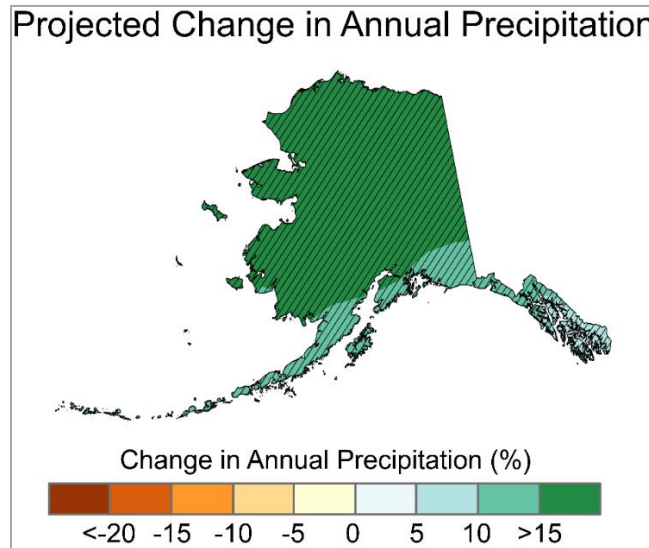
The location of HHPDs and potential failure events in the State of Alaska is not expected to change due to climate change. However, failure events may become more frequent as annual precipitation is projected to increase due to climate change. Increased precipitation and increased snowmelt due to rising global temperatures may lead to a reclassification of dams after inspection, increasing the number of HHPDs in the state. Additionally, existing dams, spillways, and other attenuation methods may require modification due to increased rainfall and snowmelt.

4.1.9.11.3 Range of Anticipated Intensities

Annual precipitation in Alaska, especially in high northern latitudes, is projected to increase due to climate change. Under the CMIP5 (Coupled Model Intercomparison Project 5) climate mode, annual precipitation increases of about 15% to 30% are projected for the state by late this century if global emissions continue to increase (USGCRP 2018). Increased precipitation, especially during a short duration, may lead to increased overtopping events and eventual dam failure events or the need for dam expansion. Additionally, as global temperatures rise, snowmelt is projected to occur earlier in the year than it has historically, and shifts from snowfall to rainfall are projected as temperatures are projected to

remain above freezing for longer periods of time. Increased incidents of rain on snow events or atmospheric rivers (especially in southeast) are anticipated.

Figure 4.1.9-11 depicts current projections for increases in annual precipitation by the middle of the century.



(Source: CISESS, NEMAC, and NOAA, 2022)

Figure 4.1.9-11 Projected Change in Annual Precipitation from the 20th Century to the Mid-21st Century

Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018). Increased temperatures will continue to cause permafrost degradation, which has the potential to impact those dams constructed on permafrost. See Section 4.1.7.11.3 for details regarding increase temperatures under different modeled scenarios.

4.2 VULNERABILITY OF STATE ASSETS

This section outlines the vulnerability process for determining potential losses for Alaska from various hazard impacts.

This vulnerability assessment predicts the extent of the exposure that may result from a given hazard event and its impact intensity within regional areas. This qualitative analysis provides data to identify and prioritize potential mitigation measures by allowing state agencies and communities to focus attention on the areas with the greatest risk. This risk analysis is divided into the following three focus areas:

1. Asset inventory
2. Vulnerability Assessment: Infrastructure risk, vulnerability, and losses from identified hazards
3. Data limitations

4.2.1 Asset Inventory

Assets that may be affected by hazard events include critical facilities and infrastructure, population (for community-wide hazards), and residential buildings (where data are available).

These assets are grouped into two types:

- Critical infrastructure
- Residential properties

4.2.1.1 Critical Infrastructure

The following critical infrastructure information is used in applying state risk mitigation analysis in the most effective manner.

Critical infrastructure is defined as facilities that provide essential products and services to the general public, such as preserving quality of life while fulfilling important public safety, emergency response, and disaster recovery functions. Because many of Alaska's communities are in remote rural locations (i.e., are a long distance from their nearest neighboring community), most or all of the facilities are deemed to be "critical" to the community's survival or the functioning of a state agency in these communities. The critical facilities identified in this 2023 Update are considered the state's most vulnerable assets, including (but not limited to) community lifelines. The critical facilities include the following facilities (see also Table 4.2-1):

- Government: State, city, and tribal administrative office facilities, departments, and agencies
- Emergency response: Police departments and firefighting equipment
- Educational: Public schools (K through 12), universities (including UAA, UAS, and UAF), colleges, and charter schools
- Health care: Medical clinics, congregate living, health, residential, and continuing care and retirement facilities
- Community gathering places: Community, tribal, and youth centers and culturally significant and ceremonial sites
- Utilities: Electric and alternative power generation, communications, water and wastewater treatment, sewage lagoons, and landfills

Table 4.2-1: Alaska’s Critical Infrastructure

Hospitals, Clinics, and Assisted Living Facilities	Satellite Facilities	Power Generation Facilities	Oil and Gas Pipeline Structures and Facilities	Schools
Fire Stations	Radio Transmission Facilities	Potable Water Treatment Facilities	Service Maintenance Facilities	Community Washeterias
Police Stations	Highways and Roads	Reservoirs and Water Supply Lines	Community Halls and Civic Centers	National Guard Facilities
Emergency Operations Centers	Critical Bridges	Wastewater Treatment Facilities	Community Stores	Landfills and Incinerators
Any Designated Emergency Shelter	Airports	Fuel Storage Facilities	Community Freezer Facilities	Community Cemeteries
Telecommunications Structures and Facilities (including datacenters)	Harbors/Docks/Ports			

Notes:

The above table has no particular order except that the left column starts with First Responders and progresses to the right to less critical facilities—the order is subjective.

The 2023 State Hazard Management Plan’s (SHMP) critical facilities were consolidated and updated with new data from the Division of Risk Management, Department of Transportation, Alaska Railroad, and Division of Homeland Security and Emergency Management (DHS&EM) and were incorporated into the risk analysis and resultant vulnerability assessment.

The State of Alaska Division of Risk Management uses the Marshall & Swift Valuation Service Classification Class list for determining and maintaining a list of State-owned, insured buildings. Risk management does not use this list for construction cost determinations. Classification categories include:

- Class “A” buildings have fireproofed structural steel frames with reinforced concrete or masonry floors and roofs.
- Class “B” buildings have reinforced concrete frames with concrete or masonry floors and roofs.
- Class “C” buildings have masonry or concrete exterior walls with wood or steel roofs and floors, except for concrete slab on grade.
- Class “D” buildings generally have a wood frame, floor, and roof structure. They may have a concrete floor on grade and other substitute materials, but they are considered combustible construction. This class includes engineered pole frame buildings.

- Class “S” buildings of Alaska. (For the purpose of the evaluation of State structures, this class will not be used until future updates of the plan, when the State Risk Manager incorporates this class into the classification of structures.)
- Class “E” buildings are statewide leased.
- Class “F” buildings are uninsured properties.

Alaska Division of Risk Management uses the 2002 “Marshall Valuation Service Classification of Construction Statement” to determine the State’s valuation methodology and statement.

The following tables provide information about state-owned critical facilities. Table 4.2-2 lists the types of state-owned facilities, their counts, and their total estimated value. Table 4.2-3 lists the types of state transportation facilities and their counts. Table 4.2-4 lists transportation mileage in the state by facility type. Table 4.2-5 lists local critical facility types, their counts, and their total estimated values.

Table 4.2-2: State-Owned Facility Types, Counts, and Estimated Values

State Facility Type	Count	Estimated Value
Airports	53	\$1,903,146,376
Corrections	154	\$820,515,116
Education	37	\$215,845,525
Emergency Services	58	\$30,092,700
Healthcare/Nursing Homes/Protected Populations	64	\$811,938,925
Law Enforcement	62	\$177,786,920
Libraries & Museums	3	\$143,425,000
Maintenance	380	\$637,851,010
Office Facilities	864	\$2,492,806,048
Ports & Harbors	46	\$47,254,100
Total	1,721	\$7,280,661,720

Notes: State Risk Management Office. Data include estimated values of insured state assets.

Table 4.2-3: Transportation Facilities

Facility Type	Count
Airports	289
Bridges	1,272
Ferry Terminals	39
Harbors	149
Maintenance Facilities	81
Ports	13
Railroad Facilities	14
Total	1,857

Notes: State-wide transportation facilities with various ownership (duplicates removed from table above, but comprehensive value information is not available). Numbers include state-owned and other ownership for airports, ferry terminals, and harbors.

Table 4.2-4: Transportation Route Mileages

Facility Type	Miles
Roads	14,231
Alaska Railroad	695
Total	14,926

Table 4.2-5: Local Community Critical Facilities

Facility Type	Count	Estimated Value
Bridges/Culverts	3	\$2,000,000
Community	1,418	\$82,952,000
Education	331	\$127,500,829
Emergency	330	\$4,446,110
Government	568	\$26,083,000
Health	205	\$16,963,365
Housing	149	\$1,130,000
Transportation	10	\$44,594,857
Utilities	2,791	\$157,952,536
Total	5,805	\$463,622,697

Notes: Local community critical facility data are incomplete and may include duplicate data from state-owned critical facilities. This information has been collected from historical inventories and local and tribal hazard mitigation plans. Estimated values are not available for most communities and are therefore incomplete.

4.2.1.0 Residential Properties

The State of Alaska Department of Labor and Workforce provided residential property values from municipalities or jurisdictions levying a property tax (Table 4.2-6). Jurisdictions not levying property taxes were excluded.

Table 4.2-6: 2022 Residential Property Values by Borough

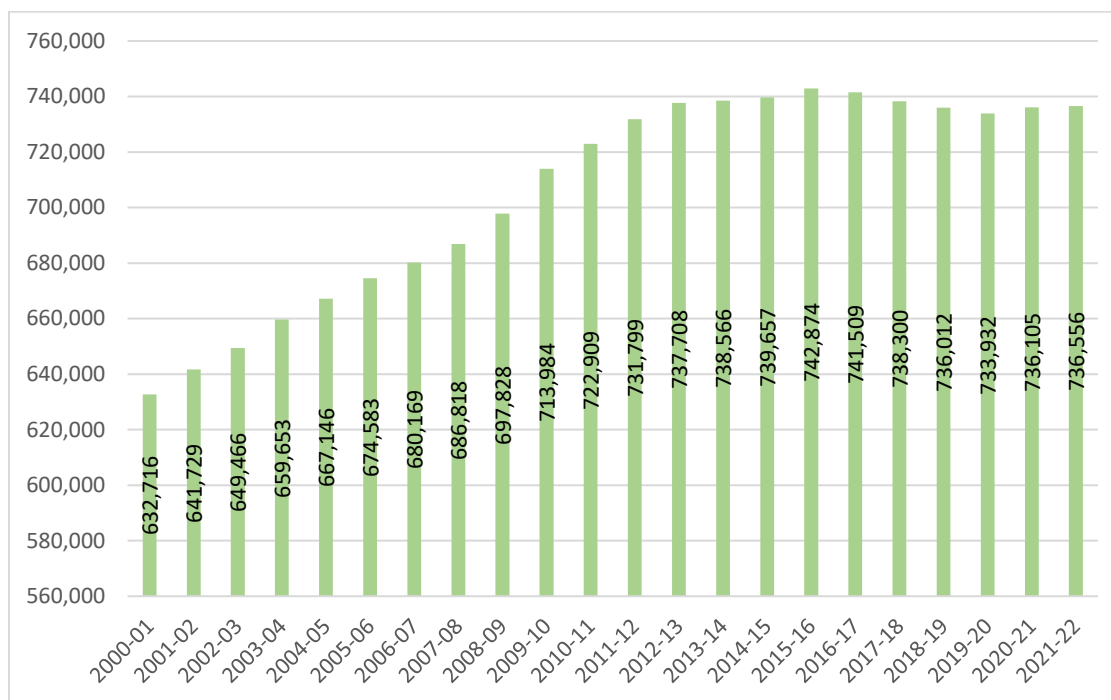
Boroughs and Unified Municipalities	Locally Assessed Real Property	Locally Assessed Personal Property	Approximate Total Assessed Values
Municipality of Anchorage	\$33,992,978,419	\$2,508,300,656	\$36,501,279,075
Bristol Bay Borough	\$203,750,637	\$236,690,815	\$440,441,452
Cordova	\$230,229,625	\$0	\$230,229,625
Craig	\$116,414,800	\$0	\$116,414,800
Dillingham (2021 values)	\$161,339,490	\$37,143,993	\$198,483,483
Fairbanks North Star Borough	\$8,962,424,861	\$0	\$8,962,424,861
Haines Borough	\$402,868,400	\$0	\$402,868,400
City and Borough of Juneau	\$5,378,434,308	\$375,569,690	\$5,754,003,998
Kenai Peninsula Borough	\$7,083,296,600	\$334,488,475	\$7,417,785,075
Ketchikan Gateway Borough	\$1,614,772,535	\$50,178,443	\$1,664,950,978
Kodiak Island Borough	\$1,356,823,091	\$159,819,657	\$1,516,642,748
Matanuska-Susitna Borough	\$12,082,920,123	\$64,342,295	\$12,147,262,418
Nenana	\$20,361,662	\$29,292	\$20,390,954
Nome	\$345,218,600	\$45,492,367	\$390,710,967
North Slope Borough	\$780,878,619	\$248,876,800	\$1,029,755,419
Pelican	\$11,750,347	\$180,996	\$11,931,343
Petersburg Borough	\$335,928,100	\$0	\$335,928,100
City and Borough of Sitka	\$1,128,946,688	\$0	\$1,128,946,688
Skagway	\$370,190,418	\$0	\$370,190,418
Unalaska	\$551,990,800	\$262,121,944	\$814,112,744
Valdez	\$325,980,319	\$0	\$325,980,319
Whittier	\$47,879,900	\$50,092,343	\$97,972,243
City and Borough of Wrangell	\$150,310,997	\$0	\$150,310,997
City and Borough of Yakutat	\$59,727,500	\$0	\$59,727,500
Unorganized Borough Assessed Value	\$0	\$0	\$0
Statewide Value of Assessed Property	\$75,715,416,839	\$4,373,327,766	\$80,088,744,605

4.2.1.1 Population

According to the Alaska Department of Labor and Workforce Development, Alaska's population has declined in 2022 to 736,566 from 738,300 in 2018. There are a number of factors contributing to the population decline:

- The number of births, as a percentage of total population, has decreased from 1.4% to 1.27%.
- The number of deaths, as a percentage of total population, has increased from 0.6% to 0.87%.
- The total number of people leaving Alaska is greater than the number moving to Alaska. The total number moving to Alaska from 2017/2018 to 2021/2022 was 193,116 compared to 221,263 leaving Alaska in the same period.

Figure 4.2-1 shows the population of Alaska from 2000-2022 in 1 year increments.



Source: Alaska Department of Labor and Workforce Development 2023.

Figure 4.2-1: Alaska Population, 2000–2022

Table 4.2-7 shows the population of the state by economic region, borough, and Census area for 2010 and April 2020 to July 2022.

Table 4.2-7: Population of Alaska by Economic Region, Borough, and Census Area, 2010 and April 2020 to July 2022

Area Name					Natural Increase		Net Migration		Population Change		Average Annual	
	Census	Census	Estimate	Estimate	(Births-Deaths)		(In-Out Migrants)				Growth Rate (Percent)	
	April 2010	April 2020	July 2021	July 2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022
Alaska	710,231	733,391	736,105	736,556	67,000	8,222	-43,840	-5,057	23,160	3,165	0.32	0.19
Anchorage/ Matanuska-Susitna Region	380,821	398,328	399,496	401,562	36,349	4,191	-18,842	-957	17,507	3,234	0.45	0.36
Anchorage, Municipality of	291,826	291,247	290,410	289,810	28,113	3,137	-28,692	-4,574	-579	-1,437	-0.02	-0.22
Matanuska-Susitna Borough	88,995	107,081	109,086	111,752	8,236	1,054	9,850	3,617	18,086	4,671	1.84	1.90
Gulf Coast Region	78,631	81,619	81,700	82,481	4,821	466	-1,833	396	2,988	862	0.37	0.47
Chugach Census Area	6,684	7,102	7,028	7,013	497	83	-79	-172	418	-89	0.61	-0.56
Copper River Census Area	2,955	2,617	2,637	2,619	126	-17	-464	19	-338	2	-1.21	0.03
Kenai Peninsula Borough	55,400	58,799	59,108	60,017	2,833	253	566	965	3,399	1,218	0.60	0.91
Kodiak Island Borough	13,592	13,101	12,927	12,832	1,365	147	-1,856	-416	-491	-269	-0.37	-0.92
Interior Region	112,021	109,425	111,552	110,588	12,636	1,849	-15,232	-686	-2,596	1,163	-0.23	0.47
Denali Borough	1,826	1,619	1,658	1,645	101	29	-308	-3	-207	26	-1.20	0.71
Fairbanks North Star Borough	97,581	95,655	97,729	96,747	11,645	1,747	-13,571	-655	-1,926	1,092	-0.20	0.50
Southeast Fairbanks Census Area	7,026	6,808	6,897	7,046	610	86	-828	152	-218	238	-0.32	1.53
Yukon-Koyukuk Census Area	5,588	5,343	5,268	5,150	280	-13	-525	-180	-245	-193	-0.45	-1.63
Northern Region	26,445	28,870	28,342	27,774	3,837	555	-1,412	-1,651	2,425	-1,096	0.88	-1.72
Nome Census Area	9,492	10,046	9,715	9,682	1,418	228	-864	-592	554	-364	0.57	-1.64
North Slope Borough	9,430	11,031	11,033	10,746	1,164	161	437	-446	1,601	-285	1.56	-1.16
Northwest Arctic Borough	7,523	7,793	7,594	7,346	1,255	166	-985	-613	270	-447	0.35	-2.62
Southeast Region	71,664	72,286	72,683	72,218	3,382	159	-2,760	-227	622	-68	0.09	-0.04
Haines Borough	2,508	2,080	2,621	2,575	30	3	-458	492	-428	495	-1.87	9.45

Area Name					Natural Increase		Net Migration		Population Change		Average Annual	
	Census	Census	Estimate	Estimate	(Births-Deaths)		(In-Out Migrants)				Growth Rate (Percent)	
	April 2010	April 2020	July 2021	July 2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022	2010–2020	2020–2022
Hoonah-Angoon Census Area	2,149	2,365	2,357	2,349	47	-3	169	-13	216	-16	0.96	-0.30
Juneau, City and Borough of	31,275	32,255	32,237	32,202	1,860	137	-880	-190	980	-53	0.31	-0.07
Ketchikan Gateway Borough	13,477	13,948	13,930	13,762	657	24	-186	-210	471	-186	0.34	-0.60
Petersburg Borough	3,203	3,398	3,376	3,357	132	2	63	-43	195	-41	0.59	-0.54
Prince of Wales-Hyder Census Area	6,172	5,753	5,747	5,720	254	-19	-673	-14	-419	-33	-0.70	-0.26
Sitka, City and Borough of	8,881	8,458	8,408	8,350	287	24	-710	-132	-423	-108	-0.49	-0.57
Skagway Borough, Municipality of	968	1,240	1,206	1,146	55	4	217	-98	272	-94	2.46	-3.50
Wrangell, City and Borough of	2,369	2,127	2,102	2,084	20	-17	-262	-26	-242	-43	-1.08	-0.91
Yakutat, City and Borough of	662	662	699	673	40	4	-40	7	0	11	0.00	0.73
Southwest Region	40,649	42,863	42,332	41,933	5,975	1,002	-3,761	-1,932	2,214	-930	0.53	-0.97
Aleutians East Borough	3,141	3,420	3,586	3,685	69	9	210	256	279	265	0.85	3.32
Aleutians West Census Area	5,561	5,232	5,118	5,003	192	27	-521	-256	-329	-229	-0.61	-1.99
Bethel Census Area	17,013	18,666	18,485	18,207	3,149	552	-1,496	-1,011	1,653	-459	0.93	-1.11
Bristol Bay Borough	997	844	824	800	27	5	-180	-49	-153	-44	-1.66	-2.38
Dillingham Census Area	4,847	4,857	4,729	4,673	615	72	-605	-256	10	-184	0.02	-1.72
Kusilvak Census Area	7,459	8,368	8,163	8,158	1,742	323	-833	-533	909	-210	1.15	-1.13
Lake and Peninsula Borough	1,631	1,476	1,427	1,407	181	14	-336	-83	-155	-69	-1.00	-2.13

Source: Alaska Department of Labor and Workforce Development. 2023.

4.2.2 Vulnerability Assessment

4.2.2.1 Methodology

A worst-case exposure analysis was conducted using a geographic information system (GIS) analysis. The project team gathered data from SHMP-participating agencies such as the Alaska Volcano Observatory (AVO), the Alaska Division of Geological & Geophysical Surveys (DGGs), the Alaska Department of Transportation and Public Facilities (ADOT&PF), the Alaska Interagency Coordination Center (AICC), and the University of Alaska (UAA, UAF, UAS). Infrastructure values were totaled for each hazard where GIS data were available. This vulnerability assessment is a simplified potential hazard risk assessment without considering recurrence probabilities or damage levels.

The methodology employs a two-pronged effort. First, the project team, the State, and participating agencies compiled an inventory of critical facilities for potential hazard threat exposure and vulnerability analysis. Second, these data were used to develop a relevant location vulnerability assessment for those facilities.

For example, the following process was used to define potential volcanic ash impacts throughout the state:

To analyze the volcanic ashfall hazard, the state was divided into 10-kilometer (km) grids. Each grid was given a score for historic ashfall event frequency and a score for its proximity to volcanos. These two scores were totaled for each grid square, resulting in a hazard score.

Therefore: $X + Y = Z$

where

X represents the value given for the total number of historic ashfall events within each 10 km square as follows:

If 0 to 4 events, $X = 0$

If 5 to 9 events, $X = 1$

If 10 to 13 events, $X = 2$

Y represents the value given based on each 10 km square's proximity to historically active volcanos (whether ash producing or not).

If no volcano is within 100 km, $Y = 0$

If a volcano is within 100 km but has no confirmed or questionable historical ash-producing eruption, $Y = 0$

If a volcano is within 100 km and has a questionable historical ash-producing eruption account, $Y = 1$

If a volcano is within 100 km and has a confirmed historical ash-producing eruption, $Y = 2$

Note: If a grid square is within 100 km of an ash-producing volcano and a non-ash-producing volcano, the higher score was given.

Z represents the calculated hazard score of $X + Y$ for each 10 km grid square.

If $Z = 0$, hazard is low

If $Z = 1$, hazard is low-moderate

If $Z = 2$, hazard is moderate

If $Z = 3$ or 4, hazard is high

In summary, the ash hazard level is based on the proximity to ash-producing, historically active volcanos and the frequency of historic ashfall events across the state. The following list summarizes this process:

Volcano ash frequency data recode	Recode ash frequency (historic ashfall events) key to: 0–4 = 0 5–9 = 1 10–13 = 2
Volcano ash data recode	Ash recode + volcano recode = hazard score: 0 = low 1 = low-moderate 2 = moderate 3 and 4 = high
Volcano Presence Recoding	0 = No volcano within 100 km = 0 0 = No confirmed or questionable historical eruption with ash cloud within 100 km 1 = Questionable historical eruption account that mentions ash cloud within 100 km 2 = Confirmed historical eruptions with ash cloud production within 100 km

Source: DGGS and
AECOM 2018

4.2.2.2 Vulnerability Exposure Analysis

The SHMP's GIS vulnerability assessment is based on the following parameters. Table 4.2-8 lists the exposure analysis assumptions. Table 4.2-9 lists the permafrost data and risk analysis parameters. Table 4.2-10 lists the permafrost risk levels.

Table 4.2-8: GIS-based Exposure Analysis Assumptions

Hazard	Severity/Description Determination
Cryosphere: Glacier	DGGS identified potential glacier hazard risk zones as any flowline, area, or waterbody (as defined by the National Hydrography Dataset, www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products) within 1 km (0.62 mi) of a glacier (as defined by the Randolph Glacier Inventory 5.0, https://www.denali.gov/wp-content/uploads/2019/11/Statewide-Threat-Assessment-Final-Report-20-November-2019.pdf). These flowline, areas, and waterbodies were buffered by 3 km.
Cryosphere: Avalanche	DGGS identified Potential Release Areas using a digital surface model as input and modeled based on geostatistical parameters (elevation, slope, and curvature) and land cover overlay (excluding conifer forest) within 10 km of roads. Therefore, avalanche high risk will occur from slope grades spanning from 28 to 60 degrees on nonevergreen vegetated slopes. This risk is not yet mapped in areas off the road system.
Cryosphere/ground failure: Permafrost*	No risk along with low, moderate, and high-risk categories are based on the likelihood of permafrost degradation as a function of permafrost distribution (extent), soil texture, ground ice volume, current modeled mean annual ground surface temperature, and year 2040 modeled change in active layer thickness (seasonally thawed surface layer above permafrost) (based on data from Jorgenson and others, 2008; and Denali Commission Threat Assessment & UAF, 2018). See Table 4.2-9 and Table 4.2-103.

Hazard	Severity/Description Determination
Earthquake	Ground motion expressed as a percentage of gravitational (%g) forces examining PGA with a 5% probability of exceedance in 50 years. Moderate shaking: 3.9–9.2 (%g) Strong shaking: 9.2–18 (%g) Very strong + shaking: > 18 (%g)
Coastal flooding	Within a 10-mile buffer of DGGS-identified coastal flood-threatened communities, AECOM buffered the coastline by 0.5 mile to represent the hazard area (based on data from USACE, GAO, and IAWG).
Coastal erosion	Shoreline change data were examined for current erosion hazards, and erosion forecast data were used to represent future erosion hazards (based on data from DGGS).
Riverine flooding	Within a 20-mile buffer of USACE- and DGGS-identified riverine flood-threatened communities, AECOM buffered linear river features by 0.25 mile to represent the hazard area (based on data from USACE, GAO, NOAA-NWS).
Ground failure: Landslide	Road segments identified with unstable rock slopes, soil slopes, and embankments were buffered by AECOM by 0.5 mile to simulate release downslope runout/washout areas.
Volcanic ash	Classification number 1, 2, 3 represent (event frequency) + (proximity to historically active ash volcanoes).
Tsunami	AECOM examined maximum inundation zones where available (DGGS) and assessed USACE- and DGGS-identified tsunami-threatened community areas from sea level to approximately 100-foot elevations where the data were unavailable.
Weather	All Alaska population and infrastructure are vulnerable to weather impacts.
Wildland fire	Wildfire exposure data (Ziel and Schmidt 2023) Mapping the wildfire threat for boreal communities. University of Alaska Anchorage, Institute of Social and Economic Research, Anchorage, AK. https://www.frames.gov/node/397800 were used as a starting point. The data (both 100-meter resolution and a 500-meter resolution versions) had exposure values reset to a value of 0 by isolating wildfire boundaries occurring from 2014 to 2022. Then, a buffer of 500 meters was applied to point feature critical facilities. Zonal statistics were performed to determine the maximum exposure value within a 500-meter buffer for both dataset resolutions. These maximum exposure values were joined to the critical facility points, and the maximum exposure values from both the 100-meter resolution and the 500-meter resolution was the one reported in the analysis. A similar analysis was performed with line feature critical facilities (roads and railroads). The line features were segmented in mile-long segments or less, which were then buffered by 500 meters. The same zonal statistics for maximum exposure value were applied to these linear segments.

Notes:

* Permafrost analysis assumptions and detailed parameters are listed in Table 4.2-9. Scores of 0–3 were tallied from all input parameters to arrive at a total Permafrost Risk Level; the risk level scoring schema is shown in Table 4.2-10.

DGGS = Alaska Division of Geological & Geophysical Surveys

GAO = U.S. Government Accountability Office

GIS = geographic information system

IAWG = Immediate Action Workgroup

km = kilometer(s)

mi = mile(s)

NOAA = National Oceanic and Atmospheric Administration

NWS = National Weather Service

PGA = Peak Ground Acceleration

USACE = U.S. Army Corps of Engineers

Table 4.2-9: Permafrost Data and Risk Analysis Parameters

Score	Jorgenson PF_EXTENT ¹	Jorgenson TEXTURE ¹	Jorgenson ICECLOWASS ¹	MAGST ²	Active Layer Thickness Change (ALTC) ³
0	G, U, W	Ice, water	Glacier, unfrozen	No permafrost, based on Jorgenson dataset	No permafrost, shown as no data in ALTC dataset
1	I	Rocky	Low	< -5 degrees C	0.0 to 0.05 m
2	D, S	Sandy	Moderate, variable	-5 to -2 degrees C	> 0.05 m
3	C	Silty	High	> -2 degrees C	Permafrost disappears, shown as -9999 in ALTC dataset

Data sources:

1. Jorgenson et al. 2008.

Mean Annual Ground Surface Temperature (MAGST) (Data source: Denali Commission Threat Assessment; UAF 2018.

2040 Projected Active Layer Thickness Change (ALTC) (Data source: Denali Commission Threat Assessment; UAF, 2018.

Notes:

Acronyms:

PF-EXTENT: Permafrost extent

C: Continuous permafrost (>90%)

D: Discontinuous permafrost (50–90%)

S: Sporadic permafrost (10–50%)

I: Isolated permafrost (>0–10%)

U: Unfrozen

G: Glacier

W: Water

TEXTURE: General textural composition of surface deposits

ICECLOWASS: Excess ice volume in top 5 m of ground

□ High (>40% volume)

□ Moderate (10–40% volume)

□ Low (<10% volume)

□ Variable (buried glacial ice)

□ Unfrozen

□ Glacier

Table 4.2-10: Permafrost Risk

Risk Level (Total Score)
No risk: 0
Low risk: 1–5
Moderate risk: 6–11
High risk: 12–15

The following tables summarize GIS-based exposure analyses for Alaska's loss estimation. Table 4.2-11 lists the population and number of residential housing units exposed to each hazard type. Table 4.2-12 lists the state facility types by number of facilities (count) and value of facilities exposed to each hazard type. Table 4.2-13 lists statewide critical transportation facilities and route mileages exposed to each type of hazard. Table 4.2-14 lists the number of local community critical facilities exposed to each type of hazard.

Section 4.2 provides a narrative explanation of these data results. GIS-based hazard area figures for the following hazards are located in the following sections:

- Glacial Hazard Areas
- Permafrost Hazard Areas
- Avalanche Hazard Areas
- Earthquake Hazard Areas
- Coastal Flooding Hazard Areas
- Riverine Flooding Hazard Areas
- Coastal Erosion Hazard Areas (communities identified have detailed shoreline change and/or shoreline erosion forecasting)
- Ground Failure (Landslide) Hazard Areas
- Tsunami Hazard Areas
- Volcanic Ash Hazard Areas
- Wildfire Hazard Areas
- High Hazard Potential Dam Locations

Table 4.2-11: Potential Hazard Exposure Analysis: Population and Residential Housing Units

Hazard Type	Severity	Description	Population	Housing Units
Glacier	High	Descriptive	24,832	12,336
Avalanche	High	Slopes 28° to 60° (within 10 km from roads)	2,751	1,365
Ground failure: Permafrost	Low risk: 1–5	<10% volume	124,009	56,923
	Moderate risk: 6–11	10–40% volume	258,450	109,377
	High risk: 12–15	>40% volume	119,936	52,091
Earthquake	Moderate shaking	3.9–9.2 (%g)	49,483	20,389
	Strong shaking	9.2–18 (%g)	63,773	28,939
	Very strong + shaking	>18 (%g)	614,524	273,876
Flood (coastal)	Descriptive	Buffer of 0.5 mile along threatened community coastlines	248,422	118,046
Flood (riverine)	Descriptive	Buffer of 0.25 mile along threatened community embankments	75,124	32,755
Erosion	Descriptive	USACE Identified threatened community coastlines *shoreline change	16,372	5,535
Ground failure (landslide)	Descriptive	Slopes > 28 degrees	14,688	7,345
Tsunami (seiche)	Descriptive	Sea level to elevation of 100 feet	118,890	55,445
Volcano (ash)	Low-moderate (1)	1, 2, 3 represents (event frequency) + (proximity to historic ash volcanoes)	137,147	69,355
	Moderate (2)		411,667	170,020
	High (3)		42,286	23,979
Severe weather	Descriptive	Entire state	736,566	326,200
Wildland fire	No data available	UNK	107,848	54,649

Hazard Type	Severity	Description	Population	Housing Units
	Very low to low exposure	0–40	368,821	153,687
	Moderate exposure	41–60	136,150	57,504
	Significant exposure	61–80	78,218	36,651
	Considerable exposure	81–100	45,529	26,708
High hazard potential dams	Descriptive	Manual analysis by State Dam Engineer	~4,000	—

Notes:

UNK = unknown

USACE = U.S. Army Corps of Engineers

* Communities identified within the USACE Shoreline Change Assessment have individually mapped data.

Table 42-12: Potential Hazard Exposure Analysis: Statewide Critical Facilities

Hazard Type, Severity, Description			State Facility Type																			
			Airports		Corrections		Education		Emergency Services		Healthcare/Nursing Homes/Protected Populations		Law Enforcement		Libraries and Museums		Maintenance		Offices		Ports and Harbors	
			Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value
Glacier	High	Descriptive	—	—	8	\$8,006,150	17	\$8,113,350	5	\$5,086,200	—	—	—	—	—	—	31	\$7,939,000	40	\$63,765,722	7	\$9,519,500
Avalanche	High	Slopes of 28 to 60 degrees (within 10 km from roads)	—	—	—	—	—	—	5	\$5,086,200	—	—	1	\$64,000	—	—	—	—	3	\$2,216,800	—	—
Permafrost	Low risk: 1-5	<10% volume	—	—	38	\$27,773,287	—	—	6	\$5,170,200	2	\$1,953,600	4	\$2,946,300	—	—	53	\$76,359,410	133	\$191,196,434	—	—
	Moderate risk: 6-11	10%-40% volume	40	\$1,761,402,600	13	\$160,622,649	1	\$417,750	35	\$8,823,700	29	\$421,046,450	32	\$118,086,689	—	—	230	\$387,135,800	210	\$444,083,279	—	—
	High risk: 12-15	>40% volume	13	\$141,743,776	7	\$42,873,636	1	\$266,175	14	\$4,488,800	11	\$217,085,824	5	\$26,188,450	—	—	69	\$132,687,000	63	\$672,201,445	—	—
Earthquake	Moderate shaking	39-92 (%g)	—	—	8	\$20,641,472	—	—	12	\$3,119,100	6	\$70,948,350	8	\$11,319,431	—	—	50	\$68,720,000	141	\$195,013,221	13	\$20,572,850
	Strong shaking	92-18 (%g)	—	—	17	\$55,123,500	2	\$3,167,775	6	\$2,102,400	11	\$84,472,625	12	\$6,558,850	1	\$139,000,000	144	\$227,553,200	116	\$541,249,392	4	\$1,591,200
	Very strong+ shaking	>18 (%g)	53	\$1,903,146,376	129	\$744,750,144	35	\$212,677,750	40	\$24,871,200	47	\$666,517,950	42	\$159,908,639	2	\$4,425,000	182	\$307,907,810	594	\$1,739,378,518	29	\$25,090,050
Flood (coastal)	Descriptive	Buffer of 0.5 mile along threatened community coastlines	—	—	4	\$7,896,769	124	\$83,447,125	—	—	137	\$1,504,994,150	15	\$33,307,500	17	\$17,440,000	64	\$121,412,000	358	\$1,613,502,301	68	\$94,854,300
Flood (riverine)	Descriptive	Buffer of 0.25 mile along threatened community embankments	1	\$94,146,150	9	\$2,500,000	1	\$11,588,400	3	\$29,963,250	4	\$11,716,250	13	\$94,146,150	—	—	87	\$ 69,048,000	96	\$379,881,479	1	\$31,800
Erosion	Descriptive	USACE-identified threatened community coastlines *Shoreline Change	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	\$950,000	—	—
Ground failure (landslide)	Descriptive	Slopes > 28 degrees	—	—	39	\$66,138,292	—	—	—	—	—	—	2	\$3,255,150	—	—	21	\$27,274,000	20	\$51,541,990	10	\$16,997,050
Tsunami (seiche)	Descriptive	Sea level to elevation of 100 feet	—	—	8	\$8,006,150	32	\$186,493,825	—	—	2	\$4,143,300	—	—	2	\$4,425,000	14	\$26,242,800	39	\$99,457,779	17	\$15,016,450
Volcano (ash)	Low-moderate (1)	1, 2, 3 represents (event	13	\$141,743,776	14	\$134,665,836	18	\$95,613,350	40	\$10,452,500	9	\$115,055,350	16	\$24,898,472	—	—	140	\$271,171,000	193	\$309,578,765	11	\$9,840,750

			State Facility Type																			
			Airports		Corrections		Education		Emergency Services		Healthcare/Nursing Homes/Protected Populations		Law Enforcement		Libraries and Museums		Maintenance		Offices		Ports and Harbors	
Hazard Type	Severity	Description	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value	Count	Est. Value
	Mod/late (2)	frequency)+ (proximity to historic ash volcanoes)	40	\$1,761,402,600	101	\$53,263,863	2	\$683,925	7	\$16,636,200	31	\$479,391,775	15	\$113,493,798	—	—	31	\$35,601,800	264	\$1,110,847,030	—	—
	High (3)		—	—	14	\$71,820,445	—	—	5	\$801,600	1	\$10,982,000	10	\$6,502,750	—	—	12	\$18,585,210	90	\$144,756,626	—	—
Severe weather	Descriptive	Entire state	53	\$1,903,146,376	154	\$820,515,116	37	\$215,845,525	58	\$30,092,700	64	\$811,988,925	62	\$117,786,920	3	\$143,425,000	380	\$637,851,010	864	\$2,492,806,048	46	\$47,254,100
Wildland fire	No data available	UNK	—	—	25	\$137,845,672	35	\$215,161,600	—	—	17	\$147,083,775	9	\$22,905,660	3	\$143,425,000	46	\$74,282,600	296	\$52,804,209	36	\$34,760,750
	Very low to low exposure	0-40	32	\$1,700,934,250	14	\$158,298,000	2	\$683,925	17	\$8,205,300	5	\$37,873,550	18	\$20,648,681	—	—	69	\$164,490,200	89	\$52,873,502	3	\$2,975,100
	Mod/late exposure	41-60	—	—	40	\$72,126,226	—	—	11	\$12,322,600	12	\$244,159,600	5	\$3,361,975	—	—	55	\$82,518,800	154	\$223,619,318	—	—
	Significant exposure	61-80	15	\$178,369,098	33	\$21,478,712	—	—	—	—	21	\$251,443,225	15	\$12,754,616	—	—	28	\$31,326,000	124	\$481,920,660	—	—
	Considerable exposure	81-100	6	\$23,843,028	42	\$430,771,506	—	—	30	\$9,564,800	9	\$131,378,775	15	\$118,115,998	—	—	182	\$285,233,410	200	\$400,871,588	7	\$9,518,250
High hazard-potential lands	See Table 4.2-15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes:
—=not applicable
km=kilometer(s)
*Communities identified within the USACE Shoreline Change Assessment have individually mapped data.

Table 4.2-13: Potential Hazard Exposure Analysis: Statewide Critical Transportation Facilities and Route Mileages

			Transportation Facilities							Transportation Route Mileages	
			Airports	Bridges	Ferry Terminals	Harbors	Maintenance Facilities	Ports	Railroad Facilities	Roads (mi)	ARRC (mi)
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count		
Glacier	High	Descriptive	10	164	2	7	6	4	2	80.86	687.26
Avalanche	High	Slopes 28 to 60 degrees (within 10 km from roads)	—	1	—	—	—	—	1	23.70	3.14
Permafrost	Low risk: 1–5	<10% volume	49	180	—	7	8	—	3	165.55	2,965.01
	Moderate risk: 6–11	10%–40% volume	98	422	—	4	35	—	3	217.43	4,968.83
	High risk: 12–15	>40% volume	16	136	—	1	5	—	8	182.57	1,766.02
Earthquake	Moderate shaking	3.9–9.2 (%g)	55	120	6	37	8	—	—	927.86	—
	Strong shaking	9.2–18 (%g)	89	241	4	34	21	—	—	2,404.58	3.21
	Very strong + shaking	>18 (%g)	133	909	29	78	51	13	14	10,791.81	692.28
Flood (coastal)	Descriptive	Buffer of 0.5 mile along threatened community coastlines	306	730	117	492	54	32	4	3,850.13	83.50
Flood (riverine)	Descriptive	Buffer of 0.25 mile along threatened community embankments	52	415	—	7	9	—	8	1,983.25	239.97

			Transportation Facilities							Transportation Route Mileages	
			Airports	Bridges	Ferry Terminals	Harbors	Maintenance Facilities	Ports	Railroad Facilities	Roads (mi)	ARRC (mi)
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count		
Erosion	Descriptive	USACE-identified threatened community coastlines *shoreline change	—	—	—	2	1	—	—	9.43	—
Ground failure (landslide)	Descriptive	Slopes > 28 degrees	4	197	5	14	7	—	1	842.51	51.58
Tsunami (seiche)	Descriptive	Sea level to elevation 100 feet	46	137	33	111	6	8	—	6.82	374.31
Volcano (ash)	Low-moderate (1)	1, 2, 3 represents (event frequency) + (proximity to historic ash volcanoes)	54	434	5	19	27	6	7	4,849.13	392.43
	Moderate (2)		29	353	7	17	14	4	7	4,359.71	278.17
	High (3)		29	51	2	6	7	2	—	1,556.69	—
Severe weather	Descriptive	Entire state	289	1,272	39	149	81	13	14	14,231.00	695.00
Wildland fire	No data available	UNK	89	441	33	121	25	9	2	2,422.00	86.00
	Very low to low exposure	0–40	30	53	—	10	11	1	4	1,190.00	45.00
	Moderate exposure	41–60	66	75	—	4	5	2	2	1,725.00	43.00

			Transportation Facilities							Transportation Route Mileages	
			Airports	Bridges	Ferry Terminals	Harbors	Maintenance Facilities	Ports	Railroad Facilities	Roads (mi)	ARRC (mi)
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count		
	Significant exposure	61–80	23	168	—	3	8	1	2	2,182.00	100.00
	Considerable Exposure	81–100	81	535	6	11	32	—	4	6,713.00	422.00
High-hazard-potential dams	— See Table 4.2-15	—	—	—	—	—	—	—	—	—	—

Notes:

— = not applicable

AK RR = Alaska railroads

UNK = unknown

* Communities identified within the USACE Shoreline Change Assessment have individually mapped data.

Table 4.2-14. Potential Hazard Exposure Analysis: Local Community Critical Facilities

			Local Community Facilities ³								
			Bridges/ Culverts	Community	Education	Emergency	Government	Health	Housing	Transportation	Utilities
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count	Count	Count
Glacier	High	Descriptive	—	30	6	5	8	4	—	—	85
Avalanche	High	Slopes of 28 to 60 degrees (within 10 km from roads)	—	—	1	—	—	—	—	—	1
Permafrost	Low risk: 1–5	<10% volume	—	237	61	54	102	35	43	—	536
	Moderate risk: 6–11	10%–40% volume	3	484	128	106	210	76	64	4	961
	High risk: 12–15	>40% volume	—	101	20	18	31	15	6	—	295
Earthquake	Moderate shaking	3.9–9.2 (%g)	—	295	82	75	140	42	46	—	529
	Strong shaking	9.2–18 (%g)	2	564	120	96	224	67	61	7	854
	Very strong + shaking	>18 (%g)	1	500	117	140	175	84	29	3	1,271
Flood (coastal)	Descriptive	Buffer of 0.5 mile along threatened community coastlines	2	1,263	230	286	497	150	56	25	1,632
Flood (riverine)	Descriptive	Buffer of 0.25 mile along threatened community embankments	—	580	127	116	253	72	69	1	1,106

			Local Community Facilities ³								
			Bridges/ Culverts	Community	Education	Emergency	Government	Health	Housing	Transportation	Utilities
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count	Count	Count
Erosion	Descriptive	USACE-identified threatened community coastlines *shoreline change	—	—	—	—	—	—	—	—	12
Ground failure (landslide)	Descriptive	Slopes > 28 degrees	—	41	5	7	8	3	—	—	76
Tsunami (seiche)	Descriptive	Sea level to elevation of 100 feet	—	184	28	45	65	21	6	—	236
Volcano (ash)	Low-moderate (1)	1, 2, 3 represents (event frequency) + (proximity to historic ash volcanoes)	—	209	57	50	77	37	19	—	595
	Moderate (2)		—	99	22	24	38	19	2	—	315
	High (3)		—	147	27	49	54	28	14	—	350
Severe weather	Descriptive	Entire state	3	1,418	331	330	568	205	149	10	2,791
Wildland fire	No data available	UNK	—	391	84	103	155	50	18	6	657
	Very low to low exposure	0–40	2	164	46	43	79	27	30	—	335
	Moderate exposure	41–60	—	256	62	72	128	46	40	—	514

			Local Community Facilities ³								
			Bridges/ Culverts	Community	Education	Emergency	Government	Health	Housing	Transportation	Utilities
Hazard Type	Severity	Description	Count	Count	Count	Count	Count	Count	Count	Count	Count
	Significant exposure	61–80	—	180	61	45	78	28	24	—	403
	Consider-able exposure	81–100	1	427	78	67	128	54	37	4	882
High-hazard-potential dams	See Table 4.2-15		—	—	—	—	—	—	—	—	—

Notes:

km = kilometer(s)

USACE = U.S. Army Corps of Engineers

UNK – unknown

* Communities identified within the USACE Shoreline Change Assessment have individually mapped data.

4.2.2.3 Narrative Summaries

4.2.2.3.1 Cryosphere

Alaska can expect to experience ever-changing effects from melting polar ice sheets, mountain glaciers, and other cryosphere hazard impacts. Based on human location and habitation, a person could experience exposure risks ranging from moderate to significant ground failure as the ground ice melts and residential and public infrastructure is negatively impacted. It is probable that Alaska residents could experience infrastructure damage and personal injury throughout the northern portions of the state where permafrost and subsurface conditions are changing. Glacier-related hazards include ice collapse, glacial lake outburst flood, and glacial surge. Snow avalanches, similar to landslides and other forms of ground failure, can reach speeds of up to 200 miles per hour and run out for immense distances; the power of a snow avalanche can destroy homes and infrastructure and cause significant injury and loss of life. Coastal residents will likely experience less sea ice and more open water, which in turn will impact their hunting and fishing subsistence capacity. The existing, transient, and future population, residential structures, critical facilities, and infrastructure are exposed to changing cryosphere impacts that potentially threaten the populations and critical facilities discussed below.

4.2.2.3.1.1 Glacier

The state facilities and infrastructure at risk of glacier-related hazards include:

- 24,832 people (2022 estimate) in 12,336 residences (2020 estimate)
- 8 corrections facilities (approximate value \$93,006,150)
- 17 education facilities (approximate value \$93,113,350)
- 5 emergency services facilities (approximate value \$5,086,200)
- 31 maintenance facilities (approximate value \$57,939,000)
- 40 office facilities (approximate value \$63,756,722)
- 7 ports and harbors (approximate value \$9,519,500)

Other transportation facilities and infrastructure at risk of glacier-related hazards include:

- 10 airports
- 164 bridges
- 2 ferry terminals
- 7 harbors
- 6 maintenance facilities
- 4 ports
- 2 railroad facilities

The transportation route mileages at risk of glacier-related hazards include:

- 80.86 miles of road
- 687.26 miles of Alaska railroad

Local community facilities at risk of glacier related hazards include:

- 30 community facilities
- 6 education facilities
- 5 emergency facilities
- 8 government facilities
- 4 healthcare facilities
- 85 utility facilities

Glacier hazard areas are shown in Figure 4.2-2 below.

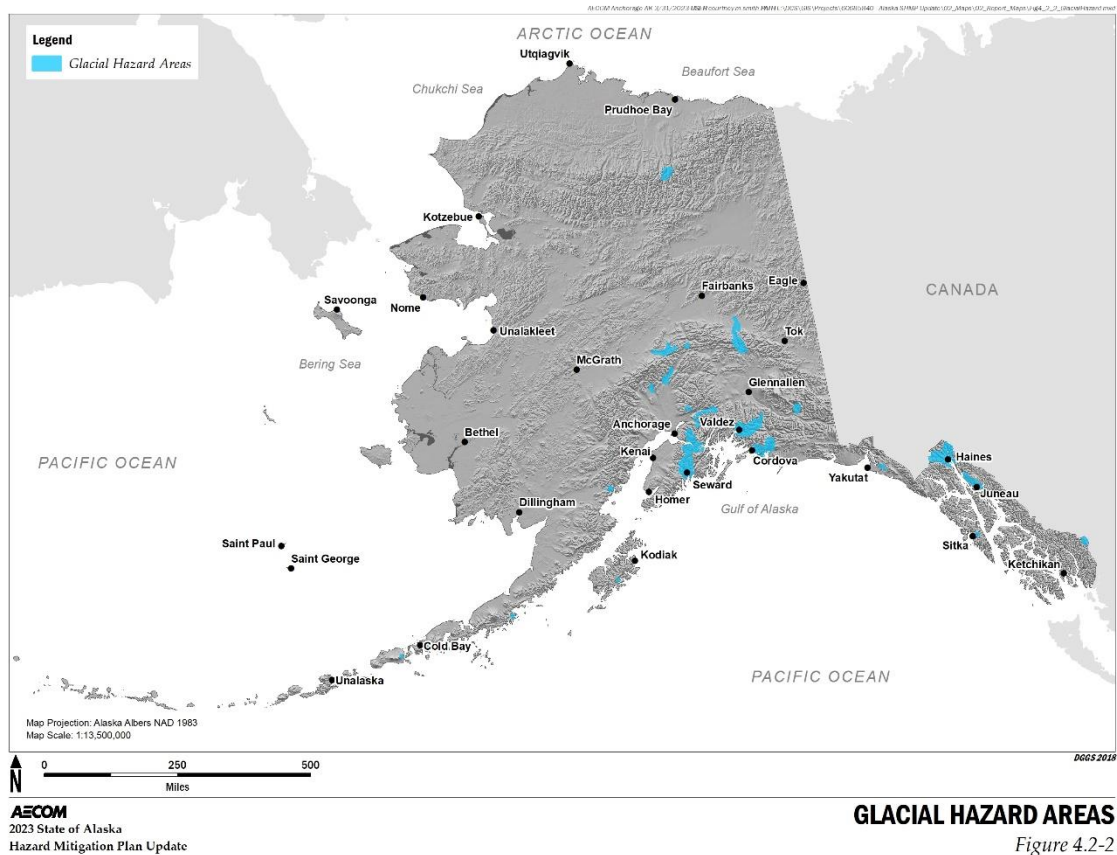


Figure 4.2-2: Glacial Hazard Areas

4.2.2.3.1.2 Permafrost

State facilities and infrastructure at **low** risk of permafrost degradation (> 10% volume) include:

- 124,009 people (2022 estimate) in 56,923 residences (2020 estimate)
- 38 corrections facilities (approximate value \$277,773,287)
- 6 emergency services facilities (approximate value \$5,170,200)
- 2 healthcare/nursing homes/protected populations facilities (approximate value \$1,953,600)
- 4 law enforcement facilities (approximate value \$2,946,300)
- 53 maintenance facilities (approximate value \$76,359,410)
- 133 office facilities (approximate value \$191,196,434)

Other transportation facilities and infrastructure at **low** risk of permafrost degradation (> 10% volume) include:

- 49 airports
- 180 bridges
- 7 harbors

- 8 maintenance facilities
- 3 railroad facilities

Transportation route mileages at **low** risk of permafrost degradation (> 10% volume) include:

- 166.55 miles of road
- 2,965.01 miles of Alaska railroad

Local community facilities at **low** risk of permafrost degradation (> 10% volume) include:

- 237 community facilities
- 61 education facilities
- 54 emergency facilities
- 102 government facilities
- 35 healthcare facilities
- 43 housing facilities
- 536 utility facilities

State facilities and infrastructure at **moderate** risk of permafrost degradation (10%–40% volume) include:

- 258,450 people (2022 estimate) in 109,377 residences (2020 estimate)
- 40 airports (approximate value \$1,761,402,600)
- 13 corrections facilities (approximate value \$160,622,649)
- 1 education facility (approximate value \$417,750)
- 35 emergency services facilities (approximate value \$8,823,700)
- 29 healthcare/nursing homes/protected populations facilities (approximate value \$421,046,450)
- 32 law enforcement facilities (approximate value \$118,086,689)
- 230 maintenance facilities (approximate value \$387,135,800)
- 210 office facilities (approximate value \$444,093,279)

Other transportation facilities and infrastructure at **moderate** risk of permafrost degradation (10%–40% volume) include:

- 98 airports
- 422 bridges
- 4 harbors
- 35 maintenance facilities
- 3 railroad facilities

Transportation route mileages at **moderate** risk of permafrost degradation (10%–40% volume) include:

- 217.43 miles of road
- 4,968.83 miles of Alaska railroad

Local community facilities at **moderate** risk of permafrost degradation (10%–40% volume) include:

- 3 bridges/culverts
- 484 community facilities
- 128 education facilities
- 106 emergency facilities
- 210 government facilities
- 76 healthcare facilities

- 64 housing facilities
- 4 transportation facilities
- 961 utility facilities

State facilities and infrastructure at **high** risk of permafrost degradation (> 40% volume) include:

- 119,936 people (2022 estimate) in 52,091 residences (2020 estimate)
- 13 airports (approximate value \$141,743,776)
- 7 corrections facilities (approximate value \$42,873,636)
- 1 education facility (approximate value \$266,175)
- 14 emergency services facilities (approximate value \$4,488,800)
- 11 healthcare/nursing homes/protected populations facilities (approximate value \$217,085,825)
- 5 law enforcement facilities (approximate value \$26,188,450)
- 69 maintenance facilities (approximate value \$132,687,000)
- 63 office facilities (approximate value \$672,201,445)

Other transportation facilities and infrastructure at **high** risk of permafrost degradation, (> 40% volume) include:

- 16 airports
- 136 bridges
- 1 harbor
- 5 maintenance facility
- 8 railroad facilities

Transportation route mileages at **high** risk of permafrost degradation, (> 40% volume) include:

- 182.57 miles of road
- 1,766.02 miles of Alaska railroad

Local community facilities **high** risk of permafrost degradation, (> 40% volume) include:

- 101 community facilities
- 20 education facilities
- 18 emergency facilities
- 31 government facilities
- 15 healthcare facilities
- 6 housing facilities
- 295 utility facilities

Permafrost hazard areas are shown in Figure 4.2-3 below.

