City and Borough of Yakutat and Yakutat Tlingit Tribe 2024 Multi-Jurisdictional Hazard Mitigation Plan Update

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Prepared by:

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Acronyms/Abbreviations

°F	Degrees Fahrenheit
AICC	Alaska Interagency Coordination Center
AK	Alaska
BRIC	Building Resilient Infrastructure and Communities
CBY	City and Borough of Yakutat
CFR	Code Of Federal Regulations
CS	Cryosphere
DCCED	Department of Commerce, Community, and Economic Development
DCI	Disaster Cost Index
DCRA	Division of Community and Regional Affairs
DGGS	Division of Geological and Geophysical Survey
DHS	Department of Homeland Security
DHS&EM	Division of Homeland Security and Emergency Management
DMA 2000	Disaster Mitigation Act Of 2000
DMVA	Department of Military and Veterans Affairs
ENSO	El Niño/La Niña Southern Oscillation
EPA	Environmental Protection Agency
EQ	Earthquake
ER	Erosion
FEMA	Federal Emergency Management Agency
FL	Flood
ft	Feet
GF	Ground Failure (Landslide)
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
Kts	Knots
M	Magnitude
MAP	Mitigation Action Plan
MH	Multi-Hazard
MJHMP	Multi-Jurisdictional Hazard Mitigation Plan
MMI	Modified Mercalli Intensity
mph	Miles Per Hour
NCAR CCSM4	National Center for Atmospheric Research Community Climate System Model 4.0
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PGA	Peak Ground Acceleration
RCP(s)	Representative Concentration Pathway(s)
SE	Southeast Alaska
SHMP	2023 Alaska State Hazard Mitigation Plan
SNAP	Scenarios Network for Alaska + Arctic Planning
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act
SW	Severe Weather
THRHA	Tlingit-Haida Regional Housing Authority
Tribe	Yakutat Tlingit Tribe

Acronyms/Abbreviations

TS	Tsunami
UAF	University of Alaska Fairbanks
US, U.S., or USA	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDM	U.S. Drought Monitor
USGCRP	United States Global Change Research Program
USGS	United States Geological Survey
WF/CF	Wildland Fire/Community Fire
YTT	Yakutat Tlingit Tribe

EXECUTIVE SUMMARY

The purpose of hazard mitigation planning is to reduce or eliminate long-term risk to people and property from natural hazards. The City and Borough of Yakutat (CBY) updated their 2019 Hazard Mitigation Plan (HMP) to include the Yakutat Tlingit Tribe (YTT or Tribe) as a participating jurisdiction and to make the residents of the Yakutat area less vulnerable to future hazard events. This plan was prepared following the requirements of the Disaster Mitigation Act of 2000 so that the CBY and the Tribe would be eligible for the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance (HMA) grant programs and other federal programs.

The CBY and YTT followed a planning process prescribed by FEMA, which began with the formation of a Hazard Mitigation Planning Team comprised of key CBY and YTT representatives across various departments. The Planning Team reviewed the 2019 CBY HMP to identify areas of the Plan that needed to be updated; conducted a risk assessment review that identified and profiled hazards that pose a risk to Yakutat; assessed their vulnerability to those hazards; and examined the capabilities currently in place to mitigate them.

The people, property, and lands that the community members depend on are vulnerable to several hazards that are identified, profiled, and analyzed within this Plan. Earthquake, ground failure (landslide), tsunami, flood, erosion, severe weather, wildland and community fires, and changes in the cryosphere are among the hazards that could have a significant impact on the people, property, and lands in Yakutat.

The hazards of greatest concern to the Planning Team are ground failure (landslide), tsunami, severe weather, and erosion. The Planning Team is particularly concerned by the association of earthquakes, landslides, and tsunamis where an earthquake could trigger a local landslide, which could then induce a tsunami at Yakutat.

Based upon the risk assessment review and goal setting process, the Planning Team developed the following overarching goals for this Plan:

1. Minimize loss of life and property from natural hazard events
2. Increase public awareness of risk from natural disasters
3. Protect public health and safety
4. Promote rapid hazard disaster recovery

The 2024 MJHMP Update establishes a series of specific mitigation strategies that were developed collaboratively with the intent to meet the identified mitigation goals, by the Planning Team. These strategies provide a basis for continued planning to develop specific action plans. These will be implemented over time and can provide a means to measure progress towards hazard reduction. The Plan also describes future update and maintenance procedures.

Participating Jurisdiction(s): City and Borough of Yakutat, Yakutat Tlingit Tribe

Year MJHMP Completed: 2024

Table 0-1 Executive Summary Snapshot

		Earthquake	Severe Weather	Wildland and Community Fire	Ground Failure (Landslide)	Tsunami	Flood	Erosion	Changes in the Cryosphere
Estimated Losses	# of people:	673	673	673	0	0	67	0	0
	# of CF:	151	151	151	24	24	34	5	0
	$ of CF:	$411,209,622	$411,209,622	$411,209,622	$58,0044,964	$58,0044,964	$179,404,964	$34,400,000	$0
	# of residences	441	441	441	29	29	29	0	0
	$ of residences	$271,555,011	$271,555,011	$271,555,011	$17,857,359	$17,857,359	$17,857,359	$0	$0
Extent (Magnitude/ Severity)		Critical	Limited to Critical	WF: Negligible CF: Critical	Critical	Critical	Limited	Limited	Negligible
Probability		Highly Likely	Highly Likely	Possible	Possible	Possible	Possible	Likely	Likely to occur Possible to impact the community
Recent Development									
Planned Development									
Priority Mitigation Actions									

Table 0-2 Ownership of Critical Facilities

	Facility	Facility Owner	Land Owner
Government	City Hall	CBY	CBY
	Elementary School-Yakutat Tlingit Tribal Offices	CBY	State of Alaska
	Jacobson Bldg.-Yakutat Tlingit Tribal Offices	YTT	YTT
	Courthouse Bldg.-City & Borough of Yakutat Planning & Public Works Offices/State of Alaska Courthouse/YTT Radio Station	CBY	CBY
	Quonset - City & Borough of Yakutat Public Works Shop	CBY	CBY
	Federal Transportation Security Administration	Marc Lenart	State of Alaska
	FAA Office/Warehouse	FAA	FAA
	USCG Tower	USCG	CBY
	FAA Communication Tower 1	FAA	State of Alaska
	FAA Communication Tower 2	FAA	State of Alaska
	NOAA Offices	NOAA	USFS
	USFS Shop	USFS	USFS
	USFS Ranger Office	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc.
Emergency Response	Tsunami Siren (existing)	CBY	CBY
	Tsunami Siren (new)	CBY	TBD
	Fire and Police Station	CBY	CBY
Medical	Yakutat Community Health Center	YTT	YTT
Educational	Yakutat School (K-12)	CBY	State of Alaska
	Yakutat School-Vocational Shop	CBY	State of Alaska
	Tlingit & Haida HeadStart	CBY	CBY
Transportation	Airport Runways	State of Alaska	State of Alaska
	Airport Terminal	Alaska Airlines	State of Alaska
	Harbor Building	CBY	CBY
	Harbor Public Restroom	CBY	CBY
	Boat Harbor	CBY	CBY
	DOTPF Shop	State of Alaska DOT	State of Alaska
	DOTPF Administrative	State of Alaska DOT	State of Alaska
	Ocean Cape Dock (Fish Processing & Ferry Load/Unload)	CBY	CBY
	Multi-Purpose Dock (Fuel & AML Freight)	CBY	CBY
Roads and Subsistence Trails	110.44 miles of road and trails	N/A	N/A

	Facility	Facility Owner	Land Owner
Bridges	Ankau Bridge	CBY	State of Alaska: Over water CBY-Kwaan: Road Surface
Utilities	Fuel Storage Tanks (school): 1,000-gallon gas, 1,000-gallon diesel	Yakutat Schools/CBY	CBY
	Landfill Class III Muni	CBY	CBY
	Satellite, ATT	ATT	CBY
	Satellite, GCI	GCI	CBY
	Tower, GTP	Aircell, LLC	CBY
	Satellite/Data, CTC	CTC	CBY
	Power Plant Generation Facility	AVEC	AVEC
	Power Maintenance Shop	AVEC	AVEC
	Facility Manager’s House	AVEC	AVEC
	Power Plant Fuel Storage Tanks: 10,000 gallons	AVEC	AVEC
	Redwood Water Tank (scheduled for demo 2024, no replace, new pump system alternative)	CBY	CBY
	Water Tank - 1,000,000 gallon	CBY	CBY
	CTC Internet Towers	CTC	CBY
	CTC Microwave Towers (x3)	CTC	CBY
	Waste Water Treatment Plant	CBY	CBY
	Waste Water Lift Stations x 7	CBY	CBY
	Airport Waste Water Lagoon	CBY	State of Alaska
	Delta Western 3 large storage tanks 10,000-20,000 gallon	Delta Western	Delta Western
Community	Cemetery 1	CBY	CBY
	Cemetery 2	CBY	CBY
	Cemetery 3	CBY	CBY
	ANB Hall	Alaska Native Brotherhood	Alaska Native Brotherhood
	US Post Office	L&C Rentals	L&C Rentals
	St Ann's Catholic Church	Church of Diocese	Church of Diocese
	Church of Latter-Day Saints	Church of Latter-Day Saints	Church of Latter-Day Saints
	Lakeside Chapel Assembly of God	Assemblies of God	Assemblies of God
	Manse -Assembly of God	Assemblies of God	Assemblies of God
	Presbyterian Church	Presbyterian Church	Presbyterian Church
	Manse-Presbyterian Church	Presbyterian Church	Presbyterian Church
	Yakutat Seafoods- Cannery, Bunkhouse, Shop	CBY	CBY
	YKI Facility	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc./CBY

	Facility	Facility Owner	Land Owner
	Community Garden	CBY	AK DNR/AK DOT
	Community Food Waste Recycling Center	YTT	YTT
Vulnerable Populations	Senior Center	YTT	YTT
	YTT Childcare and Essential Personnel Housing	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc.

FEMA APPROVAL LETTER

PLAN DISTRIBUTION LIST

The City and Borough of Yakutat and the Yakutat Tlingit Tribe's 2024 Multi-Jurisdictional Hazard Mitigation Plan Update is distributed to:

- City and Borough of Yakutat
- Yakutat Tlingit Tribe
- Federal Emergency Management Agency (FEMA)
- State of Alaska Division of Military and Veterans Affairs (DMVA), Department of Homeland Security and Emergency Management (DHS&EM)

RECORD OF CHANGES

Hazard Mitigation Plans should be continually updated as circumstances change, new data becomes available, hazards are mitigated, etc. This Record of Changes Table is included to summarize and document changes to this document as they are made throughout time.

Change ID	Description of Changes	Date
01	Updated August 2019 CBY HMP Update and included the Yakutat Tlingit Tribe as a participating jurisdiction	XX

1. PLAN INTRODUCTION AND BACKGROUND

Hazard mitigation planning is required under the Disaster Mitigation Act of 2000 (DMA 2000) which identified the need for Tribal, Local, and State jurisdictions to coordinate mitigation planning and implement mitigation efforts. It also provided the legal basis for the Federal Emergency Management Agency's (FEMA) mitigation plan requirements for mitigation grant assistance.

1.1 PURPOSE

Disasters may cause loss of life, damage buildings and infrastructure, and have devastating effects on a community's economic, social, and environmental well-being. The CBY and the Tribe intend to reduce or eliminate the long-term risk to life and property from hazards by implementing a Hazard Mitigation Plan. The Plan is intended to reduce community risk and promote long-term sustainability by:

- Protecting the public and preventing loss of life and injury.
- Reducing harm to existing and future community assets.
- Preventing damage to a community's cultural, economic, and environmental assets.
- Minimize downtime and speed up recovery following disasters.
- Reducing the costs of disaster response and recovery and the exposure of first responders to risk.
- Help accomplish other community objectives, such as leveraging capital improvements, infrastructure protection, and economic resiliency.

1.2 MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN LAYOUT DESCRIPTION

The City and Borough of Yakutat and Yakutat Tlingit Tribe's 2024 Multi-Jurisdictional Hazard Mitigation Plan (MJHMP) Update consists of the following sections and appendices:

- **Section 1- Introduction and Background**

  Defines what a hazard mitigation planning is. Provides Yakutat's general history and background, including historical trends for population, the demographic and economic conditions that have shaped the area, as well as the government and leadership within the CBY and the Tribe.

- **Section 2- Planning Process**

  Describes the planning process for the MJHMP update, identifies the CBY and the YTT's Planning Team members, lists the meetings held as part of the planning process, and lists the key stakeholders within the surrounding area. This section documents public outreach activities performed by the CBY and the YTT (supporting documents are in Appendix D); including document reviews and relevant plans, reports, and other appropriate information data utilized for MJHMP update development.

- **Section 3- Risk Assessment (Hazard Analysis/Summary of Vulnerability)**

  Describes the process through which the Planning Team identified, screened, and selected the hazards for profiling in this version of the MJHMP Update. The hazard analysis includes the nature of the hazard, previous occurrences (history), location, extent, and impact of past events, and future event recurrence probability for each hazard. The influence of climate change is also discussed within each hazard profile.

  Identifies the CBY and YTT's potentially vulnerable assets—people, critical facilities, critical infrastructure, and residential and non-residential buildings (where available). The resulting information identifies the full range of hazards that the community could face and the potential damages, economic losses, and social impacts. Land use and development trends are also discussed.

- **Section 4- Mitigation Strategy**

Defines the CBY and YTT's mitigation strategy which provides a blueprint for reducing the potential losses identified in the vulnerability analysis. This section lists the community's policies, programs, available resources, and governmental authorities.

Outlines specific mitigation goals and potential actions that the Planning Team selected and prioritized to address the risks facing Yakutat. Provides a status update for projects identified in the 2019 HMP.

- **Section 5- Plan Maintenance**

  Describes the formal Plan maintenance process to ensure that the MJHMP remains an active and applicable document. This section includes an explanation of how the Planning Team intends to organize their efforts to ensure that updates and revisions to the MJHMP occur in an efficient, well-managed, and coordinated manner.

- **Section 6- Plan Update**

  This section describes changes in development since 2019; changes in mitigation priorities; and describes how the mitigation plan was integrated into other planning mechanisms.

- **Section 7- Plan Adoption**

  Describes the CBY and YTT's adoption process of the MJHMP Update. Supporting documentation can be found in Appendix C.

- **Section 8- References**

  Lists reference materials and resources used to prepare this MJHMP Update.

- **Section 9- Appendices**

  Appendix A: Delineates federal, state, and other potential mitigation funding sources. This section will aid the CBY and the YTT with researching and applying for funds to implement their mitigation strategy.

  Appendix B: Provides the FEMA Local and Tribal Mitigation Plan Review Tools, which documents compliance with FEMA guidelines.

  Appendix C: Provides the CBY and YTT's adoption resolution.

  Appendix D: Provides public outreach information, including newsletters.

1.3 COMMUNITY PLANNING AREA

This section describes Yakutat's location, history, culture, government, geography, climate, transportation, economic, and demographic information.

Note: Throughout this HMP, the abbreviation CBY is used as a geographic term to describe the entire geography of the City and Borough of Yakutat as well as a term for the governmental body/jurisdiction of the City and Borough of Yakutat.

1.3.1 LOCATION

Yakutat is isolated among the lowlands along the Gulf of Alaska, 225 miles northwest of Juneau, 220 miles southeast of Cordova, and 367 miles southeast of Anchorage (Figure 1-1). Yakutat is located on the north coast of the Gulf of Alaska, and it is the only community of significant size for a nearly 400-mile-long stretch of the coast between Cordova and Gustavus.

Figure 1-1 Yakutat Location Map

Yakutat's Tlingit name is Yaakwdáat- *The Place Where Canoes Rest.*

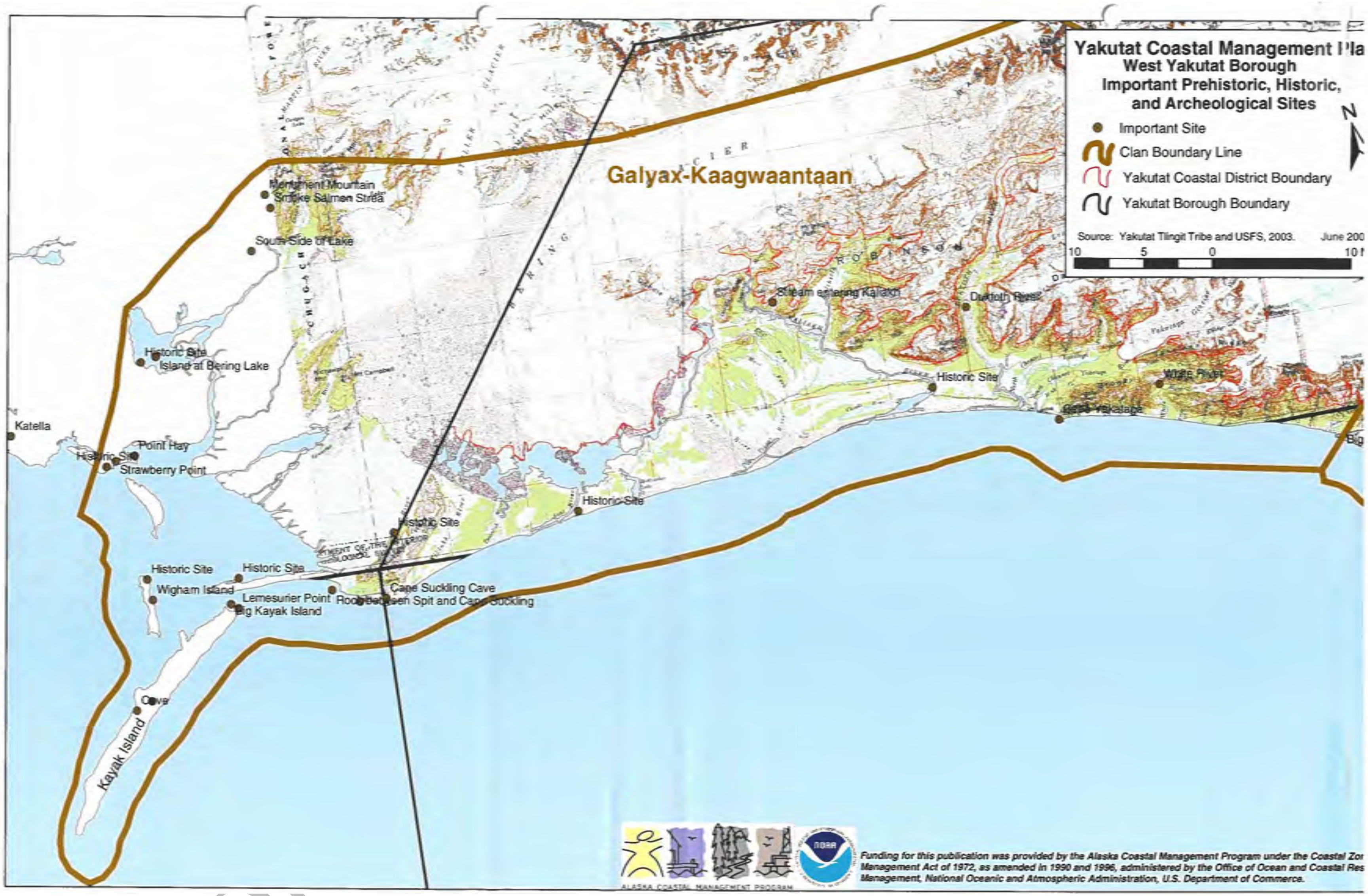
Like most of Southeast Alaska, Yakutat is relatively isolated with no road access. The community lies at the mouth of Yakutat Bay, one of the few refuges for vessels along this stretch of coast. Yakutat lies at approximately 59.546940º North Latitude and -139.727220º West Longitude. Yakutat is located in the Juneau Recording District.

Khaantak Island, populated with dense forest, provides shelter to Monti Bay and Yakutat Roads, the small boat harbor area, from coastal winds and storms.

The CBY is roughly the size of Vermont and encompasses approximately 7,650 square (sq.) miles of land and 1,809 sq. miles of water.

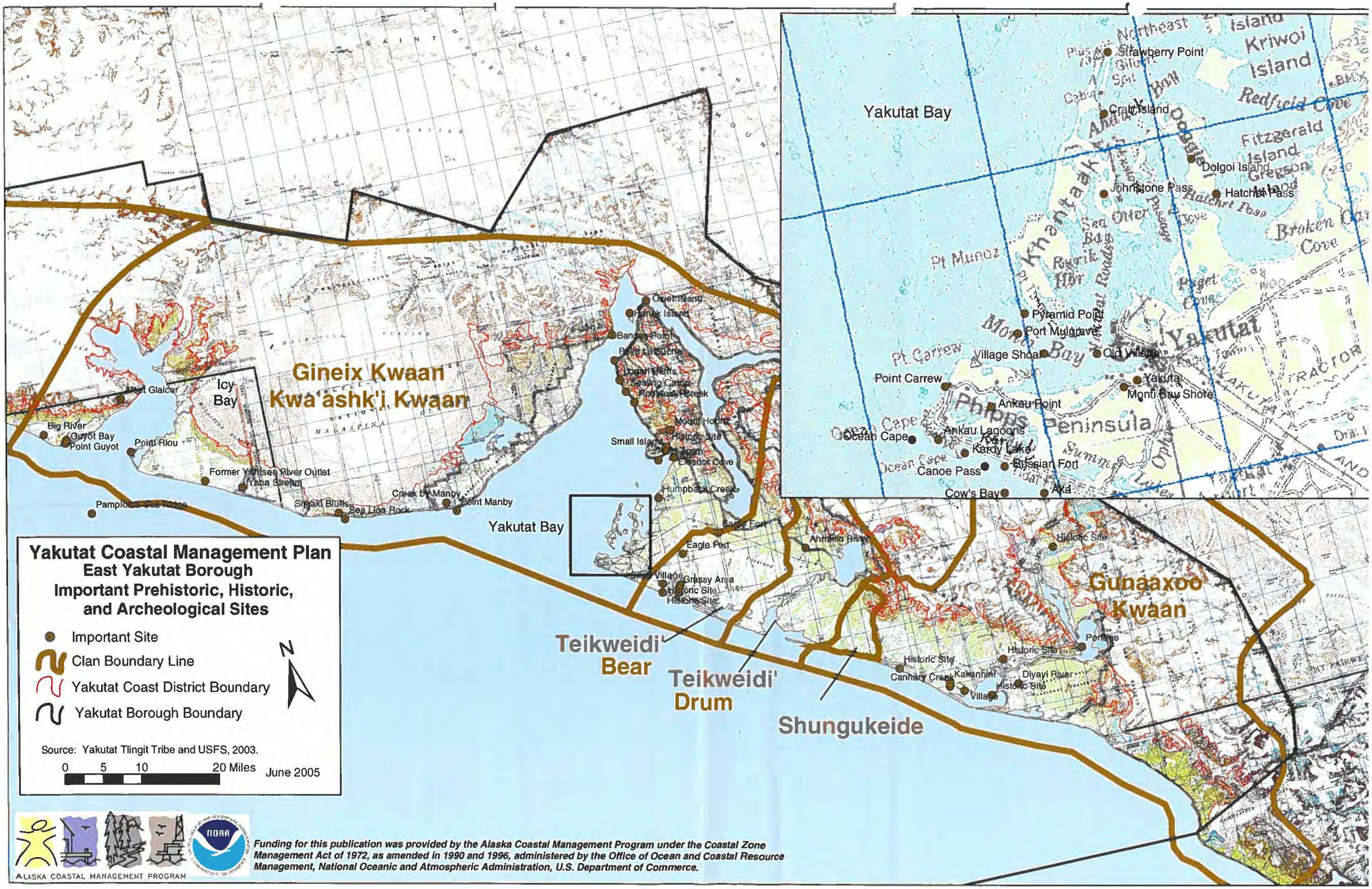
Source: Yakutat Parcel Viewer 2023

Figure 1-2 City and Borough of Yakutat Boundary Map



Source: YTT 2023

Figure 1-3 Yakutat Clan Boundary (West)



Source: YTT 2023

Figure 1-4 Yakutat Clan Boundary (East)

For this HMP Update, the Planning Area will consist of a combined geography of the City and Borough of Yakutat and the Yakutat Tlingit Traditional Clan boundaries (Figure 1-5). However, due to the remote geography of the Planning Area, the risk assessment and loss estimations will be focused on the vicinity of the City of Yakutat (noted with the star), where the resident population is and where the majority of critical facilities are located.

Figure 1-5 Planning Area

The Planning Area is within and surrounded by the Tongass National Forest, Wrangell-St. Elias National Park and Preserve, Glacier Bay National Park and Preserve, and Yakutat State Game Refuge (Figure 1-6).

Source: Yakutat Parcel Viewer 2023

Figure 1-6 National Forest, National Park, and State Refuge Boundaries in the Planning Area

1.3.2 YAKUTAT HISTORY, CULTURE, AND GOVERNMENT

Yakutat has a diverse cultural history. The original settlers are believed to have been Eyak-speaking people from the Copper River area who were conquered by the Tlingit. Yakutat means "the place where the canoes rest." In the 18th and 19th centuries, English, French, Spanish and Russian explorers came to the region. Fur traders were attracted by the region's sea otters. The Russian-American Company built a fort in Yakutat in 1805 to harvest sea otter pelts. Because the Russians would not allow local Tlingit access to their traditional fisheries, a Tlingit war party attacked and destroyed the post.

In 1884, the Alaska Commercial Company opened a store in Yakutat. By 1886, the black sand beaches in the area were being mined for gold. In 1889, the Swedish Free Mission Church had opened a school and sawmill in the area. The Stimson Lumber Company constructed a cannery, sawmill, store, and railroad, beginning in 1903. Most residents moved to the current site of Yakutat to be closer to this cannery, which operated through 1970. During World War II, a large aviation garrison and paved runway were constructed. Troops were withdrawn after the war, but the runway is still in use.

In 1970, Yakutat's cannery operators went bankrupt, the plant closed, and, until the community-operated cold storage plant and associated dock were completed in April 1971, welfare was a major source of income for many Yakutat fishermen. The community-owned cold storage operation continued to run until the processing and storage building burned down in 1977. Today, the Ocean Cape Dock facility is operating in Yakutat.

In the fall of 1993, the Yakutat Tlingit Tribe was officially recognized by the U.S. government as a tribal government. The Yakutat Tlingit Tribe has jurisdiction over lands outside the CBY, as shown in the Clan Maps (Figure 1-3 and Figure 1-4).

Yakutat maintains a traditional Tlingit culture with influences from the original Eyak, Athabascan, as well as Russian, English, and American traders, and miners. Fishing and subsistence activities are prevalent in Yakutat (DCRA 2023).

The City of Yakutat was incorporated in 1948, with just over three-square miles within City limits. In September 1992, residents of the City of Yakutat voted to dissolve the City, and incorporate the 5,875 square mile Home Rule City and Borough of Yakutat, which stretched from the Alsek River on the southeast to Icy Bay on the west and Canada to the north. In 1997, CBY annexed the area from Icy Bay west to Cape Suckling.

CBY is a unified single governmental unit with a Home Rule Charter. Section 1.1 of the Home Rule Charter of CBY reads as follows:

> *"The Borough shall be a municipal corporation known as the "City and Borough of Yakutat." Whenever it deems it in the public interest to do so, the Borough may use the name "City and Borough of Yakutat Home Rule Borough"* (CBY 2004)

1.3.3 HISTORY OF THE YAKUTAT TLINGIT TRIBE

The Yakutat Tlingit Tribe's webpage provides the following historical information of the YTT:

<u>Looking Back: A Brief History of the Yakutat Tlingit Tribe</u>

> *The Five Chiefs Council was a Tribal Government formed in the 1950s for the purpose of negotiating with the federal government to begin oil exploration drilling in the Yakutat Territory. Led by one member from each of the five founding clans, the Council has been granted monetary settlement, and the oil drilling commenced in the areas from Icy Bay to Dry Bay.*
>
> *In 1971, the federal government awarded a monumental lawsuit to all Alaska Natives for the lands taken when Alaska was sold by Russia to the United States. As a result, forty million acres of land and monetary settlement were turned over and entrusted to for-profit regional corporations.*

Village corporations were then created under the regional corporations, receiving per capita settlement and approximately 20,000 acres of land surrounding their communities. These lands that were entrusted to regional and village corporations were meant to be used as tools for economic development, and the profits generated from these were to be distributed to the shareholders.

In Yakutat, a scholarship account was set up by the corporation to assist young individuals with their education, but afterwards realized that there were other social service programs they were unable to meet. This prompted the corporation to form a non-profit organization authorized to contract with the federal government under the provisions of Public Law 93-638, otherwise known as the Indian Self-Determination and Educational Assistance Act, for the services and programs that were administered by the Bureau of Indian Affairs. Thus, the Yakutat Native Association was born.

In the early 1990s, the Yakutat Native Association began to draft a constitution that would allow it to reorganize and become recognized as a tribal government under the authority of the Indian Reorganization Act. On March 24, 1993, the Yakutat Native Association finally earned its federal recognition – bringing forth the emergence of the Yakutat Tlingit Tribe.

<u>Moving Forward: The Yakutat Tlingit Tribe Today</u>

For over thirty-four years, the Yakutat Tlingit Tribe has successfully provided services for its Tribal members. To this date, the Yakutat Tlingit Tribe has remained true to its purpose by continuously uplifting the cultural, social, and economic aspects of its community; genuinely advancing the welfare of its 820 enrolled Tribal members as well as the entirety of the Tribe's traditional territory which extends to the Yakutat Borough boundaries, encompassing nine thousand four hundred and sixty (9,460) square miles.