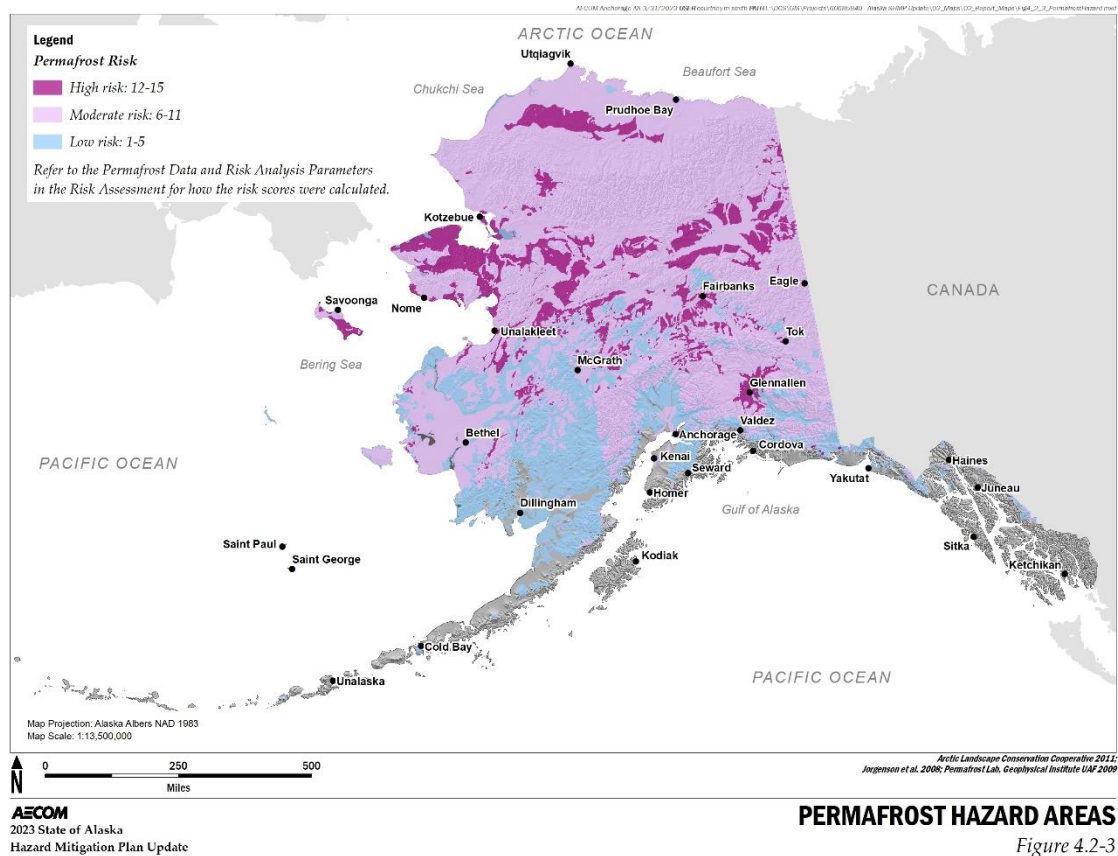


Figure 4.2-3: Permafrost Hazard Areas

4.2.2.3.1.3 Sea Ice

State facilities and infrastructure are not located offshore and are not vulnerable to sea ice hazards.

4.2.2.3.1.4 Avalanche

State facilities and infrastructure at risk of avalanche include:

- 2,751 people (2022 estimate) in 1,365 residences (2020 estimate)
- 5 emergency services facilities (approximate value \$5,086,200)
- 1 law enforcement facility (approximate value \$64,000)
- 3 office facilities (approximate value \$2,216,800)

Other transportation facilities and infrastructure at risk of avalanche include:

- 1 bridge
- 1 railroad facility

Transportation route mileages at risk of avalanche include:

- 23.70 miles of road
- 3.14 miles of Alaska railroad

Local community facilities at risk of avalanche include:

- 1 education facility
- 1 utility facility

Avalanche hazard areas are shown in Figure 4.2-4 below.

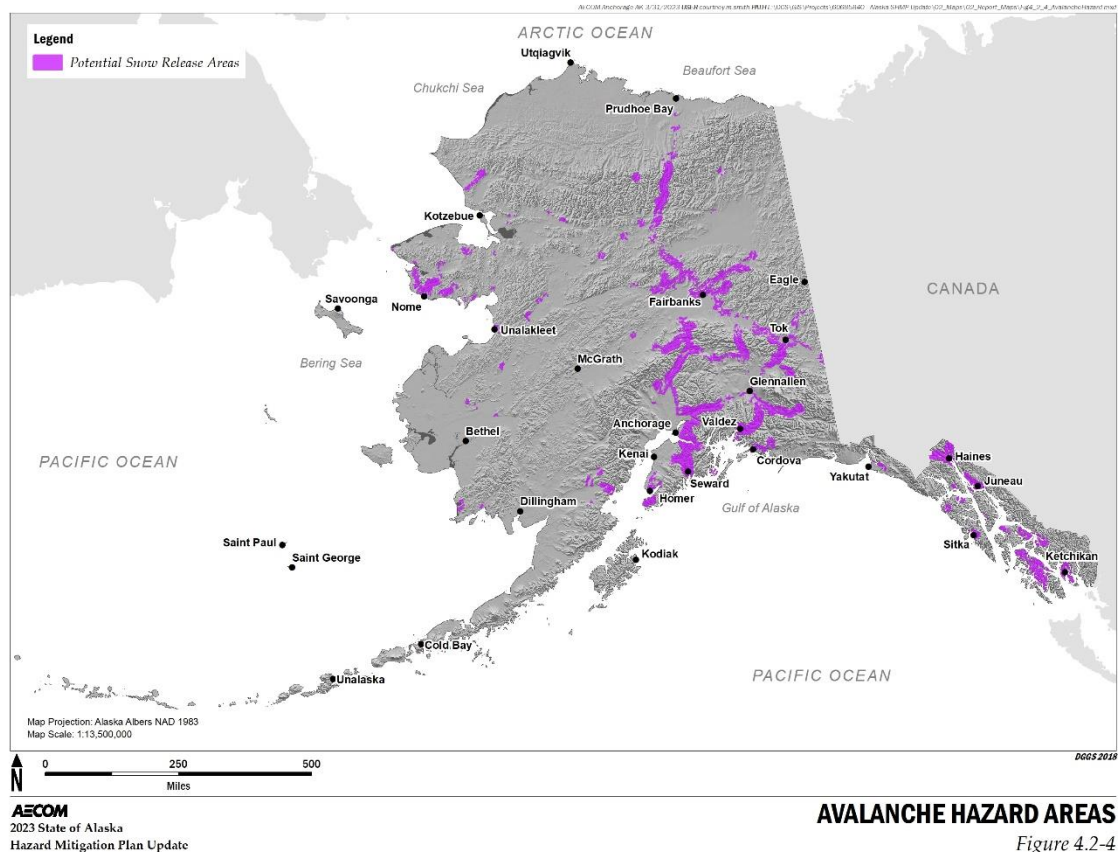


Figure 4.2-4: Avalanche Hazard Areas

4.2.2.3.2 Earthquake

Alaska is the most seismically active state in the United States and is among the most seismically active regions on Earth, with the Alaska Earthquake Center detecting an earthquake every 10 minutes on average. Alaska's geologic and tectonic setting is capable of producing earthquakes that can release immense destructive power and have the potential to damage resilient buildings and infrastructure, although multi-story steel structures and masonry structures are more at risk than smaller wooden structures such as private residences. The majority of Alaska's school, state, and federal buildings are built and sited based on stringent seismic construction standards and are expected to survive major earthquake events. However, ground motion may result in infrastructure damage and personal injury throughout portions of the interior and southern regions of the state where "severe" events are most likely to occur and where the majority of the state's population is concentrated.

Based on the Probabilistic Seismic Hazard Analyses (PSHAs) conducted by the U.S. Geological Survey (USGS) in 2007, the majority of the state is at risk of experiencing “moderate” to “violent” earthquake impacts, with the North Slope and a small section of western Alaska being the only exceptions. The Peak Ground Acceleration and Perceived Shaking map (Figure 4.2-2) depicts Peak Ground Accelerations (PGAs) that can be expected for a range of earthquake exceedance probabilities and the associated degree of ground shaking. Although individual earthquakes are impossible to predict, continued seismic activity in the state is certain, and most of Alaska is at risk of experiencing the impacts of earthquakes due to its close proximity to a major convergent tectonic plate boundary (the Alaska-Aleutian subduction zone) and the resulting extensive network of faults. Therefore, the probability of earthquakes in Alaska is categorized as “highly likely.”

State facilities and infrastructure at risk of **moderate shaking**, causing “very light” potential damage (3.9–9.2 [%g]) include:

- 49,483 people (2022 estimate) in 20,389 residences (2020 estimate)
- 8 correctional facilities (approximate value \$20,641,472)
- 12 emergency response facilities (approximate value \$3,119,100)
- 6 healthcare/nursing home/protected populations facilities (approximate value \$70,948,350)
- 8 law enforcement facilities (approximate value \$11,319,431)
- 50 maintenance facilities (approximate value \$68,720,000)
- 141 office facilities (approximate value \$195,013,221)
- 13 ports and harbors (approximate value \$20,572,850)

Other transportation facilities and infrastructure at risk of **moderate shaking**, causing “very light” potential damage (3.9–9.2 [%g]) include:

- 55 airports
- 120 bridges
- 6 ferry terminals
- 37 harbors
- 8 maintenance facilities

Transportation route mileages at risk of **moderate shaking**, causing “very light” potential damage (3.9–9.2 [%g]) include:

- 927.86 miles of road

Local community facilities at risk of **moderate shaking**, causing “very light” potential damage (3.9–9.2 [%g]) include:

- 295 community buildings
- 82 education facilities
- 75 emergency facilities
- 140 government facilities
- 42 healthcare facilities
- 46 housing facilities
- 529 utility facilities

State facilities and infrastructure at risk of **strong shaking**, causing “light” potential damage (9.2–18 [%g]) include:

- 63,773 people (2022 estimate) in 28,939 residences (2020 estimate)
- 17 correctional facilities (approximate value \$55,123,500)

- 2 education facilities (approximate value \$3,167,775)
- 6 emergency response facilities (approximate value \$2,102,400)
- 11 healthcare/nursing home/protected populations facilities (approximate value \$84,472,625)
- 12 law enforcement facilities (approximate value \$6,558,850)
- 1 library and museum (approximate value \$139,000,000)
- 144 maintenance facilities (approximate value \$227,553,200)
- 116 office facilities (approximate value \$541,249,392)
- 4 ports and harbors (approximate value \$1,591,200)

Other transportation facilities and infrastructure at risk of **strong shaking**, causing “light” potential damage (9.2–18 [%g]) include:

- 89 airports
- 241 bridges
- 4 ferry terminals
- 34 harbors
- 21 maintenance facilities

Transportation route mileages at risk of **strong shaking**, causing “light” potential damage (9.2–18 [%g]) include:

- 2,404.58 miles of road
- 3.21 miles of Alaska Railroad

Local community facilities at risk of **strong shaking**, causing “light” potential damage (9.2–18 [%g]) include:

- 2 bridges/culverts
- 564 community buildings
- 120 education facilities
- 96 emergency facilities
- 224 government facilities
- 67 healthcare facilities
- 61 housing facilities
- 7 transportation facilities
- 854 utility facilities

State facilities and infrastructure at risk of **very strong shaking**, causing “moderate” potential damage (>18 [%g]) include:

- 614,524 people (2022 estimate) in 273,876 residences (2020 estimate)
- 53 airports (approximate value \$1,903,146,376)
- 129 correctional facilities (approximate value \$744,750,144)
- 35 education facilities (approximate value \$212,677,750)
- 40 emergency response facilities (approximate value \$24,871,200)
- 47 healthcare/nursing home/protected populations facilities (approximate value \$656,517,950)
- 42 law enforcement facilities (approximate value \$159,908,639)
- 2 libraries and museums (approximate value \$4,425,000)
- 182 maintenance facilities (approximate value \$307,907,810)

- 594 office facilities (approximate value \$1,739,378,518)
- 29 ports and harbors (approximate value \$25,090,050)

Other transportation facilities and infrastructure at risk of **very strong shaking**, causing “moderate” potential damage (>18 [%g]) include:

- 133 airports
- 909 bridges
- 29 ferry terminals
- 78 harbors
- 51 maintenance facilities
- 13 ports
- 14 railroad facilities

Transportation route mileages at risk of **very strong shaking**, causing “moderate” potential damage (>18 [%g]) include:

- 10,791.81 miles of road
- 692.28 miles of Alaska railroad

Local community facilities at risk of **very strong shaking**, causing “moderate” potential damage (>18 [%g]) include:

- 1 bridge/culvert
- 500 community buildings
- 117 education facilities
- 140 emergency facilities
- 175 government facilities
- 84 healthcare facilities
- 29 housing facilities
- 3 transportation facilities
- 1,271 utility facilities

Earthquake hazard areas are shown in Figure 4.2-5 below.

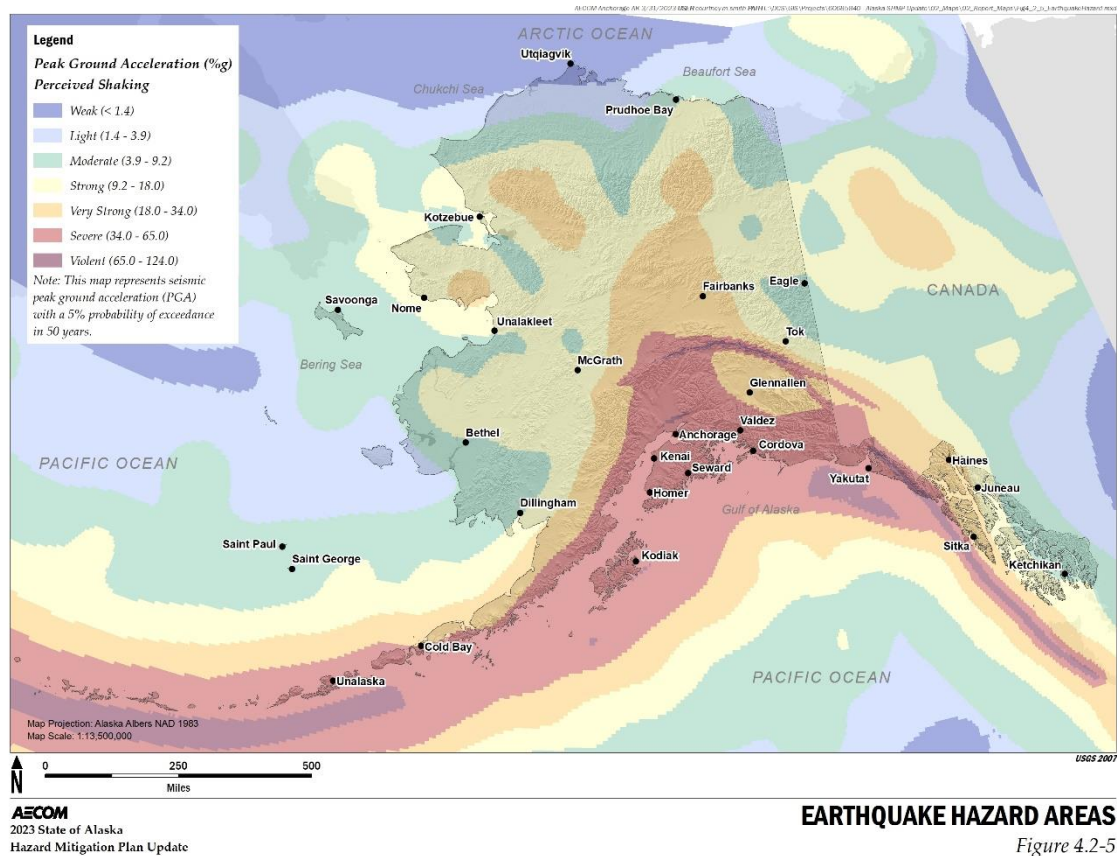


Figure 4.2-5: Earthquake Hazard Areas

4.2.2.3.3 Flood and Erosion

Approximately 6,600 miles of Alaskan coastline is at risk of severe flooding and associated and normal erosion conditions. Flooding is the most common disaster in Alaska, disrupting community and infrastructure functioning and threatening lives and livelihoods.

Typical flood and erosion impacts include the following:

- High water flow storm surge floods scour (erode) coastal embankments and coastal protection barriers and result in infrastructure and residential property losses. Additional impacts can include roadway embankment collapse, foundation exposure, and damaging impacts.
- Damage to structures, roads, bridges, culverts, and other features from high-velocity flow and debris carried by floodwaters can occur. Such debris may also accumulate on bridge piers and in culverts, decreasing water conveyance and increasing loads, which may cause feature overtopping or backwater damages.
- Sewage, hazardous or toxic materials release, materials transport from wastewater treatment plant or sewage lagoon inundation, storage tank damages, and/or severed pipeline damages can be catastrophic to rural remote communities.

- Economic losses through business and government facility closure; utilities such as energy generation, communications, potable water and wastewater; and transportation service disruptions can occur.
- Flood soil and debris deposition as well as embankment or shoreline erosion from coastal and riverine high-water flow and wind can occur.

Detailed 100-year flood analyses have not been prepared for all Alaska flood-prone communities due to Federal Emergency Management Agency (FEMA) and State budgetary constraints. The U.S. Army Corps of Engineers (USACE) Floodplain Manager has not been able to provide flood information or 100-year floodplain maps that comply with National Flood Insurance Program (NFIP) regulations.

Alaska flood- and erosion-threatened population and infrastructure are listed below.

4.2.2.3.1.5 Coastal Flood

State facilities and infrastructure at risk of coastal flooding include:

- 248,422 people (2022 estimate) in 118,046 residences (2020 estimate)
- 4 corrections facilities (approximate value \$7,896,769)
- 124 education facilities (approximate value \$933,447,125)
- 137 healthcare/nursing homes/protected populations facilities (approximate value \$1,504,994,150)
- 15 law enforcement facilities (approximate value \$33,307,500)
- 17 libraries and museums (approximate value \$174,400,000)
- 64 maintenance facilities (approximate value \$121,412,000)
- 358 office facilities (approximate value \$1,613,502,301)
- 68 ports and harbors (approximate value \$94,854,300)

Other transportation facilities and infrastructure at risk of coastal flooding include:

- 306 airports
- 730 bridges
- 117 ferry terminals
- 492 harbors
- 54 maintenance facilities
- 32 ports
- 4 railroad facilities

Transportation route mileages at risk of coastal flooding include:

- 3,850.13 miles of road
- 83.50 miles of railroad

Local community facilities and infrastructure at risk of coastal flooding include:

- 2 bridges/culverts
- 1,263 community facilities
- 230 education facilities
- 286 emergency facilities
- 497 government facilities
- 150 healthcare facilities
- 56 housing facilities
- 25 transportation facilities

- 1,632 utility facilities

Other transportation facilities and infrastructure at risk of riverine flooding include:

- 52 airports
- 415 bridges
- 7 harbors
- 9 maintenance facilities
- 8 railroad facilities

Transportation route mileages at risk of riverine flooding include:

- 1,983.25 miles of road
- 239.97 miles of railroad

Local community facilities and infrastructure at risk of riverine flooding include:

- 580 community facilities
- 127 education facilities
- 116 emergency facilities
- 253 government facilities
- 72 healthcare facilities
- 69 housing facilities
- 1 transportation facility
- 1,106 utility facilities

Riverine Flooding hazard areas are shown in Figure 4.2-7 below.

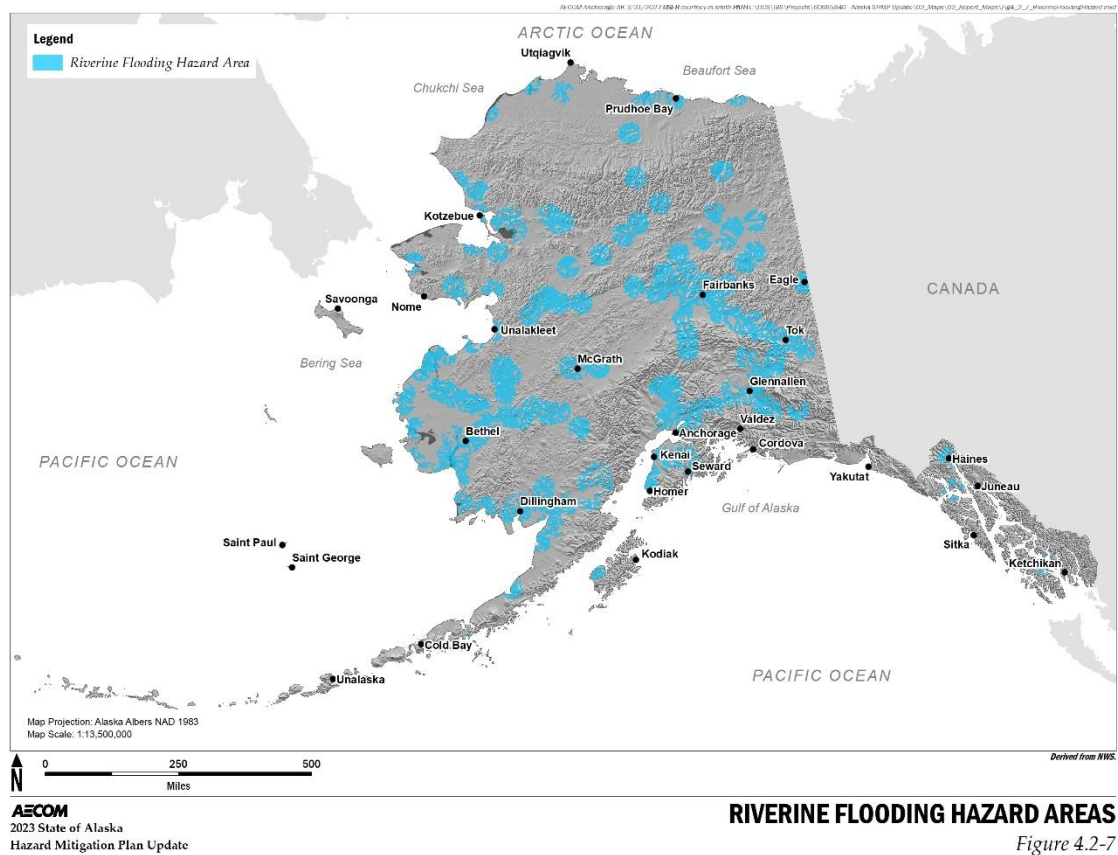


Figure 4.2-7: Riverine Flooding Hazard Areas

4.2.2.3.1.7 Erosion: Shoreline Change

State facilities and infrastructure at risk of shoreline change (2020 estimate) include:

- 16,372 people (2022 estimate) in 5,535 residences (2020 estimate)
- 2 office facilities (approximate value \$950,000)

Other transportation facilities and infrastructure at risk of shoreline change (2020 estimate) include:

- 2 harbors
- 1 maintenance facility

Transportation route mileages at risk of shoreline change (2020 estimate) include:

- 9.43 miles of road

Local community facilities at risk of shoreline change (2020 estimate) include:

- 12 utility facilities

4.2.2.3.1.8 Erosion: Forecasted Coastal Erosion

State facilities and infrastructure at risk of forecasted coastal erosion (2021 estimate) include:

- 9,956 people (2022 estimate) in 3,372 residences (2020 estimate)
- 2 maintenance facilities (approximate value \$1,260,000)
- 5 office facilities (approximate value \$4,245,536)

Other transportation facilities at risk of forecasted coastal erosion (2021 estimate) include:

- 1 airport

Transportation route mileages at risk of forecasted coastal erosion (2021 estimate) include:

- 11.65 miles of road

Local community facilities at risk of forecasted coastal erosion (2021 estimate) include:

- 16 community facilities
- 5 education facilities
- 7 government facilities
- 1 healthcare facility
- 3 housing facilities
- 37 utility facilities

Coastal Erosion (both shoreline change and forecasted) hazard areas are shown in Figure 4.2-8 below (Note that erosion does occur in southeast Alaska and additional data is required to determine locations).

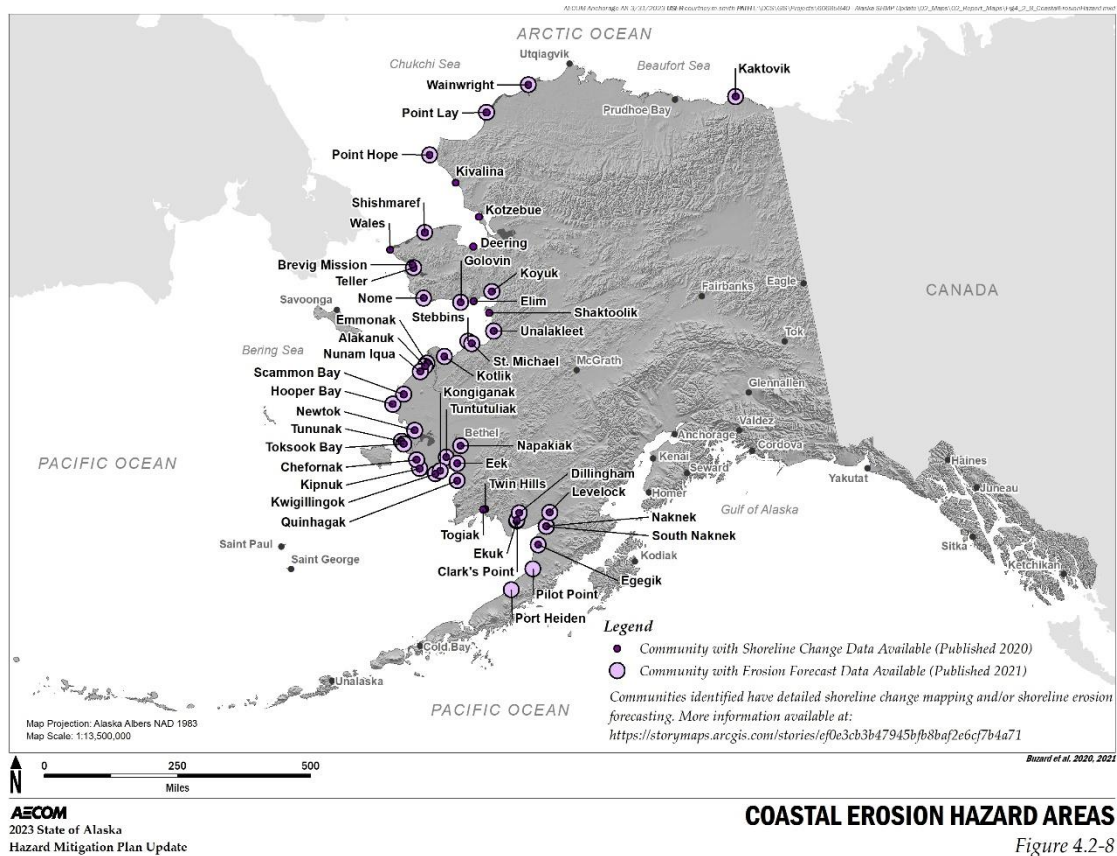


Figure 4.2-8: Coastal Erosion Hazard Areas

4.2.2.3.4 Ground Failure

Potential ground failure impacts from landslides and subsidence are widespread in Alaska, and degrading permafrost, steep slopes, heavy rain, retreating glaciers, wildland fires, lahars from volcanic eruptions, and ground shaking from earthquakes are some of the common important natural mechanisms that can trigger landslides. Other ground failure events are typically caused by groundwater, degrading permafrost, ground shaking from earthquakes, and local or regional subsidence or upheaval. Potential debris flows and landslides can damage and disrupt transportation, utility systems, and water and waste treatment infrastructure, and damage public, private, and business structures located adjacent to steep slopes, along riverine embankments, or within alluvial fans or natural drainages. Landslides are also capable of triggering tsunamis. Subsidence and other ground failure events can damage foundations, make roadways impassable, and cause utility outages by breaking utility connections such as sewer and water off of buildings.

Response and recovery efforts will likely vary from minor cleanup to more extensive utility system or transportation infrastructure rebuilding. Utility disruptions are usually local and terrain dependent. Damages may require re-establishing electrical, communication, and fuel pipeline connections from specific breakage points. Initial debris clearing from emergency routes and high-traffic areas may be

required. Water and wastewater utilities may need treatment to quickly improve water quality by reducing excessive water turbidity and re-establishing waste disposal capability.

Landslide, mud, and debris flow impacts are based on their slope, with slopes greater than 28 degrees presenting a potential hazard. Few landslide hazard maps exist for the state. USGS elevation datasets and the USGS U.S. Landslide Inventory were used to determine where these risks are located throughout Alaska (Figure 4.2-3). Facilities and infrastructure within half a mile of unstable rock slopes, soil slopes, and embankments are considered threatened. Threatened population and infrastructure potentially include the following:

State facilities and infrastructure at risk of landslide include:

- 14,688 people (2022 estimate) in 7,345 residences (2020 estimate)
- 39 correctional facilities (approximate value \$66,138,292)
- 2 law enforcement facilities (approximate value \$3,255,150)
- 21 maintenance facilities (approximate value \$27,274,000)
- 20 office facilities (approximate value \$51,541,990)
- 10 ports and harbors (approximate value \$16,997,050)

Other transportation facilities and infrastructure at risk of landslide include:

- 4 airports
- 197 bridges
- 5 ferry terminals
- 14 harbors
- 7 maintenance facilities
- 1 railroad facility

Transportation route mileages at risk of landslide include:

- 842.51 miles of road
- 51.58 miles of Alaska railroad

Ground Failure (landslide) hazard areas are shown in Figure 4.2-9 below.

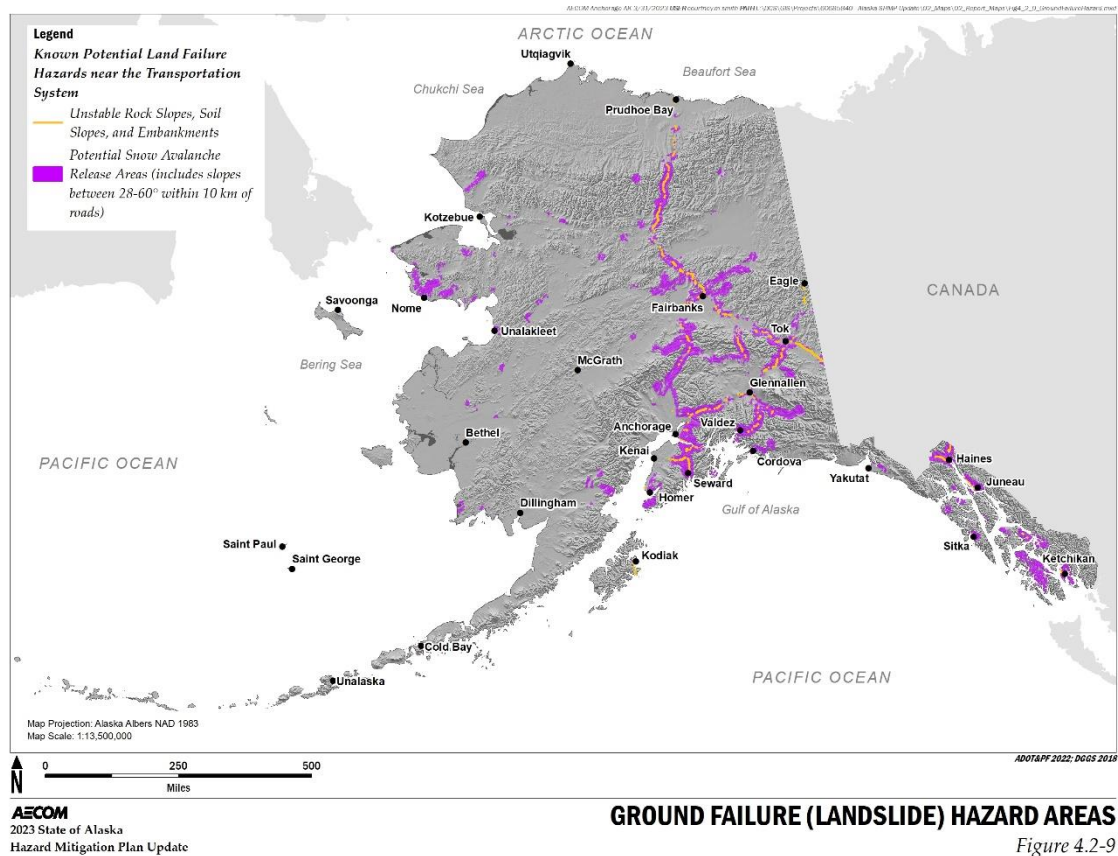


Figure 4.2-9: Ground Failure (Landslide) Hazard Areas

4.2.2.3.5 Tsunami and Seiche

Alaska communities in the Aleutian Islands, the Alaska Peninsula (including the southern Bering Sea communities), the Gulf of Alaska, and Southeast Alaska all have and will continue to be exposed to local and distant tsunami and seiche impacts (see Section 4.1.5, Tsunami and Seiche).

Tsunamis and seiches are generated by a range of natural phenomena and are therefore impossible to predict. All communities along Alaska's Pacific Ocean coastline (from Southeast Alaska to the far western Aleutians) should be aware of potential local and distant tsunami hazards. Bering Sea communities may also experience tsunamis, though they are slightly more removed from the Alaska-Aleutian Subduction Zone. Underwater slope failures can generate a tsunami anywhere along Alaska's vast coastline.

State facilities and infrastructure at risk of a tsunami include:

- 118,890 people (2022 estimate) in 55,445 housing units (2020 estimate)
- 8 corrections facilities (approximate value \$93,006,150)
- 32 education facilities (approximate value \$186,493,825)
- 2 healthcare/nursing home/protected populations facilities (approximate value \$4,143,300)
- 2 libraries and museums (approximate value \$4,425,000)
- 14 maintenance facilities (approximate value \$26,242,800)

- 39 office facilities (approximate value \$99,457,779)
- 17 ports and harbors (approximate value \$15,016,450)

Other transportation facilities and infrastructure at risk of a tsunami include:

- 46 airports
- 137 bridges
- 33 ferry terminals
- 111 harbors
- 6 maintenance facilities
- 8 ports

Transportation route mileages at risk of a tsunami include:

- 6.82 miles of road
- 374.31 miles of Alaska Railroad

Local community facilities and infrastructure at risk of a tsunami include:

- 184 community facilities
- 28 education facilities
- 45 emergency services facilities
- 65 government facilities
- 21 healthcare facilities
- 6 housing facilities
- 236 utility facilities

Tsunami hazard areas are shown in Figure 4.2-10 below.

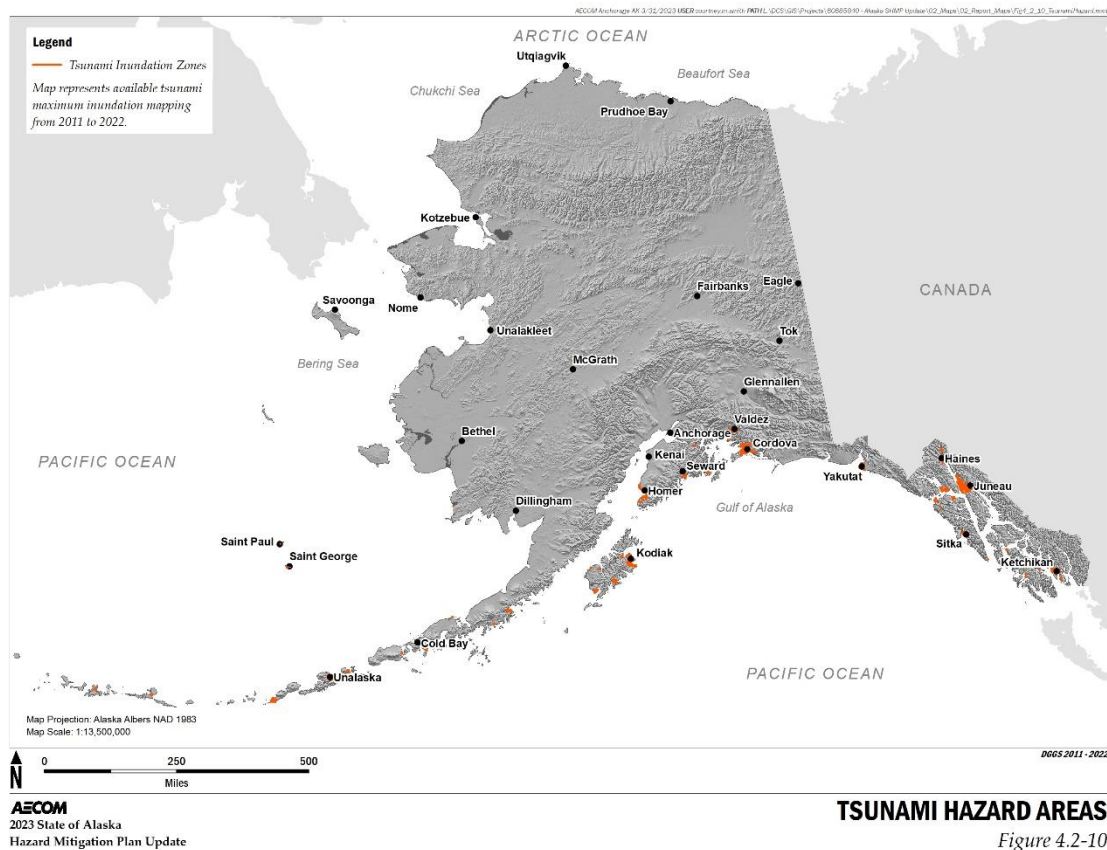


Figure 4.2-10: Tsunami Hazard Areas

4.2.2.3.6 Volcano

Due to its tectonic setting, Alaska has experienced regular volcanic eruptions throughout history, with the state containing approximately 100 volcanoes that have been active within the last 10,000 years and at least 50 volcanoes that have been active since the year 1760. Although many volcanoes are in lesser populated regions of the state, significant volcanic eruptions, particularly in Southcentral Alaska, are capable of disrupting air travel across a large area by necessitating air route deviations or flight cancellations due to large ash clouds, and ashfalls are capable of interrupting daily life in communities hundreds to thousands of miles away from an erupting volcano. Impacts from volcanic ash may include respiratory problems from the airborne ash; damage to aircraft, vehicles, and other property; structural damage from ash loading; state/regional transportation interruption and stranded residents, business closures, and loss of commerce; school closures; and water supply contamination (see Section 4.1.6, Volcano). In addition, volcanoes can unleash devastating lahars and landslides that have the potential to impact facilities, infrastructure, and communities closest to the eruption, displacing residents, causing personal injury and property damage, and capable of triggering tsunamis.

Volcanic ash clouds are capable of reaching more than 65,000 feet above the erupting volcano, and ashfall can be deposited thousands of miles away. These ash clouds are the principal volcanic hazard in Alaska, and even small amounts of ash can have significant impacts; therefore, the state's entire existing and future population, residences, and critical facilities have a potential volcanic ash impact risk. Population and infrastructure potentially threatened by volcanic hazards include:

State facilities and infrastructure at **low-moderate** risk of impacts from volcanic ash:

- 137,147 people (2022 estimate) in 69,355 housing units (2020 estimate)
- 13 airports (approximate value \$141,743,776)
- 14 correctional facilities (approximate value \$134,665,836)
- 18 education facilities (approximate value \$95,613,350)
- 40 emergency response facilities (approximate value \$10,452,500)
- 9 healthcare/nursing home/protected populations facilities (approximate value \$115,055,350)
- 16 law enforcement facilities (approximate value \$24,898,472)
- 140 maintenance facilities (approximate value \$271,171,000)
- 193 office facilities (approximate value \$309,578,765)
- 11 ports and harbors (approximate value \$9,840,750)

Other transportation facilities and infrastructure at **low-moderate** risk of impacts from volcanic ash:

- 54 airports
- 434 bridges
- 5 ferry terminals
- 19 harbors
- 27 maintenance facilities
- 6 ports
- 7 railroad facilities

Transportation route mileages at **low-moderate** risk of impacts from volcanic ash:

- 4,849.13 miles of road
- 392.43 miles of Alaska railroad

Local community facilities **low-moderate** risk of impacts from volcanic ash:

- 209 community facilities
- 57 education facilities
- 50 emergency facilities
- 77 government facilities
- 37 healthcare facilities
- 19 housing facilities
- 595 utility facilities

State facilities and infrastructure at **moderate** risk of impacts from volcanic ash:

- 411,667 people (2022 estimate) in 170,020 housing units (2020 estimate)
- 40 airports (approximate value \$1,761,402,600)
- 101 correctional facilities (approximate value \$538,263,863)
- 2 education facilities (approximate value \$683,925)
- 7 emergency response facilities (approximate value \$16,636,200)
- 31 healthcare/nursing home/protected populations facilities (approximate value \$479,391,775)
- 15 law enforcement facilities (approximate value \$113,493,798)
- 31 maintenance facilities (approximate value \$35,601,800)
- 264 office facilities (approximate value \$1,110,847,030)

Other transportation facilities and infrastructure at **moderate** risk of impacts from volcanic ash:

- 29 airports
- 353 bridges
- 7 ferry terminals
- 17 harbors
- 14 maintenance facilities
- 4 ports
- 7 railroad facilities

Transportation route mileages at **moderate** risk of impacts from volcanic ash:

- 4,359.71 miles of road
- 278.17 miles of Alaska railroad

Local community facilities **moderate** risk of impacts from volcanic ash:

- 99 community facilities
- 22 education facilities
- 24 emergency facilities
- 38 government facilities
- 19 healthcare facilities
- 2 housing facilities
- 315 utility facilities

State facilities and infrastructure at **high** risk of impacts from volcanic ash:

- 42,286 people (2022 estimate) in 23,979 housing units (2020 estimate)
- 14 correctional facilities (approximate value \$71,820,445)
- 5 emergency response facilities (approximate value \$901,600)
- 1 healthcare/nursing home/protected populations facility (approximate value \$10,982,000)
- 10 law enforcement facilities (approximate value \$6,502,750)
- 12 maintenance facilities (approximate value \$18,585,210)
- 90 office facilities (approximate value \$144,756,626)

Other transportation facilities and infrastructure at **high** risk of impacts from volcanic ash:

- 29 airports
- 51 bridges
- 2 ferry terminals
- 6 harbors
- 7 maintenance facilities
- 2 ports

Transportation route mileages at **high** risk of impacts from volcanic ash:

- 1,556.69 miles of road

Local community facilities at **high** risk of impacts from volcanic ash:

- 147 community facilities
- 27 education facilities
- 49 emergency facilities

- 54 government facilities
- 28 healthcare facilities
- 14 housing facilities
- 350 utility facilities

Volcanic Ash hazard areas are shown in Figure 4.2-11 below.

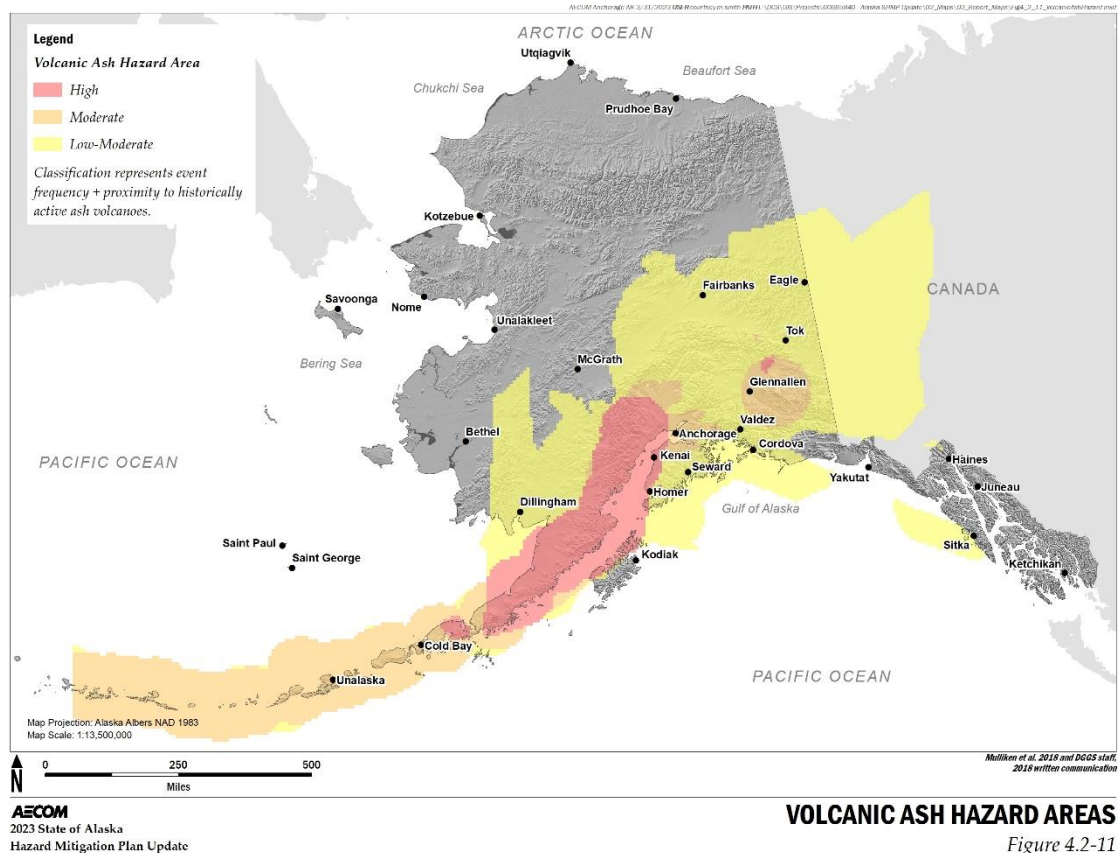


Figure 4.2-11: Volcanic Ash Hazard Areas

4.2.2.3.7 Severe Weather

Alaska experiences a wide range of severe weather events, including extreme cold, blizzards, high winds, heavy rain and/or snow, ice storms, thunderstorms, and storm surges. Some of the impacts associated with severe weather events include roof collapse, trees and power lines falling, damage to light aircraft and the sinking of small boats, injury and death resulting from snow machine or vehicle accidents, hypothermia, and overexertion while shoveling after a heavy snowfall. A quick thaw after a heavy snow can also cause substantial flooding. Impacts from extreme cold may include hypothermia, disruptions to transportation from fog and ice, congealed fuel, frozen pipes, utility disruptions, and carbon monoxide poisoning. Additional impacts may occur from secondary weather hazards or complex storms such as extreme high winds combined with freezing rain, high seas, and storm surge. Section 4.1.7, Severe Weather, provides additional detail regarding severe weather impacts. Buildings that are older and/or not constructed with materials designed to withstand heavy snow and wind (e.g., hurricane ties on crossbeams and appropriate

roofing materials) are more vulnerable to severe weather damage. The entire state of Alaska is threatened by severe weather events.

State facilities and infrastructure at risk of experiencing severe weather include:

- 736,566 people (2022 estimate) in 326,200 residences (2020 estimate)
- 53 airports (approximate value \$1,903,146,376)
- 154 correctional facilities (approximate value \$820,515,116)
- 37 education facilities (approximate value \$215,845,525)
- 58 emergency services facilities (approximate value \$30,092,700)
- 64 healthcare/nursing homes/protected populations (approximate value \$811,938,925)
- 62 law enforcement facilities (approximate value \$177,786,920)
- 3 libraries and museums (approximate value \$143,425,000)
- 380 maintenance facilities (approximate value \$637,851,010)
- 864 office facilities (approximate value \$2,492,806,048)
- 46 ports and harbors (approximate value \$47,254,100)

Other transportation facilities and infrastructure at risk of experiencing severe weather include:

- 289 airports
- 1,272 bridges
- 39 ferry terminals
- 149 harbors
- 81 maintenance facilities
- 13 ports
- 14 railroad facilities

Transportation route mileages at risk of experiencing severe weather include:

- 14,231 miles of road
- 695 miles of Alaska railroad

Local community facilities at risk of experiencing severe weather include:

- 3 bridges/culverts
- 1,418 community facilities
- 331 education facilities
- 330 emergency facilities
- 568 government facilities
- 205 healthcare facilities
- 149 housing facilities
- 10 transportation facilities
- 2,791 utility facilities

4.2.2.3.8 Wildfire

Impacts associated with a wildland fire event include the potential for loss of life and property. A wildland fire event can also impact livestock and pets, destroy forest resources, and contaminate water supplies. Buildings closer to the outer edge of town, those with heavy vegetation surrounding structures, and those constructed with wood are more vulnerable to wildland fire damages. Section 4.1.8, Wildland Fire and Community Conflagration, provides additional detail regarding wildland/tundra fire impacts.

According to the Alaska Interagency Coordination Center (AICC), 2,375 wildland fires have occurred within Alaska from 2018–2022 (Section 4.1.8, Wildland Fire and Community Conflagration) and have burned 6,544,207 acres since the legacy 2018 SHMP was implemented. The state’s population centers’ wildfire threats and recurrence probabilities are provided for locations dependent on fuel loading and weather. The following threat classifications: No Data Available, Very Low to Low, Moderate, Significant, or Considerable describe potential impacts within the following ranked fuels locations.

State facilities and infrastructure with **No Data Available** for potential exposure to wildfires include:

- 107,848 people (2022 estimate) in 51,649 housing units (2020 estimate)
- 25 corrections facilities (approximate value \$137,845,672)
- 35 education facilities (approximate value \$215,161,600)
- 17 healthcare/nursing homes/protected populations facilities (approximate value \$147,083,775)
- 9 law enforcement facilities (approximate value \$22,905,650)
- 3 libraries and museums (approximate value \$143,425,000)
- 46 maintenance facilities (approximate value \$74,282,600)
- 296 office facilities (approximate value \$852,804,209)
- 36 ports and harbors (approximate value \$34,760,750)

Other transportation facilities and infrastructure with **No Data Available** for potential exposure to wildfires include:

- 89 airports
- 441 bridges
- 33 ferry terminals
- 121 harbors
- 25 maintenance facilities
- 9 ports
- 2 railroad facilities

Transportation route mileages with **No Data Available** for potential exposure to wildfires include:

- 2,422 miles of road
- 86 miles of Alaska railroad

Local community facilities and infrastructure with **No Data Available** for potential exposure to wildfires include:

- 391 community facilities
- 84 education facilities
- 103 emergency facilities
- 155 government facilities
- 50 healthcare facilities
- 18 housing facilities
- 6 transportation facilities
- 657 utility facilities

State facilities and infrastructure with a **Very Low to Low Exposure** (maximum exposure value 0–40) potential to wildfires include:

- 368,821 people (2022 estimate) in 153,687 housing units (2020 estimate)
- 32 airports (approximate value \$1,700,934,250)

- 14 corrections facilities (approximate value \$158,293,000)
- 2 education facilities (approximate value \$683,925)
- 17 emergency services (approximate value \$8,205,300)
- 5 healthcare/nursing homes/protected populations (approximate value \$37,873,550)
- 18 law enforcement (approximate value \$20,648,681)
- 69 maintenance facilities (approximate value \$164,490,200)
- 89 office facilities (approximate value \$529,873,502)
- 3 ports and harbors (approximate value \$2,975,100)

Other transportation facilities and infrastructure with a **Very Low to Low Exposure** (maximum exposure value 0–40) potential to wildfires include:

- 30 airports
- 53 bridges
- 10 harbors
- 11 maintenance facilities
- 1 port
- 4 railroad facilities

Transportation route mileages with a **Very Low to Low Exposure** (maximum exposure value 0–40) potential to wildfires include:

- 1,190 miles of road
- 45 miles of Alaska railroad

Local community facilities and infrastructure with a **Very Low to Low Exposure** (maximum exposure value 0–40) potential to wildfires include:

- 2 bridges/culverts
- 164 community facilities
- 46 education facilities
- 43 emergency facilities
- 79 government facilities
- 27 healthcare facilities
- 30 housing facilities
- 335 utility facilities

State facilities and infrastructure with a **Moderate Exposure** (maximum exposure value 41–60) potential to wildfires include:

- 136,150 people (2022 estimate) in 57,504 housing units (2020 estimate)
- 40 corrections facilities (approximate value \$72,126,226)
- 11 emergency services (approximate value \$12,322,600)
- 12 healthcare/nursing homes/protected populations (approximate value \$244,159,600)
- 5 law enforcement (approximate value \$3,361,975)
- 55 maintenance facilities (approximate value \$82,518,800)
- 154 office facilities (approximate value \$223,619,318)

Other transportation facilities and infrastructure with a **Moderate Exposure** (maximum exposure value 41–60) potential to wildfires include:

- 66 airports

- 75 bridges
- 4 Harbors
- 5 maintenance facilities
- 2 ports
- 2 railroad facilities

Transportation route mileages with a **Moderate Exposure** (maximum exposure value 41–60) potential to wildfires include:

- 1,725 miles of road
- 43 miles of Alaska railroad

Local community facilities and infrastructure with a **Moderate Exposure** (maximum exposure value 41–60) potential to wildfires include:

- 256 community facilities
- 62 education facilities
- 72 emergency facilities
- 128 government facilities
- 46 healthcare facilities
- 40 housing facilities
- 514 utility facilities

State facilities and infrastructure with a **Significant Exposure** (maximum exposure value 61–80) potential to wildfires include:

- 78,218 people (2022 estimate) in 36,651 housing units (2020 estimate)
- 15 airports (approximate value \$178,369,098)
- 33 corrections facilities (approximate value \$21,478,712)
- 21 healthcare/nursing homes/protected populations (approximate value \$251,443,225)
- 15 law enforcement (approximate value \$12,754,616)
- 28 maintenance facilities (approximate value \$31,326,000)
- 124 office facilities (approximate value \$481,920,650)

Other transportation facilities and infrastructure with a **Significant Exposure** (maximum exposure value 61–80) potential to wildfires include:

- 23 airports
- 168 bridges
- 3 harbors
- 8 maintenance facilities
- 1 port
- 2 railroad facilities

Transportation route mileages with a **Significant Exposure** (maximum exposure value 61–80) potential to wildfires include:

- 2,182 miles of road
- 100 miles of Alaska railroad

Local community facilities and infrastructure with a **Significant Exposure** (maximum exposure value 61–80) potential to wildfires include:

- 180 community facilities
- 61 education facilities
- 45 emergency facilities
- 78 government facilities
- 28 healthcare facilities
- 24 housing facilities
- 403 utility facilities

State facilities and infrastructure with a **Considerable Exposure** (maximum exposure value 81–100) potential to wildfires include:

- 45,529 people (2022 estimate) in 26,708 housing units (2020 estimate)
- 6 airports (approximate value \$23,843,028)
- 42 corrections facilities (approximate value \$430,771,506)
- 30 emergency services (approximate value \$9,564,800)
- 9 healthcare/nursing homes/protected populations (approximate value \$131,378,775)
- 15 law enforcement (approximate value \$118,115,998)
- 182 maintenance facilities (approximate value \$285,233,410)
- 200 office facilities (approximate value \$400,871,588)
- 7 ports and harbors (approximate value \$9,518,250)

Other transportation facilities and infrastructure with a **Considerable Exposure** (maximum exposure value 81–100) potential to wildfires include:

- 81 airports
- 535 bridges
- 6 ferry terminals
- 11 harbors
- 32 maintenance facilities
- 4 railroad facilities

Transportation route mileages with a **Considerable Exposure** (maximum exposure value 81–100) potential to wildfires include:

- 6,713 miles of road
- 422 miles of Alaska railroad

Local community facilities and infrastructure with a **Considerable Exposure** (max. exposure value 81–100) potential to wildfires include:

- 1 bridge/culvert
- 427 community facilities
- 78 education facilities
- 67 emergency facilities
- 128 government facilities
- 54 healthcare facilities
- 37 housing facilities
- 4 transportation facilities
- 882 utility facilities

Wildfire hazard areas are shown in Figure 4.2-12 below.

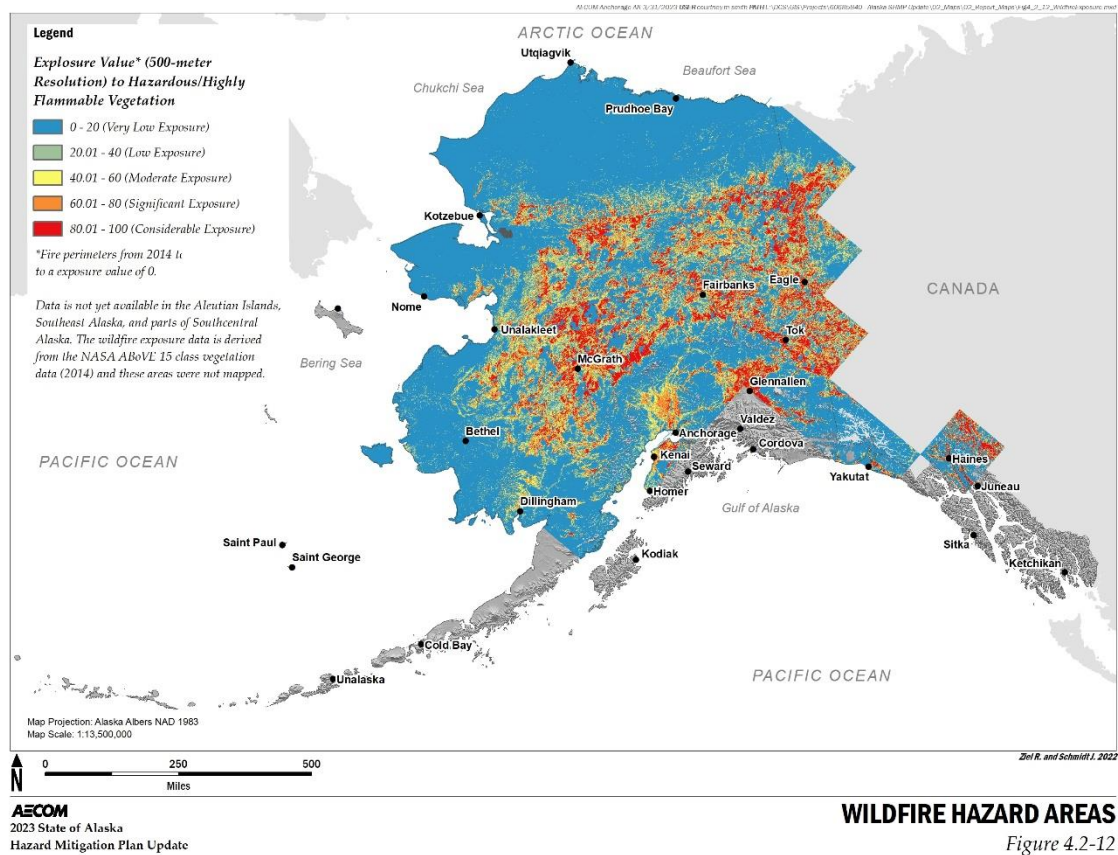


Figure 4.2-12: Wildfire Hazard Areas

4.2.2.3.9 High Hazard Potential Dams

Impacts associated with High Hazard Potential Dam failure event include the potential for loss of life and property. A dam failure event can also impact critical facilities, infrastructure, and contaminate water supplies. People, buildings, and infrastructure closer to the dam structure and in the inundation area are at higher risk. Section 4.1.9 provides additional detail regarding High Hazard Potential Dam impacts.