Situated in the heart of the traditional territory, the Yakutat Tlingit Tribe bears witness to the village's struggling economy that largely consists of fishing, fish processing, and tourism during the months of April to September. The nature of the economy in the area leaves an evident trend of seasonal and unstable employment as many rely upon commercial fishing and subsistence hunting and fishing as means of livelihood. Subsequently, the Yakutat Tlingit Tribe, as the self-governing body duly formed to oversee the affairs of the Tlingit people and its native land, constantly aims to mitigate the otherwise inevitable social difficulties that accompany an unstable economy.

The Tribe addresses these concerns by the unwavering effort to develop programs and support services to maximize the social, health and well-being of its tribal members and promote economic growth within the community of Yakutat and its traditional territory. (Yakutat Tlingit Tribe 2023)

1.3.4 GEOGRAPHY

The landscape in Yakutat is dramatic with high mountains, extensive icefields, glacial valleys, fjords, bays, rivers, forests, and wetlands. The landscape is constantly changing due to its location along the northern edge of the earth's Pacific Plate, the fact that the land is rising as it rebounds from the weight of former glaciers, and because the coastline is exposed to the full force of waves and the storms that roll in across the Pacific Ocean and hit land with full force.

The Planning Area has an incredibly diverse habitat including glaciers, large and tall mountain ranges, floodplains, estuaries, wetlands, tidelands, islands, lagoons, freshwater rivers and lakes. This wide range of environments is home to many species of bird, fish, shellfish, and marine and terrestrial mammals. Between the Saint Elias Mountains and the Gulf of Alaska, there are gently sloping outwash plains known as the Yakutat, Malaspina and Yakataga Forelands. The forelands are unique to this region and were formed during recent geologic times.

The abundant rainfall, mild temperatures, high water table, and gravel substrate make the Forelands especially productive spawning and rearing habitat for anadromous fish. All five salmon species (king, sockeye, pink, chum, and coho) are present in the area. The Alaska Department of Fish and Game has identified over 90 anadromous fish streams in the Planning Area, between Cape Suckling and Cape Fairweather. Yakutat residents have a deep passion for their rich fish and wildlife and these natural resources provide outstanding commercial, subsistence and sport fishing, which are the backbone of the local economy.

The mountainous landscape found in much of Planning Area was shaped by the collision of two tectonic plates. These mountains are being constantly modified by glaciation, erosion, deposition, and wave, and wind action. The Saint Elias Mountains and its massive icefields run the length of the borough. This includes the Bering Glacier, part of the largest icefield in North America and the Hubbard Glacier, located on Yakutat Bay, which has a tidewater terminus over six miles wide and 92 miles long.

The position of land in relation to the sea level has fluctuated widely in the Yakutat area. While sudden uplifting and depression of land has been caused by tectonic events, the expansion and contraction of glaciers has had more gradual but equally significant effects. The recession of glaciers causes the land to rise slowly as the weight of glaciers is removed, although there is usually a time lag between melting and rebound. As of 1983, land in the Yakutat area had been emerging at an average rate of 0.21 inches per year. Theoretically, this rate of uplift could result in an emergence of 10.5 inches in 50 years and create as much as 50 feet of new land in coastal areas where the slopes are very gentle.

1.3.5 CLIMATE

Yakutat falls within the southeast maritime climate zone, characterized by cool summers, mild winters, and heavy rain throughout the year. The combination of heavy precipitation and low temperatures at high altitudes in the coastal mountains of southern Alaska accounts for the numerous mountain glaciers. Yakutat receives some of the heaviest precipitation in the state, averaging 132 inches of precipitation and 219 inches of snowfall each year. Summer temperatures range from 42 to 60 degrees Fahrenheit (ºF); winter temperatures range from 17 to 39ºF (DCRA 2023).

Table 1-1 shows average weather data for Yakutat.

Table 1-1 Average Weather Data for Yakutat (1991-2020)

Season	Max Temp (ºF)	Min Temp (ºF)	Avg Temp (ºF)	Rainfall (in)	Snow (in)
Annual	48.1	34.0	41.1	140.36	147.3
Winter	36.3	23.7	30.0	36.64	86.0
Spring	46.9	30.6	38.7	25.31	37.9
Summer	60.7	47.2	54.0	26.95	0.0
Autumn	48.7	34.7	41.7	51.46	23.4

Data collected at the Yakutat Airport.
Source: NCEI 2023- U.S. Climate Normals Quick Access

1.3.6 TRANSPORTATION

Like most of Southeast Alaska, Yakutat is relatively isolated with no road or rail access. The airport has daily commercial jet service that directly connects with Juneau, Cordova, Anchorage, and Seattle. There are also air taxis and float plane services to Yakutat. The state owns two jet-certified runways; one is 6,475 feet (ft) long by 150 ft wide of concrete, and the other is 7,745 ft long by 150 ft wide of asphalt. The airport is located three miles southeast of town, and a seaplane float is available one-mile northwest. The U.S. Forest Service owns five airstrips in the vicinity, and the National Park Service operates one at East Alsek River.

Figure 1-7 Welcome to Yakutat Sign

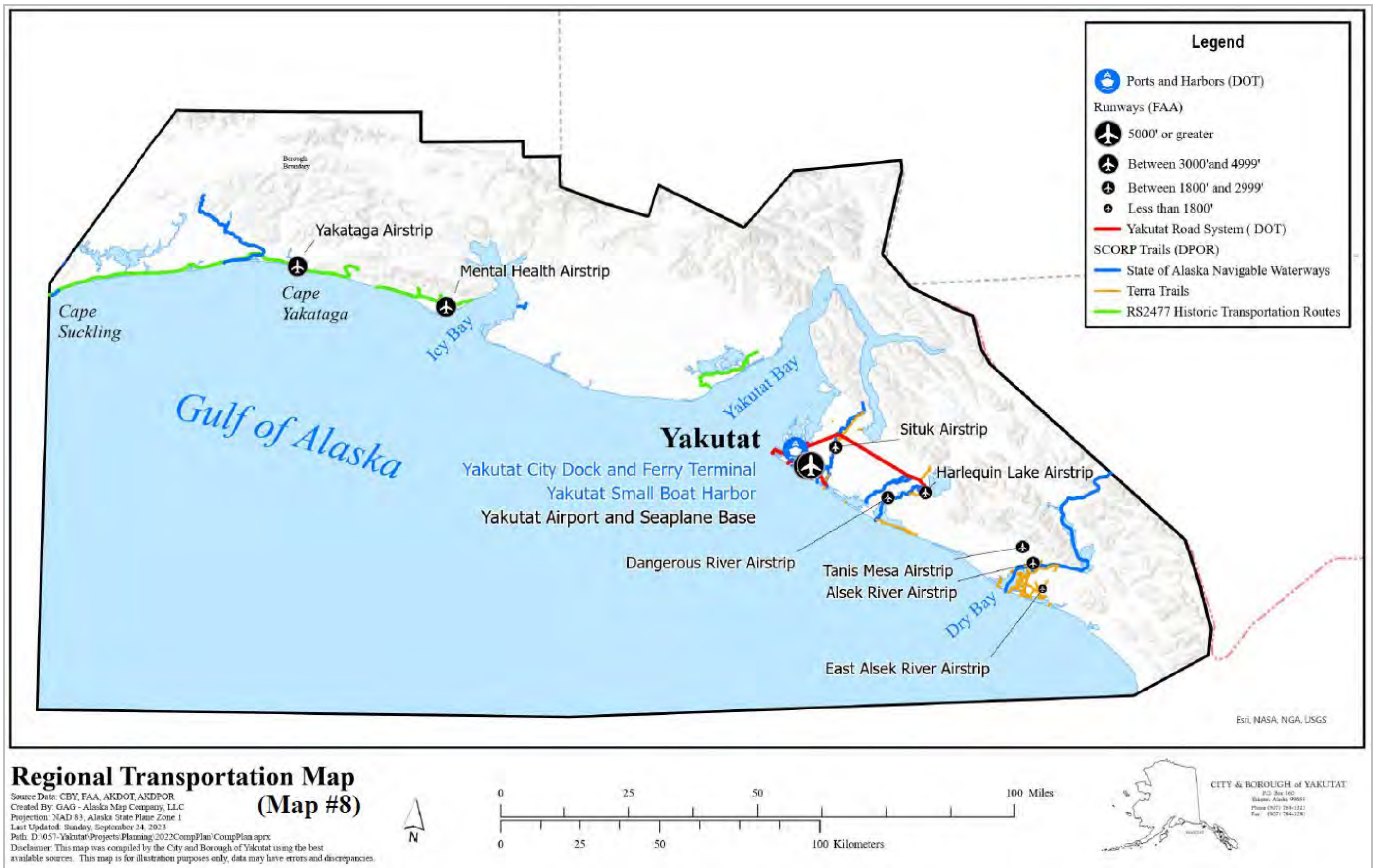
The Borough operates the state-owned boat harbor and the Ocean Cape Dock. Monti Bay is the only sheltered deep water port in the Gulf of Alaska. Barges deliver goods monthly during the winter and more frequently in summer. The State Ferry serves Yakutat, however, severe seas in the Gulf of Alaska during winter months restrict the ferry service to summers only (DCRA 2023).

Yakutat heavily relies on the Alaska Marine Highway/Ferry System for transportation, services, supplies, and tourism. The ferry is the cheapest transportation option for the movement of goods into and out of Yakutat. In March 2023, Alaska DOT&PF announced that they would be cutting back ferry services due to short staffing, and entirely eliminating services to Yakutat for the summer (Alaska's News Source 2023). CBY Manager and Planning Team member, Jon Erickson, was interviewed to discuss how the ferry cancellation affects Yakutat. He states:

> *"It really puts everyone in a bind. We do not have any basic services here. We don't have a service station in town. We don't have an auto body shop in town. We don't have any kind of just general services that you would use.* [Regarding tourism], *In Yakutat, we have almost 300 beds in town. And, so, if the beds aren't full, that's going to really hurt us."* (Alaska's News Source 2023)

The Planning Team states that while the ferry was not servicing Yakutat, they experienced a 10% increase in the cost of goods that were imported into Yakutat. The ferry provided a lower-cost alternative to airline travel or the barge from Seattle/Anchorage. There are no auto repair shops in Yakutat and for any services, residents have to travel to Anchorage/Seattle for repair. Jon Erickson stated that a typical $1,000 trip to Anchorage on the ferry cost nearly $6,000 to put a vehicle on the barge plus airfare. Residents are eager to have ferry service back in Yakutat.

Figure 1-8 shows transportation facilities in Yakutat.



Source: Yakutat 2023 Comprehensive Plan

Figure 1-8 Regional Transportation Map

1.3.7 ECONOMY

The following is a brief history of the different industries that shaped Yakutat's economy (CBY 2023):

Furs: In the 1790s, the Russians came to Yakutat in pursuit of sea otter pelts, eventually building a fort. However, Russians blocked locals from accessing the community's traditional fishing grounds, leading residents to destroy the fort in 1805.

Mining: In the 1880s, the area's black sand beaches attracted hundreds of gold miners. In the early 2000s an Oklahoma company staked claims to 60,000 acres in the area for mining, but failed to identify commercial quantities of gold.

Timber: In 1889, a sawmill was built in the community. The passage of the Alaska Native Claims Settlement Act (ANCSA) in 1971 allowed Yak-Tat Kwaan to select 23,040 acres in the vicinity. Timber played a large role in the Borough's economy between the 1960s through the early 2000s when the Icy Bay Logging Camp closed, and more than 100 timber jobs were lost. In 2018, Yak Timber restarted timber operations. In October 2022, the timber company announced it would cease operations.

Seafood: A cannery was built in 1903 and it operated until 1970 when the cannery operators went bankrupt. Currently, several small seafood processors operate in Yakutat, as well as Yakutat Seafoods, which has been in operation since 2005 and operates the cannery under a lease from the Borough. Seafood jobs, home-ported fishing boats, and pounds landed annually have all gradually decreased over time; however, commercial fishing remains an integral part of the economy and subsistence fishing is essential for households.

Tourism: The community's tourism economy is largely centered around lodges that cater to sportfishing and hunting. Surfing, kayaking, birding, Cannon Beach, and the Hubbard Glacier are also key visitor attractions. The community saw its first large cruise ship visit in 2015, but currently cruise visitors are limited to a couple dozen small cruises.

Health Care: Health care became an important part of the Yakutat economy in 2020 when a new facility was developed in the community. This 22,000 square foot facility is Tribally-owned and -operated and received a commitment from the Indian Health Service to fund operations for 20 years.

Yakutat's economy is experiencing historic strength in the early 2020s. Its annual (seasonally unadjusted) unemployment rate in 2022 was 5.1% (Alaska Department of Labor and Workforce Development (ADOLWD)), the lowest recorded in at least 30 years. Annual wages have increased, averaging about $59,000 in 2022, over a 90% increase compared to 2010. The economy looks very different from the economy of 2010. In 2022, the largest components of the Yakutat economy were seafood, local and tribal government, and health care. However, economic development in Yakutat is also limited by a lack of housing availability plus prohibitive pricing, directly contributing to worker shortages (CBY 2023).

Table 1-2 General Economic Conditions in Yakutat (2000-2022)

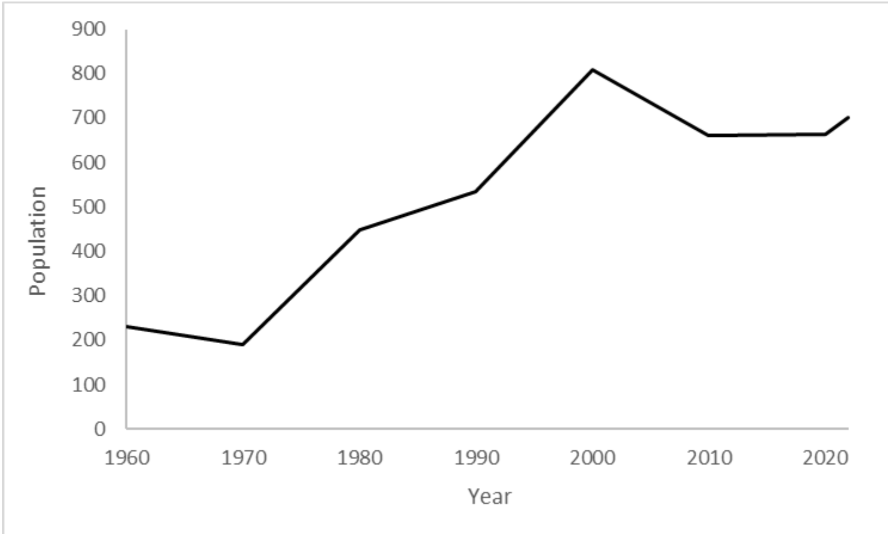
	2000	2010	2015	2022	Change 2010-2022
Total Labor Force (jobs and self-employed)	466	436	415	461	+6%
Total Job Earnings (in millions)	$16.1	$15.2	$15.8	$29.8	+96%
Total payroll (in millions), excludes self-employed	$9.3	$10.5	$10.7	$20.3	+93%
Average Annual Wage	$32,659	$33,422	$38,110	$59,055	+77%
Annual Unemployment Rate (seasonally unadjusted)	6.8%	11.1%	8.5%	5.1%	-6%

Source: CBY 2023

1.3.8 DEMOGRAPHICS

Yakutat first appeared on the 1880 U.S. Census as the unincorporated Tlingit-Yakutat village with 300 residents.

The DCRA certified population for 2022 recorded 673 residents in Yakutat, of which the median age was 36 years: indicating a moderately young population. Figure 1-9 shows the historical population of Yakutat. The population drop after the year 2000 is partly due to the closure of the Icy Bay Logging Camp in 2004.



Data from DCRA 2023

Figure 1-9 Historical Population of Yakutat

The population of Yakutat is fairly diverse with approximately 38.53% of residents recognizing themselves White, 28.81% Alaska Native, 8.38% Asian, 5.7% African American, 0.34% Native Hawaiian or Pacific Islander, 1.68% as another race, and 16.58% two or more races (DCRA 2023). The composition of the population is 59.3% female and 40.7% male. There are an estimated 216 households in the community with the average household size of 2.31 (US Census 2021).

Looking from 1880 when the population was 300 to 2022 when it is 673 residents, the population change over this 140+ year period averaged just over a half a percent annually (+0.6%). That change blends periods of growth and periods of decline, which are linked to the number of residents being born and dying, to economic conditions, and to personal choices about community, culture, and family (CBY 2023).

About every five years, ADOLWD releases a 30-year population projection for the state. The state is projecting a population decline for Southeast Alaska and Yakutat (CBY 2023). Southeast Alaska has experienced steady population losses over recent years and there is uncertainty about future population trends. Compared to the rest of the state, the region has a low birth rate and a high median age, so in order for the region to grow, more people must move to the region than move out of the region (an increase in net in-migration). For Southeast Alaska, the 2021 population was 72,494 and the ADOLWD predicts a decline for the region between now and 2050 of -0.47% average annual per year, resulting in a regional population in 2050 of 63,099 (down about 9,400 people). For Yakutat, the state's 2022 population estimate is 673 with a forecasted decline of -0.32% average annual per year, resulting in a 2050 population of 636 (down about 60 people). The accuracy of these projections will depend on economic and other trends in Yakutat, the region, and the country, all of which impact how many people choose to move to, from, and stay in Yakutat (CBY 2023).

Figure 1-10 shows an aerial image of Yakutat.

Figure 1-10 Aerial Image of Yakutat

2. PLANNING PROCESS

This section provides an overview of the planning process; identifies the key stakeholders and Planning Team members, documents public outreach efforts, and summarizes the review and incorporation of existing plans, studies, and reports used to update this MJHMP. Meeting information regarding the Planning Team and public outreach efforts are included below and outreach support documents are provided in Appendix D.

This section addresses Element A of the Local Mitigation Plan regulation checklist and a portion of Element A of the Tribal Mitigation Plan regulation checklist.

Regulation Checklist- 44 Code of Federal Regulations (CFR) § 201.6 Local Mitigation Plans
ELEMENT A. Planning Process
A1. Does the plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement 44 CFR § 201.6(c)(1))
A1-a. Does the plan document how the plan was prepared, including the schedule or time frame and activities that made up the plan's development, as well as who was involved?
A1-b. Does the plan list the jurisdiction(s) participating in the plan that seek approval, and describe how they participated in the planning process?
A2. Does the plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development as well as businesses, academia, and other private and non-profit interests to be involved in the planning process? (Requirement 44 CFR § 201.6(b)(2))
A2-a. Does the plan identify all stakeholders involved or given an opportunity to be involved in the planning process, and how each stakeholder was presented with this opportunity?
A3. Does the plan document how the public was involved in the planning process during the drafting stage and prior to plan approval? (Requirement 44 CFR § 201.6(b)(1))
A3-a. Does the plan document how the public was given the opportunity to be involved in the planning process and how their feedback was included in the plan?
A4. Does the plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement 44 CFR § 201.6(b)(3))
A4-a. Does the plan document what existing plans, studies, reports, and technical information were reviewed for the development of the plan, as well as how they were incorporated into the document?
Source: FEMA 2022 (Local)

Regulation Checklist- 44 CFR § 201.7 Tribal Mitigation Plans
ELEMENT A. Planning Process
A1. Does the plan document the planning process, including how it was prepared and who was involved in the process? [44 CFR § 201.7(c)(1)]
A2. Does the plan document an opportunity for public comment during the drafting stage and prior to plan approval, including a description of how the tribal government defined "public"? [44 CFR § 201.7(c)(1)(i)]
A3. Does the plan document, as appropriate, an opportunity for neighboring communities, tribal and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? [44 CFR § 201.7(c)(1)(ii)]
A4. Does the plan describe the review and incorporation of existing plans, studies, and reports? [44 CFR § 201.7(c)(1)(iii]
Source: FEMA 2017 (Tribal)

2.1 OVERVIEW

The City and Borough of Yakutat (CBY) contracted Fairweather Science, LLC (Fairweather Science) to facilitate and guide the Planning Team through the HMP update process. The CBY invited the Yakutat Tlingit Tribe (YTT or Tribe) to join the Planning Team as a participating jurisdiction to pursue a Multi-Jurisdictional Hazard Mitigation Plan (MJHMP).

This MJHMP Update follows the following FEMA Guidance for Mitigation Planning:

- FEMA 2022/2023 Local Mitigation Planning Policy Guide (Released April 2022, Effective April 2023).
- FEMA 2019 Tribal Mitigation Planning Handbook, which is a companion to the Tribal Mitigation Plan Review Guide, released by FEMA in 2017.

The planning process began in February of 2023 with a kickoff meeting between the CBY Project Manager/Planner and Fairweather Science to discuss the project schedule, public involvement process, and planning team composition. The CBY Project Manager met again with the consultant in March and April to discuss progress on the planning team and public involvement as well as inviting the YTT to join the HMP process.

The CBY Project Manager invited the YTT to join the planning effort and also engaged the local high school to attempt to recruit a student planning team member.

On August 9, 2023, Fairweather Science met with the Planning Team for the official project Kickoff Meeting. Fairweather Science provided a project overview and schedule to the Planning Team. The Planning Team reviewed the hazards identified in the 2019 HMP discussed if they were still applicable or needed to be updated. The Planning Team discussed hazard history and significant events, and how they perceive climate change is influencing each hazard. The Planning Team reviewed the list of critical facilities identified in the 2019 HMP and provided initial ideas for mitigation projects. They then reviewed a draft online survey to engage the public and discussed other potential avenues for public engagement.

On August 24, 2023, the public survey was posted on the CBY Facebook page and website. On October 4, 2023, the survey was posted to the and YTT Facebook page to inform the public about the project and request information to inform the draft risk assessment.

On November 6, 2023, the Planning Team met with Fairweather Science to discuss the draft risk assessment that they reviewed. The Team shared feedback on the draft risk assessment and additional mitigation project ideas. Progress on finalizing the draft risk assessment stalled over the Holidays, but on January 26, 2024, the Planning Team met again to refresh on the project status and discuss the updated project schedule.

On February X, 2024, the draft risk assessment was made available for public review. The CBY published a memo on the CBY website with a link to the draft risk assessment and contact information to whom to direct public comments to.

In Spring 2024, the Draft MJHMP was made available for public review and comment. The CBY published a memo on the CBY website with a link to the draft MJHMP and contact information to whom to direct comments to.

The following changes were made to the Draft MJHMP based on comments received:

- Update based on comments received

In summary, the following five-step process took place from February 2023 through Summer 2024.

1. Organize resources: members of the Planning Team identified resources needed in the development of the hazard mitigation plan update- including staff, agencies, and local community members who could provide technical expertise and historical information.
2. Monitor, evaluate, and update the Plan: the Planning Team developed a process to monitor the plan to ensure it was used as intended while fulfilling the needs of the community. The team then developed a process to evaluate the plan to compare how their decisions affected recognized hazard impacts. The team then outlined a method to share their successes with members of the community. By sharing their successes, the team aimed to encourage support for mitigation activities and to provide data for incorporating mitigation actions into existing planning mechanisms and to provide data for the plans five-year update.

3. Assess risks: with the assistance of a hazard mitigation planning consultant (Fairweather Science), the Planning Team identified the hazards specific to Yakutat and the consultant developed the risk assessment for the identified hazards. The Planning Team reviewed the risk assessment prior to and during the development of the mitigation strategy.
4. Assess capabilities: the Planning Team reviewed current capabilities to determine whether existing provisions and requirements adequately addressed relevant hazards. Examples of these capabilities are administrative and technical, legal, regulatory, and fiscal.
5. Develop a mitigation strategy: after reviewing the risks posed by each defined hazard, the Planning Team developed a comprehensive range of potential mitigation goals and actions. The Planning Team then identified and prioritized the actions for implementation.

Table 2-1 describes Planning Team meetings convened to update this MJHMP.

Table 2-1 Hazard Mitigation Planning Team Meetings

Date	Agenda	Attendees	
03/20/2023	Request native file format of the 2019 HMP; discuss participating jurisdictions- discuss inviting the Tribe to participate; Planning Team composition (elders, youth, etc.); project schedule; initial ideas for public engagement (survey, newsletter, etc.); set date for kickoff meeting	CBY	Martha Indreland
		Fairweather Science	Laura Young
08/09/2023	Project Kickoff Meeting with members from the CBY and YTT. MJHMP overview; project schedule; roles and responsibilities, review hazards identified in the 2019 HMP; initial suggestions for mitigation projects; current critical facilities; discussion about community input via an online survey.	Yakutat Planning Team	Martha Indreland (CBY) Jon Erickson (CBY) Michael Jensen (CBY) Melenda Lekanof (YTT) Geno Cisneros (USFS)
		Fairweather Science	Laura Young Olivia Kavanaugh
11/06/2023	Review of draft risk assessment and comments from Planning Team, identify stakeholders to be invited to participate in the planning process, discussion of vulnerable and underserved populations.	Yakutat Planning Team	Martha Indreland (CBY) Jon Erickson (CBY)
		Fairweather Science	Laura Young Olivia Kavanaugh
01/26/2024	Post-holiday regroup meeting. Discuss YTT comments on draft risk assessment, updated project schedule, discuss publishing draft risk assessment for public comment period.	Yakutat Planning Team	Martha Indreland (CBY) Mary Porter (YTT)
		Fairweather Science	Laura Young Olivia Kavanaugh
--/2024	Identify/update CBY and YTT resources and capabilities, obtain statuses for actions from the 2019 HMP, discuss current ideas for mitigation projects, review public feedback from the survey results. Review and prioritize a list of proposed mitigation actions,	Yakutat Planning Team	
		Fairweather Science	Laura Young Olivia Kavanaugh

2.2 HAZARD MITIGATION PLANNING TEAM

Table 2-2 identifies the complete hazard mitigation Planning Team.

Table 2-2 Hazard Mitigation Planning Team

Name	Title	Organization	Key Input
Martha Indreland	Borough Planner	City and Borough of Yakutat	Planning team lead, project management, data input, and MJHMP review.
Jon Erickson	Borough Manager	City and Borough of Yakutat	Planning team member, data input, and MJHMP review.
Michael Jensen	Public Works Supervisor	City and Borough of Yakutat	Planning team member, data input, and MJHMP review.
Melenda Lekanof	Lands & Cultural Resources Director	Yakutat Tlingit Tribe	Planning team member, data input, and MJHMP review.
Mary Porter	Environmental Director	Yakutat Tlingit Tribe	Planning team member, data input, and MJHMP review.
Geno Cisneros	Hoonah Ranger District	US Forest Service	Planning team member, data input, and MJHMP review.
Laura Young	Project Manager, Hazard Mitigation Planner	Fairweather Science, LLC	Responsible for project management/ coordination, subject matter expertise in plan development, and MJHMP review.
Olivia Kavanaugh	Staff Scientist, Hazard Mitigation Planner	Fairweather Science, LLC	Responsible for MJHMP development, writer, research, and analysis.

2.3 OPPORTUNITIES FOR STAKEHOLDERS AND OTHER INTERESTED PARTIES TO PARTICIPATE

Fairweather Science extended an invitation to all individuals and entities identified on the project mailing list in which they described the planning process and announced the upcoming communities' planning activities. The announcement was emailed to relevant academia, nonprofits, and local, state, and federal agencies on date.

The following agencies, neighboring communities, and community stakeholders were invited to participate and review the MJHMP Update:

- Yak-Tat Kwaan
- Alaska Mental Health Trust
- Chugach Corporation
- Sealaska Corporation
- Neighboring Communities
  - Juneau- National Guard, Coast Guard
  - Sitka
- American Red Cross of Alaska- Disaster Program Manager

- American Red Cross of Alaska- Juneau Office
- Alaska Department of Community, Commerce, and Economic Development (DCCED)
    - DCCED, Division of Community and Regional Affairs (DCRA)
    - DCCED, National Flood Insurance Program (NFIP)
    - DCCED, Risk Mapping, Assessment and Planning (Risk MAP)
- Alaska Department of Environmental Conservation (DEC)
    - DEC, Division of Spill Prevention and Response (DSPR)
- Alaska Department of Fish and Game (ADF&G)
- Alaska Department of Health and Social Services (DHSS)
- Alaska Department of Military and Veterans Affairs (DMVA)
    - DMVA, Division of Homeland Security and Emergency Management (DHS&EM)
- Alaska Department of Natural Resources (DNR)
    - DNR, Mining, Land, and Water (MLW)
    - DNR, Division of Geological and Geophysical Surveys (DGGS)
        - DGGS, Coastal Hazards
        - DGGS, Geology
    - DNR, Division of Forestry (DOF)
- Alaska Department of Public Safety (DPS)
- Alaska Department of Transportation and Public Facilities (DOT/PF)
    - Southcoast Region
- Alaska State Troopers- Southeast Alaska
- FEMA Region 10
- National Oceanic and Atmospheric Administration (NOAA)
    - NOAA, National Weather Service (NWS)
        - NWS Southeast Region
- Sitka Sound Science Center
- University of Alaska Fairbanks (UAF)
    - UAF, Alaska Earthquake Information Center (AEC)
    - UAF, Alaska Volcano Observatory (AVO)
    - UAF, Geophysical Institute (GI)
    - UAF, Scenarios Network for Alaska + Arctic Planning (SNAP)
- US Army Corps of Engineers, Alaska Region (USACE)
- US Bureau of Land Management (BLM)
- US Department of Agriculture (USDA)
    - USDA, Division of Rural Development (RD)
    - USDA, Natural Resources Conservation Service (NRCS)
    - USDA, Forest Service (USFS)
- US Department of Housing and Urban Development (HUD)
- US Department of the Interior
    - National Park Service (NPS)

    - NPS, Yakutat District Office
  - Bureau of Indian Affairs (BIA)
- US Environmental Protection Agency (EPA)
- US Fish & Wildlife Service (USFWS)
- US Geological Survey (USGS)
  - USGS, Alaska Science Center

2.4 PUBLIC INVOLVEMENT AND TRIBAL DEFINITION OF MEMBERSHIP

The Tribe defines “public” as all community members, tribally enrolled or not. Tribally enrolled members are descendants.