The State Dam Safety Engineer states that Alaska's informal population risk estimate for state and federal, Class I (High) hazard potential dams in Alaska is approximately 4,000 people. While inundation mapping does exist for all High hazard Potential Dams as part of their required EAPs, this data has not been digitized. The State Dam Safety Engineer conducted a manual analysis to provide the critical facilities and infrastructure at risk from a dam failure event:

Table 4.2-15: Critical Facilities and Infrastructure at Risk from Dam Failure Event

Dam Name	NID ID	Critical Facilities Vulnerable Downstream
Lowell Creek	AK00060	Hospital, city government offices, likely others, large portions of Seward could be impacted
Bridge Creek Dam	AK00101	Sterling highway could be impacted
Eklutna Dam	AK00033	Glenn Highway and most of the community of Eklutna downstream of the Highway
Carlanna Lake	AK00011	Tongass Highway, Bailey Power Plant, potentially other structures
Bettinger Upper Reservoir Dam	AK00022	Overhead utility lines, roads, potentially other structures
Meals Lake Dam	AK00018	Whitshed Road and utilities buried in road
Lower Fire Lake Dam	AK00189	Glenn Highway could be impacted
Wrangell Upper	AK00013	Wrangell Upper failure may lead to cascade failure of Wrangell Lower
Wrangell Lower	AK00014	Critical road and possibly a low risk to the water treatment plant
Lake "O" The Hills	AK00034	Unclear regarding state assets; O'Malley Elementary School is in flow path
Ship Creek Dam	AK00035	Glenn Highway, child development center, sewer transmission line, hatchery, other roads
New Kake Dam	AK00305	Hatchery, road
Lake Connell	AK00010	Tongass Highway
Moose Creek Dam	AK00085	Could flood Fairbanks, possibly some state facilities

High Hazard Potential Dams are shown in Figure 4.2-13 below.

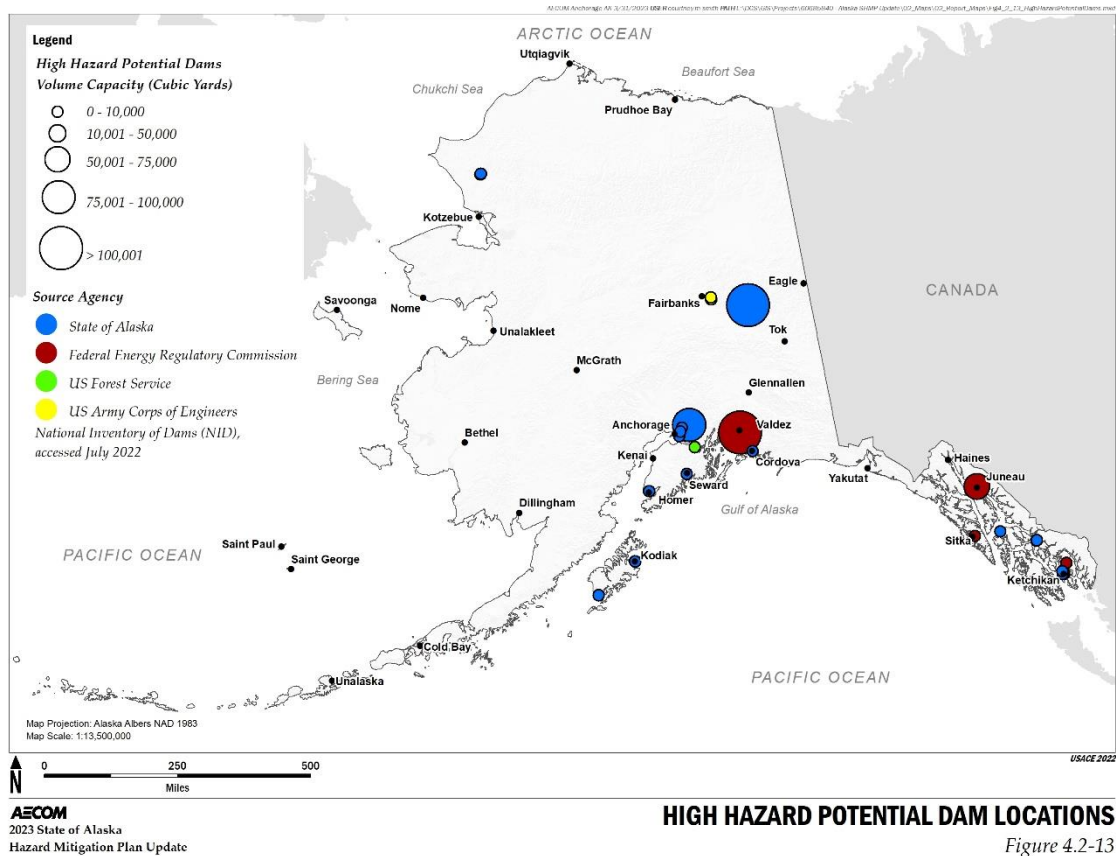


Figure 4.2-13: High Hazard Potential Dam Locations

4.2.3 Data Limitations

The vulnerability estimates provided herein use the best data currently available, and the methodologies applied result in risk approximations. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning hazards and their effects on the built environment and the use of approximations and simplifications that are necessary for comprehensive spatial analyses.

It is also important to note that the quantitative vulnerability assessment results are limited to the exposure of people, buildings, critical facilities, and infrastructure to the identified hazards. It was beyond the scope of this SHMP to develop a more detailed or comprehensive assessment of risk (including annualized losses, people injured or killed, shelter requirements, and loss of facility/system function). Such impacts may be addressed with future SHMP updates.

4.3 VULNERABILITY OF LOCAL JURISDICTIONS

DHS&EM has reviewed all local hazard mitigation plans submitted to the state and analyzed each jurisdiction's vulnerability to the identified hazards. The probability and magnitude/severity of each local community's vulnerability was rated between 0 and 4 (0 being the lowest or no risk and 4 being the highest risk) based on the results of the SHMP's risk assessment, knowledge of historical events, review and analysis of the State of Alaska Hazard Mitigation Plan (HMP), and subject matter expertise.

Potential loss estimates for local communities are included in the tables and narratives above and are based on the state-wide critical facility inventory by community. Potential loss estimates to identified vulnerable structures identified in the local risk assessments will continue to be analyzed and inventoried for future SHMP updates.

4.3.1 Socially vulnerable and underserved communities

Socially vulnerable and underserved communities in Alaska have been identified using the small and impoverished communities (a community of 3,000 or fewer individuals and identified as a rural community) definition (44CFR201.2). This includes the majority of the State of Alaska off the road system.

A subset of these communities has been identified by the DCRA in the Bethel, Kusilvak and Yukon-Koyukuk census areas as being especially vulnerable because all three census areas are located in the unorganized borough that does not provide services or support for natural hazard events. The impacts of all natural hazard events that occur in these areas are long lasting and more significant without support from resources available in other areas of the state. Individual HMPs for communities provide more detailed information regarding each jurisdiction's risk.

Table 4.3-1 lists local community risk (probability and magnitude/severity) for those communities that have submitted a HMP to DHS&EM.

Table 4.3-1: Local Jurisdiction Probability and Magnitude

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Afognak	3	2	0	0	1	1	1	1	1	2	1	1	2	1	0	0
Akhiok	3	3	3	1	2	1	1	1	2	3	1	1	2	1	0	0
Akiachak	1	1	3	2	4	2	3	2	0	0	0	0	3	2	1	1
Akiak	3	1	4	4	4	4	0	0	0	0	0	0	3	2	1	1
Akutan	4	3	0	0	0	0	0	0	2	3	4	3	3	2	0	0
Alakanuk	2	1	4	3	3	3	2	1	0	0	0	0	3	2	1	1
Alatna	2	1	3	2	3	2	2	1	0	0	0	0	3	2	3	2
Aleutians East Borough	4	4	3	3	2	2	0	0	4	4	3	2	2	2	0	0
Allakaket	0	0	3	2	3	2	2	1	0	0	0	0	3	2	3	1
Ambler	4	2	2	2	2	1	3	2	0	0	1	1	4	2	4	3
Anaktuvuk Pass	1	1	4	3	2	3	3	2	0	0	0	0	4	3	3	2
Anchor Point	3	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Anchorage (includes MOA, Chugiak, Eagle River, Girdwood)	3	4	0	0	3	1	3	2	0	0	2	2	3	2	2	3
Anderson	2	2	0	0	3	2	3	2	0	0	0	0	4	2	4	3
Angoon	2	2	2	1	1	1	1	1	1	2	0	0	3	2	2	1
Aniak	2	1	3	3	3	3	0	0	0	0	0	0	4	2	4	3
Anvik	1	1	4	1	3	2	0	0	0	0	0	0	3	2	3	1
Atmautluak	2	2	2	1	2	1	3	2	0	0	0	0	3	2	1	1
Atkasuk	1	1	2	2	2	3	3	2	0	0	0	0	4	3	3	2
Ayakulik	3	3	1	1	2	1	1	1	1	2	1	1	2	1	0	0
Belkofski	4	3	0	0	0	0	0	0	2	3	4	3	3	2	0	0

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Bethel	1	1	2	2	2	2	4	3	0	0	0	0	3	2	3	3
Bettles	1	1	2	1	3	2	2	1	0	0	0	0	3	2	3	1
Big Lake	3	3	0	0	1	1	0	0	0	0	3	1	2	3	3	3
Brevig Mission	4	1	2	2	2	1	3	2	0	0	0	0	3	2	1	1
Buckland	1	1	3	2	3	2	3	3	0	0	1	1	4	2	4	3
Candle	1	1	1	1	1	1	0	0	0	0	1	1	4	2	4	2
Cantwell	4	2	3	2	3	2	1	1	0	0	0	0	4	2	3	2
Chefornak	1	1	4	3	1	2	1	1	0	0	0	0	4	2	0	0
Chena Hot Springs	3	3	3	3	4	4	0	0	0	0	2	0	4	3	3	3
Chevak	0	0	4	2	2	2	4	2	0	0	0	0	4	2	1	4
Chickaloon	3	2	2	2	3	3	0	0	0	0	3	1	2	3	2	3
Chignik	3	2	4	2	2	2	3	2	2	3	2	3	3	2	3	3
Chignik Lagoon	3	2	2	2	2	2	2	2	2	3	2	3	3	2	3	3
Chignik Lake	3	2	2	2	2	2	2	2	2	3	2	3	3	2	3	3
Chiniak	3	2	3	1	2	1	1	1	1	3	1	1	2	1	0	0
Chuathbaluk	1	3	0	0	0	0	0	0	0	0	0	0	4	3	4	2
Circle	3	1	3	2	3	3	3	2	0	0	0	0	3	2	3	3
Circle Hot Springs	3	1	3	2	3	3	3	2	0	0	0	0	3	2	3	3
Cold Bay	4	3	0	0	0	0	0	0	3	3	2	3	4	3	0	0
Cooper Landing	3	3	3	2	3	2	0	0	0	0	3	3	2	3	3	3
Copper Center	3	2	3	2	3	2	3	1	0	0	0	0	4	2	3	2

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Cordova	3	3	4	2	4	3	2	3	2	4	1	2	4	3	3	2
Craig	3	3	0	0	0	0	4	3	2	3	0	0	2	3	1	2
Deering	3	2	3	2	3	2	3	2	0	0	1	1	4	2	2	1
Delta Junction	2	2	2	1	2	2	2	1	0	0	2	1	3	3	3	3
Denali Borough and City of Anderson	4	4	0	0	2	2	1	1	0	0	0	0	4	4	4	3
Dillingham	1	2	3	2	3	1	1	2	1	3	2	1	4	2	3	1
Diomedede	1	1	3	2	3	2	3	2	0	0	1	1	4	2	0	0
Eagle	3	1	3	2	4	4	3	2	0	0	0	0	3	2	2	4
Eek	1	1	2	2	0	0	3	2	0	0	0	0	3	2	1	1
Egegik	1	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Elim	4	1	3	2	2	1	3	2	0	0	0	0	3	2	1	1
Emmonak	1	1	4	3	4	3	3	1	0	0	0	0	3	1	2	1
Evansville	1	1	3	2	1	2	1	1	0	0	0	0	3	2	3	1
Eyak	3	3	2	2	3	2	0	0	1	1	0	0	3	2	0	0
Fairbanks	3	3	2	2	3	3	0	0	0	0	2	0	4	3	2	2
False Pass	4	3	1	2	1	2	0	0	2	3	4	3	3	2	0	0
Fort Yukon	1	1	3	2	4	2	0	0	0	0	0	0	3	2	2	1
Galena	1	2	3	2	4	3	2	1	0	0	0	0	4	1	3	2
Gambell	1	1	1	2	4	1	2	1	0	0	0	0	3	2	1	1
Glennallen	4	2	3	2	2	2	3	2	0	0	1	1	4	2	4	4

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Golovin	2	1	3	2	3	2	3	2	0	0	0	0	3	2	3	1
Grayling	3	3	0	0	2	1	3	2	0	0	0	0	3	2	1	1
Gulkana	3	1	3	1	2	2	4	1	0	0	1	1	3	3	2	2
Haines	3	3	4	3	4	3	3	3	2	3	0	0	3	3	0	0
Haines Borough	4	4	2	1	3	4	2	3	2	3	0	0	4	3	2	2
Healy	4	2	3	2	3	2	3	2	0	0	0	0	4	2	3	2
Holy Cross	1	1	3	2	4	1	4	2	0	0	0	0	3	2	1	1
Homer	4	2	4	1	2	2	1	2	2	2	2	1	2	2	3	3
Hoonah	3	3	3	3	3	3	3	2	1	2	0	0	3	3	0	0
Hooper Bay	1	1	2	2	2	2	0	0	0	0	0	0	3	2	2	2
Hope	3	3	3	2	3	2	2	3	1	2	3	3	2	3	2	2
Houston	3	3	0	0	4	2	1	1	0	0	3	1	4	4	2	4
Hughes	1	1	3	2	3	2	2	2	0	0	0	0	3	2	3	1
Huslia	1	1	3	3	3	2	0	0	0	0	0	0	3	2	3	1
Hydaburg	1	1	0	0	1	2	1	1	2	3	0	0	1	1	1	1
Igiugig	3	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Iliamna	3	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Juneau	1	2	1	2	2	3	3	3	1	3	1	1	2	2	1	1
Kachemak	3	3	2	2	2	2	3	1	1	3	3	3	2	3	3	3
Kaguyak	3	3	1	1	2	1	1	1	1	2	1	1	2	1	0	0
Kake	1	1	4	1	0	0	4	2	1	3	0	0	3	2	1	1

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Kaktovik	1	1	4	3	4	3	3	2	0	0	0	0	4	3	3	2
Kaltag	2	1	3	1	3	2	4	1	0	0	0	0	3	2	3	1
Karluk	3	3	2	1	2	1	1	1	1	2	1	1	2	1	0	0
Kasaan	1	3	0	0	0	0	2	2	1	3	0	0	3	3	1	2
Katchemak	4	4	0	0	4	2	4	1	2	2	1	2	4	2	3	4
Kenai	3	3	2	1	3	1	0	0	1	2	2	3	3	3	3	2
Kenaitze Tribe	4	3	3	3	3	2	1	1	1	4	2	3	4	2	4	4
Ketchikan	3	1	0	0	1	2	0	0	1	3	0	0	1	2	0	0
Kiana	4	2	1	1	1	1	3	2	0	0	1	1	4	2	4	2
King Cove	4	3	1	2	0	0	0	0	3	3	4	3	3	2	0	0
Kipnuk	1	1	4	3	2	2	4	2	0	0	0	0	3	2	1	1
Kivalina	4	2	4	3	4	3	4	2	0	0	0	0	4	2	1	1
Klawock	2	3	0	0	0	0	2	2	1	1	0	0	3	2	3	3
Knik	3	3	2	2	3	3	1	1	1	2	3	1	2	3	3	3
Kobuk	3	2	3	2	3	2	3	3	0	0	1	1	4	2	4	3
Kodiak	3	2	2	1	2	1	2	2	1	3	1	1	2	1	0	0
Kokhanok	3	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Kongiganak	1	1	4	3	3	3	2	4	0	0	1	1	4	2	2	3
Kongiganak	1	1	3	3	3	3	3	2	0	0	1	1	4	2	1	2
Kotlik	1	1	4	3	4	3	3	4	1	2	0	0	3	1	1	4
Kotzebue	1	1	3	2	3	2	4	3	0	0	0	0	4	3	1	2

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Koyuk	1	1	3	2	4	2	3	2	0	0	0	0	3	2	1	2
Koyukuk	1	1	3	1	4	2	0	0	0	0	0	0	2	2	2	1
Kupreanof	1	1	0	0	1	1	2	1	1	2	0	0	0	0	0	0
Kwethluk	3	2	4	3	4	3	3	2	0	0	0	0	4	2	3	3
Kwigillingok	1	1	3	3	3	3	3	2	0	0	1	1	3	2	0	0
Lake and Peninsula Borough	4	4	3	4	2	2	1	2	2	3	2	3	4	3	2	2
Larsen Bay	3	3	2	1	2	1	1	1	1	3	1	1	2	1	0	0
Levelock	3	2	2	2	2	2	2	2	0	0	2	3	3	2	3	3
Lower Kalskag	3	1	3	3	3	2	1	1	0	0	0	0	3	2	1	2
Marshall	1	1	3	2	1	1	3	2	0	0	0	0	4	1	3	2
Matanuska-Susitna Borough	3	4	2	2	3	3	3	2	1	2	2	2	3	2	2	3
McGrath	1	1	3	2	4	3	2	1	0	0	0	0	4	1	3	3
Mekoryuk	1	2	2	3	2	1	3	2	0	0	0	0	4	1	0	0
Mountain Village	1	1	3	2	1	1	3	1	0	0	0	0	3	2	1	1
Nanwalek	3	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Napakiak	0	0	4	4	4	3	4	4	0	0	0	0	3	2	0	0
Nelson Lagoon	4	3	3	3	0	0	0	0	1	3	4	3	3	2	0	0
Nenana	1	1	3	1	3	3	0	0	0	0	0	0	3	2	4	3
New Stuyahok	1	1	3	1	2	1	1	1	0	0	0	0	3	1	2	1
Newhalen	3	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Newtok	0	0	4	4	4	4	3	2	0	0	0	0	3	2	1	1

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Nikiski	3	3	2	1	2	1	0	0	1	2	3	3	2	3	2	2
Nikolaevsk	3	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Nikolai	3	2	1	2	1	2	0	0	0	0	0	0	4	2	3	4
Ninilchik	3	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Noatak	4	2	2	2	1	1	3	3	0	0	1	1	4	2	3	2
Nome	2	1	3	3	3	3	0	0	0	0	0	0	3	2	2	3
Nondalton	3	2	2	2	2	2	2	2	0	0	2	3	3	2	3	3
Noorvik	4	2	1	2	1	1	3	2	0	0	1	1	4	2	4	2
North Pole	3	3	2	2	3	3	0	0	0	0	2	0	4	3	3	3
Northwest Arctic Borough	3	2	4	2	4	2	3	2	0	0	1	1	4	2	4	3
Nulato	2	2	4	3	4	3	3	2	0	0	0	0	4	1	3	2
Nunam Iqua	1	2	4	1	4	4	3	3	0	0	2	1	4	4	3	3
Nunapitchuk	0	0	4	4	3	1	4	3	0	0	0	0	4	2	3	3
Old Harbor	3	3	3	1	2	1	1	1	1	3	1	1	2	1	0	0
Ouzinkie	3	2	3	1	2	1	1	1	1	3	1	1	2	1	0	0
Palmer	3	3	2	2	3	3	1	1	0	0	3	1	2	3	3	3
Pauloff Harbor	4	3	0	0	0	0	0	0	2	3	4	3	3	2	0	0
Pedro Bay	3	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Perryville	3	2	2	2	2	2	2	2	2	3	2	3	3	2	3	3
Petersburg	1	1	0	0	1	1	2	1	1	3	0	0	0	0	0	0
Petersburg Borough	2	1	0	0	1	1	3	2	1	3	0	0	0	0	0	0

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Petersville	3	3	2	2	3	3	1	1	0	0	3	1	2	3	3	3
Pilot Point	1	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Pilot Station	2	1	3	2	3	2	0	0	0	0	0	0	3	2	2	1
Point Hope	1	1	4	3	4	3	3	2	0	0	0	0	4	3	1	2
Point Lay	1	1	4	3	4	3	3	2	0	0	0	0	4	3	1	2
Port Alsworth	3	2	2	2	2	2	2	2	0	0	2	3	3	2	3	3
Port Graham	3	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Port Heiden	1	2	3	2	2	2	2	2	1	2	2	3	3	2	3	3
Port Lions	3	2	2	1	2	1	1	1	1	3	1	1	2	1	0	0
Port Moller	4	3	0	0	0	0	0	0	2	3	4	3	3	2	0	0
Quinhagak	0	0	3	2	2	3	0	0	0	0	0	0	4	2	1	1
Red Devil	1	1	3	2	3	2	0	0	0	0	0	0	3	1	1	1
Ruby	1	2	1	1	1	2	0	0	0	0	0	0	3	2	3	1
Russian Mission	2	1	3	1	3	2	4	2	0	0	0	0	3	2	3	1
Saint George	2	2	1	2	1	1	2	1	1	3	0	0	4	2	0	0
Saint Mary's	3	1	2	1	2	1	2	2	0	0	0	0	3	2	0	0
Saint Michael	0	0	4	2	2	1	4	1	0	0	0	0	3	2	0	0
Saint Paul	1	2	3	2	0	0	0	0	1	3	0	0	4	3	1	2
Sand Point	4	3	0	0	0	0	0	0	3	3	4	3	3	2	0	0
Savoonga	1	1	1	2	1	1	3	1	0	0	0	0	3	2	1	1
Saxman	3	1	0	0	0	0	0	0	1	3	0	0	1	2	0	0

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Scammon Bay	1	1	3	2	1	1	4	1	0	0	0	0	3	1	1	1
Selawik	2	1	4	3	4	3	4	3	0	0	1	1	4	3	4	3
Seldovia	2	3	2	2	2	2	3	1	2	3	3	3	2	3	3	3
Seldovia Village	1	2	3	2	3	2	3	2	2	2	2	2	3	2	3	1
Seward	3	3	3	2	4	3	3	2	3	3	1	2	3	2	2	2
Shaktoolik	1	2	4	3	4	3	0	0	0	0	0	0	4	3	1	3
Shishmaref	2	2	3	4	3	3	0	0	0	0	0	0	4	3	1	3
Shungnak	2	1	2	1	2	1	3	2	0	0	1	1	4	2	4	2
Sitka	2	3	1	1	1	2	3	2	2	4	0	0	3	3	0	0
Skagway	2	3	3	3	3	3	2	3	1	3	0	0	3	3	0	0
Skwentna	3	3	2	2	3	3	1	1	1	2	3	1	2	3	3	3
Sleetmute	2	1	4	3	4	3	0	0	0	0	0	0	3	1	2	1
Soldotna	3	3	3	2	3	2	0	0	1	2	3	3	2	3	3	3
Stebbins	2	2	3	2	4	1	4	2	0	0	0	0	3	2	1	1
Talkeetna	3	3	2	2	3	3	1	1	0	0	3	1	2	3	3	3
Tanacross	1	2	3	1	0	0	3	2	0	0	0	0	3	2	2	1
Tanana	2	3	2	1	4	3	0	0	0	0	0	0	3	3	1	3
Tazlina	3	2	3	2	3	2	3	2	0	0	1	1	4	2	4	4
Teller	1	1	3	2	2	3	3	2	0	0	0	0	3	2	1	1
Thorne Bay	3	1	0	0	2	2	1	1	1	1	1	1	3	1	2	1
Togiak	1	2	3	3	3	2	0	0	0	0	1	2	4	3	0	0

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Tok	1	2	0	0	0	0	0	0	0	0	0	0	4	2	4	4
Toksook Bay	1	3	3	1	1	1	3	2	0	0	0	0	4	2	0	0
Tuluksak	2	1	3	4	4	2	4	1	0	0	0	0	3	1	1	1
Tuntutuliak	2	1	3	3	3	3	3	2	0	0	0	0	4	2	1	2
Tununak	1	1	2	3	2	3	3	3	0	0	0	0	3	2	0	0
Twin Hills	1	1	3	1	3	2	4	3	1	1	1	1	4	2	3	2
Tyonek	3	3	3	1	3	1	3	2	1	2	2	2	2	3	2	2
Uganik	3	2	1	1	2	1	1	1	1	2	1	1	2	1	0	0
Ugashik	1	2	2	2	2	2	2	2	1	2	2	3	3	2	3	3
Unalakleet	2	2	3	3	3	3	0	0	0	0	0	0	3	2	3	3
Unalaska	3	2	3	2	2	3	3	1	2	2	3	2	3	2	0	0
Unga	4	3	0	0	0	0	0	0	2	3	4	3	3	2	0	0
Upper Kalskag	2	1	3	2	3	2	1	1	0	0	0	0	3	2	1	1
Utqiagvik	1	1	4	3	4	3	3	2	0	0	0	0	4	3	2	2
Uyak	3	3	1	1	2	1	1	1	1	2	1	1	2	1	0	0
Valdez	3	3	3	2	3	2	3	1	1	3	1	1	4	2	1	1
Venetie	3	1	3	2	3	3	2	1	0	0	0	0	3	2	3	4
Wainwright	1	1	4	3	4	3	3	2	0	0	0	0	4	3	1	2
Wasilla	4	3	2	1	3	3	0	0	0	0	2	1	2	2	4	3
White Mountain	1	1	0	0	2	1	2	2	0	0	0	0	3	2	2	1
Whittier	3	2	2	1	3	2	3	1	3	3	0	0	4	2	0	0

	Earthquake		Erosion		Flood		Ground Failure/ Landslide/ Avalanche		Tsunami		Volcano		Severe Weather		Wildfire	
Community Name	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity	Probability	Magnitude/ Severity
Willow	3	3	2	2	3	3	0	0	0	0	3	1	2	3	4	4
Woody Island	3	3	0	0	2	1	0	0	3	3	1	1	2	1	1	1
Wrangell	2	1	1	1	1	1	1	1	2	1	0	0	2	2	3	1
Yakutat	2	3	2	1	1	2	4	2	1	3	0	0	4	2	2	2

4.4 CHANGES IN DEVELOPMENT

The 2023 State of Alaska HMP Risk Assessment has been updated to include new critical infrastructure and facilities and updated hazard areas statewide to reflect changes in development and changes in hazard risk areas.

Changes in development and population for socially vulnerable and underserved communities is relatively stable since the last plan update. There are annual funds available for water and sewer improvements, infrastructure maintenance including airports, bulk fuel storage, ports and harbors, education facilities, healthcare facilities as well as replacement and new construction throughout the state.

For some communities that have experienced significant flooding and shoreline loss due to natural hazard events, partial or total community relocation has occurred or is in progress. For these communities, long-term development changes are occurring as funding becomes available. Within the last several years, funding has been provided to relocate buildings and infrastructure in Newtok, Napakiak, Kotlik, Alakanuk, Kwigillingok, Golovin, Tuntutaliak, Tununak, and Teller.

The following tables provide a summary of recent development and projected/funded development throughout the state. The Statewide Transportation Improvement Program (STIP) provides detailed project status information through the ADOT&PF. STIP project descriptions provide hazard-related mitigation descriptions by local jurisdiction. DHS&EM plans to capture additional detail regarding recent and projected development in hazard risk areas for future plan updates.

Table 4.4-1: Recent and Future Development Project Type and Spending, FY20–FY23+

Program	No. of Projects	Primary Work	FY20	FY21	FY22	FY23	+2023
Highways	37	Bridge replacement, planning, ferries, reconstruction, system preservation, new construction	\$61,792,151	\$72,625,923	\$22,883,000	\$152,449,523	\$662,890,930
Aviation	1	Other work	0	0	\$500,000	0	0
Community Transportation	45	System preservation, reconstruction, bridge rehabilitation, new construction, bridge replacement, transportation enhancements, planning	\$109,197,195	\$76,499,974	\$144,847,006	\$123,003,047	\$348,648,554
Forest highways	1	Planning	0	\$354,144	0	\$2,067,202	0
National highways	122	Reconstruction, bridge rehabilitation, system preservation, new construction, other, transportation enhancements, safety corridor, ferry boats, research, bridge replacement, congestion, new bridge access, safety	\$364,402,886	\$426,876,474	\$476,946,117	\$1,045,028,278	\$3,477,190,431
Ports and harbors	6	Other, transportation enhancements, system preservation, new construction	0	0	\$900,000	\$3,350,000	\$57,230,000

Program	No. of Projects	Primary Work	FY20	FY21	FY22	FY23	+2023
Required programs and maintenance	113	Safety, planning, bridge rehabilitation, research, training, congestion, system preservation, transit, railroad, ITS, new construction, new bridge access	\$452,960,909	\$290,502,951	\$477,977,522	\$429,713,347	\$672,448,338
Trails/recreation	2	New construction, system preservation	\$1,600,000	0	\$500,000	\$4,600,000	0
Transportation alternatives	11	Transportation enhancements, new construction, safety, reconstruction	\$4,001,156	\$6,686,106	\$8,549,126	\$18,507,097	\$19,270,484
Totals:			\$993,954,297	\$873,545,572	\$1,133,102,771	\$1,778,718,494	\$5,237,678,737

Notes:

ITS = intelligent transportation systems

5 STATE CAPABILITIES

Standard State Mitigation Plan Regulation Checklist
STATE MITIGATION CAPABILITIES
S8. Does the plan discuss the evaluation of the state’s hazard management policies, programs, capabilities, and funding sources to mitigate the hazards identified in the risk assessment? [44 CFR § 201.4(c)(3)(ii)]
S8-a. Does the plan include an evaluation of state laws, regulations, policies and programs related to hazards that improve or impede resilience to future natural hazard events and other future conditions, including the effects of climate change?
S8-b. Does the plan include a general discussion of state funding capabilities for hazard mitigation actions and projects?
S8-c. Does the plan include a summary of obstacles, challenges and proposed solutions related to any state capabilities, including a brief discussion of potential strategies for overcoming any challenges related to implementing and enforcing hazard-resistant building codes statewide, as applicable, and changes since the previous plan approval?

Source: FEMA, 2022

5.1 PRE- AND POST-DISASTER HAZARD MITIGATION POLICIES, PROGRAMS, AND CAPABILITIES

5.1.1 State Laws, Regulations, Policies, and Programs Related to Hazard Mitigation

Table 5-1 lists pre- and post-disaster hazard mitigation laws, regulations, policies, and programs available in Alaska for hazard mitigation. The table provides a description of each law, regulation, policy, and program and describes how it improves or impedes resilience, including the effects of climate change. The laws, regulations, policies, and programs are listed alphabetically.

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
Adapt Alaska	Developed by Alaska Sea Grant and partners, Adapt Alaska creates a discussion space for Alaska communities, tribes, agencies, and nonprofits. The goal is to allow residents to share information and learn from one another about what they are experiencing and how they can adapt to the changing landscape, ocean conditions, and climate across Alaska. The Adapt Alaska website provides a toolbox of monitoring, mitigation, and adaptation solutions and is a portal to useful Alaska-specific web resources. Most important, Adapt Alaska provides a platform for communities to share their successes, challenges, and lessons learned.
Adapt Y-K Delta	The Yukon-Kuskokwim (Y-K) Adapt project is designed to help build resilience for Y-K Delta resources and the people who depend on them. The organization is composed of a regionally driven group of tribal and community leaders, organizations, individuals, researchers, and public resource managers.
Alaska Arctic Observatory and Knowledge Hub (AAOKH)	AAOKH provides resources and scientific information for sharing expertise on and observations of Alaska sea ice, wildlife, and coastal waters. AAOKH’s scientists, staff, steering committee, and observers weave “connections among Indigenous and scientific perspectives by putting local observations in the context of scientific measurements....” Since 2016, AAOKH observers have contributed over 2,000 observations. These are added to a database curated by the Exchange for Local Observations and Knowledge of the Arctic program. The local observations of local sea ice features and events help improve interpretation of satellite imagery, which can ultimately lead to better ice forecasts and climate models.
Alaska Arctic Policy	In 2015, the Alaska State Legislature passed the draft Alaska Arctic Policy, Alaska Statute (AS) 44.99.105. The policy consists of four pillars, three of which address climate change and hazard mitigation: • Pillar #2: Address the Response Capacity Gap ensures strengthened capacity to address Arctic maritime, science, climate, and security issues. • Pillar #3: Support Healthy Communities anticipates, evaluates, and responds to risks from climate change related to land erosion and deterioration of community infrastructure and services and supports community efforts to adapt and relocate when necessary. • Pillar #4: Strengthen Science and Research (1) strengthens efforts to incorporate local and traditional knowledge into science and research and use this community-based knowledge to inform management, health, safety, response, and environmental decisions; (2) supports monitoring and collecting baseline and observational data to enhance understanding of Arctic

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
	ecosystems and regional climate changes; and (3) invests in U.S. Arctic weather, water, and ice forecasting systems.
Alaska Center for Climate Assessment and Policy (ACCAP)	ACCAP’s mission is to “conduct innovative and collaborative research and engagement to inform climate policy, decision-making, and action for a just and sustainable future.” ACCAP focus areas include extreme events, climate resilience, outreach and engagement, and sustained assessment. ACCAP is one of 11 National Oceanic and Atmospheric Administration (NOAA) Climate Adaptation Partnerships and is funded by a 5-year cooperative agreement with NOAA. ACCAP’s work includes drought and extreme event workshops, avalanche assessment and predictions, climate partnership information distribution, and the sustained assessment network.
Alaska Climate Change Impact Mitigation Program (ACCIMP)	ACCIMP was established to provide technical assistance and funding to communities imminently threatened by climate-related natural hazards such as erosion, flooding, storm surges, and thawing permafrost. ACCIMP works with communities to develop a planned approach to shoreline protection, building relocation, and/or eventual relocation of entire villages.
Alaska Dam Safety Program	The Alaska Dam Safety Program is overseen by the Dam Safety and Construction Unit of the Department of Natural Resources (DNR). DNR regulates dams in Alaska that meet certain jurisdictional criteria defined in AS 46.17 (1987) and Article 3, Dam Safety, of 11 Alaska Administrative Code (AAC) 93 to protect life and property. As part of the Alaska Dam Safety Program, a Certificate of Approval to Construct, Modify, or Repair a Dam is required before any new construction or major modification or repair of an existing dam. A Certificate of Approval to Operate a Dam is required before a new or modified dam can be put into service. A Certificate of Approval to Abandon a Dam is required before removal or abandonment (de-regulation) of a dam. For Class I and Class II dams, an Emergency Action Plan is required by 11 AAC 93.164.
Alaska Earthquake Center	The Alaska Earthquake Center has been operating under the authority of AS 14.40.075 for over 25 years. The Alaska Earthquake Center provides mapping tools, historical information, and public outreach to a variety of stakeholders concerning earthquakes and tsunamis. It also monitors seismic events from earthquakes, landslides, and glacier calving using its statewide network of seismic instruments. During 2019-2020, the Alaska Earthquake Center was able to expand their permanent seismic monitoring network by acquiring 96 of 158 temporary USArray sites in Alaska that were set to be removed. Also, additional instrumentation was added to the stations to forecast forest fire behavior, monitoring changes in North Slope permafrost, and better recording of seismic sequences. The network now includes 96 stations adopted by the Alaska Earthquake Center and 11 stations by the Alaska Volcano Observatory.

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
Alaska Firewise	Alaska Firewise is a cooperative effort among local, state, federal, and private agencies and organizations to promote fire safety in areas vulnerable to wildland and community fires. Communities can become a Firewise Community by creating a Firewise Board and Firewise Task Force or Commission, developing a Community Wildfire Protection Plan (CWPP), sponsoring Wildfire Days public events, volunteering or investing in community wildfire mitigation, and seeking certification. There are three Firewise communities in Alaska.
Alaska Heritage Emergency Network	Founded in 2022, Alaska Heritage Emergency Network is a partnership between cultural heritage institutions, professional organizations, and emergency response agencies working to integrate cultural heritage institutions and other cultural heritage organizations into emergency management and response efforts.
Alaska Interagency Coordination Center (AICC)	AICC is the Geographic Area Coordination Center for Alaska. It is the center point for state and federal agencies involved in wildland fire management and suppression in Alaska. It provides incident information, predictive services, and logistics and dispatch. In addition, AICC coordinates and provides support for all hazard emergency response activities for federal landholding agencies in Alaska. It also provides support to the Alaska State Office–Bureau of Land Management (BLM) for non-emergency activities.
Alaska Native Tribal Health Consortium (ANTHC)	ANTHC is a non-profit Tribal health organization that serves the Alaska Native and American Indian people living in Alaska. ANTHC works with various stakeholders to create strategies that encourage wellness, resilience, and sustainability within the Alaska Native and American Indian community in Alaska. ANTHC’s Emergency Preparedness program assists in the development of emergency response plans (ERPs) for clinics, emergency operation plans (EOPs) for hospitals, and table-top, functional, and full-scale exercises. In addition, during an emergency or disaster, the ANTHC Emergency Preparedness program works as a liaison, connecting communities, partners, and Tribal health organizations with the Alaska Division of Homeland Security & Emergency Management (DHS&EM) and the Alaska Department of Health (DOH). The ANTHC Emergency Preparedness program also sends team members to communities, when requested, to respond to disasters. ANTHC’s Center for Climate and Health assists Tribal communities, helping them to better understand climate change. It provides assessments, technical assistance, training, and monitoring assistance for environmental impacts. In addition, the program coordinates the interagency One Health Group, which provides surveillance of emerging environmental, wildlife, and public health threats. In May 2023, ANTHC along with DCRA, prepared a final draft of <i>Unmet Needs of Environmentally Threatened Alaska Native Villages: Assessment and Recommendations</i> to “help improve the effectiveness of federal and state government support for Alaska communities to address climate and

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
	environmental threats, specifically erosion, flooding, and permafrost degradation.” The report identifies funding needs and priorities, and implementation strategies and goals, including community-specific data collection and analysis, fundable local coordinator positions, community-specific technical assistance teams, and a conceptual governmental “Mitigation Framework” to address environmental threats in Alaska.
Alaska Partnership for Infrastructure Protection (APIP)	APIP is a collaborative effort between the government, businesses, and nonprofits to gather, analyze, and disseminate critical infrastructure information during periods of vulnerability or threat. Since 2004, it has conducted infrastructure threat analyses, constructed detailed infrastructure maps, identified critical vulnerability interdependencies, conducted exercises to identify gaps in infrastructure protection, and prioritized a comprehensive list of integrated protection strategies.
Alaska Risk Mapping, Assessment, and Planning (MAP) Program	The Risk MAP is an innovative, FEMA-developed flood hazard mapping, multi-hazard risk assessment, and mitigation planning program designed to increase local understanding of risk, inform community decisions regarding risk, and ultimately lead to local actions to reduce risk. See Section 5.1.3 for more information about the Alaska Risk MAP Program.
Alaska Sea Grant	Alaska Sea Grant is an organization that works with communities to help Alaskans adapt and build resilience to changing climate and ecosystems. This is achieved through research, education, and outreach through Marine Advisory agents who live and work in eight coastal communities across Alaska. Alaska Sea Grant is one of 34 Sea Grant programs nationwide and is headquartered at UAF.
Alaska Seismic Hazards Safety Commission	The Alaska Seismic Hazards Safety Commission is charged by statute to recommend goals and priorities for seismic risk mitigation for the public and the private sectors and to recommend policies, including needed research, mapping, and monitoring programs, to the governor and legislature to reduce the state’s vulnerability to earthquakes. The Commission, administered by the Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS), consists of 11 members appointed by the governor from the public and private sectors for 3-year terms. The Commission offers advice on coordinating disaster preparedness and seismic hazard mitigation activities to government at all levels, reviews the practices for recovery and reconstruction after a major earthquake, and recommends improvements to mitigate losses from similar future events. The Commission also reviews proposed seismic hazard notifications and supporting information from state agencies, evaluates possible socioeconomic consequences, recommends that the governor issue formal seismic hazard notifications when appropriate, and advises state and local agencies on appropriate responses.

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
Alaska Silver Jackets Team	Silver Jackets teams are interagency teams that facilitate collaborative solutions to state flood risk priorities. The state-led teams bring together various stakeholders to learn from one another and work together to reduce risk from floods and other natural disasters. The state sets the priorities for mitigation. The Alaska Silver Jackets Team utilizes the new National Wetlands Inventory geodatabase to create wetland maps specific to the City of Bethel, Village of Aniak, and the Alaska Native Village of Napaimute of the Yukon-Kuskokwim Delta. These maps highlight the infrastructure, culturally important areas, and natural features of each community in relation to the location and category of existing wetlands, with the goal of informing future development and floodplain management planning decisions. The team is also focusing on ice jam expertise. It is using information from the United States Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory to train state and local practitioners on Alaska-specific ice jam issues.
Alaska Volcano Observatory (AVO)	AVO is a joint program of the United States Geological Survey (USGS), the Geophysical Institute of the UAF, and the State of Alaska Division of Geological and Geophysical Surveys. AVO was formed in 1988; it uses federal, state, and university resources to monitor and study Alaska's hazardous volcanoes, to predict and record eruptive activity, and to mitigate volcanic hazards to life and property. In support of public land use planning, the development of emergency response plans, and general public awareness of the nature of volcanic activity in Alaska, AVO is responsible for assessing the full range of potential volcanic hazards. Hazard assessments include descriptions of the history of a given volcano, explanations of likely eruption scenarios, and determination of probable impact zones for the range of expected hazards.
Alaska Water Level Watch	Alaska Water Level Watch is a collaborative group working to improve the quality, coverage, and accessibility to water-level observations in Alaska's coastal zone. Water-level data have many applications that contribute to emergency management and hazard mitigation, including storm modeling and mapping; tsunami warnings, watches, and advisories; incident response; search and rescue operations; tidal datums; sea-level trends; and storm trends.
Arctic Urban Risks and Adaptations	Arctic Urban Risks and Adaptations is a 4-year (2020–2024) National Science Foundation project that addresses changing environmental hazards around the Municipality of Anchorage, Fairbanks and Whitehorse. The primary focus of AURA is to understand how wildfire hazards are changing and the risks associated with them and using this information to develop wildfire impact mapping and assessment tools. In addition, AURA will address other environmental hazards, including permafrost thaw and rain-in-winter.
Coastal Hazards Program	DGGS's Coastal Hazards Program tracks coastline data and develops tools to help communities in Alaska understand how the coastline has evolved and how to respond to hazardous events and long-term

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
	changes. The program’s coastal community erosion assessments show past shorelines, forecasted erosion areas, locations of infrastructure at risk to erosion, estimated erosion exposure dates, and erosion forecast uncertainty. The program is currently developing a coastal community flood assessment that shows flood heights using written accounts, photographs, historical and modern imagery, and elevation models.
Denali Commission Village Infrastructure Protection (VIP) Program	The Denali Commission Act of 1998 established the Denali Commission to deliver services of the federal government in rural Alaska. The Denali Commission is an independent federal agency that focuses on developing the basic infrastructure, economic development, and workforce training needs for rural Alaska in collaboration with state, local, Tribal, and private partners. In 2015, the White House directed the Commission to establish a VIP program to assist rural Alaskan communities that are threatened by erosion, flooding, and permafrost degradation. The goal of the VIP program is to mitigate the impact of these threats with respect to safety, health, and the protection of infrastructure. From 2016 – 2020, the agency spent approximately \$40 million for VIP-related initiatives.
Hazard Fuel Reduction Program	The State of Alaska, Division of Forestry (DOF), manages a Hazard Fuel Reduction Program. DOF’s protection responsibilities are geographically split into six separate areas and within each area the Hazard Fuel Reduction Program is carried out through hand crews, mechanical treatment and prescribed burns. Recent projects include Old Murphy Dome in Fairbanks, Delta River West Phase 1a and Delta Bison Habitat in the Delta Area, Eagle Subdivision Fuel Break in the Tok Area, Copper River, McGrath, Takotna, Nikolia, Telida in the South-West Area, Caswell, Sunset Fuels Phase 1 and Sunset in the Mat-Su Area, and Alaska State Parks Fuels Reduction Phase II, Kenai Peninsula Community College Hazard Fuel Reduction, and Denali Borough.
International Codes (I-Codes)	The I-Codes, developed by the International Codes Council, include a suite of 15 building codes. The I-Codes in place in Alaska (statewide or locally) that have a special emphasis on mitigation include: • International Building Code (IBC) 2021: The IBC addresses building requirements for commercial buildings. • International Energy Conservation Code (IECC) 2018: The IECC establishes a baseline for energy efficiency by setting performance standards for building envelopes, mechanical systems, lighting systems, and service water heating systems in homes and commercial businesses. • International Fire Code (IFC) 2021: The IFC addresses fire precautions, emergency planning and preparedness, fire department access and water supplies, automatic sprinkler systems, fire alarm systems, special hazards, and the storage and use of hazardous materials. • International Residential Code (IRC) 2018: The IRC addresses building, plumbing, mechanical, fuel gas, and electrical requirements for one- and two-family dwellings and townhouses up to three stories.

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
	The International Existing Building Code (IEBC) 2021, International Fuel Gas Code (IFGC) 2021, and International Mechanical Code (IMC) 2021 are requirements for four dwelling units (4-Plex) and above and for commercial buildings, and are adopted under the authority of the Alaska State Fire Marshal. The IBC and IFC are adopted under the authority of the Alaska State Fire Marshal. The Fire Marshal has the discretion to initiate code adoption of the IBC and IFC when new editions are available. State-agency-adopted codes are mandatory and fall under state inspection programs. Local jurisdictions may be designated as Deferred Jurisdictions, which allows local administration of building codes. Deferred Jurisdictions may adopt more recent editions and additional codes such as the IRC and IECC. The IRC and IECC are not adopted statewide. Local jurisdictions may have their own residential codes to follow, and the Alaska Housing Finance Corporation adopts the IRC for its residential standard and the IECC for its Building Energy Efficiency Standard. The IBC recognizes that Alaska is a seismically active state and requires higher loads and more stringent detailing requirements for the structures that resist them. According to the International Code Council, the IECC “establishes a minimum set of requirements and serves as the basis for the formulation of additional tools that meet the policy needs of all levels of governments and the private sector entities that have set energy, greenhouse gas emissions and cost saving targets.” As such, the IECC helps address the impacts of climate change.
Mitigation Planning Database	In 2018, DHS&EM began to build an access database to identify common threats and hazards in communities throughout the State. In 2022, DHS&EM upgraded the system to an SQL Server, which is a relational database management system developed by Microsoft. With this upgrade, DHS&EM was to store information from every local and tribal HMP they had on file and retrieve data in an online community table/report. Currently the community reports include for each community: general overview, cultural information, public safety, public services, transportation, hazards, activities (grants, other planning documents, and State Emergency Operations Center events), and limited critical facilities. The database also includes State disaster information and limited mapping. In addition, DHS&EM has created a memorandum with DCRA to share data.
National Flood Insurance Program	The National Flood Insurance Program (NFIP) is a program created by the United States Congress through the National Flood Insurance Act of 1968 and managed by the Federal Insurance and Mitigation Administration. The NFIP has two purposes: to share the risk of flood losses through flood insurance and to reduce flood damages by restricting floodplain development. The program enables property owners, renters and business owners that live in any of the 33 NFIP participating communities to purchase insurance protection through a licensed property or casualty insurance agent against losses from flooding. Thus, allowing community members to meet the purchase requirements to obtain flood

Table 5-1: Hazard Mitigation Laws, Regulations, Policies and Programs in Alaska

Program	Description
	insurance homes, and buildings located in the Special Flood Hazard Areas, the areas of high-flood risk areas designated on flood maps, for loans backed by a federally regulated lender. Section 5.1.2 for more information on the National Flood Insurance Program in Alaska.
National Tsunami Hazard Mitigation Program (NTHMP)	The NTHMP is a federal/state working group that NOAA formed in 1995, as directed by Congress. Today, NTHMP includes NOAA, FEMA, the USGS, and 28 U.S. states and territories. The group works together toward the common goals of protecting lives and reducing economic losses from tsunamis at the community level. In Alaska, the Alaska Earthquake Center, DGGs and DHS&EM are coordinating committee members of NTHMP.
River Watch Program	The River Watch Program assesses and reports river ice conditions during annual spring break-up. The program includes aerial surveillance with State Emergency Operations Center staff and NWS hydrologists of major river systems, including the Yukon and Kuskokwim, and voluntary reports of river ice conditions by pilots and community members. Reports of ice conditions and river water levels as the break-up front moves down river enable local communities to prepare for and mitigate against flooding while allowing more accurate NWS forecasts, warnings, and navigation information.
Scenarios Network for Alaska + Arctic Planning (SNAP)	SNAP is a team of boreal ecologists, visual designers, and software developers that uses climate data to create and share ideas on how the future northern climate could look. SNAP is a part of the International Arctic Research Center at the University of Alaska Fairbanks. SNAP has created and maintained the following climate tools to be freely used: Airport Winds, Alaska Garden Helper, Alaska Wildfire Explorer, Arctic-EDS, Climate Scenarios for the NWT, Community Climate Charts, Community Permafrost Data, Community Wind, Environmental Impacts to Access in Interior Alaska, Fire Tally, Fish and Fire in Interior Alaska, Historical Sea Ice Atlas, Northern Climate Reports, Precipitation Projections for Interior Alaska, and Statewide Temperature Index.
Western Alaska Partnership	The Western Alaska Partnership is one of 22 landscape conservation cooperative organizations in North America. It promotes coordination, dissemination, and development of applied science to inform landscape-level conservation focusing on climate change. For the past decade, the Western Alaska Partnership has been assisting in the development of ShoreZone, conducting extensive mapping of coastal change, and training Local Environmental Observers.

5.1.2 State Administration of the National Flood Insurance Program

DCRA serves as the NFIP Coordinator in Alaska. As the NFIP Coordinator in Alaska, DCRA coordinates with other state offices to ensure policies and regulations are in place to meet the minimum NFIP standards, supports NFIP communities, provides technical assistance to local communities and state agencies, maintains a state floodplain mapping program through a cooperative agreement with FEMA for producing and providing flood hazard maps that include best available flood and erosion information as a tool for flood hazard mitigation and implementation of the NFIP used to regulate floodplain development and mitigate for flood losses.

After damages of any cause within a NFIP community (disasters report to DMVA), the community's Floodplain Administrator (FPA) will be contacted the State NFIP Coordinator. The number of damaged structures inside the Special Flood Hazard Area will be determined by the community's FPA and provided to DCRA and DMVA Specialist. At that time, assistance will be offered to the community by DCRA Specialist for Substantial Damage Estimations (SDE). If assistance is requested, the FPA can provide the following but not limited to:

- Provide technical assistance to communities for SDE software program.
- Provide training for SDE Teams members for field work.
- Help in getting more accurate count of structures affected for SDE.
- Provide FPA with assistance for meetings with local officials.
- Provide follow-up monthly contact to update on substantial damage evaluations and disaster declaration progress.
- Long term follow will be through Community Assistance Contacts and Community Assistance Visits.
- Provide community information on Increased Cost of Compliance (ICC) Coverage and Mitigation Assistance funds which may be available.

DCRA will assist any community with training and field work to ensure that the damage estimates by the community is compliant with the NFIP. The community should request the assistance in writing to the DCRA. After the request is made to DCRA the information will be given to DCRA Director. The community should be able to estimate the number of structures in the floodplain receiving damage from the event and pass it along to the DCRA Floodplain Management Staff. At that point, the DCRA Director will make decisions on deployment of staff to assist with fieldwork or by providing technical advice or training. Any community requesting assistance from DCRA should be willing to have local individuals available to comprise the teams and operate the FEMA Substantial Damage Estimates program. If the damage is so widespread that the number of requests or the number of structures supersede the capacity of the DCRA, then a meeting with the Governor's office, DCRA Director and the State NFIP Coordinator will be initiated to determine the course of action.

In Alaska, about one-third (34%) of Alaska's 164 incorporated municipalities participate in the NFIP. This participation includes 33 communities and boroughs and an additional 25 cities within the jurisdictional boundaries of participating NFIP boroughs. Most of Alaska's population resides within the communities that participate in the NFIP as follows: 85 percent reside in organized boroughs and 3 percent reside in the cities in the unorganized boroughs. NFIP participation in Alaska grew 2.24% from 2010 to 2021. Alaskan communities that participate in the NFIP are 20 Cities: City of Aniak, City of Bethel, City of Cordova, City of Dillingham, City of Emmonak, City of Fort Yukon, City of Galena, City of Homer, City of Hoonah, City of Kotzebue, City of Kenai, City of Koyukuk, City of Kwethluk, City of McGrath, City of Nenana, City of Nome, City of Seward, City of Shishmaref, City of Togiak, City of

Valdez and 12 Boroughs: Municipality of Anchorage, Fairbanks North Star Borough, Haines Borough, City and Borough of Juneau, Kenai Peninsula Borough, Lake and Peninsula Borough, Matanuska-Susitna Borough, Northwest Arctic Borough, Petersburg Borough, City and Borough of Sitka, and Municipality of Skagway.

The City of Kenai was accepted into the NFIP program in 2022, and North Slope Borough has been working with DCRA to get policies and regulations established to apply to join the NFIP in the next 18 months. The NFIP continues to expand within the State of Alaska and the DCRA staff support and encourage communities that have land use authority to join the NFIP.

Communities are encouraged to join the Community Rating System (CRS) which offers discounts to the entire community on flood insurance premiums if communities reduce their number of Repetitive Loss (RL) structures or Severe Repetitive Loss (SRL) structures and participate in other community wide mitigation activities. Most RL structures are present within communities due to the structure being built before the community joined the NFIP. Currently, there are 48 structures listed as RL, of those structures there are 4 that are SRL buildings. DCRA is actively using grant funds to remove RL structures from the floodplain and communities continue to seek and utilize grant funds to remove RL structures or elevate structures within the floodplain to mitigate risks during flood events.

The NFIP prevents the development of structures within the floodplain that do not meet the regulations and standards, such as the requirement to build above the base flood elevation (BFE). If a RL structure is damaged or requires improvement repairs the local FPA would determine if the work would cost more than 50 percent of the market value of the structure, meaning the building is being substantially improved, SI or has substantial damage, SD. If work on buildings constitutes SI/SD, then structures must be brought into compliance with the NFIP requirements for new construction.

There are 2,250 flood insurance policies within the NFIP communities in Alaska as of April 1, 2021, reported by FEMA Headquarters. Of those policies 1,685 are single family homes. The Fairbanks North Star Borough has 28% of the policies followed by Anchorage Municipality with 18% of the policies. There are 48 RL structures in Alaska and 4 are shown to be SRL structures. The DCRA and local NFIP communities work to secure grant funding to acquire and relocate at-risk structures. After a substantial damage event, a property or business owner with flood insurance can secure ICC funds to elevate their structure to prevent future risk of flood damages.

In addition to the NFIP, communities can voluntarily participate in CRS. The CRS program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of NFIP. Property owners in CRS communities receive discounted flood insurance premium premiums rates that can range from 5% to 45% depending on the rating level a community meets within the program. There are seven communities in Alaska that participate in CRS: Anchorage Municipality, City of Homer, Ketchikan Gateway Borough, City of Nome, City of Seward and City of Valdez. The classification ratings are based on the floodplain management practices in place in a community—the more the community does in activities, Public Information, Mapping and Regulations, Flood Damage Reduction, and in Flood Preparedness, the lower the class rating and the higher the discounted insurance premiums.

DCRA staff promote the CRS and help communities join the program by explaining the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification. The DCRA improves local programs by offering training, templates, models, and examples help communities improve their floodplain management activities to improve their CRS standing.

5.1.3 FEMA’s Risk Mapping, Assessment, and Planning (Risk MAP) Program

The Alaska Risk MAP Program is funded through a Cooperating Technical Partnership between the State of Alaska and FEMA. The Alaska Risk MAP Coordinator (RMC) serves as the intermediary and primary point of contact between Alaska’s local jurisdictions and FEMA and is supported by a Risk Map Project Team, subject matter experts, and stakeholders, as needed.

The *Alaska Mapping Business Plan: Integrating Mapping, Assessment, and Resilience Planning* (DCRA, 2022) comprehensively evaluates the status of Alaska’s flood maps, setting priorities for future mapping and risk assessment and outlining a collaborative relationship with FEMA to fully execute the Risk MAP within Alaska. In Alaska, Risk MAP priorities are determined through the Alaska Prioritization and Future Studies Sequencing Decision Support System, which is a ranking methodology based on flood risk, flood needs, and flood action potential within a watershed. The results of this analysis showed that the high-priority watersheds (and the NFIP-communities within them) for Risk Map studies, including the Upper Kenai Peninsula, South Central Alaska, and Western Alaska coastal areas. In addition, environmentally threatened Alaska Native villages are also prioritized for Risk Map studies. These villages are selected through the ranking provided in the Alaska Statewide Threat Assessment.

The RMC can provide training and technical assistance to Alaska communities in the areas of:

- Benefit Cost Analysis (BCA) – Support communities to identify, capture, and document the necessary data to run a BCA as well as understand how to run the FEMA approved BCA model.
- Building Science – Support communities in the understanding of construction issues and opportunities in the identified natural hazard and risk areas.
- Community Capability Development – Support building community capability to sponsor and implement mitigation actions through activities such as: capability assessment; gap analysis; and process, change, and project management.
- Community Rating System (CRS) – How to integrate CRS elements into mitigation plans and floodplain ordinances (public information, mapping and regulation, flood damage reduction, warning, and response).
- Community Planning – Support communities in the consideration of natural hazards in all relevant areas of community planning, i.e., comprehensive plans, capital improvement plans, stormwater management, etc.
- Grant Application Development – Support communities in the development of scopes of work, schedules, and budgets for a successful mitigation activity grant application.
- Mitigation Planning Technical Assistance – Support communities by the creation and dissemination of training and technical assistance for achieving mitigation actions. Training can be provided at any time during the Risk MAP project. It may be desired to include a series of training activities over the course of a flood risk project.
- Risk Assessment – Support communities in the assessment of relative risk for decision support, including HAZUS or other methods. Provide technical assistance on how to use a risk assessment tool.
- Risk MAP Data Availability and Tools – Support building community capability to use and understand the regulatory and flood risk components and tools of a Risk MAP project including Flood Risk Products.

The Risk MAP process typically takes 4 to 6 years, with extensive technical assistance provided to the community. Risk MAP not only focuses on flood maps but also on all natural hazards impacting the community, and how new data, risk assessments, and tools can be integrated into community plans and

ongoing efforts to increase community resilience. Once a watershed is selected for Risk MAP based on prioritization from the Alaska Prioritization and Future Studies Sequencing Decision Support System and the Alaska Statewide Threat Assessment, the Alaska Risk MAP Coordinator reaches out to the community to determine its interest in Risk MAP and the community’s primary needs and concerns. After an engagement strategy has been determined, community and Tribal officials, subject matter experts, and stakeholders meet with the Alaska RMC and Risk MAP Project Team (which consists of FEMA, FEMA’s contractors, the Alaska NFIP Coordinator, the Alaska State Hazard Mitigation Officer [SHMO], the Alaska Mitigation Planner, and the Alaska Mitigation Grants Officer) several times throughout the process, including during the following phases:

- Kickoff or “discovery,” including a discovery meeting, post-meeting coordination and project scope development, and discovery report
- Data collection and analysis, including draft work maps and a flood risk review meeting
- Risk reduction, including a risk report, preliminary Flood Insurance Rate Maps (FIRMs) and studies, a meeting with the Consultation Coordination Officer, a public meeting/open house, and a resilience workshop/meeting

The public is invited to participate in Risk MAP by reviewing and commenting on the preliminary FIRMs or studies at the public meeting/open house and to develop and/or refine mitigation strategies at a resilience workshop. Based on input received at the resilience workshop, mitigation strategies are revised to reflect community priorities. During this final phase of Risk MAP, FEMA and the Alaska Risk MAP Coordinator will work with the community to integrate Risk MAP information into local plans, implement the actions identified during the resilience workshop, and seek funding to implement projects identified during the risk reduction phase.

As of September 2022, 19 incorporated municipalities (the Municipality of Anchorage, Fairbank North Star Borough, City and Borough of Juneau, Kenai Peninsula Borough, Ketchikan Gateway Borough, Kodiak Island Borough, Matanuska-Susitna Borough, City and Borough of Sitka, and the Cities of Aniak, Bethel, Cordova, Emmonak, Kotzebue, Kwethluk, and Valdez) within Alaska have been recipients of Risk MAP studies, which have just begun, are under way, or have been completed. Four of these incorporated municipalities were also involved with studies begun under the Map Modernization Program, which has been superseded by Risk MAP. The studies range from risk and vulnerability assessments to LiDAR acquisition to physical map revisions.

5.2 FUNDING CAPABILITIES FOR HAZARD MITIGATION

Table 5-2 lists funding capabilities available in Alaska for hazard mitigation. A description of each funding capability and a discussion of whether and how the funding has been used previously in Alaska are provided in the table. Funding capabilities are listed alphabetically by department or agency.

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
Alaska Center for Climate Assessment and Policy (ACCP) Small Grants Program	ACCP runs a small grants program for statewide and regional non-profit organizations that serve Alaska Native Peoples. The objectives of the grant program include enhancing the capacity for resilience and adaptation and developing leadership for addressing climate challenges. The program is funded in partnership with the United States Arctic Research Commission. In 2022, ACCP awarded small grants up to \$50,000 to the Chugach Regional Resources Commission, Copper River Native Association, Kodiak Area Native Association, and Yukon River Inter-Tribal Watershed Council to focus on climate adaptation needs.
Alaska Department of Commerce, Community, and Economic Development – Division of Community and Regional Affairs: Alaska Climate Change Impact Mitigation Program (ACCIMP) Community Planning Grants	The majority of ACCIMP funds were directed to specific communities that the Governor’s Subcabinet on Climate Change, Immediate Action Workgroup (IAW) has identified as imminently threatened. ACCIMP provides non-competitive funding to these communities for Community Planning Grants to address the recommendations for immediate actions made by the IAW in its 2008 Recommendations Report to the Governor’s Subcabinet on Climate Change. In addition, communities that complete Hazard Impact Assessments are eligible to receive Community Planning Grants, as funding becomes available. Communities that have received ACCIMP funds include Shishmaref, Kivalina, Newtok, Koyukuk, Unalakleet, Shaktoolik, Atmautluak, and Kipnuk. Based on the scope of the community planning project, communities were eligible for grants of up to \$150,000.
FEMA: Assistance to Firefighters Grant (AFG) Program	The AFG Program is a direct annual competitive grant program that focuses on enhancing the safety of the public and firefighters with respect to fire and fire-related hazards. Funding can be used to purchase equipment, protective gear, and emergency vehicles and provide training and other resources related to fire hazards. The AFG Program provides financial assistance directly to eligible fire departments, nonaffiliated emergency medical service organizations, and state fire training academies. Total national funding for fiscal year (FY) 2022 were \$325 million. Since 2018, 38 AFG grants have been awarded in Alaska. The Alaska Department of Public Safety received four grants totaling \$1.63 million for the state’s fire training academy and 34 additional grants totaling \$5.16 million were awarded to local jurisdictions and fire departments to fund various operation and safety measures.
FEMA: Emergency Management Performance Grant (EMPG)	EMPGs are annual pass-through grants that provide state, local, Tribal, and territorial emergency management agencies with the resources required for implementation of the National Preparedness System and works toward the National Preparedness Goal of a secure and resilient nation. Allowable costs support efforts to build and sustain core capabilities across the prevention, protection, mitigation, response and recovery mission areas. Total funding for EMPGs in FY 2022 was \$405.1 million.
FEMA: Emergency Operations Center (EOC) Grant Program	The EOC Grant Program is congressionally directed spending that is intended to improve emergency management and preparedness capabilities by “supporting flexible, sustainable, secure, strategically located, and fully interoperable emergency operations centers with a focus on addressing identified deficiencies and needs” to ensure the continuity of operations and continuity of government during and after any major disaster or emergency. Mitigation staff are often

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
	present in an EOC during disaster or emergency response, and the EOC creates and maintains documentation for immediate or future mitigation opportunities. EOC grants are available to state and local agencies and federally recognized Tribal governments with projects identified in the Notice of Funding Opportunity.. Total funding for the EOC Grant Program for FY 2022 was \$49.02 million. In 2022 the Alutiiq Tribe of Old Harbor was awarded \$1.5 million for a new tsunami shelter.
FEMA: Fire Management Assistance Grant (FMAG)	FMAG is an ongoing non-competitive disaster assistance grant program that is available to state and local agencies, federally recognized Tribal governments, and volunteer fire agencies for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands. To receive funding, the Governor or Governor’s Authorized Representative must submit a request for a fire management assistance declaration to FEMA while a fire is burning or threatens to become a major disaster. Eligible activities may include expenses for field camps; equipment use, repair, and replacement; mobilization and demobilization activities; and tools, materials, and supplies. The State of Alaska most recently received FMAG funds from FEMA on June 25, 2022, to pay for firefighting costs for the Clear Fire in Yukon/Koyukuk Census Area/Denali Borough, Alaska.
FEMA: Hazard Mitigation Assistance (HMA), Building Resilient Infrastructure and Communities (BRIC)	BRIC is an annual competitive pass-through grant program that focuses on reducing the nation’s risk by funding public infrastructure projects that increase a community’s resilience before a disaster affects an area. BRIC was created in 2020 as part of the Disaster Recovery Reform Act of 2018 and replaces FEMA’s legacy Pre-Disaster Mitigation grant program. BRIC funds a wide variety of mitigation activities, including microgrids, flood control, wetland restoration, community relocation/buyouts, seismic retrofits, and nature-based solutions. BRIC is available to state and local agencies and federally recognized tribal governments with a FEMA-approved and locally adopted HMP. In Alaska, the State Hazard Mitigation Advisory Committee (SHMAC), under the guidance of DHS&EM, prioritizes state and local sub-applicants based on the state’s mitigation priorities. (See Section 7.3.1 for more information on the SHMAC.) Total funding for BRIC for FY 2022 was \$2.295 billion. In 2021 Native Village of Ouzinkie was awarded technical assistance help through BRIC to conceptualize a tsunami shelter project.
FEMA: HMA, Flood Mitigation Assistance (FMA)	FMA is an annual competitive pass-through grant program to reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP. FMA funds are available to state and local agencies and federally recognized Tribal governments with a FEMA-approved and adopted HMP. In Alaska, the SHMAC, under the guidance of DHS&EM, prioritizes state and local sub-applicants based on the state’s mitigation priorities. Total funding for FMA in FY 2022 was \$800 million.

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
FEMA: HMA, Hazard Mitigation Grant Program (HMGP)	HMGP is pass-through grant program that supports pre- and post-disaster mitigation plans and projects for state and local agencies and federally recognized Tribal governments. HMGP funding is authorized with a Presidential Major Disaster Declaration. A governor or Tribal chief executive may request HMGP funding when submitting a disaster declaration. The amount of funding made available to the applicant is generally 15% of the total federal assistance amount provided for recovery from the Presidential Major Disaster Declaration. Since 2019, the State of Alaska has received HMGP funding associated with the following disasters: Alaska Earthquake (DR-4413-AK, declared on January 31, 2019); Alaska Mckinley Fire (FM-5287-AK, declared on August 20, 1029) and Alaska Deshka Landing Fire (FM-5290-AK, declared on August 22, 2019) which were rolled into DR-5282 to administration purposes; Alaska Covid-19 Pandemic (DR-4533-AK, declared on April 9, 2020); Alaska Severe Storm, Flooding, Landslides, and Mudslides (DR-4585-AK, declared on February 19, 2021); Alaska Severe Storms, Straight-line Winds, Flooding, Landslides, and Mudslides (DR-4638-AK, declared on January 15, 2022); Alaska Severe Winter Storm and Straight-line Winds (DR-4646-AK, declared on March 14, 2022); Alaska Severe Winter Storm and Straight-line Winds (DR-4648-AK, declared on March 24, 2022); Alaska Landslide (DR-4661-AK, declared on July 26, 2022); Alaska Flooding (DR-4667-AK, declared on August 26, 2022); Post Fire (DR-5442, declared June 6, 2022; and Alaska Severe Storm, Flooding, and Landslides (DR-4672-AK, declared on September 23, 2022). In Alaska, the SHMAC, under the guidance of DHS&EM, prioritizes state and local sub-applicants based on the state’s mitigation priorities with generally 7% of HMGP funding reserved for local/tribal HMPs.
FEMA: HMA, Hazard Mitigation Grant Program Post Fire (HMGP–Post-Fire)	HMGP–Post-Fire is a pass-through grant program that provides funding for state and local agencies and federally recognized Tribal governments to reduce wildfire risks. Funded projects include (but are not limited to) defensible space initiatives, ignition-resistant construction, hazardous fuels reduction, erosion control measures, slope failure prevention measures, and flash flooding prevention. HMGP–Post-Fire grants are available to eligible states and territories that receive Fire Management Assistance declarations and to federally recognized Tribal governments that have land burned within a designated area. A Post-Fire Presidential Disaster Declaration is not required to activate funding. Funding amounts are determined by FEMA and are based on a national aggregate calculation of historical FMAG declarations over the past 10 years. In Alaska, the SHMAC, under the guidance of DHS&EM, prioritizes state and local sub-applicants based on the state’s mitigation priorities. In 2022, FEMA made \$786,552 available to the State of Alaska through the HMGP–Post-Fire for the mitigation of future wildfires and related hazards, such as flood after fire or erosion. Some eligible wildfire project types include defensible space measures, ignition-resistant construction, and hazardous fuels reduction.
FEMA: Homeland Security National Training Program	The HSNTF CTG program provides funding via “cooperative agreements to partners to develop and deliver training to prepare communities to prevent, protect against, mitigate, respond to, and recovery from natural, technological and man-made hazards. Including acts of terrorism.” For FY 2022, the total amount of HSNTF funds available for CTG

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
(HSNTP) Continuing Training Grants (CTG) Program	was \$6 million for two focus areas: climate resilience for equitable outcomes and equity in tribal and rural preparedness.
FEMA: National Earthquake Hazard Reduction Program (NEHRP) Earthquake State Assistance Grant Program	There are two types of NEHRP grants: Individual State Earthquake Assistance (ISEA) and Multi-State and National Earthquake Assistance (MSNEA). NEHRP ISEA is a non-competitive grant that funds earthquake safety, mitigation, and resilience activities for states determined to have high or very high earthquake risks. Eligible activities include seismic mitigation planning, critical facility and lifeline inventory and analysis, building code, zoning code and ordinance seismic safety updates, earthquake outreach and education, and promotion of earthquake insurance. Total funding for FY 2022 was \$2.15 million. NEHRP MSNEA is an annual competitive grant open to nonprofit organizations and institutions of higher education through research and activities in the fields of earthquake science and engineering. Total funding for NEHRP FY 2022 was \$1.39 million.
FEMA: Nonprofit Security Grant Program (NSGP)	NSGPs are annual competitive pass-through grants that provide funding support for target hardening and other physical security enhancement activities to nonprofit organizations that are at a high risk of terrorist attack. The program is designed to promote coordination and collaboration in emergency preparedness activities among public and private community representatives, as well as state and local government agencies. Total funding for NSGP-S in FY 2022 was \$125 million.
FEMA: Port Security Grant Program (PSGP)	PSGPs are annual competitive direct grants that provide funding to state, local and private-sector partners to help protect critical port infrastructure from terrorism, enhance maritime domain awareness, improve port-wide maritime security risk management, and main or reestablish maritime security mitigation protocols that support port recovery and resiliency capabilities. Total funding for PSGP in FY 2022 was \$100 million.
FEMA: Rehabilitation of High Hazard Potential Dams (HHPDs) Grant Program	The HHPDs Grant Program is an annual competitive pass-through grant program that provides technical, planning, design, and construction assistance for eligible rehabilitation activities (repair, replacement, reconstruction, or removal of a dam) that reduce dam risk and increase community preparedness. The HHDPs Grant Program is available to state agencies and federally recognized Tribal governments in states with a state dam safety program authorized by state legislation. There are several requirements for this grant program, including that each applicant must have FEMA-approved and adopted HMP, must participate in the NFIP, and have ADNR's award approval. Total funding for FY 2022 will be \$22 million. There have been no HHDP grants awarded in the state of Alaska since program inception in 2019.
FEMA: State Homeland Security Program (SHSP)	SHSP grants are annual competitive pass-through grants that assist state, local, Tribal, and territorial efforts in preventing, protecting against, mitigating, responding to and recovering from acts of terrorism and other threats. It provides grantees with the resources required for implementation of the National Preparedness System and works

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
	toward the National Preparedness Goal of a secure and resilient nation. Allowable costs must have a nexus to terrorism preparedness and fall into the categories of planning, organization, exercises, training, or equipment to building capability, closing capability gaps, and/or sustaining capabilities. Total funding for SHSP in FY 2022 was \$415 million.
FEMA: Tribal Homeland Security Grant Program (THSGP)	THSGP is an annual competitive grant to provide funding directly to eligible tribes to strengthen their capacity in preventing, protecting against, mitigating, responding to and recovering from acts of terrorism and other threats. It provides grantees with the resources required for implementation of the National Preparedness System and works toward the National Preparedness Goal of a secure and resilient nation. Allowable costs must have a nexus to terrorism preparedness and fall into the categories of planning, organization, exercises, training, or equipment to building capability, closing capability gaps, and/or sustaining capabilities. Total funding for THSGP in FY 2022 was \$15 million. In 2021 the Inupiat Community of the Arctic Slope received \$1.78 million.
FHWA: Federal Highways Administration (FHWA) Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program	PROTECT funds projects to “improve the resilience to natural hazards and climate change impacts” by reducing damage and disruption to transportation systems and improving the safety of public travel. It does so through funding projects that improve the resilience of the surface transportation system, including highways, public transportation, ports, and intercity passenger rail. In addition, it also funds nature-based solution for conservation, restoration, and/or construction of riparian and streambed treatments, marshes, wetlands, native vegetation, stormwater bioswales, breakwaters, reefs, dunes, and shade trees along transportation systems. FHWA will seek to award projects to communities that demonstrate a strong need for the funding and will set aside funding for rural communities and Indian Tribes. Total funding for FY 2022 and FY 2023 was \$250 million annually with an additional \$400 million appropriated. Currently, \$300 million is authorized annually for FYs 2024, 2025, and 2026.
National Institute of Standards and Technology and the U.S. National Science Foundation: Disaster Resilience Research Grant (DRRG)	The DRRG is an annual competitive grant program that funds institutional research to improve the ability of buildings, infrastructure, and communities to hold strong against natural hazards. Total funding for this grant program in FY 2022 will be \$7.6 million. There have been no DRRG grants awarded in the state of Alaska since program inception in 2020.
National Science Foundation (NSF) grants	The NSF is an independent federal agency that supports fundamental research and education in the non-medical fields of science and engineering. In FY 2021, the NSF awarded \$56.05 million in Alaska. Some of this funding was used to support the Fire and Ice project, which is led by UAF. The “fire” part of the project focuses on the boreal forest. Researchers are working to identify drivers of fire weather, map active fire behavior, and evaluate the impacts of wildfire on ecosystem services in affected communities. This project will inform fire management and lead to the development of improved fire-spread

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
	models and tools for fire risk evaluation and web-based fire forecasts. In addition, University of Alaska Anchorage’s (UAA) Institute of Social and Economic Research is developing a new online wildfire exposure map as part of the National Science Foundation’s Arctic Urban Risks and Adaptations.
National Oceanic and Atmospheric Administration (NOAA): Environmental Literacy Program	The Environmental Literacy Program is an annual competitive grant program that focuses on helping communities build environmental literacy around resilience to extreme weather, climate change, and other environmental hazards. NOAA’s vision is to help communities understand current conditions, project future changes, and make informed decisions that reduce vulnerability and increase the ability to cope—or mitigate—natural hazards. The Environmental Literacy Program is available to institutions of higher education, public and independent schools and school systems, other nonprofits, state and local agencies, and federally recognized Tribal governments. Total funding for FY 2022 will be \$5 million. The Chugach School District was one of 9 out of 237 pre-applicants selected for an Environmental Literacy Award in 2018. The district received \$499,888 to “bring together traditional Alaska Native ways of knowing and Western scientific data” to help Alaskan students, teachers, and their communities to build resilience to extreme weather events and other environmental hazards.
NOAA NWS: Tsunami Financial Assistance	Since passage of the Tsunami Warning, Education, and Research Act in 2017 (P.L. 115-25, Title V) and its predecessor legislation in 2007 (TWEA, P.L. 109-479 Title VIII), Congress has authorized and directed NOAA’s NWS to provide financial assistance to state and local agencies and federally recognized Tribal governments through the NTHMP. Financial assistance is provided for hazard assessment and mapping, community preparedness, public notification and warning, drills and exercises, and participation in the NTHMP. In FY 2019, DHS&EM (and subgrantee UAF) were awarded tsunami financial assistance to conduct community outreach visits and development of tsunami education materials, travel for the Emergency Management member and Science member of the NTHMP Coordinating Committee to NTHMP meetings and a Powell Center workshop, publish technical reports and Approximate Tsunami Hazard Zone Boundaries for 11 communities in the Kodiak and Aleutian Islands, south-central and southeast Alaska, conduct two-and-a-half day workshop that discusses the science of tsunamis, local threat, preparedness, warning and alerting procedures, as well as response and recovery for community leaders and local emergency managers, publish and present the technical reports for highly threatened communities: Akohok, Chiniak, and Old Harbor, conduct high-resolution mapping and technical reports for Ouzinkie and Port Lions, estimate tsunami currents in two harbors of southeastern Alaska, design and print evacuation brochures for 9 communities, and conduct tsunami siren status checks/evaluation.
NOAA and the National Fish and Wildlife Foundation, and other governmental and private-sector	NCRF is a direct annual competitive grant program that supports the implementation of nature-based solutions to enhance the resilience of coastal communities and ecosystems by reducing the “threats from coastal hazards (such as rising sea- and lake-levels, more intense storms, increasing flooding and erosion, and melting permafrost) to property

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
partners: National Coastal Resilience Fund (NCRF)	and key assets, such as hospitals and evacuation routes.” The NCRF funds nature-based solutions including restoring coastal marshes, reconnecting floodplains, rebuilding dunes or other natural buffers, and installing living shorelines. NCRF grants are available to state and local agencies and federally recognized Tribal governments within the coastal areas of the United States. Total funding for NCRF for FY 2022 will be \$140 million. In 2018, the Alaska Native Tribal Health Consortium was awarded \$2.7 million to decommission 12 houses and all associated infrastructure to restore 3 acres of coastal wetland habitat in Newtok, Alaska. In 2019, the Agviq Environmental Services received \$215,000 to identify and assess potential shoreline sites at risk to coastal erosion, flooding, and storm surge for adaptation and to develop resiliency projects in and around Point Hope, Alaska. Also in 2019, the Native Village of Shaktoolik was awarded \$1.0 million to build a nature-based storm surge berm. In 2020, the Alaska Native Tribal Health Consortium received \$1.3 million to provide adaptation planning and development of coastal erosion and flood hazard mitigation and restoration solution support for 44 Alaskan Resilience Hub communities.
Natural Resources Conservation Service (NRCS): Watershed Programs	The NRCS Watershed Programs provides technical and financial assistance to help implement conservation practices that address watershed resource concerns through the following programs: Emergency Watershed Protection (EWP) Program: The EWP Program offers technical and financial assistance to help relieve imminent threats to life and property caused by floods, fires, windstorms, and other natural disasters that impair a watershed. EWP grants are available to local agencies, conservation districts, federally recognized Tribal governments, and interested public and private landowners that have a sponsor. EWP does not require a disaster declaration by the federal or state government. In Alaska, federally recognized Tribal governments are often the primary local sponsors requesting federal assistance through EWP. Over the past 11 years, NRCS has completed EWP projects in 24 Alaska communities. Most recently, in 2020, NRCS provided EWP assistance to two federally recognized tribes in rural Alaska to relocate homes threatened by rapid riverbank erosion. Watershed Protection and Flood Prevention (WFPO) Program: The WFPO Program provides technical and financial assistance to help plan and implement watershed programs, including flood prevention. It is available to state and local agencies and federally recognized Tribal governments and for watersheds that are 250,000 acres and smaller. Watershed Rehabilitation Program (REHAB): REHAB provides technical and financial assistance to rehabilitate aging dams that are reaching the end of their design life and/or no longer meet federal or state safety criteria or performance standards or build or augment existing water supplies based on current and future water supply demands. In 2022, NRCS received \$918 million of Bipartisan Infrastructure Law funding to allocate through its watershed programs.
Office of Wildland Fire: Burned Area Rehabilitation (BAR) Program	The BAR Program supports efforts to repair or improve burned landscapes unlikely to recover without human assistance. The program, which must be implemented within the first 5 years after a fire, “jump-starts” the landscape

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
	recovery process by spreading native plant seeds or planting native seedlings, applying herbicides to kill invasive plants, removing them by hand, or introducing bacteria to control them, and using heavy equipment to disrupt the growth of targeted plant species or contour landscapes to control runoff. This program also funds the repair or replacement of minor infrastructure damaged by a wildfire, such as small trail bridges, handrails, campgrounds, boat ramps, stock tanks, or informational kiosks. Although BAR’s scope of work is limited to federally managed lands only, in Alaska approximately 65% of the land is owned and managed by the United States Federal Government as public lands. Total funding for BAR in FY 2021 was \$20.5 million.
Office of Wildland Fire: Fuels Management Program	The Fuels Management Program supports the “strategic removal of grasses, shrubs, and trees to restore and maintain ecosystems and limit the negative impacts of wildfires.” This support is achieved through such activities as deliberately prescribed fire, thinning forested areas with chainsaws or heavy equipment, removing brush and small trees by hand, reducing the quantity of grasses and shrubs mechanically or by placing domestic, grazing animals (e.g., cows, goats) on a landscape, and chemically treating an area overgrown with invasive plants using herbicides. Similar to the BAR Program, the Fuels Management Program is limited to federally managed lands only. In September 2022, \$3.3 million in funding from the DOI’s wildland fire management investments was allocated to fuel treatments for 8,000 acres of “high wildfire hazard potential” areas in Alaska.
United States Army Corps of Engineers (USACE): Civil Works Program	The USACE Civil Works Program funds studies and projects to maintain existing infrastructure and to repair damage and dredge channels in response to floods and coastal storms. For FY 2022, the USACE will utilize \$22.81 billion in supplemental funding from the Infrastructure Investment and Jobs Act (also known as the Bipartisan Infrastructure Law) and 2022 Disaster Relief Supplemental Appropriations Act. Over \$5 billion will be used to improve community resilience to climate change. In January 2022, the Alaska District’s Civil Works Program was awarded \$940.7 million by the USACE Civil Works Program to fund critical civil works projects, including the Lowell Creek Flood Diversion Project, the Moose Creek Dam Safety Modification Project, the Kenai River Bluffs Erosion Project, and the Barrow Alaska Coastal Erosion Project.
USACE: Corps Water Infrastructure Financing Program (CWIFP)	The USACE Corps Water Infrastructure Financing Program (CWIFP) is authorized by the Water Infrastructure and Finance Innovation Action to “enables local investment in infrastructure projects that address community water resource needs, promote economic prosperity, and improve environmental quality.” Currently, CWIFP provides up to \$7.5B+ in loans for maintaining, upgrading and repairing dams for any non-Federal borrowers.
United States Department of Housing and Urban Development (U.S. HUD): Community	CDBG-DR grants helps state and local agencies and federally recognized Tribal governments recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. CDBG-DR funds a broad range of recovery activities, but each activity must address a direct or indirect impact from the disaster in a most-impacted and distressed area, be a CDBG-eligible activity, and meet a national objective

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
Development Block Grant–Disaster Recovery (CDBG-DR)	(combating climate crisis and advancing equity). Grantees must ensure that their activities align with the mitigation strategy of their State Hazard Mitigation Plan (SHMP). In 2022, HUD allocated nearly \$3 billion in CDBG-DR funds for major disasters occurring in 2020 and 2021. In response to the 2018 Cook Inlet Earthquake (DR-4413) in January 2020, HUD allocated \$35.86 million CDBG-DR funds into the state of Alaska to address unmet housing needs. HUD identified the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Kenai Peninsula Borough as the only CDBG-DR-eligible jurisdictions in their entirety and identified the Municipality of Anchorage as the “most impacted and distressed” area. The State of Alaska is using the funds for the relocation of households to safer areas, affordable housing, other unmet housing needs, and planning activities to aid in regional recovery. The CDBG-DR program is operated under the oversight of the DCRA.
U.S. HUD: Community Development Block Grant–Mitigation (CDBG-MIT)	CDBG-MIT provides funding for mitigation activities that “increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering and hardship, by lessening the impact of future disasters.” In response to DR4413, HUD allocated an additional \$2.29 million in CDBG-MIT grants to the State of Alaska in January 2021. Specifically, \$1.1M was allocated to the Municipality of Anchorage and another \$1.1M to the Matanuska-Susitna Borough and the Kenai Peninsula Borough. Unlike other forms of federal disaster recovery assistance, CDBG-DR and CDBG-MIT grants have “a statutory focus on benefiting vulnerable lower-income people and communities and targeting the most impacted and distressed area,” which HUD designated for the Municipality of Anchorage. The CDBG-MIT program is operated under the oversight of DCRA. As the lead administrative agency, DCRA has developed a CDBG-MIT Action Plan (draft, November 2022) to “provide an in-depth analysis of current and future risks to the State, as well as propose a high-level strategy for how the funding will be used to address these risks and disaster mitigation needs in eligible jurisdictions.”
United States Environmental Protection Agency (US EPA): Wetland Program Development Grants (WPDG)	WPDGs promote “the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys and studies relating to the causes, effects, extent, prevention, reduction and elimination of water pollution.” The program is meant to build capacity to both increase the quantity and quality of wetlands in the U.S. by conserving and restoring wetland acreage and improving wetland condition. WPDGs eligibility is dependent on grant cycle and can include state and local agencies, federally recognized Tribal governments, non-profits (including non-profit universities), non-governmental organizations, interstate agencies, and intertribal consortia. Alaska has been the recipient of several WPDGs including Sitka Tribe of Alaska Wetlands Program Plan Development, AUU Wetland Map Development for the Matanuska-Susitna Basin and Alaska Department of Natural Resources – Alaska Wetland Collaborative.
United States Fish and Wildlife Service (USFWS): National Coastal	The NCWC Grants Program is an annual competitive grant program through the USFWS to fund projects that protect, restore, and enhance coastal wetland ecosystems and associated uplands. Grants range from \$50,000 to \$1 million and

Table 5-2: Hazard Mitigation Funding Capabilities for State Use

Type	Overview and State Use
Wetlands Conservation (NCWC) Grants Program	are available to eligible state agencies (which often collaborate with land trusts, tribes, conservation organizations, and other entities to plan and “deliver the conservation outcomes”). The total funding for the NCWC Grants Program for FY 2022 was \$20 million. In April 2021, the State of Alaska (Department of Natural Resources) was awarded an NCWC grant of \$340,000 to acquire and protect 0.44 square mile of coastal wetland habitat in the Kasilof River Flats, including 2.25 miles of river shoreline. This project will not only protect and provide habitat for wildlife but will help prevent erosion of the dunes, thereby reducing the chances of lowland area flooding.
United States Forest Service (USFS): Community Wildfire Defense Grant (CWDG)	The CWDG, funded through the Bipartisan Infrastructure Law, is intended to help at-risk local communities and tribes reduce their risk from wildfire. The grant provides funding for two types of projects: the development and revision of Community Wildfire Protection Plans (CWPPs) and the implementation of projects described in CWPPs that were written less than 10 years ago. Priority is given to at-risk communities in an area that is identified as having high or very high wildfire hazard potential, low income, and/or has been impacted by a severe disaster.

5.3 OBSTACLES, CHALLENGES, AND SOLUTIONS TO ALASKA’S HAZARD MITIGATION CAPABILITIES

A major obstacle to hazard mitigation in Alaska is that not all I-Codes are adopted and/or enforced statewide. Local jurisdictions may have their own residential codes to follow, and the Alaska Housing Finance Corporation adopts the IRC for its residential standard and the IECC for its Building Energy Efficiency Standard. However, if a residential building is built outside of a jurisdiction with a residential code and without financing, it may not be built to meet the basic requirements of the IRC. In addition to lack of code adoption, there is limited code enforcement in Alaska. Many rural Alaskan communities lack the personnel and technical experience to carry out code enforcement responsibilities. One solution to overcoming the lack of code adoption would be to have greater public outreach around the importance of the IRC and IECC.

As noted previously, another major obstacle is the lack of participation in the NFIP. In Alaska, many jurisdictions are ineligible to join the NFIP due to their inability to adopt and enforce a flood damage prevention ordinance. The 2022 Alaska Mapping Business Plan notes that the inability of many jurisdictions to adopt and enforce flood damage prevention ordinances is of concern because most of Alaska’s federally declared disasters involving flood or severe storm events have occurred in the Unorganized Boroughs within the Bethel, Kusilvak, and Yukon-Koyukuk census areas, where there are no residential building codes or flood damage prevention ordinances. Within these three census areas, only 9 of the 87 Alaska Native villages participate in the NFIP. More than half of the villages within these census areas are ineligible to participate in the NFIP. Similar to the lack of I-code adoption, one solution to overcoming the lack of code adoption would be to have greater public outreach around the importance of the NFIP.

Another challenge to hazard mitigation in Alaska is the lack of accurate, statewide hazard data to support mapping, planning, and policy mitigation strategies and risk communication. These gaps are often extensive because of the challenges of collecting data in vast remote and cold environments. To overcome these gaps, in recent years:

- The Alaska Earthquake Center has partnered with DGGS and DHS&EM to evaluate and map potential tsunami inundation by using numerical modeling of tsunami wave dynamics. Communities are selected for mapping based on their tsunami hazard exposure, location, infrastructure, availability of data, and “willingness to incorporate the results into a hazard mitigation plan.”
- DGGS, through its Coastal Hazards Program, has worked to address the lack of hazard data by developing erosion and flood forecasts for Alaska communities. To date, DGGS has mapped and developed detailed erosion reports for nearly 50 Alaska coastal communities. In addition, DGGS is creating similar assessments for floods and has completed community flood assessments for two communities, with similar assessments planned for other communities.
- UAA’s Institute of Social and Economic Research is currently creating new online maps that show wildfire impact. Maps are available statewide, minus Southeast Alaska and the Aleutian Islands. Site-specific maps are also available for the Municipality of Anchorage. Maps are available for the Anchorage, Fairbanks and Whitehorse.
- TUSFWS’s National Wetlands Inventory program is currently working to map nearly 200 million acres of wetlands, including communities in the Yukon-Kuskokwim Delta that experience coastal and riverine flooding. The USACE and USFWS, along with other stakeholders, are using this data to create community-specific maps with the goal of informing future development and floodplain management planning decisions.

5.3.1 Changes in Alaska’s Hazard Mitigation Capabilities since the 2018 SHMP

Since the preparation of the 2018 HMP, the following changes have occurred to Alaska’s hazard mitigation capabilities:

- A mitigation planning database has been developed to store information from every local and tribal HMP they had on file and retrieve data in an online community table/report.
- Wetland maps specific to the City of Bethel, the Village of Aniak, and the Native Village of Napaimute of the Yukon-Kuskokwim Delta have been created using the National Wetlands Inventory geodatabase.
- State and local practitioners have been trained on Alaska-specific ice jam issues using USACE Cold Regions Research and Engineering Laboratory information.
- AURA has been created to addresses changing environmental hazards around Anchorage, Fairbanks, and Whitehorse through community involvement and the development wildfire impact mapping and assessment tools. Lower resolution wildfire impact maps have also been created statewide.
- The following building codes have been adopted: 2021 IBC, 2021 IEBC, 2018 IECC, 2021 IFC, 2021 IFGC, 2021 IMC and 2018 IRC.
- The Alaska Volcano Observatory now has approximately 200 stations installed to monitor Alaska's volcanoes with ground-based geophysics, including seismometers, infrasound sensors, webcams, and GNSS monuments.
- Tsunami inundation maps and a mobile-friendly tsunami hazard map tool have been created for 27 at-risk communities.
- Community erosion assessments have been created for 50 communities and community flood assessments have been developed for two communities.
- The City of Kenai joined the NFIP.

6 MITIGATION STRATEGY

Standard State Mitigation Plan Regulation Checklist
MITIGATION STRATEGY
S9. Does the mitigation strategy include goals to reduce long-term vulnerabilities from the identified hazards? [44 CFR § 201.4(c)(3)(i)]
S9-a. Does the plan identify hazard mitigation goals representing what the state seeks to accomplish through mitigation plan implementation using a wide range of funding, including non-FEMA funding?
S9-b. Are the goals consistent with the hazards and vulnerabilities identified in the risk assessment?
S10. Does the plan prioritize mitigation actions to reduce vulnerabilities identified in the risk assessment? [44 CFR §§ 201.4(c)(3)(i), 201.4(c)(3)(ii) and 201.4(c)(3)(iii)]
S10-a. Does the plan identify actions based on the current risk assessment to reduce the vulnerability of jurisdictions within the state, as well as the vulnerability of state assets as described in Elements S5 and S6?
S10-b. Does the plan describe the process used by the state to evaluate and prioritize actions that are cost-effective, environmentally sound, and technically feasible?
S10-c. Does the plan describe how each action contributes to the hazard mitigation goals?
S10-d. Does the plan describe how local government mitigation strategies link to the state mitigation strategy?
S11. Does the plan identify current and potential sources of funding to implement mitigation actions and activities? [44 CFR § 201.4(c)(3)(iv)]
S11-a. Do mitigation activities include the identification of current and/or potential sources of federal, state, local or private funding for implementation?
S11-b. Does the plan identify FEMA mitigation funding sources (if applicable), including, but not limited to: HMGP, BRIC, FMA and PA Mitigation, at a minimum?
S12. Was the plan updated to reflect progress in statewide mitigation efforts and changes in priorities? [44 CFR § 201.4(d)]
S12-a. Does the plan provide a narrative of the status of each mitigation action in the previous plan?
S12-b. Was the prioritization of mitigation actions and activities updated based on the updated analysis of risks, capabilities and progress?

Source: FEMA 2022.

6.1 GOALS

Mitigation goals are defined as general guidelines that explain what a community wants to achieve in terms of hazard and loss prevention. Goal statements are typically long-range, policy-oriented statements representing a community-wide vision. The goals for the 2023 State Hazard Mitigation Plan (SHMP) are as follows:

- Goal 1: Increase public awareness about the risks from and resilience to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard potential dams.
- Goal 2: Identify locations and State of Alaska (State) critical facilities (CFs) that are vulnerable to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard

potential dams and support local and tribal communities through technical and/or financial assistance in their efforts to do the same.

- Goal 3: Implement projects to reduce risks and increase resilience to the following hazards: cryosphere and permafrost degradation, earthquake, flood and erosion, ground failure, tsunami and seiche, volcano, severe weather, wildland and community fire, and high hazard potential dams and support local and tribal communities through technical and/or financial assistance in their efforts to do the same.

6.2 PRIORITIZED MITIGATION ACTIONS

Mitigation actions help achieve the goals of the 2023 SHMP. A list of mitigation actions was developed based on the 2023 SHMP (Section 4, Hazard Identification and Risk Assessment; Section 5, State Capabilities; and Section 7, Local Planning and Coordination and Capability Building), lessons learned from recent disasters, Federal Emergency Management Agency (FEMA) success stories and best management practices, State agency/department plans and reports, and input from the 2023 SHMP Task Force and other relevant practitioners.

As shown in Table 6-1, each mitigation action developed has been grouped in the following categories: hazard mitigation planning, assessment and mapping, structure and infrastructure, nature-based solutions, and outreach and awareness. Each mitigation action has been assigned a priority of “high” or “very high” by the task force based on the action’s ability to address a major capability gap (i.e., lack of necessary data) or address an urgent need (i.e., life-safety) and be cost-effective, environmentally sound, and technically feasible to the greatest extent possible.

Tables 6-2 through 6-6 list detailed project descriptions; hazards mitigated; potential funding sources; project sources; and cost, environmental, and technical considerations for each mitigation action. In addition, for each mitigation action there is description of how the action contributes to the SHMP’s hazards mitigation goals.

Table 6-2 also discusses how mitigation actions identified in local and tribal hazard mitigation plans link to the 2023 SHMP.

Table 6-1: Prioritized Mitigation Action Plan

Project Type	Project Name	Priority
Hazard Mitigation Planning	Mitigation Planning Database Expansion	Very high
	Local and Tribal Hazard Mitigation Planning Support	Very high
	Local and Tribal Community Mitigation Strategies Link-Up to State Mitigation Strategy	Very high
Assessment and Mapping	Wildfire Exposure Map Expansion	Very high
	Risk MAP Expansion	Very high
	Coastal Community Flood Assessment Expansion	Very high
	Alaska Climate Change Impact Mitigation Program Expansion	Very high
	Landslide and Avalanche Susceptibility Map Expansion	Very high
	Tsunami Inundation Mapping Program Expansion	Very high
	Alaska Statewide Digital Elevation Model Update	Very high
	Wetland Map Expansion	Very high
	Inundation Mapping Quality and Program Expansion for High Hazard Potential Dams	High
	Erosion Forecast Mapping Expansion	High
	Shoreline Change Mapping Expansion	High
	UAF/SNAP Database Expansion	High
	Expansion of SCERP Program	High
Structure and Infrastructure	State Critical Facility Rapid Visual Screenings Expansion	Very high
	State Critical Facility Structural Hardening Assessments	Very high
	State Critical Facility Defensible Space Assessments	Very high
	Hazard Fuel Reduction Program Expansion	Very high
	Flood Buyout Expansion	Very high
	High Hazard Potential Dams Remedial Investigations and Repair	Very high
	Increase Instrumentation and Data Accessibility for the National Volcano Early Warning System	Very high
	Complete High Hazard Potential Dam Failure Dataset	High
	Statewide Transportation Facilities Comprehensive Dataset Expansion	High
Nature-Based Solutions	Coastal and Riverbank Stabilization Program	High
	Wetlands Action Plan Templates	High
Outreach and Awareness	Hazard Mitigation Training	Very high
	Rural Resilience Workshop Expansion	High
	Tsunami Operations Workshop Expansion	High
	TsunamiReady and StormReady Expansion	High
	Community Wildfire Protection Plan Outreach Expansion	High

Table 6-1: Prioritized Mitigation Action Plan

Project Type	Project Name	Priority
	Alaska Firewise Expansion	High
	Continuation of Building Safety Month	High
	Continuation of Fire Prevention Month	High
	Volcano Awareness Month	High
	National Flood Insurance Program Expansion	High
	Increase Awareness of the ShakeOut Program/Drill	High

Notes:

MAP = Mapping, Assessment, and Planning

Table 6-2: Hazard Mitigation Planning Actions

Mitigation Planning Database Expansion	
Description	Background: As described in Sections 5 and 7, DHS&EM has created a database that contains information from every local and tribal HMP on file with the State. With this information, DHS&EM can quickly generate community tables/reports. Action: Grow the database to be able to quickly identify threats and hazards within a community or communities and generate a standardized community-specific executive summary sheet that contains hazards/threats, mitigation strategy (goals/prioritized actions), and critical assets (particularly, the owners of the assets). Establish a criterion for hazard probability and magnitude for future updates to Table 4.3-1: Local Jurisdiction Probability and Magnitude. Include interactive hazard mapping within the database. Additional Information: Overall, an expansion of the DHS&EM Mitigation Planning Database will allow local and tribal hazard mitigation plans, including CF lists, risk assessments and mitigation strategies, to be queried by DHS&EM on a regular basis and be captured to include in future versions of the State HMP.
Hazard Mitigation Goal	Goal 2: The expanded DHS&EM Mitigation Planning Database will help DHS&EM staff better understand areas and CFs that are vulnerable to all hazards. Goal 3: The expanded DHS&EM Mitigation Planning Database will help DHS&EM staff develop an inventory of HMP mitigation projects to reduce risks and increase resilience.
Hazards Mitigated	All
Potential Funding Source	BRIC and HMGP
Project Source	DHS&EM
Cost Considerations	Data acquisition, operational and maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with database management capabilities and hazard mitigation program knowledge
Local and Tribal Hazard Mitigation Planning Support	
Description	Background: DHS&EM's Hazard Mitigation Program was initiated in response to DMA 2000, which mandates community hazard mitigation planning for FEMA disaster mitigation funding eligibility. The State supports local and tribal hazard mitigation planning efforts with grant funding opportunities and direct assistance. Action: Continue to support local and tribal communities throughout Alaska with hazard mitigation planning grant funding opportunities and direct assistance.
Hazard Mitigation Goal	Goal 1: Hazard mitigation planning will increase public awareness about all hazards. Goal 2: Hazard mitigation planning will help the State and local and tribal communities identify locations and CFs that are vulnerable to all hazards.

	Goal 3: Hazard mitigation planning and direct assistance will help local and tribal communities implement projects to reduce risks and increase resilience to all hazards.
Hazards Mitigated	All
Potential Funding Source	BRIC and HMGP
Project Source	DHS&EM
Cost Considerations	Travel costs
Environmental Considerations	None
Technical Considerations	Staff with hazard mitigation program knowledge
Local and Tribal Community Mitigation Strategies Link-Up to State Mitigation Strategy	
Description	Background: As noted above, DHS&EM has created a database that contains information from every local and tribal HMP on file with the State. With this information, DHS&EM can quickly generate community tables/reports. The database does not currently include a function to quickly query local and tribal HMP mitigation strategies (goals/actions), and currently DHS&EM must either receive FEMA grant applications from local and tribal communities and/or look up each individual local and tribal HMP to understand how to support local and tribal mitigation efforts. Action: Grow the database to be able to quickly query mitigation strategy (goals/prioritized actions) in local and tribal HMPs. The query function should be able to sort mitigation actions by location, hazard type, mitigation project category (hazard mitigation planning, assessment and mapping, structure and infrastructure, nature-based solutions, and outreach and awareness) and 2023 SHMP goals (Section 6.1).
Hazard Mitigation Goal	Goal 3: Linking up local and tribal mitigation strategies to the 2023 State HMP, specifically the 2023 State HMP mitigation strategy, will help local and tribal communities implement projects to reduce risks and increase resilience from all hazards.
Hazards Mitigated	All
Potential Funding Source	BRIC and HMGP
Project Source	DHS&EM
Cost Considerations	Data acquisition, operational and maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with database management capabilities and hazard mitigation program knowledge

Notes:

BRIC = Building Resilient Infrastructure and Communities

CF = critical facility

DHS&EM = Alaska Division of Homeland Security and Emergency Management

DMA 2000 = Disaster Mitigation Act of 2000

FEMA = Federal Emergency Management Agency
HMGP = Hazard Mitigation Grant Program
HMP = Hazard Mitigation Plan
State = State of Alaska

Table 6-3: Assessment and Mapping Actions

Wildfire Exposure Map Expansion	
Description	Background: As described in Section 5, Table 5-1, AURA is a 4-year program that addresses changing environmental hazards around the Municipalities of Anchorage, Fairbanks, and Whitehorse. Action: Expand wildfire exposure mapping program so that wildfire mapping is completed for the entire state. The expanded mapping program will need to include updated data sets (current wildfire maps do not include data past 2014), more detailed work with vegetation, the identification and mapping of water sources, a public reporting tool, and ongoing maintenance to update old data.
Hazard Mitigation Goal	Goal 1: Wildfire exposure maps will increase awareness of risks and resilience from wildland and community fire hazards. Goal 2: Wildfire exposure maps will help State, local and tribal communities identify location and CFs that are vulnerable to wildland and community fire hazards.
Hazards Mitigated	Wildland and community fires
Potential Funding Source	BRIC and HMGP
Project Source	UAA
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with data acquisition, mapping skills, and public information capabilities
Risk MAP Expansion	
Description	Background: Risk MAP combines flood hazard mapping, risk assessment tools, and mitigation planning into one integrated program with the intent to establish “beneficial partnerships and innovative uses of flood hazard and risk assessment data to ensure the greatest possible reduction in flood losses.” Action: Continue to implement Risk MAP in Alaska. The RMC can provide training and technical assistance to Alaska communities in the areas of BCA, building science, community capability development, CRS, community planning, grant application development, mitigation planning technical assistance, risk assessment, and Risk MAP data availability and tools.
Hazard Mitigation Goal	Goal 1: Risk MAP will increase public awareness about flood hazards. Goal 2: Risk MAP will help the State and local and tribal communities identify locations and CFs that are vulnerable to flood hazards.
Hazards Mitigated	Flood and erosion, severe weather
Potential Funding Source	Cooperating Technical Partnership between FEMA and the State
Project Source	DCRA
Cost Considerations	Engineering, program knowledge and travel costs

Environmental Considerations	None
Technical Considerations	Staff with data acquisition and mapping skills and public information capabilities
Coastal Community Flood Assessment Expansion	
Description	Background: Coastal communities in Alaska experience frequent storm surge flooding, yet the majority do not have a clear and consistent record of flooding. Local and statewide flood mitigation decisions require a clear understanding of flood risk, but the risk for many communities has not been adequately determined due to the difficulty of discovering information or interpreting flood impacts. DGGS is compiling a list of all known floods for individual communities. The flood height is estimated using written accounts, photographs, historical and modern imagery, and elevation models. The current risk of flooding is determined by comparing historical flood extents to current infrastructure. Each community-specific report includes a flood risk category map showing current infrastructure and previous floods. To date, Golovin and Hooper Bay have completed maps, and the next flood assessments will include Alakanuk, Kotlik, and Napakiak. Action: Expand the Coastal Community Flood Assessments to cover additional coastal communities in western Alaska. Community-specific reports include a flood category map showing current infrastructure, and a graphic relating infrastructure heights with previous floods.
Hazard Mitigation Goal	Goal 1: Coastal Community Flood Assessments will increase public awareness about flood, erosion, and severe weather hazards. Goal 2: Coastal Community Flood Assessments will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to flood, erosion, and severe weather hazards.
Hazards Mitigated	Flood and erosion, severe weather
Potential Funding Source	BRIC and NCRF
Project Source	DGGS
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Data acquisition and mapping skills and public information capabilities
Alaska Climate Change Impact Mitigation Program Expansion	
Description	Background: The Alaska Climate Change Impact Mitigation Program (ACCIMP) provides funding to Alaskan communities that meet one or more of the following criteria related to flooding, erosion, melting permafrost or other climate-change-related phenomena: Life/safety risk during storm/flood events, loss of critical infrastructure, public health threats, and loss of 10% of residential dwellings. Action: The Hazard Impact Assessment (HIA) is the first step in the ACCIMP process. The HIA identifies and defines the climate-change-related hazards in the community, establishes current and predicted impacts, and provides recommendations to the community on alternatives to mitigate the impact.

Hazard Mitigation Goal	Goal 1: The ACCIMP will increase public awareness about cryosphere and permafrost degradation, flood and erosion, and severe weather hazards. Goal 2: The ACCIMP will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to cryosphere and permafrost degradation, flood and erosion, and severe weather hazards.
Hazards Mitigated	Cryosphere and permafrost degradation, flood and erosion and severe weather
Potential Funding Source	The ACCIMP funds (\$50,000), Community Planning Grants (\$150,000)
Project Source	DCRA
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with data acquisition and mapping skills and public information capabilities
Landslide and Avalanche Susceptibility Map Expansion	
Description	Background: DGGs is currently involved in a number of landslide assessment and monitoring projects in Alaska, including developing landslide inventory/susceptibility maps and modeling flow run-out of ground failure hazards, including debris flows, landslides, and avalanches for the Sitka and Homer areas. Historic avalanche zone maps have also been created for the Municipality of Anchorage. Action: Develop landslide and avalanche inventory/susceptibility maps and model flow run-out of ground failure hazards, including debris flows, landslides, and avalanches throughout Alaska.
Hazard Mitigation Goal	Goal 1: The ACCIMP will increase public awareness about ground failure hazards. Goal 2: The ACCIMP will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to ground failure hazards.
Hazards Mitigated	Ground failure
Potential Funding Source	BRIC and HMGP
Project Source	DGGS
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with data acquisition and mapping skills and public information capabilities
Tsunami Inundation Mapping Program Expansion	
Description	Background: DGGs, the Alaska Earthquake Center, and UAF help the NTHMP identify at-risk coastal communities in Alaska and provide tsunami hazard maps for hazard mitigation and emergency response training. Communities are selected based on their tsunami hazard exposure, location, infrastructure, availability of data, and willingness to incorporate results in an HMP. Sixty-six local and tribal communities in Alaska have been mapped for tsunami inundation to date.

	Action: Continue to model tsunami wave dynamics for at-risk Alaskan communities. Present findings and raise awareness about known risks.
Hazard Mitigation Goal	Goal 1: The Tsunami Inundation Mapping Program will increase public awareness about tsunami hazards. Goal 2: The Tsunami Inundation Mapping Program will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to tsunami hazards.
Hazards Mitigated	Tsunami
Potential Funding Source	NTHMP
Project Source	DGGS and the Alaska Earthquake Center
Cost Considerations	Staff with data acquisition skills, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Data acquisition and mapping skills and public information capabilities
Alaska Statewide Digital Elevation Model Update	
Description	Background: The primary goal of the Alaska Statewide Digital Mapping Initiative (SDMI) is to acquire new and better maps statewide for Alaska and to make existing map products more easily available. Alaska does not have an adequate statewide DEM maps. Action: Develop accurate, current, seamless, statewide DEM maps, online and for free to the general public.
Hazard Mitigation Goal	Goal 2: Updated and completed DEM maps will help the State as well as local and tribal communities to develop hazard mapping and/or identify locations that are vulnerable to multiple hazards, particularly floods, ground failure, high hazard potential dams, and wildland and community fires.
Hazards Mitigated	Multiple hazards, particularly floods, ground failure, high hazard potential dams, and wildland and community fires.
Potential Funding Source	State funds
Project Source	Statewide Digital Mapping Initiative, Alaska Dam Safety Program
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with data acquisition and mapping skills and public information capabilities
Wetland Map Expansion	
Description	Background: Alaska remains the only state that has not been fully mapped by the National Wetland Inventory (NWI) program. As of 2018, just over 40% of the state has been mapped following the NWI protocols. Action: Mapping and conservation assessment of wetland ecosystems is a necessary step in promoting effective management of wetland habitats by providing a uniform and comprehensive inventory of both common and rare types.