The public was encouraged to provide input regarding local hazards and ideas for mitigation projects via an online survey. The link to the survey was available on the CBY’s and YTT’s Facebook pages and websites.

Several public notices discussing the hazard mitigation planning process, requesting public input, and to notify the public of the project were shared with members of the community. The notices were posted on the CBY Website and CBY Facebook pages, as well as sent via email to project stakeholders and the CBY’s email distribution list.

Feedback received from the public was used in confirming natural hazards that impact the CBY, level of concern of each hazard, and critical facilities that the public relies on. Additionally, the Planning Team reviewed the list of mitigation projects that the public suggested; XX

Images provided by the public were used in the severe weather profile to show extent of heavy/drifting snow, and in the erosion hazard profile to show post-logging conditions.

Outreach support documents and survey results are provided in Appendix D.

2.5 REVIEW AND INCORPORATION OF EXISTING PLANS, STUDIES, AND REPORTS

During this MJHMP update, the Planning Team reviewed and incorporated pertinent information from available resources since the 2019 HMP was completed. Newly collected data included available plans, studies, reports, and technical research listed in Table 2-3. The new data was reviewed and referenced throughout the document.

Table 2-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)	Data Used (How was this information incorporated into this MJHMP?)
2008, 2015, and 2019 City and Borough of Yakutat Hazard Mitigation Plans	Review past hazard events, mitigation activities, and planning processes.	Compared hazard profiles, history, and impacts of events for risk assessment.
2018 and 2023 State of Alaska Hazard Mitigation Plan (SHMP)	Defines statewide hazards and their potential locational impacts.	Compared hazard profiles, history, and impacts of events for risk assessment.

Table 2-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)	Data Used (How was this information incorporated into this MJHMP?)
1971, 1976, 1994, 2006, 2010, and 2023 Yakutat Comprehensive Plan	Sets forth a vision and goals for a CBY's future and provides the overall foundation for all land use regulation in the CBY.	Cited information from the Plan throughout the MJHMP such as community background information, land use information, future goals of the community, and various figures and maps.
2022 Yakutat Transportation Improvement Plan	Identifies and describes the need of 8 transportation improvement projects the CBY aims to pursue.	Used to describe the condition of Max Italio Dr with images, future transportation projects
2018 YTT Long Range Transportation Plan	Identifies transportation needs, priorities, and opportunities within the Tribe's service area that has become evident through planning outreach, as critical to the Tribe, partner organizations, and community, as needed transportation infrastructure since the original transportation planning and inventory work was completed	Used maps and inventory of roads for risk assessment.
2019 YTT Strategic Tribal Transportation Safety Plan	This Safety Plan serves as a comprehensive source for YTT to identify and address transportation risk factors that have a potential of leading to serious injury or death in Yakutat.	Reviewed document to understand concerns and goals the YTT and community members have regarding transportation safety in Yakutat.
2023 YTT Yakutat 100-Year Strategic Vision	Asked for copy when plan is done	
1987 Bayview Dr. (now Max Italio Dr.) Slope Stability and Marine Terminal Traffic Study	Investigates the slope stability and port access problems in Yakutat, from the Alaska Native Brotherhood (ANB) Hall to Ocean Cape Road. Provides recommendations for improvements to reduce the slope instability problem.	Referenced report in the Ground Failure hazard profile to describe the history of slope instability of the road.
2007 USACE Erosion Information Paper- Yakutat, Alaska	Baseline erosion assessment of the community.	Used to describe historical erosion locations and impacts in the City and Borough of Yakutat.
2017 Floodplain Manager's Report- Yakutat	Provides details on historic flood events in the community.	Used to describe historical flood locations and impacts in the City and Borough of

Table 2-3 Documents Reviewed

Existing plans, studies, reports, ordinances, etc.	Contents Summary (How will this information improve mitigation planning?)	Data Used (How was this information incorporated into this MJHMP?)
		Yakutat (none were provided in the report).
NOAA Shoreline Data Explorer (https://www.ngs.noaa.gov/NSDE/)	Continually Updated Shoreline Product (CUSP) provides the most up-to-date shoreline of the United States and its territories. The national shoreline from the Coastal Mapping Program provides accurate tidal referenced shoreline, aids to navigation, hazards to navigation, and associated cultural and topographic reference data primarily for nautical chart applications. CUSP will only include shoreline and alongshore features that represent shoreline (groin, breakwater, and jetty).	Used interactive tool to analyze what portions of Yakutat's shoreline have been mapped and upcoming projects for further mapping.
5th National Climate Assessment, released November 14, 2023.	Assesses the science of climate change and variability and its impacts across the U.S., now and throughout the century.	Assessment cited several times in hazard sections describing how climate change will influence future conditions.
UAF/SNAP Database	Provides historical data and future projections on climate change impacts, wildfire danger, and other applicable hazards.	Cited several figures and other data in hazard profiles.
October 2022 DHS&EM Disaster Cost Index	Provides details for historic statewide disasters.	Incorporated relevant disaster descriptions in each applicable hazard profile to strengthen the hazard history, extent, and impact sections.

A complete list of references in provided in Section **Error! Reference source not found.**.

3. RISK ASSESSMENT

This section identifies and profiles the hazards that could affect Yakutat.

This section addresses a portion of Element B of the Local and Tribal Mitigation Plans regulation checklists.

Regulation Checklist- 44 CFR § 201.6 Local Mitigation Plans
ELEMENT B. Risk Assessment
B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the jurisdiction? Does the plan also include information on previous occurrences of hazard events and on the probability of future hazard events? (Requirement 44 CFR § 201.6(c)(2)(i)) B1-a. Does the plan describe all natural hazards that can affect the jurisdiction(s) in the planning area, and does it provide the rationale if omitting any natural hazards that are commonly recognized to affect the jurisdiction(s) in the planning area? B1-b. Does the plan include information on the location of each identified hazard? B1-c. Does the plan describe the extent for each identified hazard? B1-d. Does the plan include the history of previous hazard events for each identified hazard? B1-e. Does the plan include the probability of future events for each identified hazard? Does the plan describe the effects of 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? B1-f. For participating jurisdictions in a multi-jurisdictional plan, does the plan describe any hazards that are unique to and/or vary from those affecting the overall planning area?
Source: FEMA 2022 (Local)

Regulation Checklist- 44 CFR § 201.7 Tribal Mitigation Plans
ELEMENT B. Hazard Identification and Risk Assessment
B1. Does the plan include a description of the type, location, and extent of all natural hazards that can affect the tribal planning area? [44 CFR § 201.7(c)(2)(i)] B2. Does the plan include information on previous occurrences of hazard events and on the probability of future hazard events for the tribal planning area? [44 CFR § 201.7(c)(2)(i)] B3. Does the plan include a description of each identified hazard's impact of the tribal planning area? [44 CFR §201.7(c)(2)(ii)]
Source: FEMA 2017 (Tribal)

3.1 OVERVIEW

Hazard identification is the process of recognizing any natural events that may threaten an area. Natural hazards result from uncontrollable or unexpected natural events of sufficient magnitude. This plan does not take in account any man-made, technological, or terrorism related hazards. Historical hazards are noted, but all natural hazards that have the potential to affect the study area must be considered. Any hazards that are determined to be unlikely to occur or cause little to no damage, are eliminated from consideration.

A hazard analysis includes the identification, screening, and profiling of each hazard.

Hazard profiling entails describing hazards in terms of their nature, history, location, magnitude, frequency, extent, and probability. Hazards are identified through historical and anecdotal information collected by members of the community, previous mitigation plans, studies, and study area hazard map preparations/reviews, when appropriate. Hazard maps are then used to define the geographic extent of a hazard, as well as define the approximate boundaries of the risk area.

3.2 HAZARD IDENTIFICATION AND SCREENING

On August 9, 2023, the Planning Team reviewed and updated the possible hazards from the existing MJHMP that could affect the area. The Planning Team then evaluated and screened the comprehensive list of potential hazards. They took into consideration a range of factors including prior knowledge of the hazard and the relative risk presented by each hazard, their ability to mitigate the hazard, and the known or expected availability of information on the hazard (Table 3-1).

The Planning Team determined that eight hazards pose a threat to Yakutat: earthquake, severe weather, wildland and community fire, ground failure (landslide), tsunami, flood, erosion, and changes in the cryosphere. To meet updated FEMA guidelines, the Planning Team decided to discuss the influence of climate change within each individual hazard.

The City and Borough of Yakutat and the Yakutat Tlingit Tribe are located in the same geographic area (Figure 1-5) and thus experience the same vulnerability to hazards.

The assets at risk of the identified hazards, both within and outside of the planning area, are identified in Section 3.4.6.

Table 3-1 Identification and Screening of Hazards

Hazard Type	Updated from 2019 HMP or New Hazard?	Explanation
Earthquake	Updated	Many of the prominent faults in the Yakutat region are thought to be active. An active fault, in general, is considered to be a type of fault along which continuous or intermittent movement is taking place; motion may be abrupt or, in some cases, may be very slow. The active fault nearest to Yakutat on which historic surface displacements have been measured is the Fairweather fault, whose closest segment is about 33 miles to the northeast. From the historic record of earthquakes, other active faults, including those that moved during the September 1899 earthquakes, are inferred to exist, but they have not as yet been located and possibly either have not ruptured the surface or are concealed by glaciers or large bodies of water. There are numerous major fault zones that are close to Yakutat including the Fairweather fault, Boundary fault, Yakutat fault, Esker Creek fault, and the Bancas Pt. fault. Since the 2019 HMP was adopted, there have been 3 earthquakes, M5.0 or greater, within 100 miles of Yakutat.
Severe Weather (Cold, Drought, Rain, Snow, Wind, etc.)	Updated	Yakutat experiences severe weather events such as the following: extreme cold, freezing rain/ice storms, heavy and drifting snow, winter storms, heavy rain, atmospheric rivers, high winds, and droughts. The coldest month of the year at Yakutat Airport is January, with an average low of 25°F and high of 35°F. The coldest recorded temperature in Yakutat was -22ºF in January 1947. Atmospheric rivers impact SE Alaska quite often. On December 1, 2020, an atmospheric river event impacted SE Alaska and broke daily rainfall records in many communities. The Planning Team states that Yakutat experienced 7 atmospheric rivers events from September-December 2022. Wind gusts of 71 mph have been recorded in Yakutat. Yakutat experiences severe storm conditions accumulating over 10-20 inches of snowfall within several hours. In January 2022, CBY declared a local disaster emergency as exceptionally heavy snow, rain and ice piled atop critical buildings and infrastructure. This “very unusual” event resulted in over 6 feet of snow after a rare cold snap (ADN 2022). The town’s newly completed Yakutat Clinic Health Center was forced to close as 4 to 5 feet of heavy snow caused an estimated millions of dollars in water damage to the building and equipment (ADN 2022). Damages included: a carport at the City’s public safety building collapsed into a trailer set up for emergency management, a broken pipe flooded the community’s Head Start building, local crews scrambled to clear snow off the roof of the elementary school and gym. The borough-owned fish processing facility, power plant, as well as stores and private residences, were also in danger of roof collapse and damages (ADN 2022). To aid in snow removal, the CBY hired 10 people on top of their usual 4 to help clear snow from buildings and raised the hourly rate of pay by 50%. This additional help was still not enough capacity to meet the community’s need. The CBY declared a local disaster