Hazard Mitigation Goal	Goal 2: Updated and completed wetland maps will help the State as well as local and tribal communities to develop hazard mapping and/or identify locations that are vulnerable to multiple hazards, particularly cryosphere, permafrost degradation, floods, and erosion.
Hazards Mitigated	Multiple hazards, particularly cryosphere, permafrost degradation, floods, and erosion.
Potential Funding Source	WPDG
Project Source	UAA, DNR and EPA
Cost Considerations	Data acquisition, operational expenses, public outreach, and ongoing maintenance expenses
Environmental Considerations	None
Technical Considerations	Staff with data acquisition and mapping skills and public information capabilities
Inundation Mapping Quality and Program Expansion for High Hazard Potential Dams	
Description	Background: There are 30 HHPDs in the state. All HHPDs in the state have some level of inundation mapping, however, these maps are of variable quality and detail and maps do not provide loss estimations if a dam were to fail. Action: Expand dam inundation mapping program so that inundation mapping is of high quality and detail for all HHPDs in the state. The expanded mapping program will include more detailed information regarding facilities at risk; associated potential loss estimates; and ongoing maintenance to update old data and maps.
Hazard Mitigation Goal	Goal 2: Updating and increasing the quality of high hazard potential dam inundation maps will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to potential dam failure. Goal 3: Updating and increasing the quality of high hazard potential dam inundation maps will help the State as well as local and tribal communities implement projects to reduce risks and increase resilience to potential dam failure.
Hazards Mitigated	High Hazard Potential Dams
Potential Funding Source	State Funds
Project Source	Alaska Dam Safety Program
Cost Considerations	Costs will vary depending on level of quality of maps selected; some travel expenses may be necessary
Environmental Considerations	None
Technical Considerations	Staff with subject matter expertise and inundation mapping capabilities
Erosion Forecast Mapping Expansion	
Description	Background: In 2021, DGGS published extensive erosion exposure assessment reports for 48 individual communities. This mapping is a vital tool used for developing local hazard mitigation plans and strategies to address erosion. Action: Expand erosion forecast mapping to include more communities at risk of coastal and riverine erosion.
Hazard Mitigation Goal	Goal 2: Expanding erosion forecast mapping will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to erosion.

	Goal 3: Expanding erosion forecast mapping will help the State as well as local and tribal communities implement projects to reduce risks and increase resilience to erosion.
Hazards Mitigated	Erosion
Potential Funding Source	Denali Commission Village Infrastructure Protection Program
Project Source	DNR, DGGs
Cost Considerations	Travel costs; development of maps
Environmental Considerations	None
Technical Considerations	Staff with subject matter expertise and forecast/mapping capabilities
Shoreline Change Mapping Expansion	
Description	Background: In 2020, DGGs published detailed shoreline change maps for 46 individual communities. Maps of shoreline change and erosion rates are used by local community entities for planning and communication with state and federal agencies. Action: Expand shoreline change mapping to include more coastal communities at risk of coastal erosion.
Hazard Mitigation Goal	Goal 2: Expanding shoreline change mapping will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to erosion. Goal 3: Expanding shoreline change mapping will help State as well as local and tribal communities implement projects to reduce risks and increase resilience to erosion.
Hazards Mitigated	Erosion
Potential Funding Source	FEMA, State of Alaska, Denali Commission, and the U.S. Bureau of Indian Affairs
Project Source	DNR, DGGs
Cost Considerations	Travel costs; development of maps
Environmental Considerations	None
Technical Considerations	Staff with subject matter expertise and forecast/mapping capabilities
UAF/SNAP Database Expansion	
Description	Background: The University of Alaska's (UAF) Scenarios Network for Alaska + Arctic Planning (SNAP) database uses data to help Alaskan communities envision future climate scenarios. The SNAP database uses weather forecasts and climate models to predict changes in various environmental factors that are susceptible to climate change (winds, temperature, precipitation, permafrost profiles, wildfires). This database is a tool regularly used by State, local, and tribal hazard mitigation planners and communities. Action: Expand the SNAP database to include more Alaskan communities at risk of environmental changes due to climate change.
Hazard Mitigation Goal	Goal 2: Expanding the SNAP database will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to all relevant hazards. Goal 3: Expanding the SNAP database will help the State as well as local and tribal communities implement projects to reduce risks and increase resilience to all relevant hazards.

Hazards Mitigated	Cryosphere, Severe Weather, Wildfire
Potential Funding Source	State Funds
Project Source	UAF
Cost Considerations	Travel costs; database upgrades and modelling
Environmental Considerations	None
Technical Considerations	Staff with subject matter expertise and modelling capabilities
Expansion of SCERP Program	
Description	Background: A Small Community Emergency Response Plan (SCERP) is a customized flipbook with essential, community-specific information for responding during the first 72 hours of a disaster. SCERP toolkits are provided by DHS&EM at no cost for eligible communities. As of 05/01/2023, 134 communities have a SCERP in place. Action: Increase the number of SCERP Ready Communities and coordinate with communities to review and update existing SCERPs every 3 years.
Hazard Mitigation Goal	Goal 1: Expanding the SCERP program will increase public awareness about all hazards and assist communities to have a plan in place before a disaster occurs. Goal 2: Expanding the SCERP program will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to all hazards. Goal 3: Expanding the SCERP program will help State as well as local and tribal communities implement projects to reduce risks and increase resilience to all hazards.
Hazards Mitigated	All
Potential Funding Source	DHS&EM, assistance from ANTHC, American Red Cross of Alaska
Project Source	DHS&EM
Cost Considerations	Coordination with rural communities; development/update of SCERP
Environmental Considerations	None
Technical Considerations	Adequate staff with technical experience

Notes:

ACCIMP = Alaska Climate Change Impact Mitigation Program

AURA = Arctic Urban Risks and Adaptations

BCA = Benefit Cost Analysis

BRIC = Building Resilient Infrastructure and Communities

CF = critical facility

CRS = Community Rating System

DCRA = Alaska Division of Community and Regional Affairs

DEM = Digital Elevation Model

DGGS = Alaska Division of Geological & Geophysical Surveys

DNR = Alaska Department of Natural Resources

EPA = U.S. Environmental Protection Agency

FEMA = Federal Emergency Management Agency

HIA = Hazard Impact Assessment
HMGP = Hazard Mitigation Grant Program
HMP = Hazard Mitigation Plan
MAP = Mapping, Assessment, and Planning
NCRF = National Coastal Resilience Fund
NTHMP = National Tsunami Hazard Mitigation Program
NWI = National Wetland Inventory
RMC = Risk MAP Coordinator
State = State of Alaska
UAA = University of Alaska, Anchorage
WPDG = Wetland Program Development Grant

Table 6-4: Structure and Infrastructure Actions

State Critical Facility Rapid Visual Screenings Expansion	
Description	Background: To date, the Seismic Hazard Safety Commission has worked with several Alaska school districts to complete FEMA’s Rapid Visual Screening (RVS) of their school facilities to identify those at risk of damage in a seismic event. Action: Continue current program to complete the screening of all school districts and expand program to include RVS of all State CFs (Section 4.2) located in areas of perceived severe and violent shaking. RVS is the first of three steps to improve the seismic safety of a facility. Step 2 involves engineering evaluations to confirm that the facility is at risk and prepare a retrofit project design. Step 3 is the actual seismic retrofit.
Hazard Mitigation Goal	Goal 2: RVS will help identify State CFs that are vulnerable to earthquake hazards. Goal 3: Seismic retrofits as a result of the RVS will reduce risks and increase resilience to earthquake hazards.
Hazards Mitigated	Earthquake
Potential Funding Source	BRIC, HMGP, and NEHRP ISEA
Project Source	Seismic Hazard Safety Commission
Cost Considerations	The RVS inspection, data collection, and decision-making processes are typically completed at the building site and are expected to take less than a few hours per building.
Environmental Considerations	For the RVS only: Known historic property/district information
Technical Considerations	For the RVS only: Program manager, supervising engineer, screener resources and training, pre-identified planning, pre-field data, and existing building plans and construction documents
State Critical Facility Structural Hardening Assessments	
Description	Action: Based on the 2023 SHMP risk assessment (Section 4.2), develop a structural hardening assessment strategy for State CFs that are in areas that have significant and/or considerable exposure to hazardous/highly flammable vegetation. Identify project areas in which structural hardening assessments will occur, reach out to State departments/agencies that have State CFs in assessment areas, and conduct assessments. The final step would be to implement selected structural hardening strategies.
Hazard Mitigation Goal	Goal 2: Structural hardening assessment will help the State identify CFs that are vulnerable to wildland and community fire hazards. Goal 3: The structural hardening that results from the structural hardening assessment will reduce risks and increase resilience from wildland and community fires.
Hazards Mitigated	Wildland and community fires
Potential Funding Source	Community Wildfire Defense Grant, BRIC, and HMGP—Post Fire, Public Assistance Mitigation
Project Source	2021 Wildfire Resilience Sonoma County BRIC Project; 2021, Nevada County and Fire Safe Council of Nevada County BRIC Project

Cost Considerations	Priority for USFS Community Wildfire Defense Grants is for low-income areas recently impacted by disaster or in a wildfire hazard location.
Environmental Considerations	For the RVS only: Known historic property/district information
Technical Considerations	For the assessment only: Program manager, assessor resources and training, pre-identified planning, pre-field data, and existing building plans and construction documents
State Critical Facility Defensible Space Assessments	
Description	Action: Based on the 2023 SHMP risk assessment (Section 4.2), develop a defensible space assessment strategy for State CFs that are in areas that have significant and/or considerable exposure to hazardous/highly flammable vegetation. Identify project area where defensible space assessments will occur, reach out to State department/agencies that have State CFs and infrastructure in assessment areas, and conduct assessment. The final step would be to implement selected defensible space strategies.
Hazard Mitigation Goal	Goal 2: Defensible space assessment will help the State identify State CFs that are vulnerable to wildland and community fire hazards. Goal 3: Defensible space as a result of the defensible space assessment will reduce risks and increase resilience from wildland and community fire hazards.
Hazards Mitigated	Wildland and community fires
Potential Funding Source	Community Wildfire Defense Grant, BRIC, and HMGP—Post Fire, Public Assistance Mitigation
Project Source	2021 Wildfire Resilience Sonoma County BRIC Project; 2021 Nevada County and Fire Safe Council of Nevada County BRIC Project
Cost Considerations	For the assessment only: Costs associated with program manager, assessor resources and training, pre-identified planning, pre-field data, and site observations. For defensible space strategies: According to FEMA, defensible space is one of the most cost-effective ways of protecting a structure from a wildfire.
Environmental Considerations	For the assessment only: None
Technical Considerations	For the assessment only: Program manager, assessor resources and training, pre-identified planning, pre-field data, and site observations.
Hazard Fuel Reduction Program Expansion	
Description	Background: As described in Table 5-1, DOF manages a Hazard Fuel Reduction Program. DOF's protection responsibilities are geographically split into six separate areas, and within each area the Hazard Fuel Reduction Program is carried out through hand crews, mechanical treatment, prescribed burns, and public outreach. The program has expanded over the past several years as fuel reduction has proven effective in mitigating wildfire. As demand for fuel reduction grows, so too does the need for this program.

	Action: Expand the Hazard Fuel Reduction Program in DOF's six areas. As part of the program expansion, utilize DHS&EM's Mitigation Planning Database to identify communities that have pre-identified CFs at risk to wildland fires and also have pre-identified wildfire mitigation projects in their local/tribal HMPs and/or CWPPs.
Hazard Mitigation Goal	Goal 3: A defensible space hazard fuel reduction program will reduce risks and increase resilience from wildland and community fire hazards.
Hazards Mitigated	Wildland and community fire
Potential Funding Source	Community Wildfire Defense Grant, BRIC, and HMGP–Post Fire
Project Source	DOF
Cost Considerations	Priority for USFS Community Wildfire Defense Grants is for low-income areas recently impacted by disaster or in a wildfire hazard location.
Environmental Considerations	Changes in vegetation may impact habitat, species, surface water, groundwater, floodplains or visual aesthetics. The methods used to manage vegetation may increase erosion and sedimentation, impact species, or affect human communities. Ground disturbances could affect archaeological resources, soils, or utilities.
Technical Considerations	Site observations, maps, past similar projects, project planners, construction contractors, engineers, advice from fire management professionals, and fire mitigation reports from agencies.
Flood Buyout Expansion	
Description	Action: Support community-led efforts to plan for, develop, and launch buyout programs. Consider creating a State-supported GIS mapping to help both officials and community members better understand jurisdictional and ownership boundaries, flood vulnerability, infrastructure, and demographics, including social vulnerability. Assist local and tribal communities with developing acquisition and relocation priorities, including the NFIP's RL and SRL structures (Section 5.1.2), vulnerable populations, and additional structures identified as at-risk through other assessments. Additional information: Utilize DHS&EM's Mitigation Planning Database and/or the 2023 SHMP's risk assessment (Section 4.3) to identify communities that have pre-identified CFs at risk to flooding and pre-identified flood mitigation projects in their local/tribal HMPs for potential flood buyout projects.
Hazard Mitigation Goal	Goal 3: Flood buyouts and relocations will reduce risk and increase resilience from cryosphere and permafrost degradation, flood and erosion, and severe weather hazards.
Hazards Mitigated	Cryosphere and permafrost degradation, flood and erosion, and severe weather
Potential Funding Source	BRIC, FMA, HMGP, CDBG-DR, and NRCS-EWP
Project Source	FEMA, NOAA and DCRA
Cost Considerations	Buyouts provide a permanent solution. If a home is eligible for a buyout, the homeowner is offered a pre-disaster fair-market value for the property as determined by a certified appraiser.

	Buyout offers can be made for structures outside of Special Flood Hazard Areas, depending on the results of cost-benefit analyses; acquisition of structures inside a flood zone is assumed to meet the cost-benefit threshold if the purchase price is \$276,000 or less (Pew Trust 2022). Sellers may receive the pre-disaster value of the property. HUD permits its grant funds to be used even if the property was acquired post-disaster. HUD also allows the acquisition of commercial, agricultural, and/or vacant land if the buyout/acquisition supports one of CDBG’s national objectives: benefiting persons of low and moderate income; preventing slum or blight; or meeting an urgent community development need (Pew Trust 2022).
Environmental Considerations	Effective buyouts prevent future damage, make people safer, and ideally protect entire neighborhoods or communities. Once bought-out properties become open space, they can provide an added benefit of floodplain and wildland restoration (Pew Trust 2022).
Technical Considerations	Buyouts require an agreement by local government officials, the State, and FEMA. A buyout also requires a certified appraiser.
High Hazard Potential Dams Remedial Investigations and Repair	
Description	Background: As noted in the 2017 Guidelines for Cooperation with the Alaska Dam Safety Program, routine inspections, PSIs, or special engineering evaluations may indicate that certain repairs are necessary to reduce the probability for failure for the long-term safety of a dam. However, the repairs may not be required immediately, and remedial investigations may be necessary to determine the magnitude of the problem, the optimum solution, or both. Action: Conduct or continue to conduct remedial investigations for high or significant hazard potential dams that receive a “poor” or “unsatisfactory” condition assessment. Repair and remediate as necessary. Ensure all HHPDs have condition assessment ratings.
Hazard Mitigation Goal	Goal 2: Remedial investigations will help the State identify dams that are vulnerable due to a dam safety deficiency. Goal 3: Remedial investigations and repair will reduce risk and increase resilience from high hazard potential dams.
Hazards Mitigated	High hazard potential dams
Potential Funding Source	CWIFP and HHPD Grant Program (repair portion)
Project Source	Alaska Dam Safety Program, National Inventory of Dams
Cost Considerations	For remedial investigation only: Professional licensed engineers, existing plans and construction documents, analysis and reports
Environmental Considerations	For remedial investigation only: None
Technical Considerations	For remedial investigation only: Staff with dam design, safety, construction and maintenance experience
Complete High Hazard Potential Dam Failure Dataset	
Description	Background: Dam failure events have not been historically common in Alaska. The historical data provided by the Dam Safety Office has data gaps, as historical data is not readily available or is unknown.

	Action: Complete the historical dam failure dataset (current agency ownership, incident driver/mechanism, incident duration).
Hazard Mitigation Goal	Goal 2: Updating and completing high hazard potential dam failure specifications/details will help the State as well as local and tribal communities identify locations and CFs that are vulnerable to potential dam failure. Goal 3: Updating and completing high hazard potential dam failure specifications/details will help the State as well as local and tribal communities implement projects to reduce risks and increase resilience to potential dam failure.
Hazards Mitigated	High Hazard Potential Dams
Potential Funding Source	State Funds
Project Source	Alaska Dam Safety Program
Cost Considerations	Historical data may not be available for all components; dataset may be incomplete
Environmental Considerations	None
Technical Considerations	Historical data may not be available or reliable
Statewide Transportation Facilities Comprehensive Dataset Expansion	
Description	Background: In Section 4, estimated values for statewide transportation facilities were not available for vulnerability exposure analysis. These facilities (airports, bridges, ferry terminals, harbors, maintenance facilities, ports, and railroad facilities) are critical facilities and infrastructure for Alaskans. A comprehensive dataset for these facilities is not currently available. Action: Expand the State's transportation facilities dataset to include estimated values for potential losses for future HMP updates. This will enable the State's future risk assessments to be accurate.
Hazard Mitigation Goal	Goal 2: Expanding the transportation facilities dataset will help the State as well as local and tribal communities identify locations and transportation CFs that are vulnerable to all hazards. Goal 3: Expanding the transportation facilities dataset will help State as well as local and tribal communities implement projects to reduce risks and increase resilience of transportation facilities to all hazards.
Hazards Mitigated	All
Potential Funding Source	State Funds
Project Source	DOT
Cost Considerations	Creating database; compiling datasets from many agencies
Environmental Considerations	None
Technical Considerations	Cooperation among many agencies will be required
Increase Instrumentation and Data Accessibility for the National Volcano Early Warning System	
Description	Background: Many volcanoes in the U.S. have insufficient monitoring systems and/or obsolete equipment. The goals of the National Volcano Early Warning System are to ensure that the most hazardous volcanoes will be properly monitored, to make it possible for scientists to improve the timeliness and accuracy of hazard forecasts, and for communities to take action and reduce risks.

	Action: Increase instrumentation to monitor Alaska volcanoes at levels commensurate to their threats, build a unified system (National Volcano Information Service) to collect, aggregate, store and distribute volcano data, create and track internal alarm systems from all sensor types, and develop software tools for monitoring, visualizing, and analyzing volcano monitoring data. These actions are addressed and outlined further in the National Volcano Early Warning System developed by the USGS Volcano Hazard Program and its affiliated partners in state and academic institutions. Alaska volcanoes prioritized under NVEWS for additional instrumentation in immediate years include Redoubt, Akutan, Makushin, Spurr, Augustine, Okmok, Iliamna, Aniakchak, Katmai, Veniaminof, Atka, Hayes, Churchill, Kanaga, Kaguyak, Kasatochi, Moffett, and Seguam.
Hazard Mitigation Goal	Goal 1: Increased instrumentation for the National Volcano Warning System will increase public awareness about volcanoes. Goal 2: Increased instrumentation will help the State and partners to better identify threats from volcanoes.
Hazards Mitigated	Volcanoes
Potential Funding Source	USGS
Project Source	USGS
Cost Considerations	Cost of equipment and equipment installation, staffing, and automation to improve 24/7 monitoring of volcanoes, computer systems to distribute data, and ongoing operations and maintenance.
Environmental Considerations	All environmental laws will need to be met and/or exceeded for instrumentation location. Design alternatives will need to be developed to avoid and/or minimize effects to cultural and natural resources.
Technical Considerations	Equipment and staffing capabilities

Notes:

BRIC = Building Resilient Infrastructure and Communities

CF = critical facility

CWPP = Community Wildfire Protection Plan

DCRA = Alaska Division of Community and Regional Affairs

CDBG-DR = Community Development Block Grant–Disaster Recovery

DHS&EM = Division of Homeland Security and Emergency Management

DOF = Division of Forestry

FEMA = Federal Emergency Management Agency

FMA = Flood Mitigation Assistance

GIS = geographic information system

HHPD = high hazard potential dam

HMGP = Hazard Mitigation Grant Program

HMP = Hazard Mitigation Plan

HUD = U.S. Department of Housing and Urban Development

ISEA = Individual State Earthquake Assistance

NEHRP = National Earthquake Hazards Reduction Program

NFIP = National Flood Insurance Program

NOAA = National Oceanic and Atmospheric Administration

NRCS-EWP = Natural Resources Conservation Service–Emergency Watershed Protection Program

PSI = Periodic Safety Inspection
RL = Repetitive Loss
RVS = Rapid Visual Screening
SHMP = State Hazard Mitigation Program
SRL = Severe Repetitive Loss
State = State of Alaska
USFS = U.S. Forest Service
USGS = U.S. Geological Survey

Table 6-5: Nature-Based Solution Actions

Coastal and Riverbank Stabilization Program	
Description	Background: Traditional engineered hard “gray” shorelines use materials like steel, wood, concrete, or rock with no vegetation and include sloped armoring, vertical armoring, seawalls, and shore stabilization. In most locations in Alaska, these types of projects are necessary. While hard or gray shoreline projects are difficult to modify once completed, they are able to withstand the harsh Alaskan environment where nature-based solutions may not be as effective. Action: Prevent further coastal and riverbank loss and increase flood storage capacity through nature-based coastal and stream techniques where considered to be effective; otherwise use traditional engineered hard “gray” shoreline use materials that have been proven to withstand the harsh Alaskan weather conditions.
Hazard Mitigation Goal	Goal 3: Coastal and riverbank stabilization projects will reduce risks and increase resilience to cryosphere and permafrost degradation, flood and erosion, tsunami and seiche, severe weather, and high hazard dam hazards.
Hazards Mitigated	Cryosphere and permafrost degradation, flood and erosion, tsunami and seiche, severe weather, and high hazard potential dam hazards
Potential Funding Source	NCRF
Project Source	FEMA, EPA, National Parks Service
Cost Considerations	Park and/or community planners, engineers, and scientists evaluate data, design alternatives, and develop detailed engineering. Project manager and construction crew to implement stabilization construction activities.
Environmental Considerations	Projects should be compatible with the natural processes of the rivers, climate adaptable, sustainable, aesthetically pleasing, and cost-effective. All environmental laws will need to be met and/or exceeded. Design alternatives will need to be developed to avoid and/or minimize effects to cultural and natural resources.
Technical Considerations	Data collected will need to include the identification of soil type, geology, wetlands, rare plants, historical and cultural features, water levels, and terrestrial and aquatic species. Staff with subject matter/experience to conduct assessments; design, public outreach, construction management, and construction will be needed.
Wetlands Action Plan Templates	
Description	Background: A Wetlands Action Plan (WAP) is a guide to plan and implement projects and activities to conserve, protect, restore, and manage wetlands. WAPs can be designed to focus on wetlands in a specific watershed or region or target a wetland type or all surface water resources within the watershed. Action: Develop a WAP template to assist local and tribal communities in Alaska with the development of a WAP and overall wetland planning. WAP templates will focus on identifying and describing wetland resources, natural conditions, anthropogenic stressors that affect wetlands, wetlands baseline conditions, data gaps, restoration and protection site projects, chronic and cumulative impacts to wetlands reduction strategies, financing options, public outreach and stakeholder strategies, and project implementation and monitoring.

Hazard Mitigation Goal	Goal 2: WAPs will help local and tribal communities to identify wetland locations that are vulnerable to multiple hazards, particularly cryosphere, permafrost degradation, floods, erosion, and severe weather. Goal 3: Projects and activities identified in WAPs will reduce risks and increase resilience to cryosphere and permafrost degradation, floods, erosion, and severe weather.
Hazards Mitigated	Cryosphere, permafrost degradation, floods, erosion, and severe weather hazards
Potential Funding Source	WPDG
Project Source	EPA, New Mexico Department of the Environment
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities

Notes:

EPA = U.S. Environmental Protection Agency

FEMA = Federal Emergency Management Agency

NCRF = National Coastal Resilience Fund

WAP = Wetlands Action Plan

WPDG = Wetland Program Development Grant

Table 6-6: Outreach and Awareness Actions

Hazard Mitigation Training	
Description	Action: Expand hazard mitigation training in Alaska. Training can include FEMA-created webinar recordings, online independent study courses and on-demand workshops. Training should focus on creating / updating effective HMPs as well as developing quality HMA grant applications.
Hazard Mitigation Goal	Goal 1: Hazard mitigation training will increase awareness around all hazards.
Hazards Mitigated	All hazards
Potential Funding Source	FEMA Technical Assistance
Project Source	DHS&EM, FEMA
Cost Considerations	Materials/handouts, travel time and costs, delivering workshop, and/or follow up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Rural Resilience Workshop Expansion	
Description	Background: DHS&EM conducts workshops to bring community leaders/emergency managers in various regions together to discuss regional disaster planning and response. Workshops focus on community resilience, incident response, emergency management, and more. Action: Continue to expand the size and scope of DHS&EM's Rural Resilience Workshops.
Hazard Mitigation Goal	Goal 1: Rural Resilience Workshops will increase awareness about all hazards.
Hazards Mitigated	All hazards
Potential Funding Source	State Homeland Security Program
Project Source	DHS&EM
Cost Considerations	Materials/handouts, travel time and costs, delivering workshop, and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Tsunami Operations Workshop Expansion	
Description	Background: Alaska's NTHMP Team conducts tsunami operations workshops to bring awareness to community leaders on the risks they face from tsunamis, to help to develop plans for mitigating and responding to tsunamis, and to provide public education and outreach tools and materials. Action: Continue to expand the size and scope of NTHMP's Tsunami Operations Workshops.
Hazard Mitigation Goal	Goal 1: Tsunami Operations Workshops will increase awareness of tsunami hazards.

Hazards Mitigated	Tsunami
Potential Funding Source	National Weather Service Tsunami Financial Assistance
Project Source	DHS&EM, NTHMP
Cost Considerations	Materials/handouts, travel time and costs, delivering workshop, and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
TsunamiReady and StormReady Expansion	
Description	Background: TsunamiReady and StormReady are collaborative programs among and between local, tribal, State, and federal emergency management agencies, community leaders, and the public to promote tsunami and storm hazard preparedness. The main goal of the program is to: “improve public safety before, during and after tsunami and storm emergencies. It aims to do this by establishing guidelines for a standard level of capability to mitigate, prepare for and respond to tsunamis and storms and working with communities to help them meet the guidelines and ultimately become recognized as TsunamiReady and StormReady by the NWS”. Action: Increase TsunamiReady and StormReady participation in Alaska by increasing public outreach about the program, promoting World Tsunami Awareness Day, Tsunami Preparedness Week, providing/funding additional funding for tsunami evacuation signage, tsunami and severe weather warning systems, and tsunami evacuation plans and hazardous weather plans.
Hazard Mitigation Goal	Goal 1: TsunamiReady will increase awareness about tsunami and severe weather hazards. Goal 2: TsunamiReady will help local and tribal communities identify CFs that are vulnerable to tsunami and severe weather hazards. Goal 3: TsunamiReady will reduce risk and increase resilience to tsunami and severe weather hazards.
Hazards Mitigated	Tsunami
Potential Funding Source	NWS Tsunami Financial Assistance
Project Source	NWS
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Community Wildfire Protection Plan Outreach Expansion	
Description	Background: The CWPP is a community-based plan that identifies wildfire risk and provides a “roadmap” of mitigation actions for the community to implement to reduce their risks from wildfires. A CWPP can also address issues such as wildfire response, hazard mitigation, community preparedness, and/or structure protection. USFS wildfire reduction grants

	are available for communities to both write a CWPP and to implement the actions identified in their CWPP. In addition, having a CWPP is one of the first steps to become a Firewise Community. In 2021, DOF identified 10 communities in the Copper River Basin to create or update CWPPs. Action: Continue to expand DOF's public outreach efforts for communities that have significant and/or considerable exposure to hazardous/highly flammable vegetation to develop and/or update their CWPPs. Identify and expand public outreach efforts geared at communities that have significant and/or considerable exposure to hazardous/highly flammable vegetation through the development and/or update their CWPPs.
Hazard Mitigation Goal	Goal 1: CWPP will increase awareness of wildland and community fire hazards. Goal 2: CWPP will help local and tribal communities identify CFs that are vulnerable to wildland and community fire hazards.
Hazards Mitigated	Wildland and community fire
Potential Funding Source	Community Wildfire Defense Grant
Project Source	DOF
Cost Considerations	Maximum CWDG is \$250K per CWPP.
Environmental Considerations	None
Technical Considerations	Staff with subject matter and workshop facilitator capabilities
Alaska Firewise Expansion	
Description	Background: Alaska Firewise is a cooperative effort among and between local, tribal, State and Federal agencies, community leaders, and the public to promote fire safety in areas vulnerable to wildland and community fires. Firewise Communities must create a Firewise Board and Firewise Task Force or Commission, develop a CWPP, sponsor Wildfire Days public events, volunteer or invest in community wildfire mitigation, and seek certification. Action: Increase Firewise Communities participation in Alaska by increasing public outreach about the program, promoting Wildfire Days (first Saturday in May), and providing/finding additional funding for CWPPs and increasing the availability of wildfire exposure maps.
Hazard Mitigation Goal	Goal 1: Alaska Firewise will increase awareness about wildland and community fire hazards. Goal 2: Alaska Firewise will help local and tribal communities identify CFs that are vulnerable to wildland and community fire hazards. Goal 3: When implemented, Alaska Firewise activities will reduce risks and increase resilience to wildland and community fire hazards.
Hazards Mitigated	Wildland and community fires
Potential Funding Source	CWDG
Project Source	DOF

Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Continuation of Building Safety Month	
Description	Background: Governor Mike Dunleavy has designated May as Building Safety Month in Alaska. The Building Safety Month campaign has been presented by the International Code Council for over 40 years. The international campaign raises awareness about the critical role of building codes, including safe and sustainable construction, fire and building safety, disaster mitigation, energy conservation, and safe and abundant water supply. Action: Continue to observe Building Safety Month in Alaska.
Hazard Mitigation Goal	Goal 1: Observing Building Safety Month will increase awareness around earthquake, ground failure, severe weather, wildland and community fire hazards.
Hazards Mitigated	Earthquake, ground failure, severe weather, and wildland and community fires
Potential Funding Source	State funds
Project Source	Alaska Department of Public Safety and the Alaska State Fire Marshal
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Continuation of Fire Prevention Month	
Description	Background: Governor Mike Dunleavy has designated October as Fire Prevention Month in Alaska. Fire Prevention Month encourages all Alaskans to be proactive and take precautionary measures to avoid fires, and participate in public safety activities offered by the Alaska Department of Public Safety and emergency services throughout Alaska. Action: Continue to observe Fire Prevention Month in Alaska.
Hazard Mitigation Goal	Goal 1: Observing Fire Prevention Month will increase awareness around wildland and community fire hazards.
Hazards Mitigated	Wildland and community fires
Potential Funding Source	State funds
Project Source	Alaska Department of Public Safety and the Alaska State Fire Marshal
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Volcano Awareness Month	

Description	Action: Establish a Volcano Awareness Month as part of an effort to increase understanding of Alaskan and Russian volcanoes among residents and visitors. Topics to cover may include a year in review of volcanic activity, ash hazards from Alaskan and Russian volcanoes, recent explosive history of Alaskan and Russian volcanoes, volcanic hazard mapping, and community preparedness measures.
Hazard Mitigation Goal	Goal 1: Volcano Awareness Month will increase awareness of volcanic hazards.
Hazards Mitigated	Volcano
Potential Funding Source	State funds
Project Source	USGS and Hawai'i Volcanoes National Park
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
National Flood Insurance Program Expansion	
Description	Background: DCRA staff promote the CRS and help communities join the program by explaining the benefits of the CRS to elected officials and other local decision makers so they will encourage their staff to devote the resources needed to join the CRS or improve their classification. The DCRA improves local programs by offering training, templates, models, and examples to help communities improve their floodplain management activities to improve their CRS standing.
Hazard Mitigation Goal	Flood, erosion, and severe weather
Hazards Mitigated	Flood, erosion, and severe weather
Potential Funding Source	State funds
Project Source	DCRA
Cost Considerations	Materials/handouts, travel time and costs (if necessary), and follow-up
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities
Increase Awareness of the ShakeOut Program/Drill	
Description	Background: The Great ShakeOut is a one-day drill aimed to prepare Alaskans for major earthquakes. The ShakeOut Drill occurs yearly on the 3 rd Thursday of October. In 2023, it is scheduled for 10:19 a.m. on October 19, 2023. This means that wherever you are at that moment—at home, at work, at school, anywhere—you should Drop, Cover, and Hold On as if there were a major earthquake occurring at that very moment and stay in this position for at least 60 seconds. Action: Promote the Great Shakeout Program on DHS&EM social media pages and encourage Alaskans to participate in the drill.
Hazard Mitigation Goal	Goal 1: Increasing awareness about the ShakeOut drill will increase public awareness about earthquakes and preparedness.

Hazards Mitigated	Earthquake
Potential Funding Source	State funds
Project Source	DHS&EM
Cost Considerations	None
Environmental Considerations	None
Technical Considerations	Staff with subject matter and public information capabilities

Notes:

CF = critical facility

CRS = Community Rating System

CWDG = Community Wildfire Defense Grants

CWPP = Community Wildfire Protection Plan

DCRA = Alaska Division of Community and Regional Affairs

DHS&EM = Division of Homeland Security and Emergency Management

DOF = Division of Forestry

NTHMP = National Tsunami Hazard Mitigation Program

NWS = National Weather Service

State = State of Alaska

USFS = U.S. Forest Service

USGS = U.S. Geological Survey

6.3 PROGRESS IN STATEWIDE MITIGATION EFFORTS

Table 6-7 describes the status of each mitigation action identified in the 2018 SHMP. In addition, it states whether the action has been updated and/or modified and included in the 2023 SHMP Prioritized Mitigation Action Plan.

Table 6-7: Progress in Statewide Mitigation Efforts

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
MH 1.1	Host workshops for builders to teach or demonstrate new multi-hazard construction techniques (e.g., seismic, flood, ground failure, weather, wildfire).	Ongoing. The State of Alaska promotes safe and sustainable construction, sustainable construction, fire and building safety, disaster mitigation, and energy conservation throughout the month of May during Building Safety month.	Yes. The State would like to continue to build upon this action through Building Safety Month.
MH 1.2	Continue agency-led programs that provide readily available locational hazard risk information to the public (e.g., seismic, flood, ground failure, weather, wildfire).	Ongoing. The DHS&EM resiliency team provides annual rural resiliency and tsunami operations workshops to communities in rural Alaska. The DHS&EM outreach team has various annual outreach events throughout the state to include the annual emergency management conference every April and to take the earthquake simulator to various communities. The DHS&EM team participates in the resiliency workshops and emergency management conference.	No. This action is currently in action and ongoing. It is now considered a capability.
MH 1.3	Continue all-hazard-focused safety education and preparedness in Alaska's schools.	Ongoing. Alaska schools participate in the Great Alaska Shakeout, which promotes worldwide exercises that focus on earthquake education and emergency preparedness.	No. This action is ongoing and considered routine/efficient.
MH 1.4	Educate Alaskan communities about the benefits of the NFIP, StormReady, and Alaska Firewise programs.	Ongoing. DCRA's NFIP Coordinator, the DHS&EM Preparedness Section, and DOF's Firewise Communities Liaison promote the NFIP, StormReady, and Firewise programs respectively.	Yes. The State would like to continue to reach and teach community leaders, particularly in rural

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
			areas, about various preparedness and mitigation programs.
MH 1.5	Encourage nonstructural mitigation and preparedness activities using an all-hazards approach.	Ongoing. Alaska encourages multi-hazard, nonstructural mitigation and preparedness through many platforms, including comprehensive planning and zoning, which are outlined in the 2012 Alaska Planning Commission Handbook (Alaska Planning Commission 2012).	No. This action is ongoing and considered routine/efficient.
MH 1.6	Expand the number and locations of modern strong motion and broadband seismic recording instruments in “low-noise” installations throughout Alaska to record and evaluate the seismic and volcanic response of built infrastructure for opportunities to improve design and construction in all hazard locations.	Completed. More than 250 seismic stations continuously stream data to the Alaska Earthquake Center.	No. This action has been completed.
MH 1.7	Provide technical assistance and development support for multi-hazard-focused mitigation project grant applications that reduce future earthquake, flood, ground failure, tsunامي, weather, wildland fire, and other losses.	Ongoing. Technical assistance/support for hazard grant applications provided by various State departments and agencies (DCRA, DHS&EM, DOF, etc.).	Yes. The State would like to continue to provide technical assistance and grant application support with a particular focus on reaching rural areas.
MH 1.8	Disseminate Alaska and Russian volcano hazard information to the civilian and military aviation communities, trade shows, and other public events.	Ongoing. Volcano hazard information can be found through the Alaska Volcano Observatory’s Hazard Notification System (HANS), website, social media, and AVO Radio, a weekly 2 minute radio program carried on 10 public radio stations throughout Alaska. AVO also conducts outreach via schools, educational programs, and community engagement in multiple communities. Volcano hazard information is also shared	No. This action is ongoing and considered routine/efficient.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
		at Rural Resilience workshops. Russian volcano eruption information is no longer distributed.	
MH 1.9	Expand volcano hazard information dissemination to all Alaskan maritime and coastal communities.	Ongoing. Volcano hazard information can be found through the Alaska Volcano Observatory's weekly updates, Facebook page, Twitter page, and radio as well as the USGS volcano alert messages. Volcano hazard information is also shared during Rural Resilience workshops.	No. This action is ongoing and considered routine/efficient.
MH 1.10	Provide planning development, administrative process, technical writing, and grant application development training to improve community leadership capabilities.	Ongoing. DHS&EM provides technical assistance for the preparation of BRIC and HMGP grants.	Yes. The State would like to continue to provide technical assistance and grant application support with a particular focus on reaching rural areas.
MH 2.1	Continue DHS&EM's Mitigation Section's forward progress to implement, monitor, review, and evaluate community and tribal mitigation plan identified actions.	Ongoing. As described in Section 5, State Capabilities, Alaska DHS&EM is creating a database to implement, monitor, review, and evaluate local and tribal mitigation plans, including mitigation strategies.	Yes. Alaska DHS&EM is currently in the process of developing a database.
MH 2.2	State agencies will strive to coordinate, incorporate, and integrate mitigation planning provisions into all community planning processes such as comprehensive, capital improvement, land use plans, etc., to demonstrate multi-benefit considerations and facilitate the use of multiple funding sources.	Ongoing. DHS&EM is currently integrating sections of the 2023 SHMP into the 2023 State Emergency Operations Plan.	No. This action is ongoing and considered routine/efficient.
MH 2.3	Encourage all State and local jurisdictions to adopt, update to the current IBC, and enforce commercial and residential construction.	Ongoing. The State of Alaska promotes safe and sustainable construction, sustainable construction, fire and building safety, disaster mitigation, and energy	No. This action is ongoing and

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
		conservation throughout the month of May during Building Safety month.	considered routine/efficient.
MH 2.4	Encourage all communities to adopt or update to the current IBC for residential construction and provide sufficient resources and incentives to ensure compliance.	Ongoing. The State of Alaska promotes safe and sustainable construction, sustainable construction, fire and building safety, disaster mitigation, and energy conservation throughout the month of May during Building Safety month.	No. This action is ongoing and considered routine/efficient.
MH 2.5	Conduct statewide tests of the state's emergency warning systems annually.	Ongoing. Addressed in the State of Alaska Emergency Alert System (EAS) Plan instead of the 2023 SHMP. The EAS Plan outlines the use of the Federal Communications Commission (FCC)-mandated Emergency Alert System in Alaska.	No. This action is ongoing and considered routine/efficient.
MH 2.6	Provide sufficient resources and incentives necessary to encourage implementing IBC construction compliance for each multi-hazard category.	Deleted. Taken out of regulation in 2017.	No. This action has been deleted.
MH 2.7	Encourage jurisdictions to document natural hazard high-risk areas in land use, zoning, emergency response, and evacuation plans. (e.g., flood, ground failure, tsunami, wildfire)	Ongoing. This action is being addressed through the continued development/update of local and tribal hazard mitigation plans and emergency response plans and small community emergency response plans.	No. This action is ongoing and considered routine/efficient.
MH 2.8	City and Borough of Sitka, LHMP Update	Completed. City and Borough of Sitka has an HMP that is current through 2024.	No. This action has been completed.
MH 2.9	City of Skagway LHMP Update	Completed. The City of Skagway has a plan that is current through 2025.	No. This action has been completed.
MH 3.1	Develop an inventory of historical landslide, landslide-prone, permafrost, and other soil instability locations that is linked to specific ground failure hazard maps.	Ongoing. Alaska DCRA is currently developing landslide inventory/susceptibility maps and modeling potential debris flow run-out for the Sitka and Homer areas.	Yes. This action is still in the development phase.
MH 3.2	Promote development practices that reduce the flood risk (i.e., relocate and elevate at least 2 feet above BFE) or buy out property).	Ongoing. DCRA encourages communities that have land use authority to join the NFIP. The NFIP prevents the development of structures within the floodplain that do not meet the regulations and standards, such as the	No. This action is ongoing and considered routine/efficient.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
		requirement to build above the BFE. The DCRA and local NFIP communities work to secure grant funding to acquire and relocate at-risk structures.	
MH 3.3	Support community relocation site planning to remove threatened structures outside high hazard threat areas (e.g., areas of cryosphere and permafrost degradation, floodplains, erosion, ground failure).	Ongoing. In response to the 2018 Cook Inlet Earthquake (DR-4413) in January 2020, HUD allocated \$35.86 million CDBG-DR funds into the state of Alaska to address unmet housing needs. The State of Alaska is using the funds in part for the relocation of households to safer areas. During the summer of 2019, the Innovative Readiness Training program and Ukpeaġvik Iñupiat Corporation Construction completed critical infrastructure at Mertarvik to support the first full-time residents, 21 households with 140 adults and children (about one-third of Newtok's population), who moved from Newtok to Mertarvik in October 2019.	Yes. While this action is ongoing there is more work to be done in terms of the CDBG-DR funds. It is also considered a priority to complete.
MH 3.4	Newtok Village Council, seven home acquisition & demolition projects (RL/SRL).	Ongoing. The seven-home relocation is complete. The project goal is to relocate everyone in Newtok to Mertarvik by 2023.	No. While this action is ongoing, it is expected to be completed imminently.
MH 3.5	Matanuska Susitna Borough (MSB) Matanuska River Erosion Mitigation Project–Butte area (10 properties, 11 homes) (RL/SRL).	Completed. In 2018, FEMA awarded MSB with an HMGP grant to fund the acquisition of land and structures for 10 homes that are at severe risk for flooding and erosion damage along the Matanuska River in Butte from mile 13 to mile 17 along the Old Glenn Highway. The original scope of work was for 11 properties and 10 homes to be acquired and demolished, but only 6 homes were acquired and demolished. Matching funds were provided by the State. The project was completed in July 2021.	No. This action has been completed.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
MH 3.6	MSB Matanuska River Erosion Mitigation Project–Sutton area (five properties, five homes).	Completed. As a companion project to the 2018 HMGP funds for the Matanuska River–Butte Area, FEMA awarded funds in 2018 for another five properties to be acquired from mile 63.5 to mile 65 of the Glenn Highway near Sutton. The original scope of work was for 5 homes to be acquired and demolished, but only 2 homes were acquired and demolished. Matching funds were also provided by the State. The project was completed in July 2021.	No. This action has been completed.
MH 3.7	State of Alaska, Department of Natural Resources, Division of Parks and Outdoor Recreation (DNR, DOPR), Anchor River State Recreational Area Embankment Stabilization Project	Completed with FEMA closeout.	No. This action has been completed.
MH 3.8	Kenai Peninsula Borough (KPB), GIS software for land cover hazard assessment	Completed. The Kenai Peninsula Borough GIS Land Cover Viewer includes KWF Wetlands Assessment and other vegetation and land cover data sets.	No. This action has been completed.
MH 4.1	Identify and pursue funding opportunities to implement mitigation actions.	Ongoing. As noted in Section 5.2, there have been a number of recent funding opportunities to implement mitigation actions in Alaska. Such funding has been secured through ACCAP, AFG, FMAG, BRIC, HMGP, HMGP–Post Fire, Tsunami Financial Assistance, Fuels Management Program, CDBG-DR, CDBG-MIT, and NCWC, NCRF, and NRCS-EWP.	Yes. The State would like to identify and pursue funding opportunities with a particular focus on reaching rural areas.
MH 4.2	Fund multi-hazard mitigation retrofit projects for public facilities such as schools, bridges, airports, etc.	Ongoing. The State has approved funding for the Port of Anchorage modernization project, which will in part include seismic upgrades and shoreline stabilization measures.	No. More single hazard-specific projects have been identified in the 2023 SHMP.
MH 4.3	Prepare and fund statewide community hazard assessments and prioritize at-risk communities and infrastructure for all hazard types, including flood, erosion, storm surge, ground failure, wildfire.	Ongoing through RVS, AURA, Risk MAP, Coastal Community Flood Assessment, etc.	Yes. While this action is ongoing it is considered a priority to expand

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
			and complete these assessments.
MH 4.5	Support and fund relocating structures and other infrastructure from high hazard risk areas. (e.g., cryosphere, earthquake, flood, ground failure, wildfire).	Ongoing. In March 2018, FEMA awarded the Matanuska-Susitna Borough \$4.46M in HMGP grant funding to buy out 15 residents whose properties are at severe risk for erosion. The grant was awarded with 75% federal funds and 25% State funds. In response to the 2018 Cook Inlet Earthquake (DR-4413), HUD allocated \$35.86 million CDBG-DR funds into the state of Alaska to address unmet housing needs in January 2020. The State is using the funds in part for the relocation of households to safer areas. During the summer of 2019, the Innovative Readiness Training program and Ukpeaġvik Iñupiat Corporation Construction completed critical infrastructure at Mertarvik to support the first full-time residents, 21 households with 140 adults and children (about one-third of Newtok's population), who moved from Newtok to Mertarvik in October 2019.	Yes. While this action is ongoing it is considered a priority.
MH 4.6	Create a prioritized list of potential all-hazard (e.g., cryosphere, earthquake, flood, ground failure, wildfire) damaged or impacted structures and prepare grant applications to relocate them away from high hazard risk areas for potential FEMA funding.	Ongoing. 2023 SHMP includes an analysis of State CFs in hazard areas. In addition, the Mitigation Planning Database will eventually be able to query such information.	Yes. While this action is ongoing it is considered a priority.
MH 4.7	Support and fund community planning initiatives (e.g., CWPP, HMP, other infrastructure protection plan development) by providing State funds to match grant to federal funding.	Ongoing. The State provides matching funds for HMPs using BRIC or HMPG funds.	Yes. While this action is ongoing it is considered a priority.
MH 4.8	Support of impoverished community federal mitigation grant required matching funds for eligible mitigation projects such as HMP, USFS/AKDOF Volunteer Fire Assistance, wildfire protection, and climate change	Ongoing. The State provides matching funds for all HMGP projects in Alaska.	Yes. While this action is ongoing it is considered a priority.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
	adaptation planning, floodplain mapping, and other eligible construction-project-related grants.		
CR 5.1	Encourage agencies to develop localized landslide and avalanche zone maps and support community risk assessment efforts that provide justification for prohibiting development in high hazard areas.	Avalanche zone maps were created for the Municipality of Anchorage in 2017. However statewide avalanche zone maps do not exist. Likewise, statewide landslide maps do not exist. The State of Alaska is using the funds for the relocation of households to safer areas, affordable housing, other unmet housing needs, and planning activities to aid in regional recovery.	Yes. While this action is ongoing it is considered a priority to complete statewide hazard maps.
EQ 6.1	Deploy modern seismic instrumentation in CFs, infrastructure, and major transportation arteries to provide real-time preliminary damage assessment capability.	Ongoing. Matanuska-Susitna Borough uses the Esri's Damage Assessment solution to have a uniform way to collect, assess, and manage data during an emergency event.	No. This action is not considered a priority currently.
EQ 6.3	Expand the number and locations of modern strong motion and broadband seismic recording instruments in “low-noise” installations throughout Alaska to record and evaluate the seismic response of built infrastructure for opportunities to improve design and construction.	Ongoing. The USGS National Strong-Motion Project has the primary Federal responsibility for acquiring strong motion records of significant earthquakes in the U.S. recorded by sensors placed in the ground and in structural arrays. In Alaska, the following have sensors: one bridge/overpass in Anchorage, one hotel in Anchorage, and four commercial buildings.	No. This action is not considered a priority currently.
FL 7.1	Create a prioritized list of potential flood-damaged or impacted structures and prepare grant applications for FEMA-funded programs.	Ongoing. The DCRA and local NFIP communities work to secure grant funding to acquire and relocate at-risk structures. After a substantial damage event, a property or business owner with flood insurance can secure Increased Cost of Compliance (ICC) funds to elevate their structure to prevent future risk of flood damages.	Yes. While this action is ongoing it is considered a priority to mitigate flood hazards.
FL 7.2	Promote development practices that reduce the flood risk (i.e. relocate and elevate at least 2 feet above BFE or buy-out property).	Ongoing. The State and the DCRA staff support and encourage communities that have land use authority to join the NFIP. The NFIP prevents the development of structures within the floodplain that do not meet the regulations and standards, such as the requirement to build above the BFE.	No. This action is ongoing and considered routine/efficient.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
GF 8.1	Develop an inventory of historical landslides and landslide-prone areas to use to produce location-specific landslide hazard maps.	Ongoing. Alaska DGGS is currently developing landslide inventory/susceptibility maps and modeling potential debris flow run-out for the Sitka and Homer areas; monitoring the movement of frozen debris lobes encroaching on the Dalton Highway in the southern Brooks Range (in collaboration with the University of Alaska Fairbanks); and assessing the landslide and tsunami hazards in the upper Barry Arm with multiple State, federal, private and university entities.	Yes. While this action is ongoing it is considered a priority to develop landslide / debris flow maps throughout the State where needed.
TS 9.1	Conduct community outreach to encourage all tsunami-threatened communities to participate in the NOAA Tsunami Ready Program. Provide platform for discussing available mitigation partnerships, benefits, and grant opportunities by preparing tsunami hazard mitigation plans / EOP tsunami annexes and identifying tsunami evacuation routes.	Ongoing. DHS&EM hosts Tsunami Operations Workshops for community leaders and emergency managers in tsunami hazard areas to discuss tsunami planning and response. In addition, DHS&EM in partnership with NOAA, UA, and DGGS hosts an annual Alaska Tsunami Preparedness Week.	Yes. The State would like to continue to reach and teach community leaders, particularly in rural coastal areas, about various tsunami programs.
TS 9.2	Contact TsunamiReady-certified communities during the third year of their TsunamiReady certification to support them throughout their renewal process.	Ongoing. One borough and 12 communities have participated in TsunamiReady.	No. This action is ongoing and considered routine/efficient.
TS 9.3	Provide tsunami hazard and evacuation signs for TsunamiReady-certified communities.	Ongoing. U.S. Department of Commerce provides funds to the State of Alaska due to Alaska's high threat for tsunami. The allocation supports the promotion of local-, regional-, and State-level tsunami mitigation and preparedness, including installation of warning communications systems, tsunami signage and promotion of the TsunamiReady program in Alaska.	No. This action is ongoing and considered routine/efficient.
TS 9.4	Install tsunami warning sirens in at-risk tsunami communities.	Ongoing. See TS 9.3.	No. This action is ongoing and

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
			considered routine/efficient.
TS 9.5	Phase funded project: (1) identify, locate, and characterize tsunami sources in Alaska; (2) research and model the tsunami risk for vulnerable coastal communities; (3) obtain bathymetric data for accurate tsunami inundation mapping; (4) research and model the tsunami risk for vulnerable coastal communities; and (5) develop tsunami inundation maps for tsunami-threatened communities statewide.	Ongoing. In partnership with the DGGS and DHS&EM, the Alaska Earthquake Center maps potential inundation using numerical modeling of tsunami wave dynamics. Communities are selected with consideration to their tsunami hazard exposure, location, infrastructure, the availability of data, and willingness to incorporate the results into a hazard mitigation plan.	Yes. While this action is ongoing there are still more coastal communities to map and this action is considered a priority.
TS 9.6	Continue DHS&EM's participation on the NTHMP with UAF/GI, AEC, and DGGS partnership while advocating for continued joint planning, outreach, and Congressional NTHMP funding.	Ongoing. DHS&EM, UAF/GI, and DGGS continue to actively participate on the NTHMP Coordinating Committee and its subcommittees.	No. This action is ongoing and considered routine/efficient.
TS 9.7	Encourage NOAA to continue researching and developing rapid tsunami warning technologies such as near-real-time moment tensor inversion, extension of earthquake source inversion procedures, and "GPS shield technique" early tsunami warning efforts.	Ongoing. The Alaska Earthquake Center maintains two moment tensor catalogs to provide real-time earthquake detection. NOAA acquires real-time tsunami forecasts through 39 Deep-ocean Assessment and Reporting of Tsunami (DART) stations at sites in regions with a history of generating destructive tsunamis.	No. This action is ongoing and considered routine/efficient.
VO 10.1	Conduct comprehensive volcano hazard and risk assessments for the Cook Inlet and surrounding areas and include the results into hazard mitigation planning.	Ongoing. The USGS completed a hazard assessment for Iliamna Volcano in 1999 and the Augustine Volcano in 1998.	No. This action is not considered a priority currently.
VO 10.2	Conduct and publish individual volcano hazard and risk assessments in Cook Inlet.	Ongoing. The USGS completed a hazard assessment for Iliamna Volcano in 1999 and the Augustine Volcano in 1998.	No. This action is not considered a priority currently.
VO 10.3	Incorporate updated volcanic hazard assessments in State and local hazard mitigation plans as appropriate.	Ongoing. An updated volcano hazard assessment was included in the 2023 SHMP.	No. This action has already been addressed at the State level, ongoing at the local level.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
VO 10.4	Include updated volcanic hazard assessments in State and local Emergency Response and Operations Plans as appropriate.	Ongoing. An updated volcanic hazard assessment is included in the 2023 SHMP, and volcanoes are addressed as hazard profiles in the 2023 Alaska State Emergency Operations Plan.	No. This action has already been addressed at the State level, ongoing at the local level.
VO 10.5	Create and disseminate volcano hazard information products.	Ongoing. The USGS, Alaska Volcano Observatory, Alaska Department of Health, and Municipality of Anchorage have several volcano hazard information products available to the public.	No. This action is ongoing and considered routine/efficient.
VO 10.6	Conduct outreach and education on volcanic hazards and risk mitigation for the remote communities of the Alaska Peninsula and the Aleutian Islands.	Ongoing. Beyond Rural Resilience workshops, AVO has conducted individual community engagement activities in the past year, including Perryville, Sitka, and Port Heiden. More are planned for 2023, such as Unalaska and Adak.	No. This action is ongoing and considered routine/efficient.
WX 11.1	Strive to conduct four special statewide outreach and awareness activities to support Lightning Safety Awareness Week, Winter Weather Awareness Week, Flood Awareness Week, Tsunami Ready, and Storm Ready education and certification, as applicable.	Ongoing. The Governor of the State of Alaska proclaimed: the second to last week of March as Tsunami Preparedness Week and the last week of September as Winter Weather Preparedness Week. Flood Awareness week is the second week of March and is promoted by NOAA and FEMA while Lightning Safety Awareness Week is the third week of June and is promoted by the National Lightning Safety Council.	No. This action is ongoing and considered routine/efficient.
WX 11.2	Install more weather stations and “high sites” to the NWR network to facilitate expanding continuous broadcast and warning availability to remote locations.	Uncompleted. There are over 1,000 transmitters in the U.S. However, there are multiple areas in Alaska that do not have coverage, including the North Slope Borough and Yukon–Koyukuk Census Area. In addition, multiple Alaska transmitters were out of service as of February 2023.	No. This action is not considered a priority currently.
WX 11.3	Encourage local communities to employ and register with NOAA to receive warnings via fax, e-mail, radio, and telephone and to transmit to public in redundant methods to fulfill StormReady criteria for redundant warning and	Ongoing. Communities throughout Alaska put out public service announcements regarding registering for NOAA weather alerts via text or email.	No. This action is ongoing and considered routine/efficient.

Number	Description	Status	Updated / Modified Action Included in 2023 SHMP
	emergency information receipt and communitywide dissemination.		
WX 11.4	Conduct workshops to train community volunteers to perform all-season Storm Spotter Network activities such as Riverwatch and other extreme weather event reporting and coordination.	Completed. The NWS has created a 53-page weather-spotting training manual for community volunteers to report hazardous weather and any impacts being observed within their community. Alaska Weather Spotter Training .	No. This action has been completed.
WX 11.5	Conduct agency outreach activities to expand weather monitoring networks to facilitate communicating warnings and severe event communication and warnings.	Completed. The NWS operates 165 weather stations throughout Alaska. DGGs operates an additional seven weather stations in southern and southeastern Alaska.	No. This action has been completed.
WX 11.6	Encourage and conduct education or hands-on training to demonstrate the value of various hazard-resistant construction practices and appropriate materials selection to improve hazard event damage resistance.	Ongoing. The State of Alaska promotes safe and sustainable construction, sustainable construction, fire and building safety, disaster mitigation, and energy conservation throughout the month of May during Building Safety month.	No. This action is ongoing and considered routine/efficient.
WF 12.1	Conduct Firewise and other hazard-resistant construction and materials selection workshops to teach program requirements and best risk mitigation practices.	Ongoing. DOF conducted informational Firewise kiosks in the McGrath, Takotna, Nikolia, and Telida communities in the South-West Area.	Yes. The State would like to continue to reach and teach community leaders, particularly in rural areas, about Firewise and other selected programs.
WF 12.2	Identify, organize, and monitor the various programs responsible for fuel management in the wildland/urban interface.	Ongoing. DOF manages a Hazard Fuel Reduction Program. DOF's protection responsibilities are geographically split into six separate areas, and within each area the Hazard Fuel Reduction Program is carried out through hand crews, mechanical treatment, prescribed burns, and public outreach.	Yes. While this action is ongoing there is more work to be done with the DOF program. It is also considered a priority.

Notes:

Check mark indicates that the proposed action was updated or modified to carry forward in the 2023 SHMP Update

— = not applicable

ACCP = Alaska Center for Climate Assessment and Policy

AEC = Alaska Earthquake Center

AFG = Alaska Department of Fish and Game

AKDOF = Alaska Department of Forestry

AURA = Arctic Urban Risks and Adaptations

BFE = Base Flood Elevation

BRIC = Building Resilient Infrastructure and Communities

CDBG-DR = Community Development Block Grant–Disaster Recovery

CDBG-MIT = Community Development Block Grant–Mitigation

CF = critical facility

Covid-19 = coronavirus disease 2019

CWPP = Community Wildfire Protection Plan

DART = Deep-ocean Assessment and Reporting of Tsunami

DCRA = Alaska Division of Community and Regional Affairs

DGGS = Alaska Division of Geological & Geophysical Surveys

DHS&EM = Division of Homeland Security and Emergency Management

DOF = Division of Forestry

DOPR = Division of Parks and Outdoor Recreation

EAS = Emergency Alert System

EOP = Emergency Operations Plan

FCC = Federal Communications Commission

FEMA = Federal Emergency Management Agency

FMAG = Fire Management Assistance Grant

GIS = geographic information system

GPS = Global Positioning System

NFIP = National Flood Insurance Program

HMGP = Hazard Mitigation Grant Program

HMP = Hazard Mitigation Plan

HUD = U.S. Department of Housing and Urban Development

IBC = International Building Code

ICC = Increased Cost of Compliance

KPB = Kenai Peninsula Borough

KWF = Kenai Watershed Forum

LHMP = Local Hazard Mitigation Plan

MAP = Mapping, Assessment, and Planning

MSB = Matanuska-Susitna Borough

NCRF = National Coastal Resilience Fund

NCWC = National Coastal Wetlands Conservation

NFIP = National Flood Insurance Program

NOAA = National Oceanic and Atmospheric Administration

NRCS-EWP = Natural Resources Conservation Service–Emergency Watershed Protection Program

NTHMP = National Tsunami Hazard Mitigation Program

NWR = National Wildlife Refuge

NWS = National Weather Service
PSI = Periodic Safety Inspection
RL = Repetitive Loss
RVS = Rapid Visual Screening
SHMP = State Hazard Mitigation Program
SRL = Severe Repetitive Loss
State = State of Alaska
UA = University of Alaska
UAF-GI = University of Alaska, Fairbanks Geophysical Institute
USFS = U.S. Forest Service
USGS = U.S. Geological Survey

6.4 PRIORITIZATION OF MITIGATION ACTIONS

For the 2018 SHMP, the mitigation action prioritization process was based on the SHMP’s mission and vision statement. Mitigation actions that were consistent with the statement to minimize loss of life and injuries, minimize damages, facilitate the restoration of public services, promote economic development, were assigned a “high” priority (highest ranking).

For the 2023 SHMP, the mitigation action prioritization process was updated to be based on the 2023 SHMP Section 4, Hazard Identification and Risk Assessment, and Section 5, State Capabilities, as follows:

- A very high priority ranking was assigned to actions that addressed urgent need/life safety actions. These actions generally include the State CFs identified in Section 4, Hazard Identification and Risk Assessment, as being located in a hazard area.
- A very high priority ranking was assigned to actions that addressed data gaps. As discussed in Section 5, State Capabilities, a big challenge to hazard mitigation in Alaska is the lack of accurate, statewide hazard data to support mapping, planning, and policy mitigation strategies and risk communication.

In addition, mitigation actions that were listed in the 2018 SHMP and currently identified as ongoing or uncompleted have been updated and/or modified and included in the 2023 SHMP Prioritized Action Plan.

7 LOCAL PLANNING COORDINATION AND CAPABILITY BUILDING

Standard State Mitigation Plan Regulation Checklist
LOCAL PLANNING COORDINATION AND CAPABILITY BUILDING
S13. Does the plan generally describe and analyze the effectiveness of local government mitigation policies, programs, and capabilities? [44 CFR § 201.4(c)(3)(ii)]
S13-a. Does the plan provide a summary of current local government policies, programs and capabilities of jurisdictions to accomplish hazard mitigation?
S13-b. Does the plan describe the effectiveness of local government mitigation policies, programs and capabilities?
S14. Does the plan describe the process to support the development of approvable local government mitigation plans? [44 CFR §§ 201.3(c)(5) and 201.4(c)(4)(i)]
S14-a. Does the plan describe how the state supports developing or updating FEMA-approvable mitigation plans?
S14-b. Does the plan provide a brief summary of barriers to developing or updating, adopting, and implementing FEMA approved local government mitigation plans based on an analysis of plan and jurisdiction coverage data and trends across the state and steps to remove barriers to help local governments advance mitigation planning, including how plan and jurisdiction coverage data and trends inform those steps?
S15. Does the plan describe the criteria for prioritizing funding? [44 CFR § 201.4(c)(4)(iii)]
S15-a. Does the plan describe criteria for prioritizing jurisdictions to receive planning and project grants under available federal and non-federal programs?
S16. Does the plan describe the process and time frame to review, coordinate, and link local and tribal mitigation plans with the state mitigation plan? [44 CFR §§ 201.3(c)(6), 201.4(c)(2)(ii), 201.4(c)(3)(iii), and 201.4(c)(4)(ii)]
16-a. Does the plan describe the state's process and time frame to review and submit approvable local and tribal mitigation plans to FEMA?
S16-b. Does the plan describe the state's process and time frame to share risk assessment data and mitigation priorities with local governments for their plan updates, as well as integrate local risk assessment and mitigation actions into the state mitigation plan updates?

Source: FEMA, 2022

7.1 LOCAL GOVERNMENT MITIGATION POLICIES, PROGRAMS, AND CAPABILITIES

The State's constitution provides a very diverse self-governance structure. Therefore, "formal" planning and land management capabilities throughout Alaska's borough, city, and tribal governments vary widely due to their respective constitutional authorities. Table 7-1 describes local government policies and programs available in Alaska for hazard mitigation. Some policies and programs may not be available to all Alaskan communities, however, due to constitutional authority. The table provides: a description of the effectiveness of each policy and program; challenges to implementation, including gaps and disparities in serving underserved communities and challenges resulting from the impacts of climate change; and opportunities for implementing mitigation actions through local government capabilities, including technical assistance and funding. The policies and programs are listed alphabetically.

Table 7-1: - Local Government Mitigation Policies, Programs and Capabilities

Type	Summary
Alaska Watershed Protection and Flood Prevention Program	The Watershed and Flood Prevention Operations (WFPO) Program operates under the USDA’s Natural Resources Conservation Service. The program assists federal, state, local and tribal governments with protection and restoration of watersheds. The WFPO program provides technical and financial assistance to States, local governments and Tribal organizations to help plan and implement authorized watershed projects for the purpose of: Flood Prevention, Watershed Protection, Public Recreation, Public Fish and Wildlife, Agricultural Water Management, Municipal and Industrial Water Supply and Water Quality Management. Statutory and regulatory criteria for eligibility in this program include public sponsorship; watershed projects protect up to 250,000 acres; and benefits that are directly related to agriculture, including rural communities, must be at least 20 percent of the total benefits for the project. WFPO may be an option for some local jurisdictions to implement High Hazard Potential Dams (HHPD) mitigation activities if needed. Because the requirements to address HHPD in HMPs are new as of 2023, there is limited awareness of how programs such as WFPO may be applied to HHPD mitigation projects.
Building Codes	Building codes (where available) are typically implemented at the local or borough-wide level in Alaska. A building code is a set of rules that specify the standards for constructed objects such as buildings and non-building structures. The main purpose of building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. Building codes are generally intended to be applied by architects, engineers, interior designers, constructors and regulators but are also used for various purposes by safety inspectors, environmental scientists, real estate developers, subcontractors, manufacturers of building products and materials, insurance companies, facility managers, tenants, and others. Codes regulate the design and construction of structures where adopted into law. - A major obstacle to hazard mitigation in Alaska is that only commercial building codes are adopted and/or enforced statewide. Very few communities in Alaska enforce residential building codes. Local and borough jurisdictions may have their own residential codes to follow, and the Alaska Housing Finance Corporation adopts the IRC for its residential standard and the IECC for its Building Energy Efficiency Standard. However, if a residential building is built outside of a jurisdiction with a residential code and without financing, it may not be built to meet the basic requirements of the IRC. Many rural Alaskan communities lack the personnel and technical experience to carry out code enforcement responsibilities because they are not fiscally feasible to implement or there is a lack of funding to bring residential structures into compliance with the minimum residential building code requirements. One solution to overcoming the lack of code adoption would be educate and encourage the use of template language in procurements that require builders to build to minimum required (IRC and IECC or other) codes and include inspection costs in their construction costs. The cost for inspections could be higher for areas with no residential building codes, or no code officials to conduct inspections. - Opportunities to implement building codes locally or borough-wide typically occur through the general fund of the governing body and there are areas in Alaska with no local governing body.

Capital Improvement Plan	A Capital Improvement Plan contains all the individual capital projects, equipment purchases, and major studies for a local government, in conjunction with construction and completion schedules, and in consort with financing plans. The plan provides a working blueprint for sustaining and improving the community’s infrastructures, including hazard mitigation projects. It coordinates strategic planning, financial capacity, and physical development. The plan/program is usually short-range, 4 to 10 years. • 8 communities in Alaska have Capital Improvement Plans as of 2023, including Juneau, Homer, Klawock, Akutan, Lake & Peninsula Borough, Kake, Angoon and Yakutat (DCRA Community Plans Library 2023). It is an ongoing challenge for many communities to implement a Capital Improvement Plan. Administrative capacity may be lacking, especially in smaller rural communities, and there may be a lack of funding for positions to complete this work. The changing climate and resulting changes to infrastructure needs may also complicate work on Capital Improvement Plans. Opportunities to implement Capital Improvement Plans in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • FEMA: Hazard Mitigation Assistance (HMA), Building Resilient Infrastructure and Communities (BRIC) • FEMA: HMA, Flood Mitigation Assistance (FMA)
Climate Action Plan	A locally adopted Climate Action Plan is a comprehensive policy tool outlining specific actions that a community will undertake to reduce greenhouse gas emissions and/or adaptation strategies the community will implement to counter the negative effects of climate change. Sometimes plans cover a single community, while others are regional in scope. A Climate Action Plan typically addresses the reduction of greenhouse gas emissions through a series of local programs and policy measures related to transportation, land use, building energy, water, waste, and green infrastructure. Step-by-step technical resources can assist jurisdictions that are just undertaking the planning process or want to update and strengthen existing plans. In Alaska, few jurisdictions have plans for climate change, although some communities include the reduction of greenhouse gases in community or comprehensive plans. Challenges to implementing a Climate Action Plan include local funding and technical ability. • 5 communities in Alaska have Climate Action Plans. These include Homer, Pedro Bay, Anchorage, Juneau and Sitka. (UAF Center for Arctic Policy Studies 2020). Challenges to developing a Climate Action Plan include the lack of human capital and human resources to write and exercise the plans, particularly for remote rural communities and underserved communities. There may also be limited awareness about the plans themselves and the purpose of the plans. Opportunities to implement Climate Action Plans in local communities through local financial capabilities include the following programs: • International Council for Local Environmental Initiatives’ (ICLEI) Cities for Climate Protection Campaign.
Comprehensive Economic Development Strategy (CEDS) 2022-2027	The CEDS correlates with the DHS&EM mitigation activities in the following ways: • Objective 6.1 - Resiliency Framework - DHS&EM sees support of the CEDS by annual development of mitigation plans for as many communities as possible. • Objective 6.3 – Resilient Infrastructure - DHS&EM comments on how the state supports those efforts. • DHS&EM sees the support of CEDS through programs such as BRIC and HMGP: - HMGP – Alaska Railroad mitigation projects such as mitigation ROW from washouts

	- BRIC C&CB - Akiak bulk fuel farm risk studies. (AKIAK specifically requested for PDM 19 to move bulk fuel farm away from river) - Dalton highway DOT project • Through other initiatives and actions DHS&EM is doing distribution management plans to support recognition of logistics needs for sections across Alaska. • Redundancy: DHS&EM has ability to elevate electrical substations within communities.
Comprehensive Plan	A comprehensive plan is a guide for community land use development. It is based on a community vision and portrays the dynamics, unique qualities, and concerns of a community. It represents how residents see their community. A comprehensive plan promotes orderly growth by providing a framework for decisions about land use, transportation, public facilities, economic development, housing, and other factors that are vital to a healthy and livable community. It includes guidelines for determining the type and location of industrial, commercial, recreational, and residential development. It can also describe hazard areas and lists goals and policies to reduce the potential risk of death, injuries, and economic damage resulting from natural and human-caused hazards. • 109 communities, municipalities and boroughs in Alaska have Comprehensive Plans, though some of the plans are outdated (DCRA Community Plans Library 2023). Challenges to developing Comprehensive Plans include the need for human capital and human resources to write and exercise the plans, particularly for remote rural communities and underserved communities. Opportunities to implement Comprehensive Plans in local communities through local financial capabilities include the following programs (see Table 5-2 for further information): • Denali Commission Village Infrastructure Protection (VIP) Program
Emergency Action Plan (dams)	A dam Emergency Action Plan is a written document that identifies incidents that can lead to potential emergency conditions at a dam, identifies the areas that can be affected by the loss of reservoir and specifies pre-planned actions to be followed to minimize property damage, potential loss of infrastructure and water resource, and potential loss of life because of failure or mis-operation of a dam. The dam owner is responsible for development, maintenance, and exercise of the plan; however, there are guidelines, tools and assistance available to help owners. City, tribe, borough, and state emergency management directors and state dam safety officials can provide assistance with dam owners to create and exercise the plan. An owner can tap into this technical and emergency management expertise and can get additional support by using state and national educational materials, forms and examples, and step-by-step guidelines. • All High Hazard Potential Dams (HHPD) in Alaska have Emergency Action Plans, as required by law.
Emergency Response Plan/ Emergency Operations Plan	An Emergency Response Plan or Emergency Operations Plan is a document that lays out the series of steps a community will take during a devastating natural hazard to ensure community members' safety and minimize the impact. Emergency response plans are meant to help jurisdictions address various types of emergencies, such as wildfires, winter weather, earthquakes, floods, disease outbreaks, and other hazards. The goal is to reduce or prevent human injury and property damage during hazard events. These plans also take the guesswork out of roles and responsibilities by specifying which community members should be part of the response team and who should be contacted. • 41 communities in Alaska have ERPs/EOPs.

	Challenges to developing an Emergency Response Plan include the lack of human capital and human resources to write and exercise the plans, and lack of governmental structure to respond and utilize the plans, particularly for remote rural communities and underserved communities. Changing conditions due to climate change may also increase the difficulty of planning for future hazards that a community may not have previously experienced. Opportunities to assist with implementation of ERPs/EOPs in local communities include the Small Community Emergency Response Plans (SCERP). The State's ERP provides a toolkit for the creation of SCERP (https://ready.alaska.gov/Plans/SCERP).
FireWise Program	The Firewise USA recognition program is administered by the National Fire Protection Association and provides a collaborative framework to help residents in a community get organized, find direction, and take action to increase the ignition resistance of their homes and community and to reduce wildfire risks at the local level. Alaska Firewise is a cooperative effort among local, state, federal, and private agencies and organizations to promote fire safety in areas vulnerable to wildland and community fires. Communities can become a Firewise Community by creating a Firewise Board and Firewise Task Force or Commission, developing a Community Wildfire Protection Plan, sponsoring Wildfire Days public events, volunteering or investing in community wildfire mitigation, and seeking certification. • 3 communities in Alaska have implemented the FireWise program. The FireWise program is a volunteer-based program. For many communities in Alaska, it was proven difficult to find and retain staff. The plans can be challenging to set up, and there is often a lack of human capital. Increased susceptibility to wildfires in some areas due to climate change may also increase the difficulty of planning for fires, particularly for communities that have not have previously experienced wild fires in their area. Opportunities to implement the FireWise Program in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • FEMA: Fire Management Assistance Grant (FMAG) • FEMA: HMA, Hazard Mitigation Grant Program Post Fire (HMGP–Post-Fire)
Hazard Mitigation Plan	Hazard mitigation is “any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards.” As such, hazard mitigation is any work to minimize the impacts of any type of hazard event before it occurs. Hazard mitigation aims to reduce losses from future disasters. It is a process that identifies and profiles hazards, analyzes the people and facilities at risk, and develops mitigation actions to reduce or eliminate hazard risk. The implementation of the mitigation actions—which include short- and long-term strategies that may involve planning, policy changes, programs, projects, and other activities—is the result of this process. • 107 communities in Alaska have FEMA-approved HMPs covering 155 jurisdictions. Challenges to developing HMPs are a lack of funding for plan development and plan update, lack of data to have clear understanding of risks, and lack of funding to implement projects. Another challenge is that climate change as a profiled hazard or incorporated into other hazard profiles will need to be addressed in future plans and will require additional or updated mapping around climate change related hazards. Opportunities to implement Hazard Mitigation Plans in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • FEMA: HMA, Hazard Mitigation Grant Program (HMGP)

National Flood Insurance Program (NFIP)	The NFIP provides flood insurance to property owners, renters and businesses, and having this coverage helps them recover faster when floodwaters recede. The NFIP works with communities required to adopt and enforce floodplain management regulations that help mitigate flooding effects. The NFIP is managed by FEMA and is delivered to the public by a network of more than 50 insurance companies and the NFIP Direct. As the NFIP Coordinator in Alaska, DCRA coordinates with other state offices to ensure policies and regulations are in place to meet the minimum NFIP standards, supports NFIP communities, provides technical assistance to local communities and state agencies, maintains a state floodplain mapping program through a cooperative agreement with FEMA for producing and providing flood hazard maps that include best available flood and erosion information as a tool for flood hazard mitigation and implementation of the NFIP used to regulate floodplain development and mitigate for flood losses. • In Alaska, approximately one-third (34%) of Alaska’s 164 incorporated municipalities participate in the NFIP. This participation includes 33 communities and boroughs and an additional 25 cities within the jurisdictional boundaries of participating NFIP boroughs. Most of Alaska’s population resides within the communities that participate in the NFIP; 85 percent reside in organized boroughs and 3 percent reside in the cities in the unorganized boroughs. A major obstacle to participation in the NFIP is that many jurisdictions are ineligible to join the NFIP due to their inability to adopt and enforce a flood damage prevention ordinance. Many of Alaska’s federally declared disasters involving flooding have occurred in the Unorganized Boroughs within the Bethel, Kusilvak, and Yukon-Koyukuk census areas, where there are no residential building codes or flood damage prevention ordinances. See Section 5.3 for further discussion. Increased public outreach around the importance of the NFIP could increase code adoption, and thus increased NFIP participation. Funding opportunities to implement the NFIP in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • FEMA: HMA, Flood Mitigation Assistance (FMA)
StormReady Program	The StormReady program, run through the National Weather Service, helps arm America's communities with the communication and safety skills needed to save lives and property—before, during and after a severe weather event. StormReady helps community leaders and emergency managers strengthen local safety programs. StormReady communities are better prepared to save lives from the onslaught of severe weather through advanced planning, education and awareness. The program encourages communities to take a new, proactive approach to improving local hazardous weather operations by providing emergency managers with clear-cut guidelines on how to improve their hazardous weather operations. • 7 communities in Alaska have implemented the StormReady program. Challenges to implementing the StormReady program include lack of leadership staff and significant staff turnover, especially in small rural and underserved communities. Opportunities to implement the StormReady Program in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • NWS Tsunami Financial Assistance
TsunamiReady Program	TsunamiReady is a voluntary community recognition program that promotes tsunami hazard preparedness as an active collaboration among federal, state, local, and tribal emergency management agencies, community leaders and the public. The main goal of the program is to improve public safety before, during and after tsunami emergencies. It aims to do this by establishing guidelines for a

	standard level of capability to mitigate, prepare for and respond to tsunamis and working with communities to help them meet the guidelines and ultimately become recognized as TsunamiReady by the National Weather Service. • 9 communities in Alaska have implemented the TsunamiReady program. Challenges to implementing the TsunamiReady program include lack of leadership staff and significant staff turnover, especially in small rural and underserved communities. To be eligible, communities also need to have an All Hazards HMP in place that includes tsunamis, as well as either a SCERP or an EOP. Opportunities to implement the TsunamiReady Program in local communities through local financial capabilities include the following grant programs (see Table 5-2 for further information): • NWS Tsunami Financial Assistance • National Tsunami Hazard Mitigation Program (NTHMP)
Zoning	Zoning refers to municipal or local laws or regulations that govern how real property can and cannot be used in certain geographic areas. For example, zoning laws can limit commercial or industrial use of land from building in residential neighborhoods. These laws can be modified or suspended if the construction of a property will serve to help the community advance economically. Communities can discourage or restrict development in vulnerable areas such as floodplains, landslide areas, the wildland-urban interface or other known hazard areas as a part of hazard mitigation. Zoning is typically implemented at the local or borough-wide level in Alaska. • 74 municipalities (of 162) do not exercise planning and zoning powers (Alaska Mapping Business Plan, September 2022 Update) Challenges to effective zoning in Alaskan communities include a lack of local hazard mapping that makes it difficult to zone for hazards, as well as challenges with enforcement of zoning laws.

7.2 STATE SUPPORT FOR LOCAL JURISDICTION HAZARD MITIGATION PLANS

The State of Alaska subscribes to a whole community approach to emergency management. It is expected that extensive collaboration with the public, all levels of government, government agencies, the private sector, non-governmental organizations, and community organizations will be required to address and build mitigation policies, programs, and capabilities analysis and effectiveness. The state's intent is to foster a cooperative relationship with each community and tribal government in order to build the most resilient Alaska possible.

Open dialogue between the community and state is fostered and assistance is offered at all HMP development stages. As described below, the State, in partnership with the community and assisted by a contractor, guides community and tribal planners through the planning process from grant application to plan approval, into mitigation project development. In addition, this section addresses barriers to developing or updating, adopting and implementing FEMA-approved local HMPs.

7.2.1 State Role in Local Planning Process

The State plays multiple roles in the local planning process. Some examples of State support for local plans include:

- Helping to provide funding opportunities through Building Resilient Infrastructure and Communities (BRIC);
- Conducting outreach for plan renewal if a plan is going to expire;
- Providing outreach and education on the importance of multi-jurisdiction plans;
- Running an annual Emergency Management Conference with presentations for communities;
- Running Resiliency Workshops; and
- Partnering with FEMA for hybrid Local/Tribal workshops on HMPs with opportunities for technical assistance.

Many Local and Tribal jurisdictions complete HMPs on their own or with their own contract support. In these cases, the State is notified of the process and used as a subject matter expert for specific issues and reviews the HMP before sending to FEMA for formal approval.

The State also manages the development and review of HMPs through a pool of contractors that are assigned a specific number of communities to work with. For these contracts, the Local and Tribal Jurisdiction planning processes begin with a kick-off meeting where a State of Alaska HMP planner and/or the State-selected contractor, and community leaders come together to discuss HMP goals and needs. New or updated HMP performance expectations are covered for both the contractor and the local and tribal community as applicable. Community HMP involvement levels, local planning team development, completion timelines, and incremental and final product deliverables are discussed. Future meetings are scheduled with the local planning team(s) and community council(s) to address new HMP information or to update existing HMP information. For HMP updates, discussions occur to define any changes in infrastructure, construction, or development as well as associated risk vulnerabilities to known hazard events that have occurred since the legacy HMP was implemented.

A state representative from DHS&EM can be present to build the state-city or state-tribe relationship. State participation ensures that the local government is aware of how the plan needs to interface with applicable state mitigation processes and priorities, their planning resources, hazards and associated vulnerabilities, and mitigation options.

Any information available from the state database can be used to guide the planning process and provide a framework for the early discussions with the community. If the state already has data from that community in the database, the executive summary sheet can provide a valuable starting point for the

planning process. For those communities that do not yet have entries in the database, the blank template can serve as a guide to show communities the types of information that will be needed for the plan.

From the kick-off meeting to the final draft edit, public feedback and input is not only encouraged but essential for developing a viable HMP. The State recognizes that the community's insight and collective history may provide valuable historical information. For instance, oral histories passed down from generation-to-generation of Alaska Native tribes may contain important data on natural hazards.

The community provides the draft plan to community members and interested stakeholders to solicit comments and ensure accuracy. It can be made available on city and/or tribal websites, at town offices or other community locations. Public comments are gathered and included within the plan content.

After the completed plan has been through public review and technical editing, the State, community, or tribal contractor finalizes the draft plan. The jurisdiction, tribe, or contractor then sends it for State (DHS&EM) review. The State confirms the plan fulfills FEMA regulatory criteria by ensuring communities are aware of their hazard data, their planning resources, and that the plan follows the state's mitigation priorities. The State then sends the plan to FEMA for formal review and approval.

The State strives to review and forward mitigation plans within 30 days of receipt from the community or contractor. To support timely review, the State has added review of HMPs to their procured contract services to enhance DHS&EM staffing if multiple reviews require additional support. If FEMA requires revisions, the State will coordinate with the local government or tribe to obtain the required information, amend the plan and resubmit to FEMA in a timely manner. Once the plan has fulfilled FEMA criteria, it will move to the Approvable Pending Adoption (APA) stage. The State will contact the jurisdiction encouraging them to formally adopt their HMP; knowing the adopted plan will be approved. The State will ensure the plan is adopted within one calendar year from the APA date. Once adopted, the State will forward community and tribal resolutions (as applicable) to FEMA to complete the final phase – plan approval. FEMA's approval letter starts the plan's five-year lifecycle as determined from the HMP's approval date.

The completed HMP along with all approval letters, resolutions, review tool, and HMP development or supporting documents are packaged and sent (electronically) to local and tribal communities. An electronic copy of the HMP is provided to the Department of Commerce, Community, and Economic Development (DCCED) to post on their Community Plans Library portal.

7.2.2 State Mitigation Planning Database for Local Mitigation Planning

To support local jurisdiction hazard mitigation planning, DHS&EM has been building an internal database since 2018 to help track local mitigation efforts. The state has loaded data from every local and tribal HMP on file with the State into the database. The database includes all the State disaster information, including all of the projects associated with each disaster, communities affected by disasters, and limited mapping.

The Division of Community and Regional Affairs (DCRA) previously maintained an older database with community information. This newer database would likely have increased capability to download information. The State DHS&EM has a memorandum with DCRA to share this community data.

The State Mitigation Planning Database includes community reports with data on:

- General overview of community (location community size, government, etc.)
- Cultural information (Federally recognized tribes, Village Corporations)
- Public safety (such as fire department/state trooper posts)
- Public Services (such as health care facilities)
- Transportation (such as airports)
- Hazard data (summarized into brief text and ranked by probability and severity)

- Activities (community plans, DCRA grants, Denali Commission Reports, State Emergency Operations Center (SEOC) events [calls made], HMGP grants)
- Critical facilities data (currently limited)

As of 2023, DHS&EM continues to expand this database. DHS&EM would like to see the database grow to be able to quickly identify hazards and critical infrastructure within a community. The database would eventually be expanded to have interactive hazard mapping capabilities.

Executive Summary Sheet

DHS&EM will be adding a local requirement to future HMPs that an Executive Summary sheet is required when submitting for review. This will enable DHS&EM to enter consistent information into the database regarding hazards, populations, and critical facilities at risk as well as support prioritization of mitigation action funding.

The Executive Summary sheet would contain the following types of information for each community:

- Name of plan
- Year of plan
- Types of hazards addressed
- Number & financial value of critical facilities at risk by hazard
- Population & residential structures at risk by hazard
- Recent & planned development in hazard areas
- Mapping
- Data gaps
- Types of assets considered (i.e., land area, critical facilities, cultural facilities, population, vulnerable population, etc.)
- Types of mitigation actions included (i.e., retrofit, additional planning, public outreach, etc.)
- Funding needs
- Mitigation projects by hazard

7.2.3 Barriers to Developing or Updating Local Hazard Mitigation Plans

Rural Alaskan communities face unique challenges and barriers to developing, updating adopting and implementing local HMPs. Some of these barriers include:

- Lack of baseline local hazard data
- Lack of baseline state-wide hazard data
- Limited ability to gather new data
- Lack of financial resources
- Lack of access to, and knowledge of, funding sources
- Lack of technical assistance
- Institutional barriers to accessing technical and financial barriers
- Lack of local training
- Lack of local specialists to translate technical data into informed and actionable decisions
- Lack of local funded positions

7.2.4 Steps to Remove Barriers to Developing or Updating Local Hazard Mitigation Plans

Steps to removing these barriers to help local governments advance mitigation planning include:

- Increased hazard data collection
- Increased availability of data at the local level
- Increased education and awareness of hazards

- Increased awareness of funding opportunities
- Increased technical assistance
- Fundable local mitigation coordinator positions to address technical assistance
- Increased and expanded training

DHS&EM has developed specific strategies to overcome these barriers in the 2023 SHMP Mitigation Strategy. See Section 6, Mitigation Strategy, for complete strategy information and details. In summary, these strategies include:

Data:

- Wildfire Exposure Map Expansion
- Risk MAP Expansion
- Coastal Community Flood Assessment Expansion
- Alaska Climate Change Impact Mitigation Program Expansion
- Landslide and Avalanche Susceptibility Map Expansion
- Tsunami Inundation Mapping Program Expansion
- Alaska Statewide Digital Elevation Model Update
- Wetland Map Expansion

Funding:

- Mitigation Planning Database Expansion
- Local and Tribal Hazard Mitigation Planning Support

Technical assistance and training:

- Rural Resilience Workshop Expansion
- Tsunami Operations Workshop Expansion
- TsunamiReady and StormReady Expansion
- Community Wildfire Protection Plan Outreach Expansion
- Alaska Firewise Expansion
- Continuation of Building Safety Month
- Volcano Awareness Month
- National Flood Insurance Program Expansion

7.3 STATE PRIORITIZATION PROCESS FOR LOCAL JURISDICTION FUNDING

Alaska State agencies prioritize projects and plans for local jurisdiction funding under federal and non-federal grant programs. Various factors are applied by the agencies to prioritize funding, including:

- Communities located in areas of highest risk
- Recent disasters in communities
- Communities where certain hazards may be exacerbated by climate change
- Disadvantaged communities
- Areas with more general impacts from climate change
- Public interest/high visibility hazard potential
- Communities where development may exacerbate hazards
- Communities with critical infrastructure at high risk
- Data driven prioritization; focus on areas with greatest history of hazard
- Communities with infrastructure that is failing/impacted by climate change
- Population density

- Vulnerability of communities, including underserved communities

7.3.1 State Prioritization Process - State Hazard Mitigation Advisory Committee

The State Hazard Mitigation Advisory Committee (SHMAC) was originally formed in 2002 as an essential inter-agency coordination process to determine prioritization of funding mitigation plans and projects with federal and non-federal grants.

SHMAC membership consists of agency-selected representatives with responsibility for agency-specific mitigation needs and priorities, which supports their agency's respective missions.

Members of the SHMAC are determined by the SHMO. The typical SHMAC team comprises:

- DHS&EM State Hazard Mitigation Officer (SHMO)
- DHS&EM State Disaster Mitigation Officer
- Department of Environmental Conservation (DEC)
- Department of Natural Resources (DNR)
- Applicable Borough Emergency Managers
- Applicable state agency infrastructure subject-matter-experts

The SHMAC meets quarterly, or as warranted, to prioritize projects and plans. Under the guidance of the SHMO, the SHMAC reviews the prioritization of project and plans, and validates each project's potential effectiveness and priority. Factors considered by the SHMAC in the prioritization process include:

- Plans and projects for communities at highest risk
- Projects that reduce the threat to health and safety
- Projects that reduce the threat to critical facilities
- Projects that reduce the threat to high-risk properties, including repetitive loss and severe repetitive loss structures
- Plans and projects for areas of intense development
- Plans and projects for communities most vulnerable to climate change
- Projects and plans for underserved communities and socially vulnerable populations
- Projects that reduce the threat to private facilities or homes
- Projects that provide a long-term solution

7.3.2 State Mitigation Planning Database for Prioritization Process

Alaska's local and tribal HMPs inform and influence the state's risk assessment and mitigation priorities. The State uses information from these mitigation plans to supplement state data. It is this information that provides a broader understanding of regional vulnerabilities that will shape prioritization actions and policies to reduce risk most effectively.

The new state database will be a powerful tool for the state to track local mitigation plan activities and funding, and will thus aid in the prioritization process.

Once local and tribal communities fulfill FEMA HMP criteria, formally adopt their plans and receive FEMA final approval they can apply for FEMA and other federal agency grants.

To be eligible for HMGP funding, applicants must be: a state agency, a local government, a private non-profit organization, an Alaska Native Village or organization, or a federally recognized IRA tribe. An eligible applicant must apply to the State DHS&EM for funding, and may submit hazard mitigation plan development or construction projects to be considered by the State. Projects must meet the State's minimum criteria:

- Does the project conform to the State Hazard Mitigation Plan?

- Does the project provide a beneficial impact on the designated area such as RL/SRL locations?
- Is it cost effective?
- Will the project meet environmental requirements?

The State Hazard Mitigation Officer (SHMO) and DHS&EM mitigation staff sort project submittals and ensure that they adhere to the following:

1. Projects that address life safety concerns,
2. Local hazard mitigation plan development,
3. Other eligible mitigation projects, such as NFIP-identified RL or SRL properties,
4. Non-eligible projects or initiatives:
 - a. Other available funding sources – Non-natural hazards
 - b. Not mitigation projects: (e.g., aircraft, boats, or equipment)

Projects are then categorized according to SHMP goals, and prioritized in numerical order. The project list is then reviewed and tentatively approved by FEMA Region 10's hazard mitigation staff to validate DHS&EM's project eligibility assessment.

Specific projects could qualify as a FEMA "Expedited" or "Fast Track" project or initiative. FEMA "Expedites" or "Fast Tracks" projects to quickly fund state-identified priority projects that would not only fulfill SHMP goals, but also quickly relieve stress and hardship. This process is especially beneficial after minor disasters where minimal funding is available and proposed projects are not very complex. FEMA's Hazard Mitigation staff support this simple easily approved process because it supports FEMA's goal of quickly funding projects to protect lives and property while mitigating future disaster losses in high-hazard areas.

7.3.3 Challenges to Implementing Local HHPD Mitigation

Inclusion of hazards from HHPD in HMPs is a new requirement from FEMA as of 2023. Local communities are still becoming familiar with new requirements to address HHPDs for State and Local HMPs. Thus there may be additional challenges for prioritizing local communities' HHPD-related mitigation activities, including:

- Lack of information about HHPD in Local HMPs
- The limited number of NFIP communities in Alaska may be prohibiting the potential use of HHPD funds or other funds for HHPD mitigation actions

To address and remove these challenges, the State is pursuing mitigation strategies to support a more comprehensive understanding of HHPD hazards, as addressed in Section 6, Mitigation Strategies. In particular, these two strategies will be pursued:

- Inundation Mapping Quality and Program Expansion for High Hazard Potential Dams
- High Hazard Potential Dams Remedial Investigations and Repair

Improved inundation mapping and investigations into HHPD will help develop a better understanding of HHPD hazards. This will help the State, local and tribal communities determine if there is a need to implement projects to reduce risks and increase resilience to potential dam failure.

7.4 STATE PROCESS TO REVIEW LOCAL / TRIBAL HAZARD MITIGATION PLANS AND FEMA SUBMITTAL

A component of updating the State's mitigation strategy is the consideration and inclusion of the local and tribal mitigation plan strategies. By reviewing, prioritizing, and incorporating the types or categories of actions identified by communities, the State can better understand how to support investments in local and tribal mitigation efforts.

Reviewing the local and tribal hazard mitigation plans informs and influences the state's risk assessment and mitigation priorities. The reviews determine whether HMPs follow and fulfill state hazard mitigation goals and priorities, and if it is integrated into the state and borough HMPs, as well as numerous agency mitigation initiatives as applicable.

The State uses the State Mitigation Plan Review Guide, released April 2022, to ensure it meets the requirements of the Stafford Act and Title 44 Code of Federal Regulations (CFR) and subsequently includes it with the completed Mitigation Plan.

The new state database will also serve as a powerful tool in the process of reviewing community and tribal plans. Having all the data available in one place will facilitate tracking the plans over time. The State will maintain records of the local mitigation plan executive summaries submitted by year to track mitigation projects and review them on 4 year cycle (a year before the local jurisdiction needs to update the plan). The State can provide local jurisdiction support based on the review cycle.

Outdated HMPs do not qualify the State for disaster assistance until the HMP has been updated and received FEMA final approval; only emergency assistance to avert direct hazard impacts will be allowed. Additionally, complete, unapproved SHMPs do not allow the state to receive funding until the SHMP has received formal State adoption, and subsequent FEMA final approval. Therefore, once the SHMP has fulfilled all FEMA criteria, Alaska's governor or designee is required to sign a formal SHMP Adoption Resolution or a Letter of Promulgation. The required documents are then sent to FEMA for final SHMP approval.

FEMA's final approval assures the State eligibility for applying for appropriate disaster assistance and mitigation grant program funding.

8 REVIEW, EVALUATION, AND IMPLEMENTATION

Standard State Mitigation Plan Regulation Checklist
REVIEW, EVALUATION AND IMPLEMENTATION
S17. Is there a description of the method and schedule for keeping the plan current? [44 CFR §§ 201.4(c)(5)(i) and 201.4(d)]
S17-a. Does the plan describe the agency/office responsible for monitoring, evaluating and updating the plan?
S17-b. Does the plan describe the schedule for monitoring, evaluating, and updating the plan?
S18. Does the plan describe the systems for monitoring implementation and reviewing progress? [44 CFR §§ 201.4(c)(5)(ii) and 201.4(c)(5)(iii)]
S18-a. Does the plan describe the system for tracking the implementation of the mitigation activities and projects identified in the mitigation strategy, including all mitigation activities and not just those funded by FEMA?
S18-b. Does the system include the schedule, the agency/office responsible for coordination, and the role of the agencies/offices identified in the mitigation strategy as responsible for implementation of actions?
S18-c. Does the plan describe a system for reviewing progress on achieving the mitigation strategy's goals that includes the criteria and process for evaluating progress?

Source: FEMA, 2022

8.1 MONITORING, EVALUATING AND UPDATING THE 2023 STATE HAZARD MITIGATION PLAN

The State Hazard Mitigation Officer (SHMO) is responsible for monitoring, evaluating, and updating the State Hazard Mitigation Plan in accordance with 44 CFR 201.4(c)(5)(i). The SHMO will monitor the plan continually, evaluate the plan annually and update the plan every 5-years, or within 90 days of a presidential declared disaster (if required), or as necessary to reflect changes in state or federal law. The SHMO determines when significant changes warrant an update prior to the scheduled date.

The Alaska SHMP Annual Review Tracker will be used as the main review tool to keep the plan current (Table 8-1 below). FEMA-funded mitigation projects and non-FEMA funded projects will continue to be tracked and reviewed using the Mitigation Action Progress Report (Table 8-2 below). The SHMO will utilize these tools as needed throughout the year as activity warrants to update the mitigation activities across the state. Each year the SHMO will complete these two forms as needed to summarize the mitigation progress made for that entire year. For non-FEMA funded projects, the Responsible Agency will collaborate with the SHMO to track projects, which may include taking part in meetings as needed or providing status updates of the projects for which they are responsible. The Responsible Agency will provide the SHMO with the information necessary to fill out the Mitigation Action Progress Report.

8.2 TRACKING PROGRESS ON MITIGATION ACTIVITIES

In order to keep the plan current, the SHMO will complete the Alaska SHMP Annual Review Tracker (Table 8-1 below) every year, or more often, as activity warrants.

Table 8-1: SHMP Annual Review Tracker

Date	Disasters That Occurred	Mitigation Actions Implemented	New Relevant Studies/Reports to Include in 2028 SHMP	Public Outreach Conducted	Changes Made to 2023 SHMP
2024					
2024					
2025					
2025					
2026					
2026					
2027					
2027					
2028					
2028					

In order to track the progress of mitigation activities across the State, the SHMO will complete the Mitigation Action Progress Report (Table 8-2 below) every year, or more often, as activity warrants. The Progress Report includes the criteria used to evaluate progress of the mitigation strategy goals in the plan, including:

- Project Schedule and Milestones
- Review of Plan Goals Addressed and Success Indicators
- Budget Status
- Recent Accomplishments
- Obstacles or Delays encountered
- Resolution of Obstacles
- Next Steps

Table 8-2: Mitigation Action Progress Report**Mitigation Action Progress Report**

Progress Report Period: _____ To _____

(Date)

(Date)

Project Title: _____ Project ID#: _____

Responsible Agency: _____

Address: _____

Contact Person: _____ Title: _____

Phone #(s): _____ email Address(s): _____

List Supporting Agencies and Contacts: _____

Total Project Cost: _____

Anticipated Cost Overrun/Underrun: _____

Project Approval Date: _____ Project Start Date: _____

Anticipated Completion Date: _____

Description of project (describe each phase, if applicable, and the time frame for completing each phase: _____

Milestones	Complete	Projected Completion Date

Mitigation Action Progress Report (Continued)

Plan Goal(s) Addressed: _____

Goal: _____

Success Indicators: _____

Project Status

☐ On Schedule☐ Completed☐ Delayed*

* Explain: _____

☐ Canceled

Project Cost Status

☐ Cost Unchanged☐ Cost Overrun**

** Explain: _____

☐ Cost Underrun***

*** Explain: _____

Summary of progress on project for this report: _____

A. What was accomplished during this reporting period? _____

B. What obstacles, problems, or delays did you encounter, if any? _____

C. How was each problem resolved? _____

D. Next Steps: What is/are the next step(s) to accomplish over the next reporting period? _____

Other Comments: _____

8.3 ANNUAL REVIEW AND UPDATE OF THE STATE HMP

Beginning in 2024:

- Each year or as warranted, the SHMO will update and review the Alaska SHMP Annual Review Tracker, which provides annual summaries of the disasters that have occurred; mitigation actions that have been implemented; new relevant information (studies and reports) that becomes available; public outreach conducted; and changes made to the 2023 SHMP.
- Each year or as warranted, the SHMO will complete the Mitigation Action Progress Report, which includes updated information on specific mitigation projects, including budget, schedule, milestones and narrative summaries of progress.
- The SHMO will develop a new work plan for the 2028 plan update.
- The SHMO will begin the plan update process for the 2028 plan update.

9 ADOPTION AND ASSURANCES

Standard State Mitigation Plan Regulation Checklist
ADOPTION AND ASSURANCES
S19. Did the state provide documentation that the plan has been formally adopted? [44 CFR § 201.4(c)(6)]
S19-a. Did the state provide documentation of formal adoption by the highest elected official or designee prior to FEMA approval?
S20. Did the state provide assurances? [44 CFR § 201.4(c)(7)]
S20-a. Does the plan include assurances that the state will manage and administer FEMA funding in accordance with applicable federal statutes and regulations?
S20-b. Does the plan include assurances that the state will update its plan whenever necessary to reflect changes in state or federal laws and statutes?

Source: FEMA, 2022

9.1 ADOPTION RESOLUTION

The 2023 Alaska State HMP was adopted by the State of Alaska on October 12, 2023. The adoption letter was signed by Bryan J. Fisher, the Director of the Department of Military and Veterans Affairs, Division of Homeland Security and Emergency Management.

9.2 ASSURANCES

A copy of the Alaska State HMP adoption resolution is kept on file with the State of Alaska DHS&EM and FEMA Region X.

The State supports 44 CFR 201 and assures compliance with all applicable federal statutes and regulations.

10 HIGH HAZARD POTENTIAL DAMS

Standard State Mitigation Plan Regulation Checklist
HIGH HAZARD DAMS
HHPD1. Did Element S2 (planning process) describe how the state dam safety agency, other agencies, and stakeholders participated in the planning process and contributed expertise, data, studies, information, etc. relative to high hazard potential dams?
HHPD1-a. Does the plan describe how the state dam safety agency, other agencies, and stakeholders were involved in the planning process?
HHPD1-b. Does the plan describe the types of data contributed?
HHPD2. Did Element S6 (risk assessment) address all dam risks from high hazard potential dams in the risk assessment?
HHPD2-a. Does the plan provide a list of high hazard potential dams that have been identified by the state with their names, National Inventory of Dams identification numbers, locations by jurisdiction, and other relevant information, as well as maps?
HHPD2-b. Does the plan summarize statewide vulnerabilities to/from high hazard potential dams from hazards and the potential consequences associated with dam incidents?
HHPD2-c. Does the plan document limitations and describe the approach to address deficiencies?
HHPD3. Did Element S9 (mitigation goals) include mitigation goals to reduce long-term vulnerabilities from high hazard potential dams?
HHPD3-a. Does the plan address a reduction in vulnerabilities to/from high hazard potential dams from hazards and the potential consequences associated with dam incidents as part of their own goals or with other long-term strategies?
HHPD3-b. Does the plan link the proposed actions to reduce long-term vulnerabilities consistent with the goals?
HHPD4. Did Element S10 (mitigation actions) prioritize mitigation actions and activities to reduce vulnerabilities from high hazard potential dams?
HHPD4-a. Does the plan include actions to reduce vulnerabilities to/from high hazard potential dams?
HHPD4-b. Does the plan describe the process to evaluate and prioritize actions related to high hazard potential dams that are cost-effective, environmentally sound and technically feasible?
HHPD4-c. Does the plan describe how each action to reduce risks related to high hazard potential dams contributes to the goals and describe how strategies are linked to the state mitigation strategy?
HHPD5. Did Element S11 (funding sources) identify current and potential sources of funding to implement mitigation actions and activities for high hazard potential dams?
HHPD5-a. Does the plan include various funding sources to mitigate vulnerabilities to and from high hazard potential dams from hazards and the potential consequences associated with dam incidents, as well as funding sources to rehabilitate or remove high hazard potential dams?
HHPD6. Did Element S13 (local coordination) generally describe and analyze the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams?
HHPD6-a. Does the plan provide a summary of the local policies, programs, and capabilities to implement mitigation actions and reduce vulnerabilities from high hazard potential dams from hazards and the potential consequences associated with dam incidents?
HHPD6-b. Does the plan describe challenges to implementing local mitigation policies, programs and capabilities to reduce vulnerabilities to and from high hazard potential dams and the approach to overcome these challenges?

HHPD6-c. Does the plan describe opportunities for implementing mitigation actions to reduce risks to and from high hazard potential dams through local capabilities?
HHPD7. Did Element S15 (prioritizing funding) describe the criteria for prioritizing funding for high hazard potential dams?
HHPD7-a. Does the plan describe the method for funding actions to reduce vulnerabilities to and from high hazard potential dams if these actions were prioritized differently than mitigation actions for other hazards?
HHPD7-b. Does the plan document limitations and describe the approach to addressing deficiencies?

Source: FEMA, 2022

10.1 PLANNING PROCESS

The contractor met with the State Dam Safety Engineer (DSE) several times throughout the planning process.

- The State Dam Safety Engineer provided available data on the State jurisdiction HHPD early in the process.
- The DSE reviewed a draft of the HHPD hazard profile and provided comments. Further discussion with the DSE followed.
- The DSE provided information on critical facilities that may be vulnerable to failures of HHPD.
- The DSE provided ideas on dam risk mitigation and reviewed draft mitigation actions provided by the contractor.

10.2 HIGH HAZARD POTENTIAL DAM RISKS

Location and risks associated with HHPD are described in Section 4.1.9, Hazard Identification/HHPD. Vulnerabilities and potential consequences associated with HHPD incidents are addressed in both Section 4.1.9 and 4.2.2 (Vulnerability Assessment).

The limitation to vulnerability includes lack of quality mapping due to outdated DEM data and lack of watershed analysis. The solution is updated DEM and watershed analysis which is addressed in Section 6.2. In addition, digitizing EAP inundation mapping will better enable the DSE to conduct more detailed vulnerability analyses in future planning efforts.

10.3 HIGH HAZARD POTENTIAL DAM GOALS

Section 6.1, Mitigation Strategy/Goals, includes mitigation goals to reduce long-term vulnerabilities from high hazard potential dams (element HHPD3).

10.4 HIGH HAZARD POTENTIAL DAM PRIORITIZED MITIGATION ACTIONS

Section 6.2, Prioritized Mitigation Actions, addresses prioritized strategies and activities to reduce vulnerabilities from high hazard potential dams (element HHPD4).

10.5 HIGH HAZARD POTENTIAL DAM FUNDING SOURCES

Section 5.2, Funding Capabilities for Hazard Mitigation, identifies current and potential sources of funding to implement mitigation actions and activities for high hazard potential dams (element HHPD5).

10.6 LOCAL POLICIES, PROGRAMS AND CAPABILITIES

Section 7.1, Local Government Mitigation Policies, Programs, and Capabilities, describes and analyzes the effectiveness of local mitigation policies, programs, and capabilities that address high hazard potential dams (element HHPD6). Additional details are also provided in Section 4.1.9, Hazard Identification/HHPD.

10.7 PRIORITIZING LOCAL FUNDING OPPORTUNITIES

Section 7.3, State Prioritization Process for Local Jurisdiction Funding, describes the criteria for prioritizing funding for local plans and projects, which would include those that address high hazard potential dams (element HHPD7).

11 FIRE MANAGEMENT ASSISTANCE GRANTS

Standard State Mitigation Plan Regulation Checklist
FIRE MANAGEMENT ASSISTANCE GRANTS
FMAG1. Does the plan address wildfire risks? [44 CFR 201.4(c)(2); 44 CFR § 204.51(d)(2)]
FMAG1-a. Does the risk assessment provide an overview of the location and previous occurrences of wildfire hazards in the state?
FMAG1-b. Does the risk assessment provide an overview of the probability of future wildfire events that includes projected changes in the location, intensity, frequency and/or duration of wildfire hazards?
FMAG1-c. Does the risk assessment address the vulnerability of state assets located in wildfire hazard areas and estimate the potential dollar losses to those assets?
FMAG1-d. Does the risk assessment include an overview and analysis of local governments' vulnerability to wildfires and the potential losses to vulnerable structures?
FMAG2. Does the plan's mitigation strategy contain wildfire-related mitigation initiatives? [44 CFR 201.4(c)(3); 44 CFR § 204.51(d)(2)]
FMAG2-a. Does the mitigation strategy identify mitigation actions and activities to reduce the vulnerability of jurisdictions within the state as well as the vulnerability of state-owned assets as described in Elements S5 and S6?

Source: FEMA, 2022

11.1 WILDFIRE RISKS

Location and previous occurrences of wildfire hazards are discussed in Sections 4.1.8.2 and 4.1.8.3, Hazard Identification, respectively. Probability of future wildfire events, including projected changes in the location, intensity, frequency, and duration is discussed in Sections 4.1.8.7 through 4.1.8.11. Vulnerability of state assets, including potential dollar losses is discussed in Section 4.2 Vulnerability of State Assets. An overview and analysis of local government vulnerability and potential losses to vulnerable structures is located in Section 4.2.6.8 and Section 4.3, Vulnerability of Local Jurisdictions.

11.2 WILDFIRE PRIORITIZED MITIGATION ACTIONS

Section 6, Mitigation Strategy, contains wildfire-related mitigation initiatives, including actions and activities to reduce the vulnerability of jurisdictions within the state as well as the vulnerability of state-owned assets (element FMAG2).

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12.9 SECTION 9 - ADOPTION AND ASSURANCES

No references cited for Section 9

12.10 SECTION 10 - HIGH HAZARD POTENTIAL DAMS

No references cited for Section 10

12.11 SECTION 11 - FIRE MANAGEMENT ASSISTANCE GRANTS

No references cited for Section 11

APPENDIX A: PUBLIC HEALTH

APPENDIX A: PUBLIC HEALTH

Hazard Characteristics

The State of Alaska establishes a system for coordinating the operational phases of emergency management within the Emergency Support Function (ESF) #8 which covers Public Health and Medical Services in the State of Alaska. Response to public health or medical disasters requires the cooperation of multiple Divisions within the State of Alaska DOH, as well as external partners. The Department of Health's Emergency Operations Plan and subsequent Annex's specify how the Division of Public Health will respond to various hazards in disaster emergencies, and is designed to:

- Ensure a coordinated effort by local and tribal governments, State, Federal, volunteer, and private agencies in the management of public health emergencies or disasters to save lives
- Ensure appropriate and timely activation of the Emergency Operations Center and response staff.
- Describe conditions that affect the public health disaster response operations
- Describe public health hazards that threaten the people, property, and resources
- Assign public health emergency management tasks to local, tribal, State, Federal, volunteer, and private agencies as appropriate for response to terrorist events, natural or manmade disasters

The hazards addressed in the Emergency Operations Plan are as follows:

Department of Health Emergency Operations Base Plan

Coordinates DOH response to and recovery from emergencies and disasters. Engages in public health and medical preparedness activities in association with hospitals, community organizations, local governments, and state and federal entities.

Annex A: Department of Health Emergency Operations Center Plan

Plans, trains, exercises, and operates the Department of Health (DOH) EOC. Coordinates all activities associated with the DOH EOC.

Annex B: Risk Communication and Information Sharing

Serves as the DOH representative to the Joint Information Center (JIC). Creates all press releases and provides guidance and support to all department staff regarding public messaging during disasters or public health emergencies.

Annex C: Biological Response

Epidemiology is responsible for initial screening to determine if further testing is appropriate in cases of emerging infectious diseases. Public Health Laboratories performs testing and reports results to providers and Epidemiology.

Annex D: Chemical Response

Responds to all cases involving chemical exposure in a disaster, either confirmed or suspected. Epidemiology performs initial response and surveillance. Public Health Laboratories performs testing on samples for confirmation.

Annex E: Radiological Nuclear Response

Respond to all cases involving radiation exposure, either confirmed or suspected.

Annex F: Medical Countermeasures Management

Coordinates the maintenance, storage, and deployment of the Strategic National Stockpile, in consultation with the federal government. Coordinates the release of state-owned pharmaceuticals when appropriate.