Table 3-1 Identification and Screening of Hazards

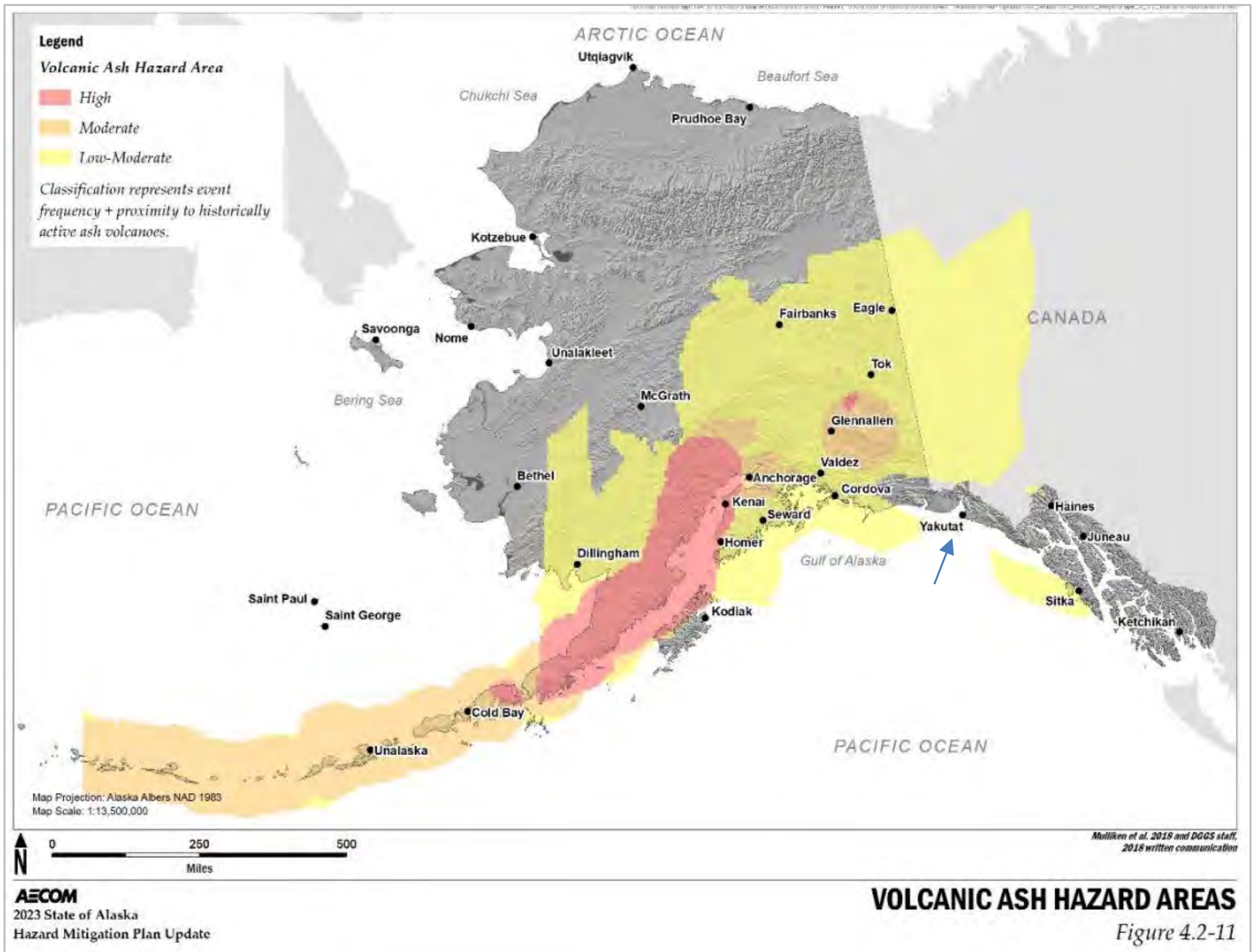
Hazard Type	Updated from 2019 HMP or New Hazard?	Explanation
		and the State sent in the Alaska National Guard to provide emergency snow removal and building safety assessment to the community. Since the 2019 HMP was adopted, there have been 28 severe weather events in Yakutat
Wildland and Community Fire	Updated	Yakutat is located in the EC7 Level II Ecoregion which is classified as Coastal Rainforests. This area is normally quite wet, but fires can occur in the Panhandle under dry conditions, which may become more frequent due to climate change (BLM 2020). According to the Alaska Interagency Coordination Center (AICC), 9 wildland fires have occurred within 100 miles of Yakutat in an 83-year period (1939-2022). The largest fire burned 7.2 acres in May 2020. In 2019, an ATV with firefighting equipment was added to the Situk River Estuary Camp at Strawberry Point. Twice in recent years, grass has caught on fire there, and the fires have been contained quickly before a forest fire could start. Since the 2019 HMP, there have been 2 wildland fire events within 100 miles of Yakutat. In 2016, a Yakutat resident was killed in a house fire likely as a result of unattended cooking (ADN 2016). The Alaska State Fire Marshal's office records fatalities due to community fires, and there have been 0 fatalities in Yakutat from structure fires between 2018-2022.
Ground Failure (Landslide)	Updated- snow avalanche moved to Cryosphere profile	Underwater landslides in Yakutat Bay and Monti Bay were recorded following earthquakes in 1899, 1958, and 1964. During September 1899, the Yakutat Bay region was shaken by a series of major earthquakes (M8.2, M8.5, M8.6), the most violent of which were felt at all settlements within a radius of 249 miles. Several heavy shocks occurred on September 4 and 10, but the main earthquake that caused great topographic changes occurred at 21:41 UTC, September 10, 1899. A USGS team did not study the region until six years after the shocks, but the topographic changes were obvious. The ground failure impacts included a maximum uplift of 47.6 ft that occurred on the west coast of Disenchantment Bay, and changes of 16.4 ft or more affected a large area. Subsidence of as much as 6.6 ft was observed in a few areas. Since the 2019 HMP was adopted, there have been 0 documented landslides in Yakutat.
Tsunami	Updated	Yakutat has not been impacted by a damaging tsunami in recent history; however, historical tsunamis have resulted in wave runup and deaths in Yakutat. In 1958, a M7.8-8.3 earthquake 100 miles SE of Yakutat triggered a landslide in Lituya Bay, which then triggered a megatsunami that caused a surge wave of over 1,700 feet and resulted in 5 deaths in Yakutat. On October 17, 2015, 180 million tons of rock slid into Taan Fiord, an arm of Icy Bay, generating a tsunami that stripped forest from 8 square miles of Wrangell St.-Elias National Park and Preserve and reached as high as 633 feet (193 m) above the fjord, the fourth-highest tsunami ever recorded. Yakutat is one of Alaska's coastal communities with completed tsunami inundation mapping. Yakutat is a NOAA recognized TsunamiReady Community and StormReady Community, which means that Yakutat has taken the proactive step of participation, which may potentially lessen the damage to the community and reduce the risk to area residents and visitors during an event. Since the 2019 HMP was adopted, there was 1 tsunami event that affected Yakutat. The 8.2 Chignik earthquake induced a small tsunami that resulted in 0.11 meters of runup in Yakutat, but no damages or injuries were reported.
Flood	Updated	Coastal flooding and glacial outburst flooding are hazards in Yakutat. In late May or early June 2002, the Hubbard Glacier pushed a moraine across the seaward entrance to Russell Fiord and began to restrict the tidal exchange between Disenchantment Bay and Russell Fiord. By early June, the moraine formed Russell Lake.

Table 3-1 Identification and Screening of Hazards

Hazard Type	Updated from 2019 HMP or New Hazard?	Explanation
		The Denali Commission 2019 Statewide Threat Assessment provides statewide risk ratings for flooding. Yakutat is located in Group 1, which are the communities that are most threatened by flooding. Most communities in Group 1 are located along Yukon and Kuskokwim rivers, or along the coast which may flood due to storm surges (Denali Commission 2019). Out of the communities assessed in Southeast, Yakutat was the only one that was placed into Group 1. Since the 2019 HMP, there have been 0 flooding events in Yakutat.
Erosion	Updated- given its own hazard profile.	Yakutat experiences coastal erosion and soil erosion from logging. Erosion from logging is discussed in this MJHMP Update for the first time. Since the 2019 HMP, erosion has occurred along Max Italio Dr., Forest Hwy No. 10, and around the community due to logging.
Changes in the Cryosphere	Updated	Glaciers, permafrost and periglacial, and snow avalanche hazards occur in the Planning Area, outside of the populated areas of Yakutat. In 1986 and 2002, the advance of the Hubbard Glacier blocked the northern of the Russell Fiord from Yakutat Bay, temporarily creating Russell Lake. Subsequent failure of the ice or moraine dams in 1986 and 2002, respectively, produced the two largest glacial outburst floods in historic times. Both of these dams failed before the lake had risen to an elevation that would have caused it to spill over the terminal moraine at the southern end of Russell Fiord into the Situk River drainage (Gubernick and Paustian 2007). Since the 2019 HMP, there have been 0 cryosphere hazard events that impacted Yakutat, but ongoing monitoring of surrounding glaciers have shown what glaciers surrounding Yakutat are melting.
Climate Change	New- influence incorporated into each hazard	Updated FEMA guidelines require that the influence of climate change is discussed as it pertains to each hazard; therefore, climate change is addressed in this MJHMP Update. The Planning Team chose to incorporate the influence of climate change into each hazard rather than profiling it as a standalone hazard. In Yakutat, sea level is falling. In the Gulf of Alaska, global sea level rise is being offset because the land is rebounding as the last remnants of ice-age glaciers disappear. Global sea level is rising, but the land is rising faster, so sea level is falling relative to a fixed local benchmark (NOAA 2021). In Yakutat, fall rainfall may increase by 31% in the next century (UAF/SNAP 2023a). Yakutat averages 155 inches of rainfall per year, which is some of the heaviest precipitation in the state. In Yakutat, average annual temperatures may increase by about 9°F by the end of the century (UAF/SNAP 2023a). Summer temperatures are increasing the most (+11°F) and spring may transition from below freezing to above freezing temperatures in the future (UAF/SNAP 2023a).

3.2.1 HAZARDS NOT PROFILED IN THIS MJHMP UPDATE

- **Volcano:** The 2023 State of Alaska SHMP identifies volcanic ash hazard areas across the state. (Figure 3-1). Volcanic ash does not pose a threat to the Planning Area. Yakutat may be indirectly impacted by a future volcanic eruption as travel/supplies may be delayed from Anchorage or Seattle if planes are not permitted to travel due to ash or other volcanic hazards.



Source: 2023 Alaska SHMP

Figure 3-1 Statewide Volcanic Ash Hazard Areas

3.3 HAZARD PROFILES

The specific hazards selected by the Planning Team for profiling have been examined based on the following factors:

- Nature (type)
- History (previous occurrences)
- Location (hazard areas)
- Extent (includes magnitude and severity)
- Impact (provides general impacts associated with each hazard)
- Probability of Future Events (likelihood of hazard occurring)
- Future Conditions Including Climate Change (how climate change is influencing the hazard)

Each hazard is assigned a rating based on the following criteria for magnitude/severity (Table 3-2) and probability of future events (Table 3-3). Estimating magnitude and severity are determined based on historic events using the criteria identified in the following tables.

Table 3-2 Hazard Magnitude/Severity Criteria

Magnitude / Severity	Criteria
Catastrophic	• Multiple deaths. • Complete shutdown of facilities for 30 or more days. • More than 50 percent (%) of property is severely damaged.
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.
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.
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 3-3 Hazard Probability of Future Events Criteria

Probability	Criteria
Highly Likely	• Event is probable within the calendar year. • Event has up to 1 in 1 year chance of occurring (1/1=100%). • History of events is greater than 33% likely per year.
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.
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.
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.

The hazards profiled for the City and Borough of Yakutat are presented throughout the remainder of this section. The presentation order does not signify their importance or risk level.

3.3.0 CLIMATE CHANGE

To meet updated FEMA guidelines, the Planning Team decided to incorporate the influence of climate change into each individual hazard rather than profile it as standalone hazard. General background information regarding climate change in Alaska, with emphasis on Southeast Alaska, is described below.

Nature

Climate change is the long-term variation in Earth's average weather patterns and atmospheric composition. These variations may be natural, but since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil, and gas) which produce heat-trapping gases. These gases act as a blanket over the Earth, and with more gases, the thicker the blanket, the warmer the earth. Trees and other plants are not able to absorb the excess carbon dioxide in the atmosphere, and this excess carbon dioxide changes precipitation and temperature patterns (NASA 2020). These changes in precipitation patterns lead to increasing frequency and intensity of storms and floods, wildfires, and substantial changes in flora, fauna, fish, and wildlife habitats.

For the past million years the natural climate has oscillated between warm periods and ice ages. This shifting in and out of warm periods and ice ages is correlated strongly with Milankovitch cycles. These cycles affect the amount of sunlight and therefore energy that Earth absorbs from the Sun (NASA 2020). They provide a strong framework for understanding long-term changes in Earth's climate, but Milankovitch cycles can't explain all climate change that's occurred over the past 2.5 million years (NASA 2020). Milankovitch cycles cannot account for the current period of rapid warming Earth has experienced since the pre-Industrial period (years 1850-1900), and particularly since the mid-20th Century. Earth's recent and continual warming is primarily due to human activities- specifically, the direct input of carbon dioxide into Earth's atmosphere from burning fossil fuels. This is significant because hazard mitigation planning relies greatly upon the historical record.

As noted in the 5th National Climate Assessment (USGCRP 2023), released in November 2023, some changes Alaska has seen from climate change include:

> Loss of sea ice, thawing permafrost, and other climate-driven changes in Alaska are transforming ecosystems, disrupting cultural practices, harming fisheries and other livelihoods, exacerbating health disparities, and placing infrastructure at risk. Rapid climate changes also threaten national security. Adaptation efforts are underway across the state, but their effectiveness will depend on substantial investment and capacity building in the communities most at risk. (USGCRP 2023)

Location

Alaska is warming two to three times faster than the global average. The physical and ecological effects of warming are evident around the state- glaciers are shrinking, permafrost is thawing, and sea ice is diminishing. The growing season is longer, and fish, mammals, birds, and insects have increased in numbers in some areas and dropped sharply in others. This combination of environmental effects has far-reaching consequences for people statewide. (USGCRP 2023)

A study by Lader et al. (2020), discusses how climate change is impacting the Southeast Alaska region:

> *"Southeast Alaska is a climatologically diverse region that is experiencing unprecedented changes due to recent warming. It is located in a transition zone between the Arctic and the extra tropics, dominated primarily by temperate coastal rain forest and expansive alpine glaciers. A 64-yr analysis from 1949 to 2012 found that temperatures in this region had risen 1.8°–2.52°F with significant increases in winter and spring.*
>
> *The Gulf of Alaska regulates the climate of southeast Alaska, and it has also experienced multiple record high temperatures within the past five years. Several studies have shown that anthropogenic warming increased the likelihood of the 2016 records of sea surface temperature and ocean heat content. This marine heat wave has further been linked to destructive impacts that propagated through the marine food webs of south coastal Alaska, including harmful algal blooms, lower nutrient density, increased disease, and fish and bird die-offs. Globally 2016 was also the warmest year of record, and although it came at the end of an El Niño, which typically leads to warmer temperatures, the magnitude of the positive global anomaly was found to be only possible when including anthropogenic forcing.*
>
> *Southeast Alaska is prone to extreme multiday precipitation events, resulting from moisture plumes known as atmospheric rivers (ARs), which transport tremendous amounts of moisture northward from the subtropics and central Pacific. Case studies of these Alaska events show they*

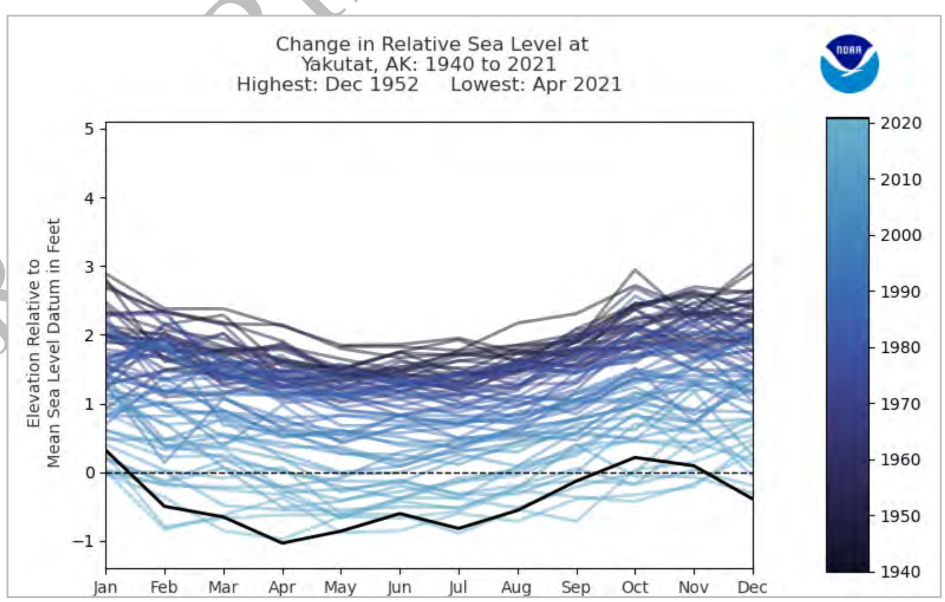
typically occur from autumn through early winter, can produce precipitation amounts exceeding 20 inches, and can cause flooding, landslides, and debris flows, which further lead to deleterious human impacts. ARs in the western United States are associated with 31%–65% of avalanche fatalities in coastal climate zones. Continued warming is expected to increase the total number of ARs that impact the west coast of North America. Trends of annual precipitation across southeast Alaska from 1969 to 2018 show increases ranging from 4.7% to 15.1%.

Given this region's orography and typical abundance of precipitation, a network of hydropower facilities has been established and is used to generate electricity for many communities. However, there are several precipitation-related issues that can jeopardize the reliability of this energy source. Avalanches can disrupt transmission lines, low snowfall amounts reduce the storage buffer that can be used for keeping reservoir levels sufficiently high during spring and summer, and drought can all put the region at risk. In 2019, parts of southeast Alaska experienced their first extreme drought conditions of record as categorized by the U.S. Drought Monitor; these not only limited hydropower activity but also led to the imposition of water restrictions, pest problems, and altered the timing of salmon runs. As temperatures continue to warm and glaciers melt, the timing of precipitation will become more important with the loss of this additional water storage buffer.

Further warming will alter the hydrological cycle by forcing an earlier peak runoff, and limited storage capacity will lead to the loss of excess runoff. This could necessitate a trade-off decision being made to either release water to support salmon runs or to generate electricity from hydropower to meet peak demand."

Global sea level has risen between 6 and 8 inches (15-20 cm) over the last 100 years (NOAA 2021). About one third of the increase is due to the thermal expansion of ocean water as it has gotten warmer, and about two-thirds is due to meltwater flowing back to the ocean as glaciers and ice sheets on land melt.

However, **in Yakutat, sea level is falling.** In the Gulf of Alaska, global sea level rise is being offset because the land is rebounding as the last remnants of ice-age glaciers disappear. Global sea level is rising, but the land is rising faster, so sea level is falling relative to a fixed local benchmark (NOAA 2021). Figure 3-2 depicts the sea level in Yakutat from 1940 to 2021. In those 81 years, the highest sea level was recorded in December 1952 and the lowest was recorded in April 2021.



Source: NOAA 2021

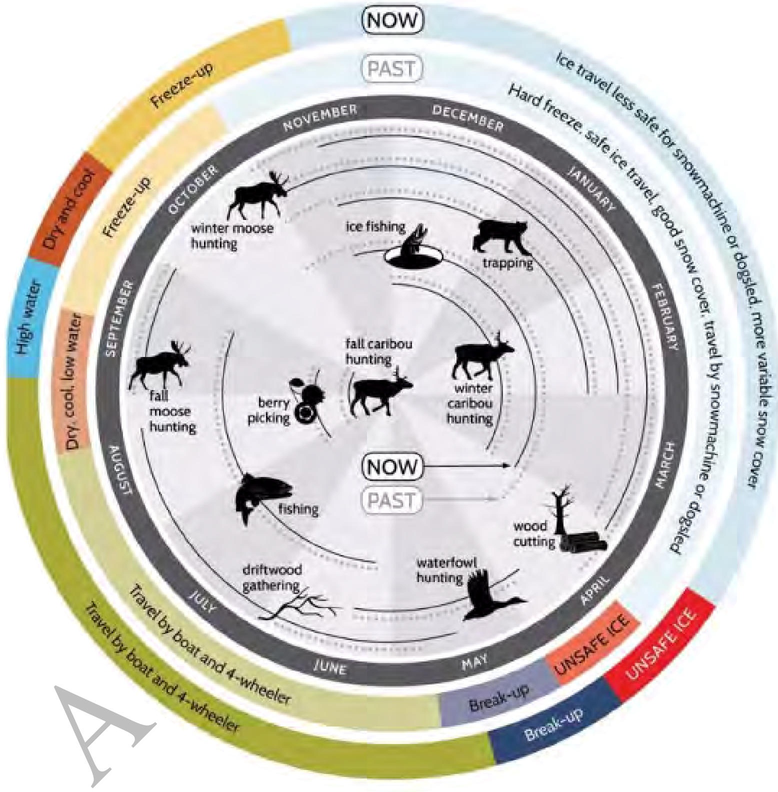
Figure 3-2 Change in Relative Sea Level in Yakutat (1940-2021)

Climate change in Alaska is driven by global trends, but regional impacts are evident. The entire Yakutat Planning Area is vulnerable to climate change.

Impact

Climate change in Alaska is causing widespread environmental change that is damaging critical infrastructure, especially in coastal communities. As climate change continues, infrastructure may become more vulnerable to damage, increasing risks to residents and resulting in large economic impacts (Melvin et al. 2016).

Alaska Native communities face an estimated $4.8 billion (in 2022 dollars) in costs to infrastructure from environmental threats over the next 50 years (USGCRP 2023). These costs may be significantly underestimated due to limitations in current model-based approaches, as well as to the omission of dispersed but culturally vital infrastructure such as fish camps. The costs of responding to climate change are unevenly distributed, with rural areas facing greater costs and few benefits, in contrast to urban areas that will realize some benefits such as reduced heating expenses and where the costs of infrastructure maintenance will be spread over a much larger population base (USGCRP 2023).



Source: Steffen et al. 2021

Figure 3-3 How Climate Change is Affecting the Timing of Traditional Subsistence Activities

Communities dealing with flooding, erosion, and permafrost degradation are responding immediately as well as planning long-term adaptations, which generally include a combination of protection of infrastructure in place, raising buildings out of the floodplain or moving them out of vulnerable areas, and entire community relocation (USGCRP 2023).

Many jobs in Alaska are affected directly or indirectly by climate change- through alterations in abundance and distribution of fish species, through changes in access to lands and waters dominated by permafrost and ice, and through the cascading effects of a changing economy (USGCRP 2023). Sustaining healthy livelihoods and ways of life in Alaska involves more than wages and salaries. Traditional cultural practices outside the cash economy include the harvest and sharing of fish, wildlife, and berries. Climate-driven changes to lands and waters, along with societal trends such as greater adoption of mainstream food practices, can reduce opportunities for subsistence harvests and thus affect cultural, nutritional, and spiritual well-being, especially for Alaska Native communities (USGCRP 2023).

Climate change is impacting food security in Alaska, especially that of Indigenous Alaskans who rely on subsistence hunting, fishing, and gathering. Observed greening of tundra biomes and browning of boreal forest biomes is affecting the abundance and distribution of animals such as reindeer and salmon, reducing available harvests of these important subsistence species, and is impacting access to and availability of foraging plants (IPCC 2019).

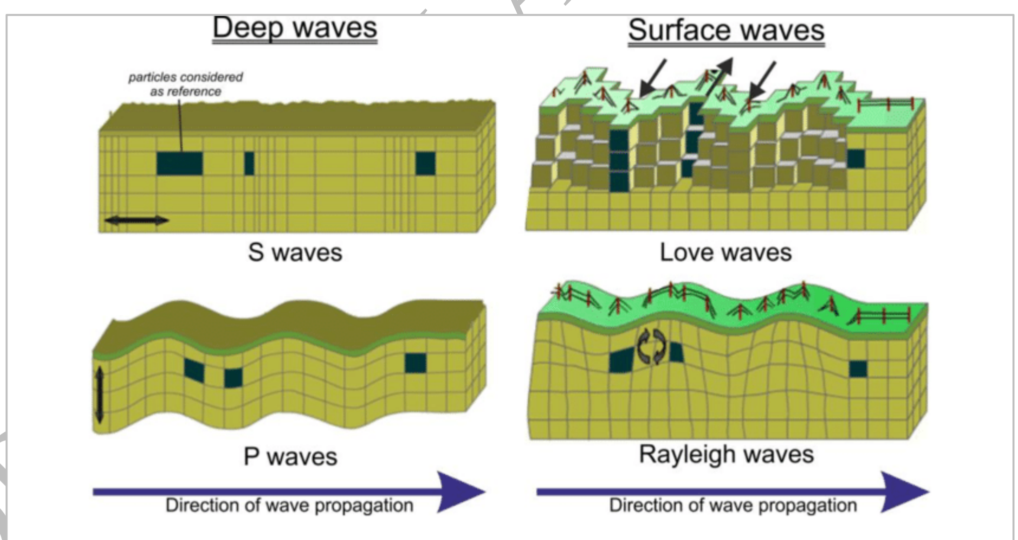
The combined impacts of changes to boreal forest and tundra biomes, ocean acidification, and ocean warming could prove highly disruptive to food security and the economy of Alaska, which relies heavily on subsistence and commercial hunting and fishing. The IPCC's 2019 report concludes that these ecosystem changes will further erode the cultural identities and livelihoods of Indigenous as well as non-Indigenous peoples (IPCC 2019).

3.3.1 EARTHQUAKE

3.3.1.1 Nature

An earthquake can be defined as any shift along the Earth's tectonic plates and faults due to accumulated strain built up by friction which precipitates a sudden movement or trembling of the Earth's crust. This sudden movement can be felt at sometimes very distant sites from the epicentre, and it usually occurs without warning. The movement can build rapidly after just a few seconds and cause significant, sometimes catastrophic, damage and severe numbers of casualties, and this often-violent motion or shaking is the most common effect of earthquakes.

Like sound, the motion of the ground is the strongest near the source and increases in concert with the amount of energy released. It also attenuates with distance, i.e., decreases in force as you travel farther away from the epicentre of the earthquake. An earthquake causes several types of waves both with the Earth's interior (seismic waves) and along the surface of the Earth (surface waves). Two distinct types of seismic waves are produced during an earthquake. Primary waves (P waves) are compressional and longitudinal in nature, and this causes back and forth oscillation in parallel to the direction of travel (the vertical motion). Secondary waves (S or shear waves) are slower in nature than the P waves and cause vibrations that are in the side-to-side plane (horizontal motion). Additionally, there are two types of surface waves: both Rayleigh and Love waves travel more slowly and usually cause considerably less damage than the seismic waves. A visual depiction of each of these waves is shown below (Figure 3-4).



Source: Martinez-Moreno 2015

Figure 3-4 Types of Seismic Waves

Besides the motion and resultant damage, there are also several other hazards which occur due to earthquakes. These are:

Fault Displacement: this is distinct movement on the surface along the two sides of a seismic fault. These displacements can be very considerable in both length and width, i.e., as much as 7 meters vertically and more than 60 kilometers along the rupture line. This type of faulting can cause severe damage to surface structures such as pipelines, roads, railways, and tunnels.

Liquefaction: when granular soil or sediments that is saturated becomes distorted due to the vibrations and surface movements. The empty spaces between the granules can collapse, and water pressure within the pores may increase enough to make the soil/sediments behave more like a fluid during the earthquake causing sometimes serious deformations. Horizontal movements (i.e., lateral spreading) of 5 meters are common but can be as much as 30 meters. Massive flows (i.e., flow failures) that are typically tens to a hundred meters can sometimes extend even to 6-7 kilometers. Liquefaction can also cause a considerable loss of bearing strength, and this can result in structures settling significantly or tipping severely. All of this can result in severe property damage.

Both the intensity and magnitude are considered during the measurement of the severity of earthquakes. The observed level of damage and effects on people, nature, and human structures are variables when describing the intensity. The severity of intensity generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. The scale most often used in the U.S. to measure intensity is the Modified Mercalli Intensity (MMI) Scale.

As shown in Table 3-4, the MMI Scale consists of 10 increasing levels of intensity that range from imperceptible to catastrophic destruction. Peak ground acceleration (PGA) is also used to measure earthquake intensity by quantifying how hard the earth shakes in a given location, or measured as acceleration due to gravity (g). The USGS describes the MMI Scale as:

> *"The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally - total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale.*
>
> *The Modified Mercalli Intensity value assigned to a specific site after an earthquake has a more meaningful measure of severity to the non-scientist than the magnitude because intensity refers to the effects actually experienced at that place."*

The following table is an abbreviated description of the comparisons of earthquake magnitude, intensity, ground-shaking comparisons, perceived shaking, and damage.

Table 3-4 Magnitude/Intensity/Ground-Shaking Comparisons

Magnitude	Intensity	PGA: Acceleration (g)	Perceived Shaking	Damage
1.0-3.0	I	<0.000464	Not felt	None
3.0-3.9	II-III	0.000464 - 0.00297	Weak	None
4.0-4.9	IV	0.00297 - 0.0276	Light	None
	V	0.0276 - 0.115	Moderate	Very light
5.0-5.9	VI	0.115 - 0.215	Strong	Light
	VII	0.215 - 0.401	Very Strong	Moderate
6.0-6.9	VIII	0.401 - 0.747	Severe	Moderate/Heavy
	IX	0.747 - 1.39	Violent	Heavy
7.0+	X+	>1.39	Extreme	Very Heavy

Adapted from: USGS (2008) and Er et al. (2010)

3.3.1.2 History

Reliable data in the seismology of Alaska has been recorded only since 1973 for most locations, and this makes the data relatively young compared to other areas. Obtained for the U.S. Geological Survey (USGS) and the archives of the UAF Geophysical Institute, State of Alaska, the information provided is based on the best-known data. Thorough research was conducted for all events since 1950 (1950-1972 data is less reliable than current data) and up to the present within the earthquake database of the USGS. Since 1900, there have been 180 recorded earthquakes M5.0 and greater within 100 miles of Yakutat.

1899 Yakutat Bay Region Earthquakes

In September 1899, the Yakutat Bay region was shaken by a series of major earthquakes (M8.2, M8.5, M8.6), the most violent of which were felt at all settlements within a radius of 250 miles. Several heavy shocks occurred on September 4 and 10, but the main earthquake that caused great topographic changes occurred at 21:41 Coordinated Universal Time (UTC), September 10, 1899.

A team from USGS did not study the region until six years after the shocks, but the topographic changes were obvious. Dead barnacles and other shellfish were found everywhere, and several uplifted beaches were observed. A maximum uplift of 47 ft occurred on the west coast of Disenchantment Bay, and changes of five meters or more affected a large area (USGS 1912). Subsidence of as much as two meters was observed in a few areas. Phenomena observed included surface faulting, avalanches, and fissures, spouting from sand craterlets, and slight damage to buildings. A destructive tsunami nearly 35 ft in height occurred in Yakutat Bay, and tsunamis also were observed at other places along the Alaskan coast.

The earthquake altered the regimen of glaciers in the area. The shattering of Muir Glacier (150 miles to the SE) started the rapid discharge of icebergs and the later retreat of this and other ice tongues in Glacier Bay. Avalanching resulted in the later advance of at least nine glaciers in Yakutat Bay and perhaps many others in more remote regions. Some severely crevassed glacier fronts, which were found six years later, had taken several years for the fractured parts to reach the sea. The first earthquake on September 10 lasted 90 seconds and was heavier at Yakutat than that of September 4 (00:22 UTC). It was strong enough to throw people off their feet at Disenchantment Bay. The main earthquake on September 10, 1899, was felt over a largely unsettled region; the total felt area is unknown. Prospectors camped on Disenchantment Bay felt over 50 aftershocks on September 10, two of which were strong. Residents at Yakutat village also described as severe two of the many aftershocks observed that day. Ten or more earthquakes were felt in the Coast and Geodetic Survey camp near the Copper River delta, and several of them were violent. Several aftershocks were also felt on September 10 in the Chugach Mountains near Prince William Sound; five were reported about 185 miles to the northeast on the Yukon River; and several were felt to the southeast at Juneau and Skagway. Many large aftershocks occurred in September and the following months (USGS 1912).