Annex G: Mass Casualty

Coordinates with hospitals to ensure medical supply, equipment, and personnel needs are met in the

affected community. Coordinates with local governments and the federal government to arrange for the transport, tracking, and care of patients who must be moved out of their current geographic location due to the emergency or disaster. This includes out of state patient movement.

Annex H: Mass Fatality

Responsible for all aspects of a mass fatality event, including the management of remains, preservation of evidence (when applicable), and investigation of fatalities.

Annex I: Behavioral Health

Supports victims of the disaster, particularly those in mass shelters. Serves as an asset to support responders and staff members with stress impact and mental health needs during the disaster or public health emergency.

Annex J: Pandemic Influenza

Conducts surveillance, collects specimens, and engages in public education related to potential and actual infectious disease outbreaks.

Annex K: Pharmaceutical Management

Coordinates with local governments, clinics, and hospitals to dispense pharmaceuticals as needed during a disaster or public health emergency.

Annex L: Volcanic Eruption and Ashfall Event Response

Details the roles and responsibilities of DOH during ashfall events and volcanic eruptions.

History

There are 27 hospitals in Alaska: 9 General Acute Care Hospital (GACH), 1 Long Term Acute Care Hospital (LTACH), 4 Specialized Hospital (Psych), 13 Critical Access Hospital (CAH). Throughout the State of Alaska, there are currently 23 acute care hospitals serving a population of approximately 739,828 people. While the population of Alaska is relatively small compared with some other states, the vast land territory of 663,268 square miles creates a unique environment for the provision of health care. Hospitals range from comprehensive facilities serving the larger urban populations to small facilities that provide the only healthcare available within a sizeable rural area. In addition to hospitals, there are tribal health care organizations, public health clinics, and nursing homes that provide a significant amount of healthcare in Alaska. In a disaster, it is likely that many of these healthcare facilities will be affected, either directly or through a surge of patients injured by the event.

Alaska has established mutual aid and assistance compacts among and between state, local, and tribal entities, as well as private and non-governmental partners. The Emergency Management Assistance Compact (EMAC) is a formalized agreement between 50 states, the District of Columbia, Puerto Rico, Guam, the Commonwealth of the Northern Mariana Islands, and the U.S. Virgin Islands to provide mutual assistance during emergencies or disasters. Alaska is a signatory to the Pacific Northwest Emergency Management Arrangement (PNEMA), a mutual aid agreement among Alaska, Oregon, Idaho, Washington, and British Columbia and the Yukon Territory in Canada.

EMAC establishes a legal foundation for sharing resources between states, solves the problems of liability and responsibilities of cost, and allows for credentials, licenses, and certifications to be honored across state lines. EMAC also establishes parameters for requesting assistance from other states and ensures prompt, full, and effective utilization of states' resources. Through the EMAC, participating states also provide cooperation in emergency-related exercises, testing, and other training activities.

Public Health resource requests will be routed through the Department of Health Emergency Operations Center (DOH EOC) to the State of Alaska Emergency Operations Center (SEOC). The SEOC will coordinate with DOH EOC on resource requests for public health emergencies. Once the SEOC has

completed the vetting process, the resource request will be submitted to FEMA and other states through the EMAC system.

APPENDIX B: PUBLIC SURVEY RESPONSES

APPENDIX B: PUBLIC SURVEY RESPONSES



Locations of survey responses from Survey #1 and Survey #2

State of Alaska 2023 Hazard Mitigation Plan Update
Survey #1

Survey Response Summary

Total # of Responses: 104

Q1 Please provide your location

Answered: 104 Skipped: 0

#	RESPONSES	DATE
1	Wasilla	3/10/2023 12:35 PM
2	Homer, Alaska	3/10/2023 11:16 AM
3	Anchorage	3/9/2023 10:33 PM
4	Anchorage	2/21/2023 3:23 PM
5	Seward, AK	2/7/2023 6:33 AM
6	Kenai Peninsula Borough	2/6/2023 9:43 AM
7	Eagle River (Eagle River Valley)	1/30/2023 10:04 AM
8	Fairbanks	1/26/2023 7:14 PM
9	Point Hope	1/25/2023 12:51 PM
10	Wailla	1/23/2023 4:15 PM
11	Fairbanks	1/23/2023 10:15 AM
12	Eagle River	1/21/2023 11:34 AM
13	Big Lake	1/20/2023 7:56 PM
14	Anchorage	1/19/2023 7:56 PM
15	Palmer	1/19/2023 11:23 AM
16	Delta Junction	1/19/2023 9:13 AM
17	Kodiak Alaska	1/17/2023 2:37 PM
18	Anchorage	1/6/2023 4:00 PM
19	Skagway	12/14/2022 10:14 AM
20	Anchorage	11/29/2022 3:04 PM
21	Valdez, Alaska	11/20/2022 6:32 PM
22	Talkeetna	11/14/2022 12:04 PM
23	Valdez	11/12/2022 8:57 AM
24	Copper Center	11/10/2022 12:07 PM
25	Talkeetna, AK	11/3/2022 8:48 PM
26	Fairbanks	11/1/2022 11:25 AM
27	King Cove Alaska	10/23/2022 8:30 AM
28	Wasilla	10/20/2022 12:20 PM
29	Two Rives, AK	10/20/2022 8:28 AM
30	Wasilla	10/18/2022 11:45 PM
31	Glacier View, Alaska 99674	10/14/2022 1:09 PM
32	Wasilla	10/10/2022 7:59 PM
33	Yakutat	10/10/2022 10:07 AM

State of Alaska Hazard Mitigation Plan Questionnaire

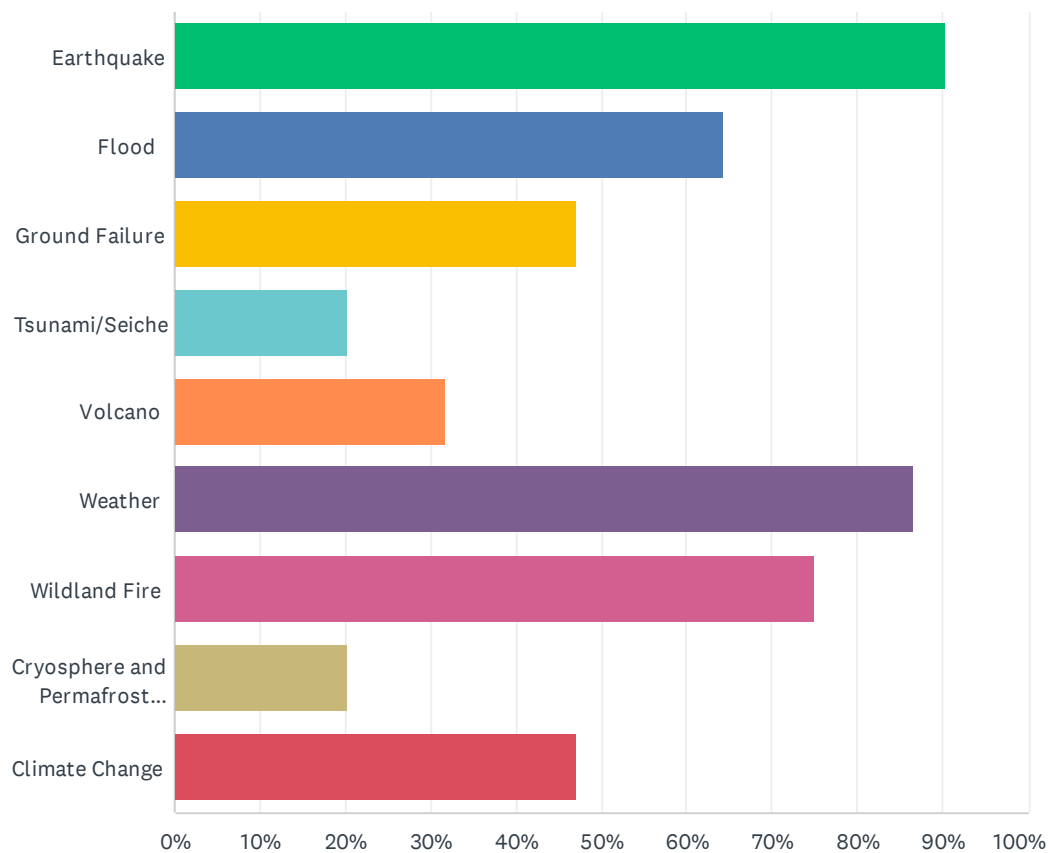
34	Matanuska Susitna Valley	10/7/2022 4:34 PM
35	Gakona	10/7/2022 4:33 PM
36	Wasilla	10/7/2022 4:32 PM
37	Glennallen	10/6/2022 7:08 AM
38	Fairbanks	10/4/2022 8:02 PM
39	Wasilla	10/1/2022 11:55 AM
40	Wasilla	10/1/2022 11:05 AM
41	Wasilla	10/1/2022 6:59 AM
42	Sutton	9/30/2022 2:36 PM
43	Matanuska Susitna Valley	9/30/2022 2:18 PM
44	Cottonwood Lake...Palmer/Wasilla	9/30/2022 9:20 AM
45	Wasilla	9/30/2022 5:39 AM
46	Mile 3 Fairview Loop Wasilla AK	9/29/2022 11:55 PM
47	Palmer, Alaska	9/28/2022 10:59 PM
48	Palmer	9/28/2022 9:34 PM
49	Anchorage	9/28/2022 11:09 AM
50	Ester, Alaska (Interior Alaska)	9/28/2022 9:16 AM
51	Palmer	9/28/2022 7:41 AM
52	Palmer, AK	9/28/2022 6:18 AM
53	Kenny Lake	9/28/2022 4:27 AM
54	Anchorage	9/28/2022 1:48 AM
55	Anchorage	9/27/2022 10:47 PM
56	Eagle river	9/27/2022 9:29 PM
57	Palmer	9/27/2022 8:59 PM
58	Big Lake	9/27/2022 8:58 PM
59	Memory Lakes Subdivision/Wasilla AK	9/27/2022 8:45 PM
60	Wasilla	9/27/2022 8:35 PM
61	Palmer	9/27/2022 7:48 PM
62	Wasilla	9/27/2022 7:47 PM
63	Meadow Lakes	9/27/2022 7:18 PM
64	Palmer	9/27/2022 7:11 PM
65	Palmer	9/27/2022 6:17 PM
66	Wasilla	9/27/2022 6:02 PM
67	Palmer, Alaska	9/27/2022 5:51 PM
68	Valdez/Copper River Basin	9/27/2022 5:39 PM
69	Homer	9/27/2022 4:48 PM
70	Gakona, alaska	9/27/2022 4:04 PM
71	Two Rivers AK	9/27/2022 12:26 PM

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72	Anchorage	9/18/2022 11:16 AM
73	Fairbanks	9/7/2022 4:24 PM
74	Houston	8/21/2022 12:32 AM
75	Wasilla	8/20/2022 6:33 PM
76	Wasilla	8/20/2022 5:55 PM
77	Wasilla	8/17/2022 10:04 AM
78	Wasilla Alaska	8/8/2022 5:13 PM
79	City of Adak, Alaska	8/8/2022 12:07 PM
80	Matanuska Valley Alaska	8/8/2022 11:51 AM
81	Tolsona, AK	8/6/2022 11:04 PM
82	Gateway, AK	8/5/2022 12:30 AM
83	Houston ALaska	8/4/2022 9:53 PM
84	WAsilla	8/4/2022 6:52 PM
85	Butte, Alaska	8/4/2022 10:47 AM
86	Wasilla	8/4/2022 10:18 AM
87	Anchorage	8/4/2022 5:55 AM
88	Palmer	8/4/2022 12:27 AM
89	MatSu	8/3/2022 9:35 PM
90	Palmer, AK	8/3/2022 5:51 PM
91	25679 W Long Lake Road, Willow AK	8/3/2022 3:54 PM
92	Palmer, AK	7/31/2022 12:08 AM
93	Wasilla	7/29/2022 1:10 PM
94	Valdez	7/29/2022 8:42 AM
95	Anchorage	7/29/2022 7:53 AM
96	Wasilla	7/28/2022 10:00 PM
97	Anchorage	7/28/2022 8:43 PM
98	Anchorage	7/28/2022 11:19 AM
99	Anchorage	7/27/2022 10:53 PM
100	Sitka	7/27/2022 2:37 PM
101	Bethel, Ak 99559	7/27/2022 2:30 PM
102	Anchorage	7/27/2022 1:31 PM
103	Wasilla	7/27/2022 1:03 PM
104	Eagle River, Alaska	7/27/2022 8:01 AM

Q2 Select which natural hazards affect your community

Answered: 104 Skipped: 0



ANSWER CHOICES	RESPONSES	
Earthquake	90.38%	94
Flood	64.42%	67
Ground Failure	47.12%	49
Tsunami/Seiche	20.19%	21
Volcano	31.73%	33
Weather	86.54%	90
Wildland Fire	75.00%	78
Cryosphere and Permafrost Degradation	20.19%	21
Climate Change	47.12%	49
Total Respondents: 104		

Q3 If you would like to share any information or stories on historic hazards in your community, add them here (specific information about when the event occurred; how significant {how many feet of flooding, how fast did the wind blow, how many feet of shoreline was lost, etc}; and specific details about loss {were people hurt, were buildings damaged, etc} will help provide details for this hazard mitigation plan.)

Answered: 48 Skipped: 56

#	RESPONSES	DATE
1	2018 earthquake loss of roadways, 2022 winter wind storm left the majority of the valley without heat and power, unable to find generators for personal use, little to no guidance from law enforcement or state on where to go or assistance offered especially for elderly or those with newborn or small children,	3/10/2023 12:35 PM
2	It feels pretty tenuous at times, being at the end of the road with so many things like a bridge failure, flood, avalanche or landslide ready to sever our connection.	3/10/2023 11:16 AM
3	Wind & rain storm, fall 2012. Excessive snow load (multiple roof collapse), winter 2012. Earthquake November 2018, lots of damage in Anchorage & valley.	2/21/2023 3:23 PM
4	See KPB Hazard Mitigation Plan Update 2019 and AARs sent to DHS	2/6/2023 9:43 AM
5	I have lived in Fairbanks for the last 40 years. The winters are shorter, the summers are longer, and the fires are more widespread than I can ever remember. Extreme weather systems have washed out our bridges, impacted coastal communities, and have caused extensive damage to infrastructure. Heavy snows last year caused several roofs in the interior to collapse.	1/26/2023 7:14 PM
6	The Mat Su River floods every year	1/23/2023 4:15 PM
7	The windstorm in Jan 2022 blew down a storage tent and I was without power for about 60 hours. Wind storms and heavy snow storms always interrupt MEA.	1/20/2023 7:56 PM
8	In the Bells Flats area of Kodiak, Sargent Creek is a small anadromous water body that is a flashy and effected by rainfall and melt waters in the mountains surrounding the Women's Bay area. Over the past ten years on nearly an annual or semi annual basis, large rain events in conjunction with high tides cause Sargent Creek to overflow and top Sargent Creek Road. These repetitive events initially cause the area residents either restricted or deny access to a subdivision of approximately 500 residents. These vents also restrict the access and egress of fire and ambulance services to these areas. Although the flooding occurs on approximately 250 feet of road, the repeated flooding has began to degrade the road structures and scour areas in the Russian River which threaten the state bridges adjacent to these areas. Although this damage has not yet incurred a great amount of costs, one significant event could destroy the single access road into the subdivision causing potential cost to area residents unable to commute too and from home to their work places. The restriction of this subdivision also commercially prevents the production and distribution of a significant source of gravel extraction for the entire Kodiak community.	1/17/2023 2:37 PM
9	2020 December extreme weather event disaster 1994 locally generated tsunami \$20 million in damage 2022 rockslide and economic impact disaster	12/14/2022 10:14 AM
10	East Talkeetna is comprised of a series of sloughs and creeks that have been disconnected by haphazard development. We need to reconnect the drainage system so we can safely mitigate the flooding risks that threaten our community of 100+ homes.	11/14/2022 12:04 PM
11	The Copper River flooded and eroded its banks over 150ft inland on this side of Copper Center at one time. Taking out paths, roads, traditional camps, fishwheels, and much more. My grandfathers camp was never rebuilt after that, there's just no way to make a new road or camp, we would need heavy equipment and tons of dirt. This was about a decade ago, and	11/10/2022 12:07 PM

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wasn't the last time the River changed its current, each year the land and waters are changing. We have sinkholes in some areas, houses and structures are either sinking or shifting.

12	For slope instability see example near Treasure creek. Department of Natural Resources land record LAS 31778. Information available from DNR State Pipeline Coordinators Section, DNR.PCO.Records@alaska.gov.	11/1/2022 11:25 AM
13	Lots of flooding and roads washed out - ice dam release causing floods - river bank erosion etc	10/20/2022 12:20 PM
14	Wildland fires are the predominant threat in the community. The community is currently (as of 10/2022) outside of a fire service area and serviced by BLM wildland fire fighters when the threat occurs. Community is threatened at an increasing rate, mandatory evacuation last happened in 2013, yet warnings at "1 Ready" and "2 Set" happen almost each year between June-August. Air quality is significantly impacted during these months as well, as the policy to "let it burn" does not allow for complete/immediate response/containment if no structures/infrastructure is threatened.	10/20/2022 8:28 AM
15	January 1, 2022 windstorm event (70-80mph sustained) knocked power out for 3.5 days at my location and when the power came back on at 3am, my forced-air gas furnace had frozen condensate in the lines which cause repeated misfiring sequences that landed me in the hospital with CO poisoning!	10/18/2022 11:45 PM
16	Hwy-1 has a serious lack of maintenance at Mile-63 s-curve nearing Sutton from Chickaloon. Jan-3 2022 i was caught mid-road in 3' snow blown over Highway-1: no plows, and location of death as well as rearending of AST auto ... AKDOT must focus on this priority.	10/14/2022 1:09 PM
17	Winds in excess of 100mph, week-long power outage, beetle-killed spruce limiting future firewood harvests, closed sportfish fisheries.	10/10/2022 7:59 PM
18	Lost a bridge in Yakutaga from flooding	10/10/2022 10:07 AM
19	Regular flooding happens all the time when ice dams break on the Tazlina River every year. 1. Floods on the Tazlina: https://www.countryjournal2020.com/2020/08/play-it-again-sam-flood-alert-at-tazlina.html 2. More floods on the Tazlina: https://www.countryjournal2020.com/2021/07/high-waters-on-tazlina-at-end-of-july.html This past summer, houses were swept into the Copper due to floods. 1. Houses going down the Copper: https://www.countryjournal2020.com/2022/05/houses-start-falling-into-copper-river.html Permafrost is an issue here. Ponds are drying up, and I know of two houses that were literally moved after permafrost issues. Our house is affected by permafrost but we do not have the funds to move it. The Tok Cutoff, especially, as well as the Richardson is affected by permafrost. Often, sinking will suddenly happen overnight out on the highways.	10/7/2022 4:33 PM
20	Copper river erosion from high waters. Copperville lost homes this year. I'm 2015 copper center lost all thier fish wheels from a flood.	10/6/2022 7:08 AM
21	winter ice - increased prevalence and occurrence in recent years.	10/4/2022 8:02 PM
22	The cluster of houses where my residence is located experiences an increased exposure to wind activity due to the orientation of the structures and layot of the geography. It is most similar to the venturi effect in a carbeurator, where air is forced through a narrow channel and in response the speed increases. In January 2022 I had an entire green house lift up and land on top of the green house next to it. They were both anchored and built out beyond the factory specs.	10/1/2022 11:55 AM
23	The borough road going into my property was eroded by the Little Susitna river flooding. The replacement road was flooded again and does not provide safe access to my future home.	10/1/2022 11:05 AM
24	I live along the Matanuska River and I remember a few years ago watching an abandoned house fall into the river when the bank eroded. The main channel of the river was flowing right up against the highway.	9/30/2022 2:36 PM
25	100+ mile an hour winds caused narrow utility right of ways to have trees fall into the power lines.	9/30/2022 2:18 PM
26	Our area is very susceptible to earthquake's.	9/30/2022 9:20 AM
27	November 30, 2019 earthquake. Roads and home impacted. January 2022 3 days of 50 mph winds, homes and property damaged.	9/30/2022 5:39 AM

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28	Earthquake 2018 damaged foundation; Winter wind storm 2021/2022 caused 14-hour power outage	9/29/2022 11:55 PM
29	Wind storm in early 2022. 90 mph sustained wind and gusts over 120 for three days straight. Buildings and roof damage, property blown away, equipment turned over, huge snow drifts blocked garage and driveway.	9/28/2022 10:59 PM
30	I have lived here 50 years. The Interior has become more temperate with more rain, more snow, wind and ice storms. Also, wild land fires are becoming more unpredictable.	9/28/2022 9:16 AM
31	80mph winds	9/27/2022 8:59 PM
32	'96 fire came through my property. 2018 earthquake hit hard, but didn't damage anything of mine.	9/27/2022 8:58 PM
33	January 22- 100 mph gusts, Nov 2018 Earthquake plus aftershocks, Summer fires	9/27/2022 7:48 PM
34	We lost a quarter of our roofing in January of 2022 in a huge windstorm. We had some house damage from the 2018 earthquake. And Wasilla creek runs the backside of our 4 acres. It's flooded 2 times in the 15 years we've lived here. No flood damage to any structures. Only floods on the lower backside.	9/27/2022 7:47 PM
35	The wind was severe last year. Approx 90 mph in January. Part of our metal roof was slamming up and down. We were trying to get a contractor after damage was done to our roof. No one was available for approx 4-5 weeks. It would be nice to have info on contractors that can come out and help.	9/27/2022 7:18 PM
36	Flooding the past 5 years near hatcher pass, earthquake damage along palmer fishhook, extreme snow years requiring heavy equipment to keep driveways passable by spring	9/27/2022 7:11 PM
37	Regular landslides, avalanches, and rockfall onto the active Old Glenn and Seward Highways, regular earthquakes, lack of escape routes or alternate routes when these disasters happen.	9/27/2022 5:51 PM
38	Rocks, rocks, and more rocks falling. Always rocks on the road or falling from the hillside.	9/27/2022 4:04 PM
39	We get seasonal flooding most years which impacts people who live and recreate near local rivers. Freezing rain has become a serious issue almost every year causing trees to fall into power lines and dangerous road conditions. Many people in Fairbanks and surrounding areas were without power for over 36 hours in 2021, due to freezing rain then we got a severe cold snap. It seems like extreme weather events are increasing.	9/7/2022 4:24 PM
40	Earthquake at sea caused tsunami alarms to go off in Seward last year I was in it	8/20/2022 5:55 PM
41	We live in a neighborhood that didn't loose power during the 2021-2022 wind storm. We were very lucky. However, I personally was had to cancel a doctors appointment due to the facility closing because of the electrical grid going down. We had tree limbs on our power lines to our house that were never addressed and had to be taken down by my husband and neighbors. Luckily no one was hurt this time. This seems like such a simple solution that can be solved if there were just funding.	8/8/2022 5:13 PM
42	January 2022's windstorm caused damage to so many homes.	8/5/2022 12:30 AM
43	i could not get to work at the hospital for 4 days last winter due to impassible roads	8/4/2022 9:53 PM
44	Loss of shoreline, homes, businesses located on the west side of Old Glenn Highway.	8/4/2022 10:47 AM
45	Multiple earthquakes and wind events causing long-term power outages, and the 2018 earthquake closed the Glenn Highway at Mirror Lake	8/4/2022 12:27 AM
46	January 2022 Valley Windstorm. Power outages during frigid temperatures. Overturned vehicles on roads.	8/3/2022 5:51 PM
47	Earthquake Damage for all quakes over 5.5	8/3/2022 3:54 PM
48	100 year flood mark is how high we build in the flood zone.	7/27/2022 2:30 PM

Q4 What are the critical facilities and infrastructure in your community that you rely upon?

Answered: 104 Skipped: 0

#	RESPONSES	DATE
1	Matsu regional hospital, matcom dispatch center, fire and ems stations, three bears, ftedmyers, Walmart, birthing centers, VA clinic, Alcantra Armory	3/10/2023 12:35 PM
2	Road system and ground transport for essentials, ferry/barge and docking facilities, hospital, library	3/10/2023 11:16 AM
3	My home, church, grocery store	3/9/2023 10:33 PM
4	Power company, gas company, water & wastewater service.	2/21/2023 3:23 PM
5	Roads, airport, hospital and clinic, bridges, diversion tunnel at Lowell Creek.	2/7/2023 6:33 AM
6	See KPB Hazard Mitigation Plan Update 2019	2/6/2023 9:43 AM
7	Multiple roads in Eagle River (Valley and South Fork) are one road in/out, which leads to evacuation challenges. We also have limited cell service, so people may not receive timely notifications.	1/30/2023 10:04 AM
8	GVEA- electric College Utilities-water/sewer grocery stores railroad parks highway richardson highway dalton highway	1/26/2023 7:14 PM
9	The native Store and the School	1/25/2023 12:51 PM
10	MEA and MTA/ENSTAR	1/23/2023 4:15 PM
11	Richardson Hwy, Steese Hwy	1/23/2023 10:15 AM
12	Bridge	1/21/2023 11:34 AM
13	MEA - electric power ATT - Cell/Data MTA - Internet Three Bears - food/gas/other items Road maintenance/plowing	1/20/2023 7:56 PM
14	Medical, law enforcement, airport, port, roads	1/19/2023 7:56 PM
15	City-managed snow plowing, water, sewer and road maintenance. Enstar Natural Gas utilities. Emergency services. MEA electric utilities.	1/19/2023 11:23 AM
16	Gas/heating fuel Grocery	1/19/2023 9:13 AM
17	Fire Station, Kodiak Island Borough Gravel extraction sites.	1/17/2023 2:37 PM
18	Power infrastructure. Roads.	1/6/2023 4:00 PM
19	All port infrastructure, south Klondike highway, clinic, school, rec center, apt power plant and petro marine tank farm	12/14/2022 10:14 AM
20	food stores, natural gas pipes, internet service	11/29/2022 3:04 PM
21	The gas station, the grocery store, the harbour, 5he ferry dock	11/20/2022 6:32 PM
22	Our community relies on safe navigation of our neighborhood roads for driving, bicycling, and walking. Our 100+ homes should be protected from flooding by ensuring that culverts and drainage systems are fully connected and offer cohesive flood management.	11/14/2022 12:04 PM
23	Hospital, road maintenance, food supply, Energy supply (electric, fuel etc)	11/12/2022 8:57 AM
24	Homes, Apartments, Tribal Community Hall, Community Church, Multipurpose Facilities.	11/10/2022 12:07 PM
25	Health Clinic, Water and Sewer, Fire Department, Airport, School, Fuel Depot, Groceries	11/3/2022 8:48 PM
26	Hospital, bridges, roads, Chena flood control project, power grid, trans Alaska Pipeline	11/1/2022 11:25 AM

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27	Fish process plant, Fuel Farms, powerhouse	10/23/2022 8:30 AM
28	Roads, public buildings, hospitals and schools	10/20/2022 12:20 PM
29	1 Chena Hot Springs Road is the only road access to communities of 1000+ households. IF this road is cut off, there is limited alternatives to reaching services (Medical/EMT/safety) in Fairbanks or North Pole. River travel is possible, but unlikely as households are not necessarily equipped for large scale evacuation by river. Community also includes an elementary school (possible shelter location), small community center, and gas station.	10/20/2022 8:28 AM
30	electricity, gas, roadways	10/18/2022 11:45 PM
31	Verbal communications ... there is no local 'gathering hole' and this also is priority over a walking-biking trail (to be used by a few dozen folks, just a few weeks a year). There needs be made a secure location for open-message pickup, AMBER Alert updates board, a Classifieds board ... in a open, focused place. The consistent keeping of thieves and con artists from our small, non-linked well, Community is a priority we all must assist AST with. Some USPS has been vandalized too much..	10/14/2022 1:09 PM
32	Grocery store, gas station, hospital, school, bank, hardware store.	10/10/2022 7:59 PM
33	Max Italio Drive sliding into the ocean	10/10/2022 10:07 AM
34	Roads, rail, fire and EMS stations	10/7/2022 4:34 PM
35	The region's infrastructure is in a state of decay. For example, Wells Fargo bank has recently closed for weeks at a time due, apparently, to staffing shortages. We have reliable electricity, but last winter, our family paid \$500 in one month for power. Critical medical facilities are not at their peak. Cross Road Medical Center announced a few weeks ago they would only be open during the day 5 days a week, with no service for the additional 16 hours in each of those days, and no service in the 24 hours each weekend day. Copper River Native Association has a clinic, too, with identical hours. So there is no weekend or after hour health care other than an ambulance provided by a company from Delta Junction. (In the past, 20 years ago, there was 24/7 medical service, and actual "doctors" at Cross Road, and a robust volunteer region-wide ambulance service.) One problem the community faces is its role as a transportation hub. During the summer and hunting and fishing season, huge numbers of people pass through, in every direction. Unlike many parts of Alaska, where roads are linear, this is the most splayed-out section of the state, coming to a point at Glennallen, a non-incorporated sprawling little community. Glennallen has more roads going out of it than any other place in the state. (For example, Anchorage essentially has only two roads leaving it -- the Glenn going north and the Seward Highway, headed south.) Glennallen has the Richardson, north and south, the Tok Cutoff, the Glenn headed into Anchorage, and ties into the McCarthy Road, the Tok Cutoff, Lake Louise Road, the Denali Highway, and the Nabesna Road, all of which are considered part of the Copper Valley community by locals and services.	10/7/2022 4:33 PM
36	Bridges, grocery stores, gas stations, roads	10/7/2022 4:32 PM
37	Water well Fuel stations	10/6/2022 7:08 AM
38	Road system; rail system; aviation (commercial and private); water treatment plant (intake/output); power plant and electric grid; Fire/Police/EMS (city, UAF, military); hospital; elder care (indigenous and non-indigenous); telecommunication (landline/cellular); grocer;	10/4/2022 8:02 PM
39	Natural Gas, Water supply. Electricity...for now, but working on a remedy to be more independent.	10/1/2022 11:55 AM
40	Roads, Electric Utility infrastructure, Natural Gas utility infrastructure	10/1/2022 11:05 AM
41	Shipping, retail	10/1/2022 6:59 AM
42	I rely on the Glenn Hwy to get to every facility/business in the valley.	9/30/2022 2:36 PM
43	power lines and roads	9/30/2022 2:18 PM
44	Fire Dept and Utilities.	9/30/2022 9:20 AM
45	Schools, hospital	9/30/2022 5:39 AM
46	Road maintenance, grocery stores, internet, electricity, natural gas	9/29/2022 11:55 PM

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47	Fred Meyers, Walmart, NAPA- roadways	9/28/2022 10:59 PM
48	Water and electricity	9/28/2022 9:34 PM
49	A road out of town. It is unimaginable that 50% of all the humans in Alaska rely on a single road, with easily damaged bridges, as their only means of escape in the event of a major disaster. Another road and the Knik Arm Bridge must be built to ensure adequate egress routes.	9/28/2022 11:09 AM
50	Water fills, grocery stores, gas stations, power generation systems, and dump sites.	9/28/2022 9:16 AM
51	Fuel supply (Diesel/Gasoline) Natural Gas Electricity	9/28/2022 7:41 AM
52	Highway between Anchorage and Palmer.	9/28/2022 6:18 AM
53	Fuel supply chain, electric, roads, well water	9/28/2022 4:27 AM
54	Power plants, port of Alaska.	9/28/2022 1:48 AM
55	Single roads outside of town. Port vulnerability, limited medical facilities	9/27/2022 10:47 PM
56	Water, gas, electric	9/27/2022 9:29 PM
57	Roads electric	9/27/2022 8:59 PM
58	Roads Gas Stores	9/27/2022 8:58 PM
59	Power/Gas/Water/Food/Damage to Shelter Communication for access to local information and access to Emergency services. unknown Public Community Plan for supports.	9/27/2022 8:45 PM
60	Hospital, roads, freight (trains) schools(which have been used in the past for housing during forest fires)	9/27/2022 8:35 PM
61	Fire, police, DOT	9/27/2022 7:48 PM
62	Fire and medical.	9/27/2022 7:47 PM
63	Ourselves and our neighbors	9/27/2022 7:18 PM
64	Utilities, roads, emergency services	9/27/2022 7:11 PM
65	Grocery stores and gas stations. Also, for the whole state, the port is an issue as well. It needs to be fixed other wise our groceries won't make it.	9/27/2022 6:17 PM
66	Electric gas water.	9/27/2022 6:02 PM
67	Roads, power lines and power plants, gas lines, telecomm systems, EMS, fire, police, coast guard. To name a few.	9/27/2022 5:51 PM
68	Fuel supplies, grocery stores	9/27/2022 5:39 PM
69	Port, harbor, main road system	9/27/2022 4:48 PM
70	I rely on the Glenn Highway to get to and from Anchorage, Palmer, Wasilla for medical, airport, family, shopping.	9/27/2022 4:04 PM
71	Passable roads to and from Fairbanks	9/27/2022 12:26 PM
72	water, sewer, roads, hospitals, etc.	9/18/2022 11:16 AM
73	The electric grid is most important and Water delivery would be a close second for me personally but medical facilities are also very important. I think a lot of people don't have enough emergency food and water for situations that last several days.	9/7/2022 4:24 PM
74	Fire department	8/21/2022 12:32 AM
75	Gas station. Grocery stores.	8/20/2022 6:33 PM
76	Stores	8/20/2022 5:55 PM
77	Water system, natural gas system, power system	8/17/2022 10:04 AM
78	MEA, electrical grid	8/8/2022 5:13 PM

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79	Tsunami Warning Sieren, Evacuation Center, Airport Terminal & Runway, Water storage, Wastewater & Sewage Facility, Medical Clinic, Fuel Tanks, Harbor & Port, Housing	8/8/2022 12:07 PM
80	Hospital, medical clinics, cellular and landline phones, grocery stores, mail service.	8/8/2022 11:51 AM
81	Roads	8/6/2022 11:04 PM
82	Power. Natural gas. Gas/Fuel stations. Grocery. Livestock feed & farm supply. Equipment rental.	8/5/2022 12:30 AM
83	roads power and communications	8/4/2022 9:53 PM
84	Wells, roads, power plants	8/4/2022 6:52 PM
85	The Old Glenn Highway and bridges connecting my community to Palmer.	8/4/2022 10:47 AM
86	Highways and airstrips	8/4/2022 10:18 AM
87	APD, AFD, Utilities, Port, Airport, Road system.	8/4/2022 5:55 AM
88	Electric, gas, highway	8/4/2022 12:27 AM
89	Electric, natural gas, cell towers, fire response.	8/3/2022 9:35 PM
90	Electricity, Natural Gas, Roads and bridges	8/3/2022 5:51 PM
91	Post Office, Airport, School, and Community Center	8/3/2022 3:54 PM
92	Road maintenance, snow removal, emergency services	7/31/2022 12:08 AM
93	Electricity, natural gas, water table, roads, bridges, ambulance, adequate medical facilities, fire response, grocery stores, Gas stations, Adequate communication including landlines cell towers and Wi-Fi,	7/29/2022 1:10 PM
94	Valdez Native Tribe	7/29/2022 8:42 AM
95	Roads	7/29/2022 7:53 AM
96	MEA Power Plant, DOT Roads, Local hospital	7/28/2022 10:00 PM
97	Roads, schools, railroads, hospitals, airports, port facilities, grocery stores, utilities	7/28/2022 8:43 PM
98	Schools, utilities, roads	7/28/2022 11:19 AM
99	Utilities, emergency response, hospitals	7/27/2022 10:53 PM
100	Hospital, airport, bridge, fire and police departments, Hydro power from dams, piped utilities	7/27/2022 2:37 PM
101	Hospital, fuel farm, barge and air freight	7/27/2022 2:30 PM
102	Hospitals, schools, power plants	7/27/2022 1:31 PM
103	Electricity, natural gas, communication, propane, gas stations, roads, grocery stores, Menard's Sports Center, etc.	7/27/2022 1:03 PM
104	Bridges, stores, utilities	7/27/2022 8:01 AM

Q5 Do you have any suggestions for projects to help mitigate impacts from natural hazards?

Answered: 78 Skipped: 26

#	RESPONSES	DATE
1	building code enforcement, more educational efforts on personal mitigation (e.g. securing water heaters properly for earthquakes, knowing where gas shutoff valves are), more promotion of training/education activities like The Great ShakeOut	3/10/2023 11:16 AM
2	Bury utility lines. Install automatic gas shut valves. Reinforce vulnerable roofs.	2/21/2023 3:23 PM
3	Reduce the amount of infrastructure built in flood plains and maintain infrastructure that is already built in flood plains, such as bridges and roads. Gravel is filling in under bridges and changes need to be made in the future to raise the level of bridges and remove gravel as it fills in under bridges. Larger box culverts or bridges need to be installed in areas where water moves over roads during high levels of rain to prevent flood damage to roads and to allow salmon to move through river systems. The Lowell Creek diversion tunnel is old and needs relocating to prevent damage to a road bridge at the end of the tunnel during flooding events.	2/7/2023 6:33 AM
4	unified public alert and warning campaigns (see the RSG! Program on info.kpb.us), water diversion structures in flood-prone areas, tsunami evacuation structures for inundation zones, regular IMT training and annual exercises, recovery and resiliency planning	2/6/2023 9:43 AM
5	Ask Eklutna Inc. to install a cell tower on Eagle River Road, offer evacuation drills for residents, increase Anchorage Fire Department wildfire training, reduce fuel loads and create fire breaks at key locations, encourage AFD to drive all roads quarterly to identify access/turn around issues.	1/30/2023 10:04 AM
6	We have a lot of old bridges that need replaced. We have a contaminated and abandoned building downtown called the "Polaris Building" that can't be torn down easily because it is made from so many hazardous materials that it has to be done in a costly and careful way.	1/26/2023 7:14 PM
7	A fully functioning SCERP.	1/25/2023 12:51 PM
8	Work with Land Planning and educate builders and relators of Earth Science and Engineering	1/23/2023 4:15 PM
9	100,000+ Alaska residents navigating the Richardson Hwy, almost all 2 lane, and prone to permafrost, weather, earthquakes, sub arctic conditions is a Scenic Byway and our only connection to the lower 48. It includes School buses, RV's Convoys, commercial vehicles bringing goods to the interior, teenage drivers, older drivers, motorcyclists, pedestrians, and much more, not to mention emergency vehicles. Putting Industrial Ore Haul trucks on the highway (2-4 an hour, 24 hrs, 365 days) that are 95', 16 axle, 85,000 lbs on the highway will kill people. Our Infrastructure cannot handle it. Our State Leadership should not be trading Alaska Resident's lives for a FREE INDUSTRIAL HAUL ROAD. It is immoral.	1/23/2023 10:15 AM
10	Long term, the electric grid should be more robust. MEA does as much as it can but as long as power comes through overhead wires, electricity may or may not be dependable.	1/20/2023 7:56 PM
11	Allow residents to remove downed trees to reduce fuel in anchorage bowl.	1/19/2023 7:56 PM
12	Allow for the excavation of gravels in the anadromous streams to ensure the pathways for the streams. Reinforce road sides and possibly raise roads to prevent additional flooding from tidal influence.	1/17/2023 2:37 PM
13	Improved wages for DOT to ensure a complete staff and operating equipment. Term contracts with private companies to boost road mazard mitigation	1/6/2023 4:00 PM
14	LiDAR assessments, rockslide excavation, create a landslide/ rockslide insurance program, establish multi agency partnerships, address accretion areas.	12/14/2022 10:14 AM
15	People should be more self-sufficient. Government should not mislead people by creating the impression that it has the power to control or prevent natural hazards.	11/29/2022 3:04 PM

State of Alaska Hazard Mitigation Plan Questionnaire

16	Borough staff and east Talkeetna residents prepared this list of suggestions for flooding mitigation in east Talkeetna: Talkeetna Flood Repair and Mitigation 1) Extend railroad bridge. Relieve water being impounded by railroad grade that has flooded East Talkeetna numerous times. (See Talkeetna Airport Improvements, Phase II, Commercial Apron Alternatives Study, Dec. 2003.) 2) Repair and raise the dike damaged by the flood to protect West Talkeetna. The dike needs to be designed to withstand the changing conditions caused by the east channel of the Susitna River as it migrates eastward toward the railroad bridge. 3) Place culverts under Second Street east of RR crossing to allow water to drain south through the Twister Creek wetlands. 4) Place culverts under airport ramp and taxi ways along west side of the State runway. The airport infrastructure and road leading to it has impounded water in East Talkeetna causing unnecessary flooding of homes. 5) Place culverts under the Talkeetna Spur Road east of the RR crossing to allow additional water to flow through the Twister Creek wetlands. 6) Make sure that the RR crossing of Twister Creek allows adequate drainage. 7) Raise Beaver Road to serve as a dike. (See Airport plan.) 8) Preserve natural drainage sloughs that wander through east and west Talkeetna. These are constantly being filled causing water to pool and not easily drain. 9) Enhance the natural drainage sloughs through east and west Talkeetna. Roads that cross these sloughs need adequately sized culverts, culverts placed at the appropriate elevation, culverts repaired and cleared of debris. Where these sloughs have been totally filled blocking drainage there needs to be drainage ditches created. Note that there are sewer and water pipes that run down some roads. This includes: West Talkeetna a - Larger culvert under Talkeetna Spur Road south of the Post Office b - Larger culvert under Second St. between the Spur Road and village airstrip c - Larger culvert under Third St. east of village airstrip. d - Drainage created north and east of the VFW to Veterans Way. e - Larger culvert under Veterans Way west of elementary school driveway. f - Drainage route enhanced and created south of Veterans Way to the river. g - Drainage ditch along D St. with ways to get water from slough to the east to the ditch. East Talkeetna a - Larger culvert and placed lower than the present culvert under F St. near the Catholic church b - Culvert placed under the northern drive into the Catholic church. c - Check all culverts that cross I St. and Easy Street to make sure they are placed correctly, are adequately sized and are not plugged with debris. 10) Protect community well from flood waters.	11/14/2022 12:04 PM
17	When we have affordable energy supply the other items can be more easily mitigated. Storing liquid fuel (diesel mostly) can be easily compromised in a natural disaster. Electrical storage is now becoming more viable for smaller communities	11/12/2022 8:57 AM
18	Riprap the Copper River's banks at the all the major bends in the populated areas, eg Copper Center.	11/10/2022 12:07 PM
19	Levee/Revetment, Bank Stabilization, Fire Breaks	11/3/2022 8:48 PM
20	Assess vulnerability of critical infrastructure to various hazards and identify and prioritize potential mitigation measures, develop a plan for implementation of priority mitigation measures over time.	11/1/2022 11:25 AM
21	Not building in flood zones- more greens space, residential building codes,	10/20/2022 12:20 PM
22	The Two Rivers community could benefit from mitigation projects such as: 1) Buried fuel tanks/heating oil tanks 2) Brush and forest clearing -30 feet+ from homes, forest "thinning" to reduce possible fuel 3) More challenging but useful - buried electric lines to homes 4) Individual household fire safety - fire knowledge/evacuation plans/smoke alarm installation (American Red Cross has this program yet would likely need funding support to administer to broader area) 5) Community education on Fire safety/wildland fire safety 6) Community Wilderness First Aid courses as response time to the community is over 45+ minutes. If the road is cut off due to fire (which happened in 2013 for a period of time) Community residents will need to provide basic medical care for 2-4 or 6 hours. This is somewhat mitigated by having BLM wildland fire and medics in the area.	10/20/2022 8:28 AM
23	better drainage so as to not erode roadways. Cell towers located away from residential communities to avoid falling hazards during a major earthquake.	10/18/2022 11:45 PM
24	DOT has amazing skills and resources to combat winter crises: yet we need shelters placed 3-5 miles apart along the roadway of Hwy-1 Nat'l Scenic ByWay: only for Emergency Uses, to save lives in snowbound or unsafe conditions. Especially due to lack of grocery, fuel, heating, security location availability for 40-50 miles to Palmer or 100+ to Glennallen, it would be proper for Glacier View to have the (above) Board list Emergency # and location map for Shelter as 1 life saved will forever be remembered as pre-planned safety; road flares, food, LP	10/14/2022 1:09 PM

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heater, cell or walkie-talkie, blankets inside ... kept up by local volunteers October - March. *
Cost far below Benefit .. *

25	Mitigation plans should all be data-driven. How often and in what locations does each hazard occur? How many people would be affected? Do any have access or functional needs? How many are seniors? What is the probability of the hazard occurring? Is that probability increasing? What are some aggravating factors? Please make sure your hazard mitigation plans include remote sensing and geographic information systems analysis as approved mitigation approaches.	10/10/2022 7:59 PM
26	Hardin the Max Italio road, help fund a new ferry dock	10/10/2022 10:07 AM
27	Making the mitigation process easier.	10/7/2022 4:34 PM
28	I haven't gotten to forest fires yet. We haven't had a huge one since the 1980s, when we had the Wilson Camp Lightning Fire in Wrangell-St. Elias Park. However, that is just luck. Much of the area is black spruce forest. Black spruce live to burn. They reproduce by burning, throwing flaming "witches' brooms" into the air. The brooms drop on our dry foliage, setting it afire, but also dropping spruce seeds. This is a natural hazard, but difficult to address. If you want to ask me about pictures you'd like to use, rummage around the Country Journal, and write me at Linda.ncountry@gci.net or call 907 320-1145 I am sure I have other thoughts, but I'm working on a visitor guide right now...	10/7/2022 4:33 PM
29	Flood erosion projects	10/6/2022 7:08 AM
30	closer network with indigenous ways for heat/warmth during cold weather events;	10/4/2022 8:02 PM
31	Core of Engineering should be more involved with land development and their findings should be sharable via a public notice system.	10/1/2022 11:55 AM
32	Flooding and erosion prevention projects to minimize impacts for borough and state roads. Retrofit and design utility infrastructure against seismic and wildfire risks.	10/1/2022 11:05 AM
33	Allow beetle kill spruce harvest on Burrough and state land.	10/1/2022 6:59 AM
34	No suggestions but I would like to know if there is a plan in place for if the reinforced river bank were to give away and compromise the highway. It seems as if it has been holding but if something were to happen, we would be cut off from Palmer and the rest of the Valley which is only 15 minutes away.	9/30/2022 2:36 PM
35	Rebuild the road to Skitawk. The river routinely threatens to overflow its banks below the bridge (Willow Fishhook Road) Empower Electric Utilities Statewide to trim outside right-of-way trees that threaten electric lines. Enable the placement of large boulders to armor roads and support homeowners with properties threatened by rivers to do the same. Encourage avalanche class transmission structures in avalanche zones for utilities statewide. Enable and encourage timber harvesting and management to prevent the mass beetle kill zones from becoming the site of a subsequent massive fire. Upper Wasilla Fishhook Road has sections likely to be eaten by the next river path shift or significant flood waters; these sections should be identified and rebuilt to divert the river's path of damage away from those bluff banks. Subdivision Exit Routes are not as built as they need to be Upper Engstrom is a great example. If a fire were ever to strike this area, it would be very difficult to get everyone out quickly.	9/30/2022 2:18 PM
36	Upgrade roads to handle the population if need to evacuate. Only 1 road in and out of Anchorage.	9/30/2022 5:39 AM
37	For future housing and business development, don't clear cut. That's easier for building, but a buffer of trees reduces the impact and intensity of wind storms.	9/29/2022 11:55 PM
38	More street lights	9/28/2022 10:59 PM
39	Buy generator	9/28/2022 9:34 PM
40	A road out of town. It is unimaginable that 50% of all the humans in Alaska rely on a single road, with easily damaged bridges, as their only means of escape in the event of a major disaster. Another road and the Knik Arm Bridge must be built to ensure adequate egress routes.	9/28/2022 11:09 AM
41	Reevaluate when to call out the National Guard. Strengthen the power generation system. Clear power right always. Set up a impact to hazards mitigation fund for private and local	9/28/2022 9:16 AM

State of Alaska Hazard Mitigation Plan Questionnaire

	emergency responders.	
42	Shore up the banks of the Matanuska where it is encroaching on the Old Glenn	9/28/2022 7:41 AM
43	Alternate route from Anchorage to Wasilla/Palmer.	9/28/2022 6:18 AM
44	Build storage facilities for fuel and food and store as much as possible.	9/27/2022 8:58 PM
45	Neighborhood cooperatives w/ localized and necessary information for emergencies - organized in sync w/ public services sites of service delivery - such as Fire/Emergency Service Stations throughout community. Master plans available at Public Library and through PSA's/Mass Media/Schools	9/27/2022 8:45 PM
46	Home owner seminars / retreats on how to fortify /prepare for earthquake,,, all new commercial buildings have earthquake mandates in building codes,, I'm not promoting such for homes although some cross over education ,, incentives like tax credits for building smart, starting with foundations, the damage or risk to damage from an earthquake could be mitigated such like the incentives in place for solar panels	9/27/2022 8:35 PM
47	Remove Spruce kill, fix roads that are starting to slough, provide education on generator use, preventing frozen pipes, proper food storage	9/27/2022 7:48 PM
48	You can not control or mitigate a natural disaster. Impacts. You can only mitigate the risks associated with how you respond to a natural disaster.	9/27/2022 7:47 PM
49	Have a list of contractors that are willing and able to come help after a disaster.	9/27/2022 7:18 PM
50	Increased snow removal crews, allow river gravel dredging as it can assist keeping channels same year after year, increased easement clearing to remove more concerning trees before power failures, more community resources available to families to prepare for emergencies such as information on food storage, generator output and maintenance, safe secondary heating options.	9/27/2022 7:11 PM
51	Stabilize the port	9/27/2022 6:17 PM
52	We need to ramp infrastructure in the valley there's too many people and not enough room to move from point a to b quickly. By pass over pass 4 lanes in and out.	9/27/2022 6:02 PM
53	A dedicated avalanche/landslide monitoring and mitigation program should be implemented on the Old Glenn highway beneath Pioneer Peak before someone gets killed. My contact information is included below if the State or FEMA would like local assistance with geohazard mitigation.	9/27/2022 5:51 PM
54	None	9/27/2022 5:39 PM
55	Tsunami warning evacuation building (w/ parking) on the Homer Spit	9/27/2022 4:48 PM
56	More snow plows. DOT needs to do more to keep roads safe	9/27/2022 12:26 PM
57	Messaging about emergency preparedness and what should be in a kit and in a home plan (e.g. where should family members meet if there's a major earthquake) might help people plan better and make it through emergencies	9/7/2022 4:24 PM
58	Facebook page	8/20/2022 6:33 PM
59	Emergency preparedness	8/20/2022 5:55 PM
60	Upgrading the existing power lines by burying them underneath the ground. The less power poles that the company has to respond to as downed and hazardous will decrease.	8/8/2022 5:13 PM
61	Line susceptible river banks with rocks or other natural materials to protect from erosion. More information to the public regarding treatment of natural resources, ie forested area, creeks, rivers, bluffs, etc.	8/8/2022 11:51 AM
62	Reduce the reliance on outside supply chain. Increase local agriculture. Provide grants for large scale, year-round, indoor, food crop production.	8/5/2022 12:30 AM
63	food security	8/4/2022 9:53 PM
64	Dredge the Matanuska River to maintain the watercourse away from populated areas and build the bridges to be earthquake proof.	8/4/2022 10:47 AM

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65	Build another road connecting the Mat-Su valley and Anchorage.	8/4/2022 10:18 AM
66	I am concerned about only having the two roads out of Anchorage. I do feel if there were a major disaster where the town needed to evacuate, many people would not make it. Right after the 2018 quake, the road system out of town quickly became overwhelmed.	8/4/2022 5:55 AM
67	Build an alternate route between Anchorage and the Valley (not the Knik Bridge through Government Hill)	8/4/2022 12:27 AM
68	No real way to mitigate against earthquakes or severe windstorms, but it would sure be helpful if the feds would provide earthquake insurance like they do for floods since homeowners does not cover it!!	8/3/2022 9:35 PM
69	More modes of transportation, ie, passenger and commercial rail	8/3/2022 5:51 PM
70	Communication infrastructure, Community Base outreach for each property I the community.	8/3/2022 3:54 PM
71	Restructure state tax to ensure forward funding for all services; listen to scientists with regards to climate change; alternate routes from Mat Su to Anchorage	7/31/2022 12:08 AM
72	Spend more money on risk analysis and have local communities take a more proactive stance on addressing hazards	7/28/2022 10:00 PM
73	Continue to upgrade port facilities around that state, move vulnerable communities to higher elevations, come up with a way to mitigate homelessness to prevent fires, provide villages with pre-fab houses or make them more accessible, invest in public education/training tools for people to understand the importance of preparing their homes for a natural disaster, ensure buildings are up to safety codes, have a standard alert system within city limits and an option for people outside of city limits (radio station?), move homes/buildings near erosion sites.	7/28/2022 8:43 PM
74	Allow clearing of dead wood on state lands in anchorage to reduce fire danger	7/27/2022 10:53 PM
75	Underground electrical distribution with elevated transformer station	7/27/2022 2:37 PM
76	Leave bethel	7/27/2022 2:30 PM
77	Make community relocation accessible. Make mitigation accessible.	7/27/2022 1:31 PM
78	Continue emergency preparedness education for general public at all public events. Knowing what radio station(s) to tune into for emergency information would be advantageous also. How to contact Red Cross, Salvation Army and other non-profit entities that assist in emergencies. How to assist in an emergency if one is able.	7/27/2022 1:03 PM

Q6 If you have any images of your community that you would like to share, upload them here. (Please add your contact information below to get credit for your image if it is used in the Plan)

Answered: 8 Skipped: 96

#	FILE NAME	FILE SIZE	DATE
1	KPB%20IMT%20Seward%20Bear%20Creek%202019%20Flood%20Even t.jpg	3.5MB	2/6/2023 9:43 AM
2	59052496-7306-4A1E-9B05-19D32C6242AA.jpeg	3.3MB	12/14/2022 10:13 AM
3	2012%20MSB%20Scope%20of%20Work%20-%20Talkeetna%20Flood%20Repair%20%26%20Mitigation.pdf	49.2KB	11/14/2022 12:04 PM
4	Frosty%2020220323.JPG	552.9KB	10/4/2022 8:02 PM
5	998B60D4-47EC-46D6-8993-793B24973749.jpeg	6.4MB	10/1/2022 11:05 AM
6	33ADCE2B-45EC-40A7-A685-6B0FF52B31AC.jpeg	137.9KB	9/28/2022 9:15 AM
7	FB9B3126-1B93-452D-A967-AF09932AF7F4.jpeg	153.6KB	9/27/2022 7:46 PM
8	915F67CF-0C09-486F-8D73-95F9D9242C0D.jpeg	1.9MB	9/27/2022 7:17 PM

Q7 About you (not required)

Answered: 49 Skipped: 55

ANSWER CHOICES	RESPONSES	
Name	100.00%	49
Company	0.00%	0
Address	0.00%	0
Address 2	0.00%	0
City/Town	0.00%	0
State/Province	0.00%	0
ZIP/Postal Code	0.00%	0
Country	0.00%	0
Email Address	100.00%	49
Phone Number	91.84%	45

#	NAME	DATE
1	Kasey Aderhold	3/10/2023 11:16 AM
2	Scott G Nelsen	2/21/2023 3:23 PM
3	Brenda Ahlberg	2/6/2023 9:43 AM
4	Julie Jessen	1/30/2023 10:04 AM
5	Samuel Cunard	1/25/2023 12:51 PM
6	Dixie Banner	1/23/2023 4:15 PM
7	Susan Wilken	1/23/2023 10:15 AM
8	micahel mortensen	1/21/2023 11:34 AM
9	TROY HENLEY	1/20/2023 7:56 PM
10	David G Conrad	1/17/2023 2:37 PM
11	Kaitlyn Jared	12/14/2022 10:14 AM
12	Pam Young	11/14/2022 12:04 PM
13	Gordon Smith	11/12/2022 8:57 AM
14	Mark J	11/10/2022 12:07 PM
15	Patty Burns	11/1/2022 11:25 AM
16	Chris Babcock	10/23/2022 8:30 AM
17	Michelle LaRose	10/18/2022 11:45 PM
18	todd schmidt	10/14/2022 1:09 PM
19	Jon Erickson	10/10/2022 10:07 AM
20	Linda Weld	10/7/2022 4:33 PM

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21	M Knighten	10/6/2022 7:08 AM
22	Daryl Schaffer	10/4/2022 8:02 PM
23	Ryan Honea	10/1/2022 11:05 AM
24	Matt Benoit	10/1/2022 6:59 AM
25	John Royce	9/30/2022 2:18 PM
26	Bryan Gearry	9/30/2022 9:20 AM
27	SHARON JOHNSON	9/30/2022 5:39 AM
28	Steven Montgomery	9/28/2022 9:34 PM
29	Scott Brown	9/28/2022 11:09 AM
30	Robert Grove	9/28/2022 9:16 AM
31	Robert Tindall	9/28/2022 6:18 AM
32	Ann Marie Garritano	9/28/2022 4:27 AM
33	Kelly Isham	9/28/2022 1:48 AM
34	TROY HENLEY	9/27/2022 8:58 PM
35	Su Kay	9/27/2022 8:35 PM
36	Larry Hawkins	9/27/2022 7:47 PM
37	Tia Marin	9/27/2022 7:18 PM
38	Cody Pink	9/27/2022 5:51 PM
39	Cathy Eckart	9/27/2022 4:04 PM
40	Ronnie Rosenberg	9/27/2022 12:26 PM
41	Shyanna Rae Mulholland	8/20/2022 6:33 PM
42	Quinn jensen	8/20/2022 5:55 PM
43	Kaysea Grove	8/8/2022 5:13 PM
44	LC Lyn Carden	8/8/2022 12:07 PM
45	Conrad	8/3/2022 5:51 PM
46	Harry Kuhn	8/3/2022 3:54 PM
47	Warren Beem	7/29/2022 8:42 AM
48	Greg	7/27/2022 2:37 PM
49	Patrick O'Brien	7/27/2022 2:30 PM

#	COMPANY	DATE

There are no responses.

#	ADDRESS	DATE

There are no responses.

#	ADDRESS 2	DATE

There are no responses.

#	CITY/TOWN	DATE

There are no responses.

#	STATE/PROVINCE	DATE

There are no responses.

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#	ZIP/POSTAL CODE	DATE
	There are no responses.	
#	COUNTRY	DATE
	There are no responses.	
#	EMAIL ADDRESS	DATE
1	kasey.aderhold@gmail.com	3/10/2023 11:16 AM
2	scottnelsen248@gmail.com	2/21/2023 3:23 PM
3	bahlberg@kpb.us	2/6/2023 9:43 AM
4	juliekjessen@gmail.com	1/30/2023 10:04 AM
5	scunard@tikigaq.com	1/25/2023 12:51 PM
6	ddbanner1@gmail.com	1/23/2023 4:15 PM
7	aksusie@me.com	1/23/2023 10:15 AM
8	apex_tundras_0o@icloud.com	1/21/2023 11:34 AM
9	troychenley@yahoo.com	1/20/2023 7:56 PM
10	dconrad@kodiakak.us	1/17/2023 2:37 PM
11	k_surdyk@yahoo.com	12/14/2022 10:14 AM
12	pamyoung2@mac.com	11/14/2022 12:04 PM
13	406gman48@gmail.com	11/12/2022 8:57 AM
14	akamarkos@yahoo.com	11/10/2022 12:07 PM
15	pattyburns@live.com	11/1/2022 11:25 AM
16	kingcovedps@gmail.com	10/23/2022 8:30 AM
17	michla01234@gmail.com	10/18/2022 11:45 PM
18	glaciertodd@gmail.com	10/14/2022 1:09 PM
19	manager@yakutatak.us	10/10/2022 10:07 AM
20	linda.ncountry@gci.net	10/7/2022 4:33 PM
21	starrmercy@yahoo.com	10/6/2022 7:08 AM
22	dschaffer2@alaska.edu	10/4/2022 8:02 PM
23	rhonea86@gmail.com	10/1/2022 11:05 AM
24	mattbenoit907@gmail.com	10/1/2022 6:59 AM
25	jsroyce@mtaonline.net	9/30/2022 2:18 PM
26	bryangearry@gmail.com	9/30/2022 9:20 AM
27	mans4@gci.net	9/30/2022 5:39 AM
28	steve.mongtomery.mvs@yahoo.com	9/28/2022 9:34 PM
29	scottnotyet@yahoo.com	9/28/2022 11:09 AM
30	robertakgrove@gmail.com	9/28/2022 9:16 AM
31	robert.tindall@nym.hush.com	9/28/2022 6:18 AM
32	dmfamg@gmail.com	9/28/2022 4:27 AM
33	kisham728@gmail.com	9/28/2022 1:48 AM

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34	troychenley@yahoo.com	9/27/2022 8:58 PM
35	bossbags@yahoo.com	9/27/2022 8:35 PM
36	alaskhawk@aol.com	9/27/2022 7:47 PM
37	tiamarin@rocketmail.com	9/27/2022 7:18 PM
38	cody@pitonexploration.com	9/27/2022 5:51 PM
39	bonbini3@hotmail.com	9/27/2022 4:04 PM
40	rdrosenberg@att.net	9/27/2022 12:26 PM
41	shymulholland@gmail.com	8/20/2022 6:33 PM
42	quinnjensen05@gmail.com	8/20/2022 5:55 PM
43	kaysea_123@hotmail.com	8/8/2022 5:13 PM
44	deputycitymanager@adak-ak.gov	8/8/2022 12:07 PM
45	c.comradsmith@gmail.com	8/3/2022 5:51 PM
46	lakesidealaska@gmail.com	8/3/2022 3:54 PM
47	warren.b@valdeztribe.org	7/29/2022 8:42 AM
48	gmcint@searhc.org	7/27/2022 2:37 PM
49	patobrien84@gmail.com	7/27/2022 2:30 PM
#	PHONE NUMBER	DATE
1	9073439915	2/21/2023 3:23 PM
2	907-262-2098	2/6/2023 9:43 AM
3	907-306-2331	1/30/2023 10:04 AM
4	19075385610	1/25/2023 12:51 PM
5	9072506321	1/23/2023 4:15 PM
6	9073883422	1/23/2023 10:15 AM
7	907229680	1/21/2023 11:34 AM
8	19073986534	1/20/2023 7:56 PM
9	9076542782	1/17/2023 2:37 PM
10	2088161597	12/14/2022 10:14 AM
11	510.725.2228	11/14/2022 12:04 PM
12	4062534778	11/12/2022 8:57 AM
13	9078224155	11/10/2022 12:07 PM
14	9078883060	11/1/2022 11:25 AM
15	9074972210	10/23/2022 8:30 AM
16	907-242-0808	10/18/2022 11:45 PM
17	907-982-3083	10/14/2022 1:09 PM
18	9077843324	10/10/2022 10:07 AM
19	907 320-1145	10/7/2022 4:33 PM
20	9078223476	10/6/2022 7:08 AM
21	907-231-6496	10/4/2022 8:02 PM

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22	6232587873	10/1/2022 11:05 AM
23	9078410911	10/1/2022 6:59 AM
24	9072272326	9/30/2022 2:18 PM
25	907-232-2614	9/30/2022 9:20 AM
26	9073154376	9/30/2022 5:39 AM
27	9073552234	9/28/2022 11:09 AM
28	907-3889885	9/28/2022 9:16 AM
29	9073317880	9/28/2022 6:18 AM
30	3135950958	9/28/2022 4:27 AM
31	9077403637	9/28/2022 1:48 AM
32	19073986534	9/27/2022 8:58 PM
33	9072273846	9/27/2022 7:47 PM
34	4802448412	9/27/2022 7:18 PM
35	9077955126	9/27/2022 5:51 PM
36	775-220-6314	9/27/2022 4:04 PM
37	9074889072	9/27/2022 12:26 PM
38	19076318770	8/20/2022 6:33 PM
39	9072901999	8/20/2022 5:55 PM
40	9074414654	8/8/2022 5:13 PM
41	9077076284	8/3/2022 5:51 PM
42	9073152378	8/3/2022 3:54 PM
43	9078354951	7/29/2022 8:42 AM
44	9072024516	7/27/2022 2:37 PM
45	9075451866	7/27/2022 2:30 PM

State of Alaska 2023 Hazard Mitigation Plan Update
Survey #2

Survey Response Summary

Total # of Responses: 34

Q1 Please provide your location

Answered: 34 Skipped: 0

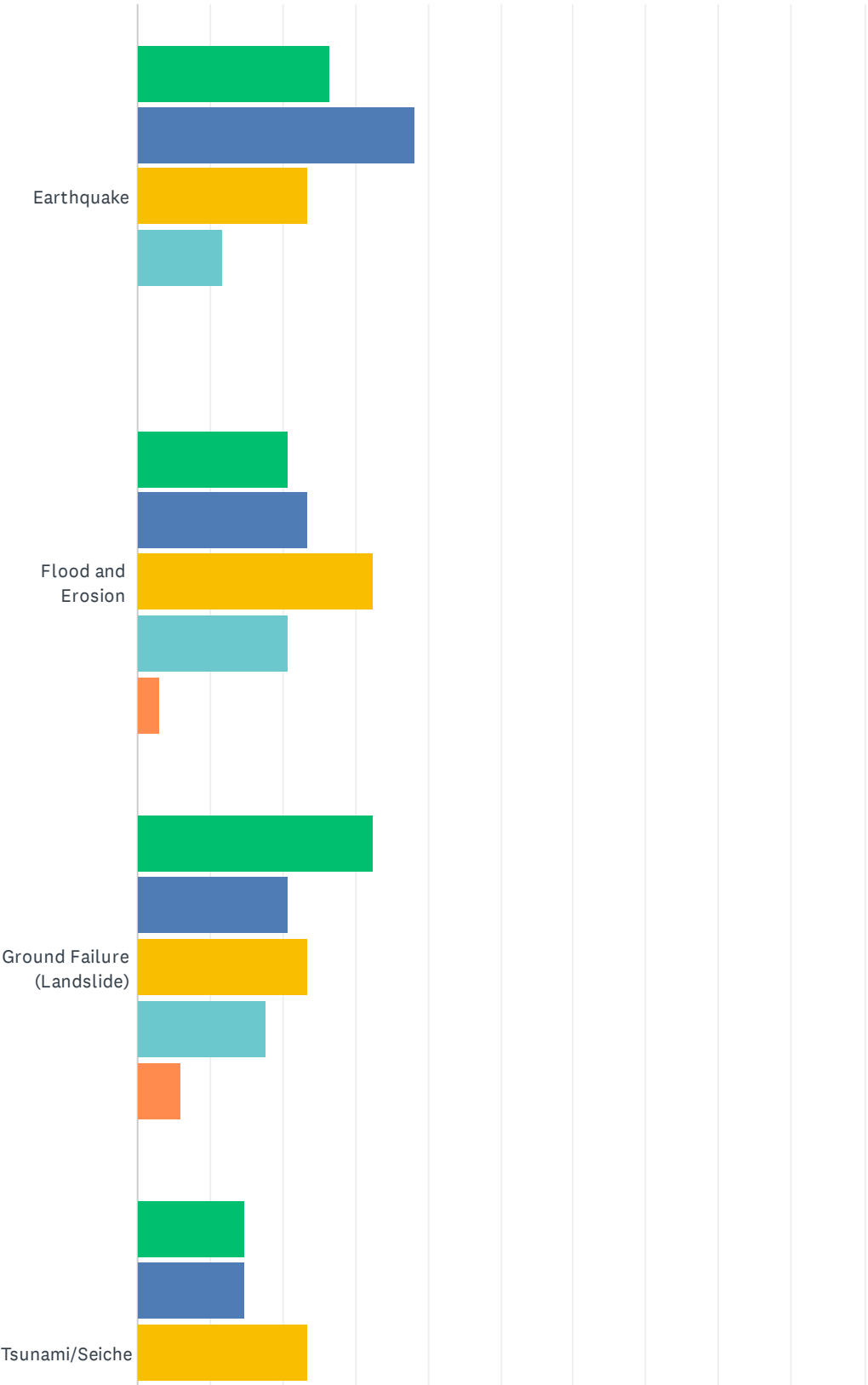
#	RESPONSES	DATE
1	Anchorage	7/11/2023 6:18 PM
2	Anchorage	7/7/2023 8:21 AM
3	juneau	7/6/2023 9:44 AM
4	Anchorage	6/29/2023 12:13 PM
5	Anchorage	6/13/2023 3:55 PM
6	Anchorage	6/13/2023 3:33 PM
7	Richardson Highway mile post 45	6/8/2023 7:06 AM
8	Anchorage	6/6/2023 9:26 PM
9	Sitka	5/31/2023 10:14 AM
10	Wasilla	5/28/2023 7:46 AM
11	Eagle River	5/27/2023 1:45 PM
12	Glennallen	5/27/2023 1:04 PM
13	Nenana	5/27/2023 12:41 AM
14	Haines, Ak	5/26/2023 8:55 PM
15	Haines	5/26/2023 8:55 PM
16	Haines	5/26/2023 8:03 PM
17	Copper Center, Alaska	5/26/2023 5:56 PM
18	Homer	5/3/2023 10:37 AM
19	Seldovia	5/1/2023 7:14 PM
20	Eagle River	5/1/2023 11:22 AM
21	Meadow lakes/Big Lake	4/29/2023 7:05 AM
22	Fairbanks	4/28/2023 5:36 PM
23	Wasilla	4/28/2023 9:45 AM
24	Chugiak, Ak	4/27/2023 8:32 PM
25	Fairbanks, AK	4/27/2023 4:30 PM
26	Barrow	4/27/2023 4:07 PM
27	Anchorage	4/26/2023 3:51 AM
28	Wasilla	4/25/2023 4:12 PM
29	Houston	4/25/2023 3:00 PM
30	Fairbanks	4/25/2023 2:20 PM
31	Big lake	4/25/2023 1:48 PM
32	Valdez	4/25/2023 1:27 PM
33	Wasilla, AK	4/24/2023 3:21 PM

State of Alaska Hazard Mitigation Plan Questionnaire #2

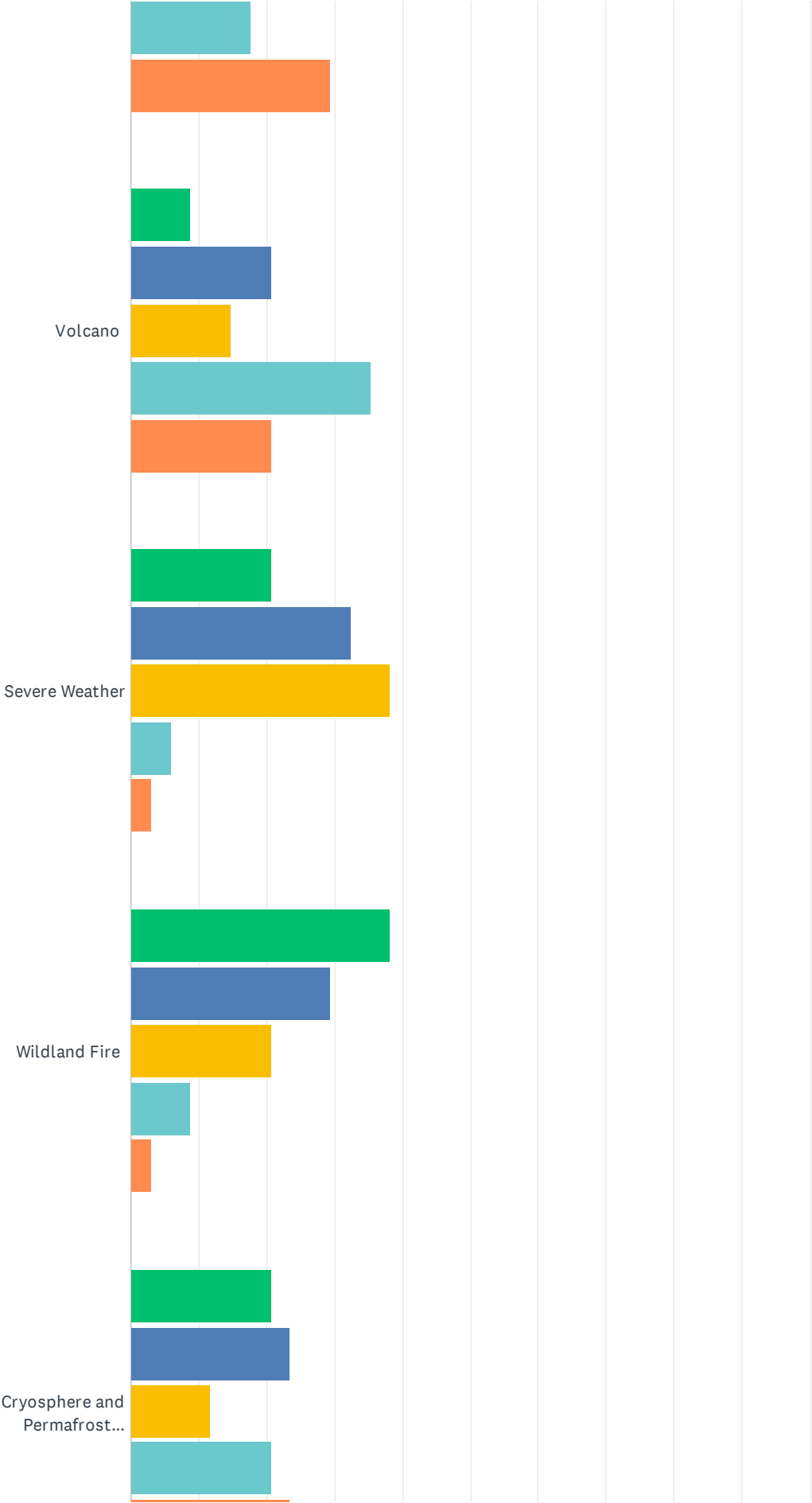
34	Fairbanks	4/2/2023 8:40 AM

Q2 What is your level of concern for the hazards that impact your community?

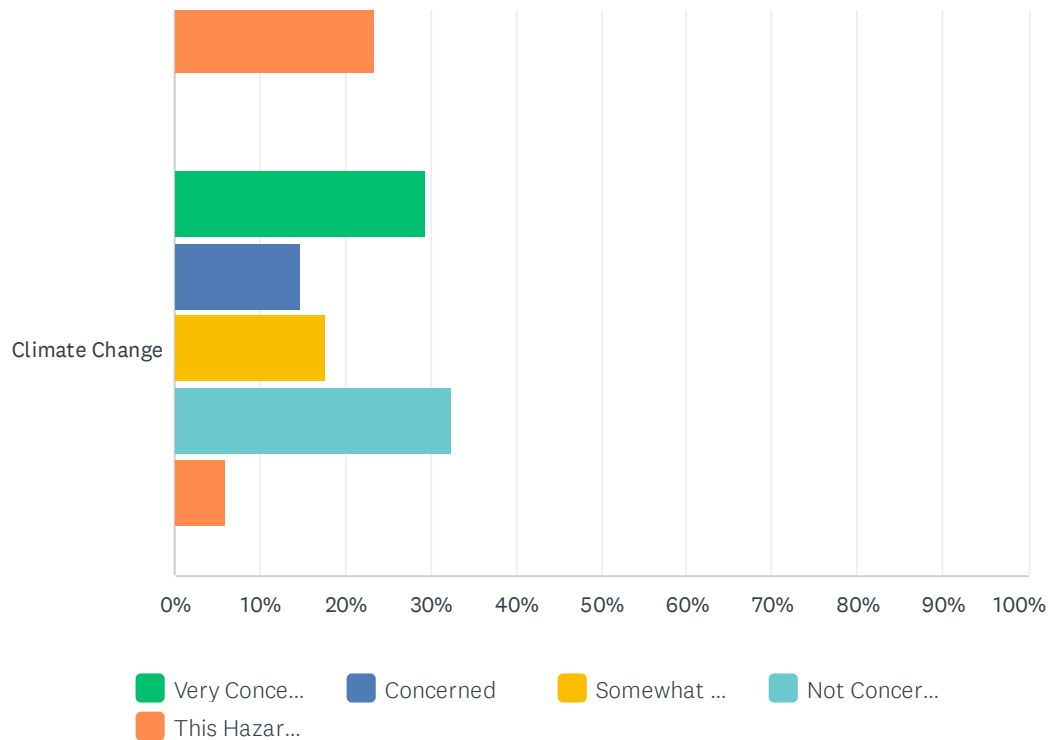
Answered: 34 Skipped: 0



State of Alaska Hazard Mitigation Plan Questionnaire #2



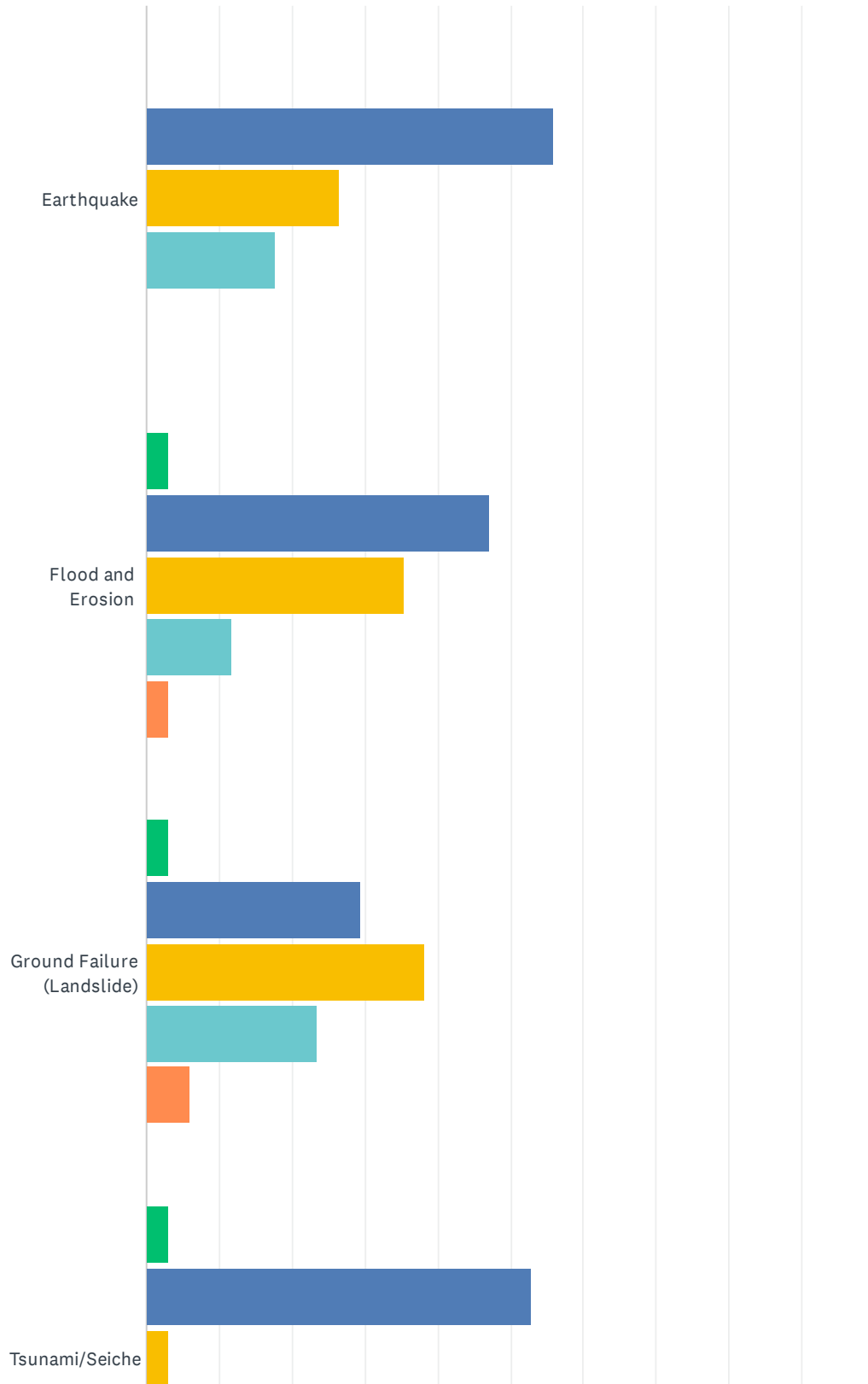
State of Alaska Hazard Mitigation Plan Questionnaire #2



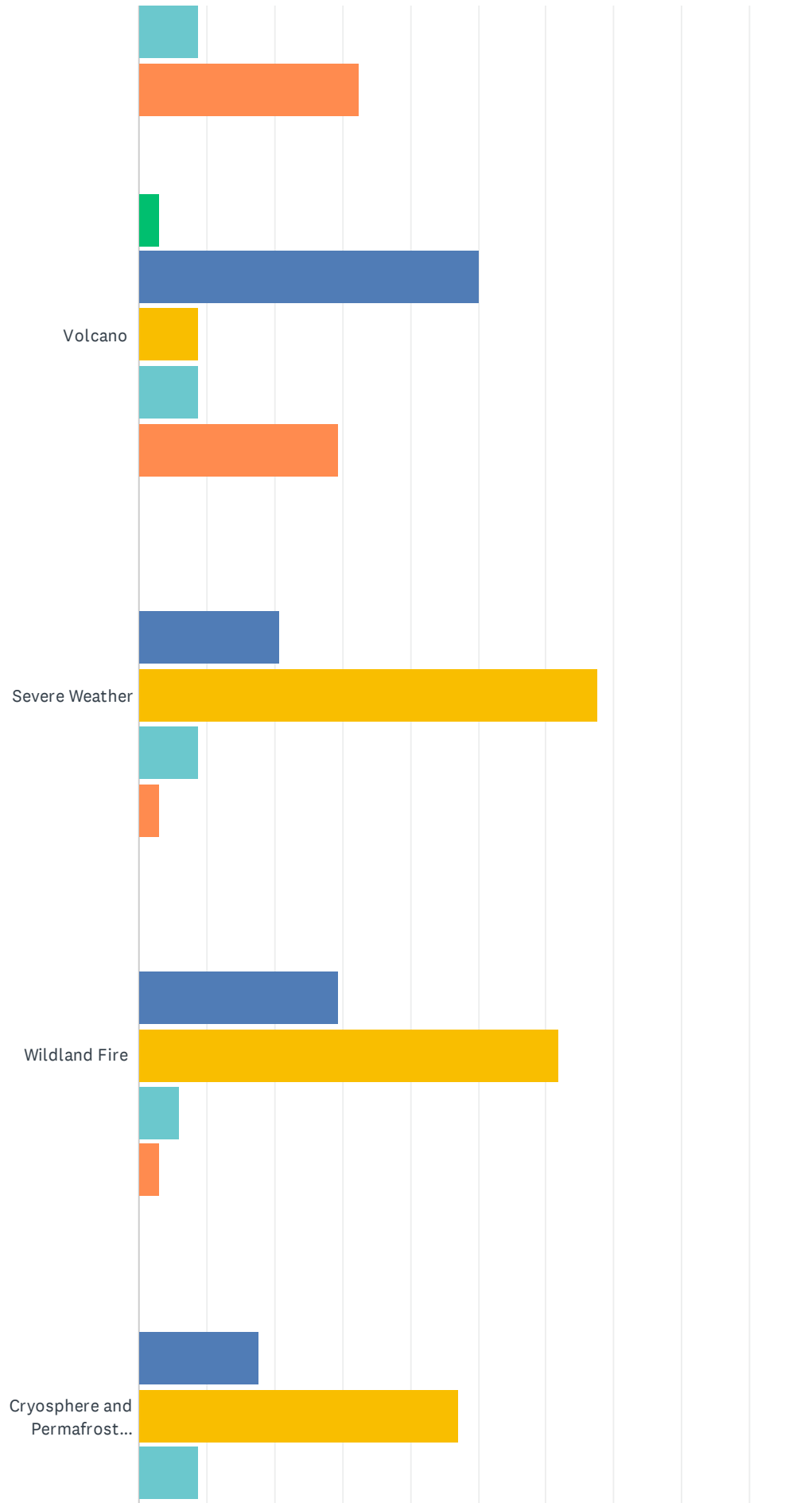
	VERY CONCERNED	CONCERNED	SOMEWHAT CONCERNED	NOT CONCERNED	THIS HAZARD DOES NOT IMPACT MY COMMUNITY	TOTAL	WEIGHTED AVERAGE
Earthquake	26.47% 9	38.24% 13	23.53% 8	11.76% 4	0.00% 0	34	2.21
Flood and Erosion	20.59% 7	23.53% 8	32.35% 11	20.59% 7	2.94% 1	34	2.55
Ground Failure (Landslide)	32.35% 11	20.59% 7	23.53% 8	17.65% 6	5.88% 2	34	2.28
Tsunami/Seiche	14.71% 5	14.71% 5	23.53% 8	17.65% 6	29.41% 10	34	2.63
Volcano	8.82% 3	20.59% 7	14.71% 5	35.29% 12	20.59% 7	34	2.96
Severe Weather	20.59% 7	32.35% 11	38.24% 13	5.88% 2	2.94% 1	34	2.30
Wildland Fire	38.24% 13	29.41% 10	20.59% 7	8.82% 3	2.94% 1	34	2.00
Cryosphere and Permafrost Degradation	20.59% 7	23.53% 8	11.76% 4	20.59% 7	23.53% 8	34	2.42
Climate Change	29.41% 10	14.71% 5	17.65% 6	32.35% 11	5.88% 2	34	2.56

Q3 Over the last 10 years, have you noticed a decrease or increase in the occurrences or intensity of any of the following hazards?

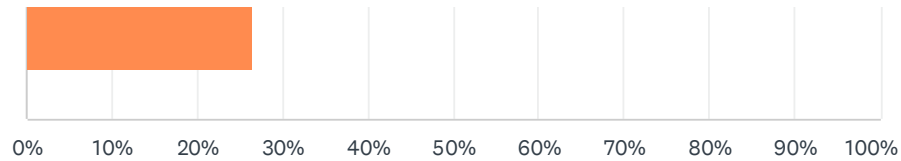
Answered: 34 Skipped: 0



State of Alaska Hazard Mitigation Plan Questionnaire #2



State of Alaska Hazard Mitigation Plan Questionnaire #2



■ Decrease (...)

■ No Change ...

■ Increase (E...

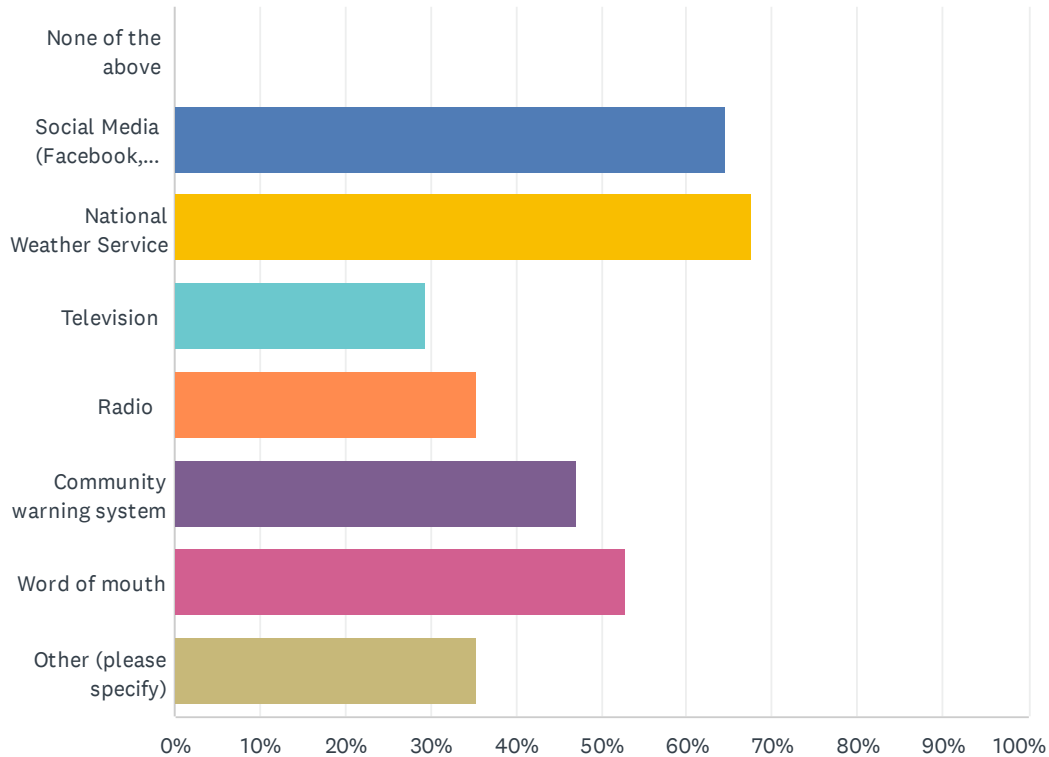
■ Not Sure

■ This Hazar...

	DECREASE (EVENTS ARE LESS COMMON NOW)	NO CHANGE (EVENTS OCCUR ABOUT THE SAME AS THEY DID 10 YEARS AGO)	INCREASE (EVENTS ARE MORE COMMON NOW)	NOT SURE	THIS HAZARD DOES NOT IMPACT MY COMMUNITY	TOTAL	WEIGHTED AVERAGE
Earthquake	0.00% 0	55.88% 19	26.47% 9	17.65% 6	0.00% 0	34	2.62
Flood and Erosion	2.94% 1	47.06% 16	35.29% 12	11.76% 4	2.94% 1	34	2.58
Ground Failure (Landslide)	2.94% 1	29.41% 10	38.24% 13	23.53% 8	5.88% 2	34	2.88
Tsunami/Seiche	2.94% 1	52.94% 18	2.94% 1	8.82% 3	32.35% 11	34	2.26
Volcano	2.94% 1	50.00% 17	8.82% 3	8.82% 3	29.41% 10	34	2.33
Severe Weather	0.00% 0	20.59% 7	67.65% 23	8.82% 3	2.94% 1	34	2.88
Wildland Fire	0.00% 0	29.41% 10	61.76% 21	5.88% 2	2.94% 1	34	2.76
Cryosphere and Permafrost Degradation	0.00% 0	17.65% 6	47.06% 16	8.82% 3	26.47% 9	34	2.88

Q4 How do you receive warnings regarding hazard events? Please check all that apply.

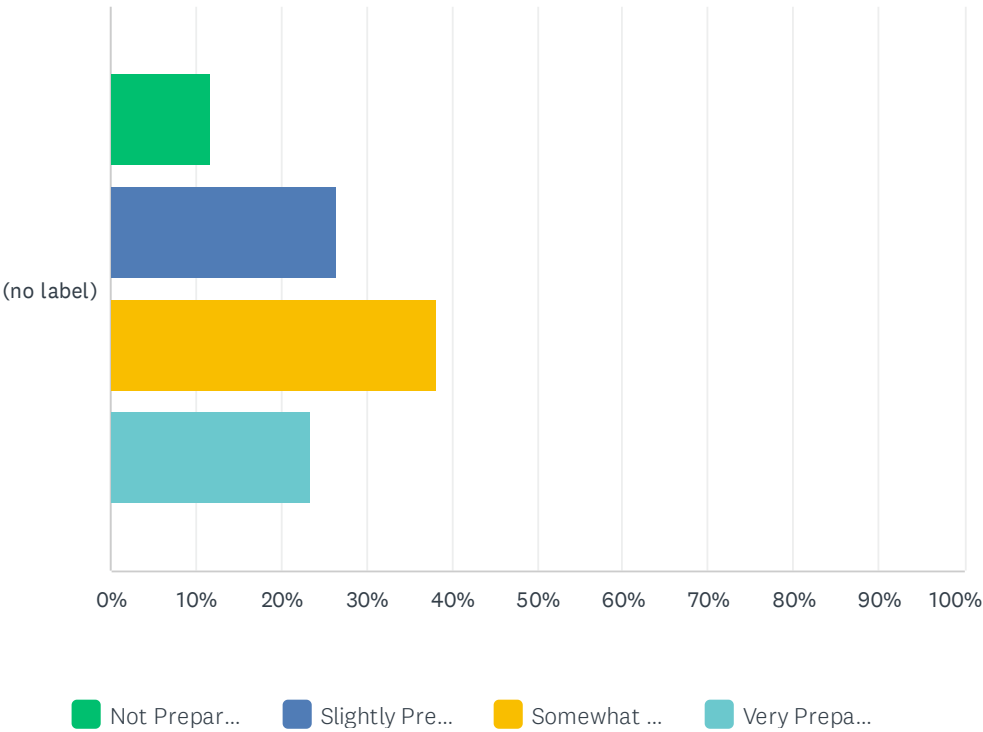
Answered: 34 Skipped: 0



ANSWER CHOICES	RESPONSES	
None of the above	0.00%	0
Social Media (Facebook, Twitter, etc.)	64.71%	22
National Weather Service	67.65%	23
Television	29.41%	10
Radio	35.29%	12
Community warning system	47.06%	16
Word of mouth	52.94%	18
Other (please specify)	35.29%	12
Total Respondents: 34		

Q5 How prepared do you feel your household is for impacts of natural hazard events likely to occur in your community?

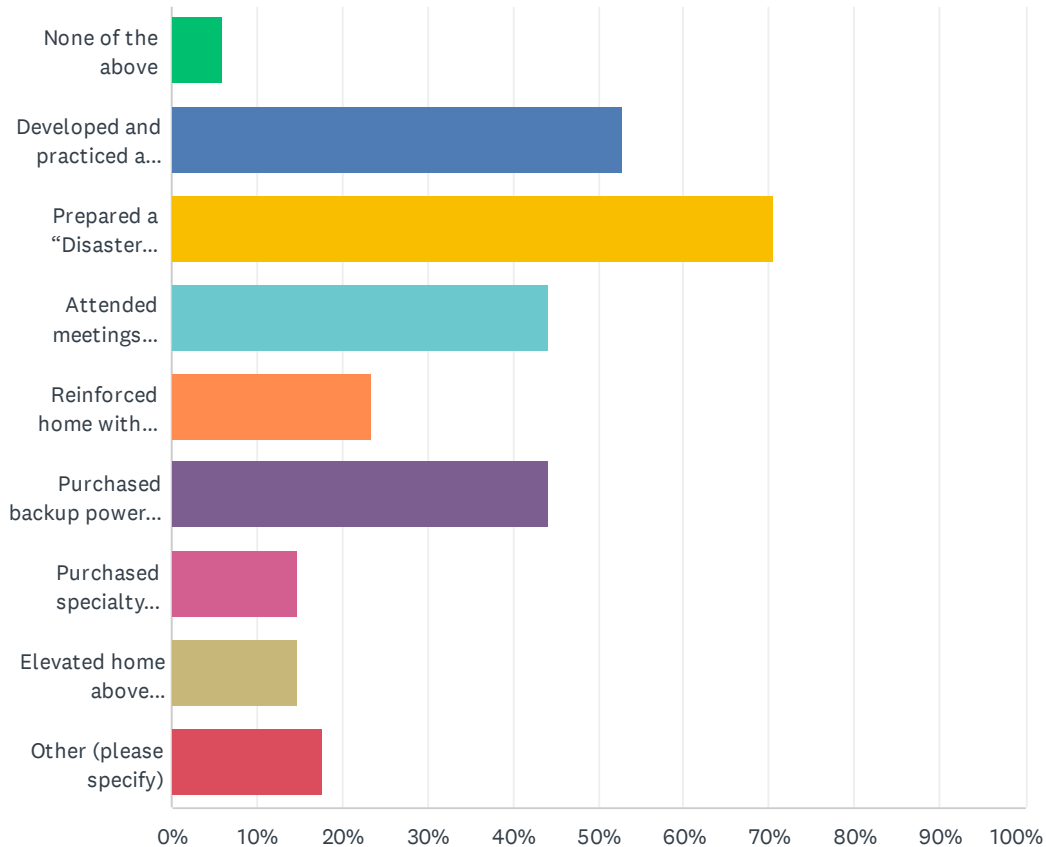
Answered: 34 Skipped: 0



	NOT PREPARED	SLIGHTLY PREPARED	SOMEWHAT PREPARED	VERY PREPARED	TOTAL	WEIGHTED AVERAGE
(no label)	11.76% 4	26.47% 9	38.24% 13	23.53% 8	34	2.74

Q6 What actions have you taken to prepare you and your household for future hazard events?

Answered: 34 Skipped: 0



ANSWER CHOICES	RESPONSES	
None of the above	5.88%	2
Developed and practiced a "Household/Family Emergency Plan" in order to decide what everyone would do in the event of a household emergency	52.94%	18
Prepared a "Disaster Supply Kit" (stored extra food, water, batteries, or other emergency supplies)	70.59%	24
Attended meetings discussing disaster preparedness	44.12%	15
Reinforced home with disaster-resistant materials (ex: installed non-structural seismic restraints for large furniture, secured roofing, etc.)	23.53%	8
Purchased backup power supply (generator, solar panels, etc.)	44.12%	15
Purchased specialty insurance (flood, earthquake, etc.)	14.71%	5
Elevated home above floodplain	14.71%	5
Other (please specify)	17.65%	6
Total Respondents: 34		

Q7 Is there any information the State of Alaska can provide to you to help you better prepare for disasters occurring in your area?

Answered: 17 Skipped: 17

#	RESPONSES	DATE
1	Not that I know of.	6/29/2023 12:13 PM
2	I don't know.	6/13/2023 3:55 PM
3	I know Sitka has no issues with forest fires to date - but after one extremely dry summer about 5 years ago - the understory and extremely dry layer of needles/branches on ground in forest and back yard reminded me of summers in Montana where forest fires we're prevalent. Very scary time for me until rains started.	5/31/2023 10:14 AM
4	I'm disabled, a senior, home bound, fixed income, a list of resources and suggestions for preparation.	5/28/2023 7:46 AM
5	More detailed information about home reinforcement.	5/27/2023 1:45 PM
6	Updated information on hydrology of the area.	5/27/2023 1:04 PM
7	Better use of social media as comms, make vids of your old info sheets and brochures, meet and greets at community gatherings for direct questions, explain in layman's terms to the public about the local level response and where you fit in that for us.	5/27/2023 12:41 AM
8	Advocacy for amendments to the Stafford Act that make federally declared IA disasters accessible to communities with small populations.	5/26/2023 8:03 PM
9	Mapping out unstable slopes, especially in coastal areas with risk to tsunamis. Create warning systems for such tsunami hazards that adds to the existing tsunami warning system.	5/3/2023 10:37 AM
10	A map of areas where there are higher landslide hazards would be very helpful.	5/1/2023 7:14 PM
11	What state parks and division of forestry are doing to reduce fire loads in wildland/urban interface areas	5/1/2023 11:22 AM
12	Any information would be helpful	4/28/2023 5:36 PM
13	People to be on the ground for these surveys and also to have people available in light of an incident so that we are not left without funding. During Murbok people in the YK area couldn't do the FEMA applications because they were only available online... in a region that had it's utilities knocked out and where there is only 1 service provider, which is not always in working condition or people cannot afford to have such a "basic" amenity.	4/27/2023 4:07 PM
14	No	4/25/2023 3:00 PM
15	No	4/25/2023 2:20 PM
16	The state should take some of that CDBG-DR funding allocated to Individual preparedness grants for homeowners especially around power systems, and food security..	4/24/2023 3:21 PM
17	More consistency in messaging and preparedness vice overly specific preparedness for one disaster differs from another disaster.	4/2/2023 8:40 AM

Q8 What are some recent development projects that have occurred in your community since 2018? (mitigation projects, new or upgraded infrastructure, new roads, etc.)

Answered: 34 Skipped: 0

#	RESPONSES	DATE
1	Upgraded transmission, new roads	7/11/2023 6:18 PM
2	New roads	7/7/2023 8:21 AM
3	new drainage systems, culverts, avalanche monitoring drone programs. Avalanche Mitigation Drone Programs.	7/6/2023 9:44 AM
4	Road improvements, power distribution improvements	6/29/2023 12:13 PM
5	I don't know.	6/13/2023 3:55 PM
6	na	6/13/2023 3:33 PM
7	None- DOT mitigates avalanche danger when necessary	6/8/2023 7:06 AM
8	Road construction, ALWAYS. But I think it's just work on the same roads, repairing damage and resurfacing them. Plus the bridge at International Rd was rebuilt after the 2018 earthquake.	6/6/2023 9:26 PM
9	New monitoring and warnings for landslides.	5/31/2023 10:14 AM
10	Use of Menard Center for homeless during covid, bulk water supply for community, use of state fair grounds during covid,	5/28/2023 7:46 AM
11	Upgraded infrastructure	5/27/2023 1:45 PM
12	Fish passage culvert replacements; community wildland fire protection planning	5/27/2023 1:04 PM
13	Bridge at 10th st over the Nenana river, biogas plant.	5/27/2023 12:41 AM
14	I live on Piedad rd in Haines after the winter disaster (I lost my daughter in the landslide) . Our road which is a state road is one of the worst in town. It needs to be fixed!	5/26/2023 8:55 PM
15	Improved roads, airport, docks, landslide and erosion repairs and mitigation,	5/26/2023 8:55 PM
16	Repaired roads, culvert replacement, dock infrastructure.	5/26/2023 8:03 PM
17	Flooding	5/26/2023 5:56 PM
18	DGGS has developed an unstable slope and landslide risk map for Homer bench but I do not think it has been released to the public.	5/3/2023 10:37 AM
19	Improved water treatment plant.	5/1/2023 7:14 PM
20	more single home development in our one way in/one way out valley	5/1/2023 11:22 AM
21	Parks hwy upgrade	4/29/2023 7:05 AM
22	Fixing permafrost sinking roads	4/28/2023 5:36 PM
23	None	4/28/2023 9:45 AM
24	Improved highways	4/27/2023 8:32 PM
25	Road repairs in response to permafrost degradation and frost heave	4/27/2023 4:30 PM
26	Certainly every rural area in Alaska (3/4 the State) needs basic telecommunication infrastructure if not upgrades. VoIP systems do not work for us because our data is so slow - which having at least 25mb download speed has been federally mandated since 2013 - SOA is	4/27/2023 4:07 PM

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way behind. Most coastal communities' fiber access points will be even further below sea level than we already are in the next 5 years.

27	Fixing schools	4/26/2023 3:51 AM
28	Road repairs from the quake.	4/25/2023 4:12 PM
29	Double lane on Parks More trees being cut down causing higher degree of winds	4/25/2023 3:00 PM
30	Poorly developed ideas of road repairs.	4/25/2023 2:20 PM
31	None	4/25/2023 1:48 PM
32	Shoring up the Glacier stream so it doesn't cause anymore erosion.	4/25/2023 1:27 PM
33	Honestly, the mitigation efforts in Mat-su have a long way to go. Lets be honest here how many homeowners can actually say they have benefitted from any state effort since the EQ of 2018. The only reference points any commuter has is overpasses and bridges. Mitigation...Laughable.	4/24/2023 3:21 PM
34	More homes being built on mountainsides subject to landslide and wildfires with limited abatement or permit restrictions.	4/2/2023 8:40 AM

Q9 Do you have any specific ideas for mitigation projects associated with the identified hazards that you would like the State to consider?

Answered: 25 Skipped: 9

#	RESPONSES	DATE
1	Resiliency or redundancy to electrical infrastructure	7/11/2023 6:18 PM
2	avalanche monitoring systems can help understand when avalanches occur in remote locations even in the dark with no one there. this helps forecasters better understand the size and nature of the current hazard.	7/6/2023 9:44 AM
3	Nothing that is not already considered.	6/29/2023 12:13 PM
4	PREVENTION. Let's stop making the climate worse by weaning ourselves off fossil fuels and moving into non-carbon energy, transportation, plastics, and chemicals.	6/13/2023 3:55 PM
5	No	6/8/2023 7:06 AM
6	STOP approving new mining and oil projects (Ambler, Willow, etc.). They cost the State money that should be used to provide critical services. These projects also add to pollution, greenhouse gas emissions, and degradation of the environment. All of this contributes to a warming Arctic, which in turn causes and exacerbates extreme weather, sea level rise, permafrost melting, and other climate-related disasters...which then cost money. Look at the long-term perspective, and stop spending Alaska's money in a way that causes us more problems in the end.	6/6/2023 9:26 PM
7	Would like evaluation of fire potential on Baranoff given changing climate.	5/31/2023 10:14 AM
8	Alternative route to Anchorage. Use of railway when highway is closed (At a low fee for residents in disaster).	5/28/2023 7:46 AM
9	Improve state subdivision roads to allow for emergency response; culvert placement and sizing assessment and project to replace undersized culverts to percent future flood damage; turn lanes and merging lanes onto major highways; rerouting of highway at Simpson hill just south of Glennallen before the Richardson highway sluffs into the copper river and shuts off all highway access south of Glennallen	5/27/2023 1:04 PM
10	Shielding the communications systems from solar disruption to prevent loss of requests for help. Redundancies for the backups for any plans.	5/27/2023 12:41 AM
11	Adaptation and relocation over trying to control change	5/26/2023 8:55 PM
12	Culverts Investment in tech solutions to provide quick training to navigate IA and PA after a disaster. Investment in tech solutions for landslide early warning systems, as developed in Sitka. Investment in tech solutions for data assessments for recovery. Housing!!!! We need to prepare for housing crises after disasters. Communities could use assistance on developing housing plans and applying for BRIC housing programs. Most of the BRIC programs for housing preparedness will likely be impractical for rural areas, but for areas like Juneau, where housing is already at crisis level, a landslide or avalanche taking out additional housing units would be devastating. Comms - Southeast Alaska needs more backup solutions for failed communication systems. Systems to prevent oil spills resulting from snow or flooding compromising home oil drums. Moving critical infrastructure out of the tsunami zones. I understand that much of the above falls into Preparedness rather than Mitigation and is unlikely to fall into an HMP. However, rural communities could still use the above.	5/26/2023 8:03 PM
13	Simpson hill in Tazlina and long lake road on Glennallen highway	5/26/2023 5:56 PM
14	Landslide-generated tsunamis. Please see our "Arctic T-SLIP" working group (webpage currently hosted by Woodwell Climate Research Center). Permafrost thaw impact on not just roads but people's homes. This is a slow-moving hazard that people are left completely alone to deal with, it's unacceptable. Can cost people more than the value of their house to address.	5/3/2023 10:37 AM

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15	I think that my community may be vulnerable to landslide events triggered by extreme rain like those that have happened in Haines and Sitka. It would be helpful to know what areas are most at risk. Also we have had severe blowdown events that have damaged homes and seem to be getting more frequent. It would be helpful if there was accurate wind forecasts to help anticipate these events.	5/1/2023 7:14 PM
16	More fuel reduction projects near populated areas, more water storage in areas without piped/municipal water sources, more multi-agency (including BLM, DOD) drills	5/1/2023 11:22 AM
17	No	4/28/2023 5:36 PM
18	Provide alternate connection between the MatSu and Anchorage. The highway is a single point of failure and a bridge failure or highway failure would leave the MatSu isolated	4/27/2023 8:32 PM
19	Eliminate the root cause - applying limiting mitigations to funding sources. Each community and region is different. Each community has it's own solutions. Stop promulgating regulations that implicate our livelihoods.	4/27/2023 4:07 PM
20	Put fire highdrants on Anchorage Hillside in case of wildfire out break	4/26/2023 3:51 AM
21	No	4/25/2023 3:00 PM
22	Massive snow storms and plowing	4/25/2023 1:48 PM
23	I would like the state to look at the Long Lake area and re-do the road in that section. It's terrifying.	4/25/2023 1:27 PM
24	The Glenn Hwy is still sliding into the Mat-su river in a plethora of places. The road to Valdez is still has areas sliding into the Copper River with more houses in danger.... The State is not doing anything about houses being washed away into what the State Calls "Pristine World Class Fishing Waters" Hey..how about we modify the Stafford Act to address these issues and slow rolling disasters such as Permafrost degradation. Maybe we can actually move these houses limit new construction and stop allowing property to pollute the waterways. Almost every waterway in the state has huge issues with erosion and loss of real property.	4/24/2023 3:21 PM
25	Need significant input of historic Indigenous knowledge regarding where develop should NOT be done and greater flexibility for relocation mitigation. Post-typhoon Merbok demonstrated a need for more localized measurement capabilities.	4/2/2023 8:40 AM

Q10 If you have any images of your community that you would like to share, upload them here.(Please add your contact information below to get credit for your image if it is used in the Plan)

Answered: 1 Skipped: 33

#	FILE NAME	FILE SIZE	DATE
1	inbound2784839097290465344.jpg	5.4MB	5/27/2023 1:03 PM

Q11 About you (not required)

Answered: 17 Skipped: 17

ANSWER CHOICES	RESPONSES	
Name	94.12%	16
Company	0.00%	0
Address	0.00%	0
Address 2	0.00%	0
City/Town	0.00%	0
State/Province	0.00%	0
ZIP/Postal Code	0.00%	0
Country	0.00%	0
Email Address	100.00%	17
Phone Number	88.24%	15

#	NAME	DATE
1	Thomas E Mattice	7/6/2023 9:44 AM
2	Bob Carmichael	6/29/2023 12:13 PM
3	Patti Saunders	6/13/2023 3:55 PM
4	Jason	6/8/2023 7:06 AM
5	Kira Lena Lajarnie	6/6/2023 9:26 PM
6	Wanda Thomas	5/28/2023 7:46 AM
7	Marnie Graham	5/27/2023 1:04 PM
8	Fawn Talladay	5/27/2023 12:41 AM
9	Kim Larson	5/26/2023 8:55 PM
10	Donna ewan	5/26/2023 5:56 PM
11	Anna Liljedahl	5/3/2023 10:37 AM
12	Bretwood Higman	5/1/2023 7:14 PM
13	Julie Jessen	5/1/2023 11:22 AM
14	Scott langley	4/27/2023 8:32 PM
15	Leanna Mack	4/27/2023 4:07 PM
16	Daryl Schaffer	4/2/2023 8:40 AM

#	COMPANY	DATE
	There are no responses.	

#	ADDRESS	DATE
	There are no responses.	

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#	ADDRESS 2	DATE
	There are no responses.	
#	CITY/TOWN	DATE
	There are no responses.	
#	STATE/PROVINCE	DATE
	There are no responses.	
#	ZIP/POSTAL CODE	DATE
	There are no responses.	
#	COUNTRY	DATE
	There are no responses.	
#	EMAIL ADDRESS	DATE
1	Tom.mattice@juneau.org	7/6/2023 9:44 AM
2	bob.carmichael@alaska.gov	6/29/2023 12:13 PM
3	saunders.patti@gmail.com	6/13/2023 3:55 PM
4	jasong302@live.com	6/8/2023 7:06 AM
5	kira_a@live.com	6/6/2023 9:26 PM
6	wandafulalaska@gmail.com	5/28/2023 7:46 AM
7	mgraham5898@gmail.com	5/27/2023 1:04 PM
8	magickaliger@hotmail.com	5/27/2023 12:41 AM
9	kimlarsen22@aptalaska.net	5/26/2023 8:55 PM
10	sheinz@chilkoot-nsn.gov	5/26/2023 8:03 PM
11	donnaewan@yahoo.com	5/26/2023 5:56 PM
12	alijedahl@woodwellclimate.org	5/3/2023 10:37 AM
13	hig314@gmail.com	5/1/2023 7:14 PM
14	juliekjessen@gmail.com	5/1/2023 11:22 AM
15	denali1973@gmail.com	4/27/2023 8:32 PM
16	leanna.russell@gmail.com	4/27/2023 4:07 PM
17	dschaffer2@alaska.edu	4/2/2023 8:40 AM
#	PHONE NUMBER	DATE
1	9072099207	7/6/2023 9:44 AM
2	19073012628	6/29/2023 12:13 PM
3	9072782802	6/13/2023 3:55 PM
4	19073988836	6/6/2023 9:26 PM
5	907-315-1986	5/28/2023 7:46 AM
6	9072595899	5/27/2023 1:04 PM
7	9076991131	5/27/2023 12:41 AM
8	9077663885	5/26/2023 8:55 PM
9	90730956	5/26/2023 5:56 PM
10	9077999780	5/3/2023 10:37 AM

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11	9072906992	5/1/2023 7:14 PM
12	907-306-2331	5/1/2023 11:22 AM
13	9073151296	4/27/2023 8:32 PM
14	9075193768	4/27/2023 4:07 PM
15	703-243-1584	4/2/2023 8:40 AM