1958 Lituya Bay Earthquake

On July 9, 1958, a 7.8-8.3 magnitude earthquake occurred in Lituya Bay, 100 miles southeast of Yakutat. The earthquake was strongly felt in the Yakutat area, with prolonged ground shaking for about 3–4.5 minutes. Several airport facilities and the runway were damaged, but at Yakutat damage to most residential and commercial buildings was slight due to wood-frame type construction. The earthquake was caused by a strike-slip on the Fairweather fault and triggered a landslide of 30 million cubic meters and 90 million tons of rock/land was displaced in the narrow inlet of Lituya Bay. The sudden displacement triggered a megatsunami that was felt throughout the region.

More information on the megatsunami can be found in Section 3.3.5.

1964 Good Friday Earthquake

Alaska's strongest earthquake, and the second largest earthquake in the world, occurred on March 27, 1964, in Prince William Sound and was magnitude M9.2. Similar to most earthquakes in Alaska, this one occurred near the Alaska-Aleutian subduction zone and was felt by many residents throughout the State. This earthquake led to a submarine landslide in Monti Bay near Yakutat, but no damages or injuries were reported. More information on the 1964 landslide can be found in Section 3.3.4.

1979 M7.1 Saint Elias Earthquake

On February 28, 1979, a M7.1 earthquake occurred beneath the Chugach and St. Elias Mountains of southeastern Alaska. A total of 308 aftershocks occurred between February 28 and March 31, 1979, which occurred in a broad zone that extends about 71 miles southeast from the epicenter of the main shock, with the highest rate of activity centering about 31 miles southeast of the epicenter of the main shock. Due to the remote location of the epicenter, there was minimal damage and no casualties reported.

Table 3-5 lists the historical earthquakes M5.0 and greater within 100 miles of Yakutat. The historical earthquake data was pulled from the USGS Earthquake Catalog from January 1, 1900, through April 11, 2023, but the first dataset for this area was from 1908.

Since the 2019 HMP was adopted, there have been 3 earthquakes, M5.0 or greater, within 100 miles of Yakutat.

Table 3-5 Yakutat's Historical Earthquakes (M5.0 and greater within 100 miles of Yakutat)

Date	Latitude	Longitude	Magnitude
05/15/1908	59.626	-141.795	6.7
07/07/1912	63.07	-146.14	7.2
07/07/1920	61.264	-140.898	6.1
04/25/1923	59	-138	5.8
10/24/1927	57.711	-136.485	7.2
11/21/1927	57.403	-137.633	5.6
12/31/1927	57.371	-137.13	6.1
11/27/1928	60.739	-146.166	5.9
08/31/1933	59.152	-139.087	5.5
09/19/1933	59.945	-142.516	5.8
08/10/1941	58.932	-137.9	5.9
02/03/1944	59.868	-137.943	6.2
11/16/1945	58.133	-137.398	6.1
03/09/1952	58.902	-136.942	6.1
06/23/1957	57.881	-137.814	6.0
07/10/1958	58.23	-136.712	7.8
07/13/1958	57.867	-137.375	5.3
08/31/1958	63.147	-144.506	5.9
09/24/1958	59.466	-143.174	6.0
06/17/1963	60.473	-141.025	5.7
06/27/1963	60.429	-140.822	5.5
03/28/1964	60.051	-146.393	5.7
03/28/1964	59.605	-146.323	6.2
03/28/1964	60.679	-144.401	5.4
03/28/1964	60.304	-146.518	5.7
03/28/1964	60.327	-146.666	6.3
03/28/1964	61.54	-146.647	5.1
03/30/1964	59.758	-145.854	6.0
03/30/1964	60.951	-144.584	5.2
04/02/1964	59.76	-144.07	5.0
04/03/1964	59.552	-144.836	5.7
04/04/1964	60.263	-146.65	5.6
04/04/1964	59.34	-145.24	5.1
04/08/1964	60.343	-146.027	5.6
04/09/1964	59.903	-145.226	5.5
04/13/1964	59.462	-142.834	5.8
04/20/1964	60.759	-145.253	5.5
04/30/1964	59.972	-142.555	5.2
05/01/1964	60.291	-146.239	5.7
05/08/1964	60.744	-143.705	5.7

Date	Latitude	Longitude	Magnitude
05/17/1964	59.409	-143.023	5.7
05/29/1964	60.001	-146.624	5.6
06/05/1964	60.295	-145.968	5.5
07/05/1964	60.634	-145.423	5.3
07/11/1964	59.609	-146.304	5.6
10/02/1964	59.569	-144.718	5.5
10/10/1964	60.455	-146.074	5.6
05/01/1965	60.35	-146.176	5.6
06/27/1965	60.281	-141.418	6.5
06/27/1965	60.194	-141.051	5.1
08/11/1965	59.36	-146.08	5.5
09/18/1965	59.38	-145.18	5.3
09/30/1965	59.28	-144.06	6.1
12/23/1965	60.481	-140.766	5.6
08/15/1966	60.316	-146.152	5.6
05/17/1967	60.78	-143.72	5.2
11/27/1967	60.196	-140.941	5.2
05/18/1969	60.301	-146.038	5.7
07/27/1969	59.266	-145.401	5.7
12/22/1969	61.592	-140.176	5.2
02/24/1970	59.51	-143.636	6.2
04/11/1970	59.61	-142.594	5.8
04/16/1970	59.702	-142.683	6.7
04/19/1970	59.571	-142.807	5.7
08/18/1970	60.538	-145.537	6.1
09/06/1970	60.095	-141.209	5.1
03/26/1971	60.2	-141.059	5.6
06/10/1972	61.507	-140.266	5.4
09/29/1972	60.172	-141.116	5.2
01/09/1973	60.311	-145.996	5.1
07/01/1973	57.84	-137.33	6.7
07/01/1973	57.78	-137.286	5.2
07/03/1973	57.98	-138.021	6.0
07/03/1973	57.993	-137.884	5.1
07/05/1973	57.905	-137.902	5.4
07/14/1973	58	-138.003	5.0
05/27/1974	60.328	-146.016	5.7
02/28/1979	60.642	-141.593	7.1
03/01/1979	60.628	-141.235	5.4
03/02/1979	60.365	-140.704	5.4
04/20/1979	60.315	-140.872	5.3
06/30/1980	60.01	-141.047	5.0
09/04/1980	59.534	-143.885	5.4
05/02/1982	60.119	-141.18	5.1
05/03/1982	60.117	-141.115	5.0
03/30/1983	61.547	-140.094	5.4
06/28/1983	60.219	-141.287	5.9
07/15/1983	60.299	-140.872	5.1
04/12/1984	60.471	-141.229	5.0
09/20/1984	60.322	-146.001	5.5
09/20/1984	60.306	-146.098	5.1
01/09/1985	60.289	-140.744	5.7

Date	Latitude	Longitude	Magnitude
09/15/1985	59.102	-136.423	5.9
11/14/1987	58.961	-135.241	5.0
11/17/1987	58.586	-143.27	6.9
11/17/1987	58.608	-143.096	5.5
11/18/1987	58.597	-143.781	5.4
11/18/1987	58.696	-143.398	5.0
11/18/1987	58.642	-143.19	5.8
11/23/1987	61.616	-141.323	5.5
11/30/1987	58.679	-142.786	7.9
11/30/1987	58.239	-142.742	5.9
11/30/1987	58.124	-142.911	5.3
12/01/1987	57.953	-142.611	5.8
12/02/1987	58.921	-142.888	5.4
12/02/1987	58.52	-142.76	5.2
12/03/1987	58.514	-142.664	5.4
12/15/1987	58.985	-142.774	5.5
03/06/1988	56.953	-143.032	7.8
03/06/1988	57.499	-142.803	6.2
03/10/1988	59.1057	-144.274	5.3
03/15/1988	57.037	-142.898	5.1
03/29/1988	57.278	-143.051	5.0
04/13/1988	57.026	-143.303	5.2
04/26/1988	57.534	-143.073	5.8
06/06/1988	58.9828	-137.525	5.2
03/17/1989	60.3445	-140.649	5.0
04/08/1989	57.064	-143.49	5.1
08/06/1989	59.9935	-140.896	5.3
02/25/1990	58.556	-142.773	5.1
07/11/1990	59.325	-136.47	5.5
06/24/1991	58.345	-136.859	5.6
09/14/1991	61.384	-140.005	5.0
08/07/1992	57.589	-142.846	6.9
09/17/1992	60.0388	-140.551	5.4
07/27/1993	59.3795	-144.709	5.1
06/06/1995	60.2587	-146.419	5.3
06/12/1995	60.953	-138.42	5.1
01/30/1997	59.21	-144.961	5.0
05/27/1999	59.3663	-139.038	5.6
01/06/2000	58.04	-136.87	6.1
02/27/2000	60.2025	-145.922	5.0
03/01/2000	60.1896	-145.901	5.4
05/02/2000	59.5979	-139.723	5.3
09/30/2000	57.502	-142.837	5.3
11/04/2000	58.6499	-139.13	5.2
06/26/2001	61.34	-140.07	5.7
11/03/2002	63.0484	-144.613	5.4
11/03/2002	63.2926	-145.712	5.6
11/03/2002	63.255	-145.52	5.4
11/03/2002	62.9312	-143.706	5.1
11/04/2002	63.1749	-144.804	5.2
11/04/2002	63.201	-144.759	5.1
11/04/2002	62.9884	-144.062	5.0

Date	Latitude	Longitude	Magnitude
11/05/2002	63.2642	-145.21	5.0
11/08/2002	62.2332	-141.823	5.0
11/08/2002	62.5589	-142.944	5.0
11/08/2002	62.8584	-143.455	5.1
01/24/2003	63.2663	-145.135	5.1
04/29/2004	61.44	-140.37	5.3
08/25/2004	61.588	-146.416	5.1
02/11/2005	60.104	-139.343	5.4
02/11/2005	60.11	-139.348	5.0
01/09/2007	59.42	-137.118	5.7
10/08/2008	60.718	-143.722	5.2
03/27/2009	61.012	-138.414	5.0
06/07/2009	58.7695	-136.658	5.0
07/25/2009	59.2961	-143.665	5.6
06/16/2010	58.0335	-139.375	5.0
11/12/2012	57.792	-142.855	6.3
06/04/2014	58.9804	-136.728	5.2
06/05/2014	61.1822	-140.255	5.1
06/05/2014	61.1732	-140.279	5.1
07/17/2014	60.2995	-140.337	6.0
07/20/2014	60.3235	-140.308	5.0
07/25/2014	58.3354	-136.971	6.0
08/27/2014	59.2244	-145.594	5.1
02/13/2017	62.512	-142.748	5.3
05/01/2017	59.8209	-136.711	6.2
05/01/2017	59.878	-136.838	5.0
05/01/2017	59.8295	-136.704	6.3
05/01/2017	59.7772	-136.629	5.6
05/01/2017	59.7689	-136.682	5.7
05/01/2017	59.7953	-136.648	5.0
09/16/2017	59.8659	-136.794	5.0
09/01/2019	59.1033	-136.973	5.0
09/10/2019	57.0194	-139.529	5.7
12/18/2019	58.5347	-137.698	5.1
01/08/2022	60.3899	-140.533	5.2
09/29/2022	60.2235	-141.194	5.0

Source: USGS 2023a

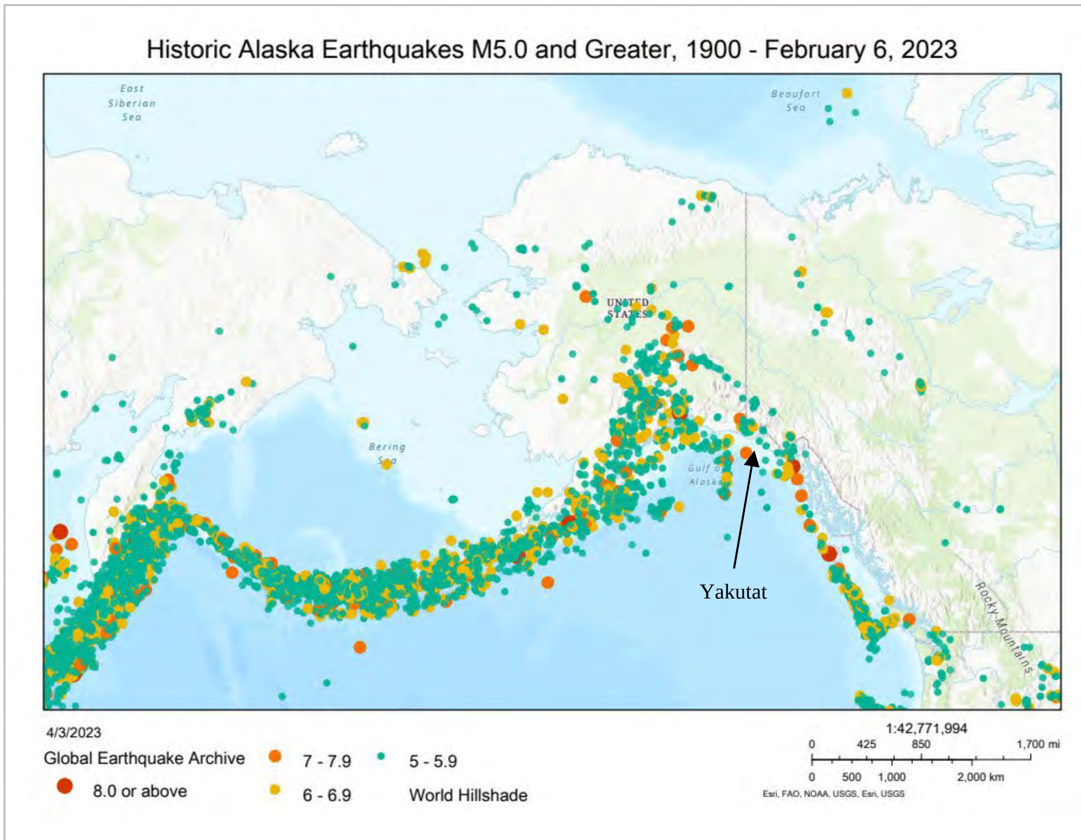
Additionally, the October 2022 DHS&EM Disaster Cost Index (DCI) provides historical earthquake disaster declarations that may have impacted Yakutat. The index lists the following events:

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, 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.

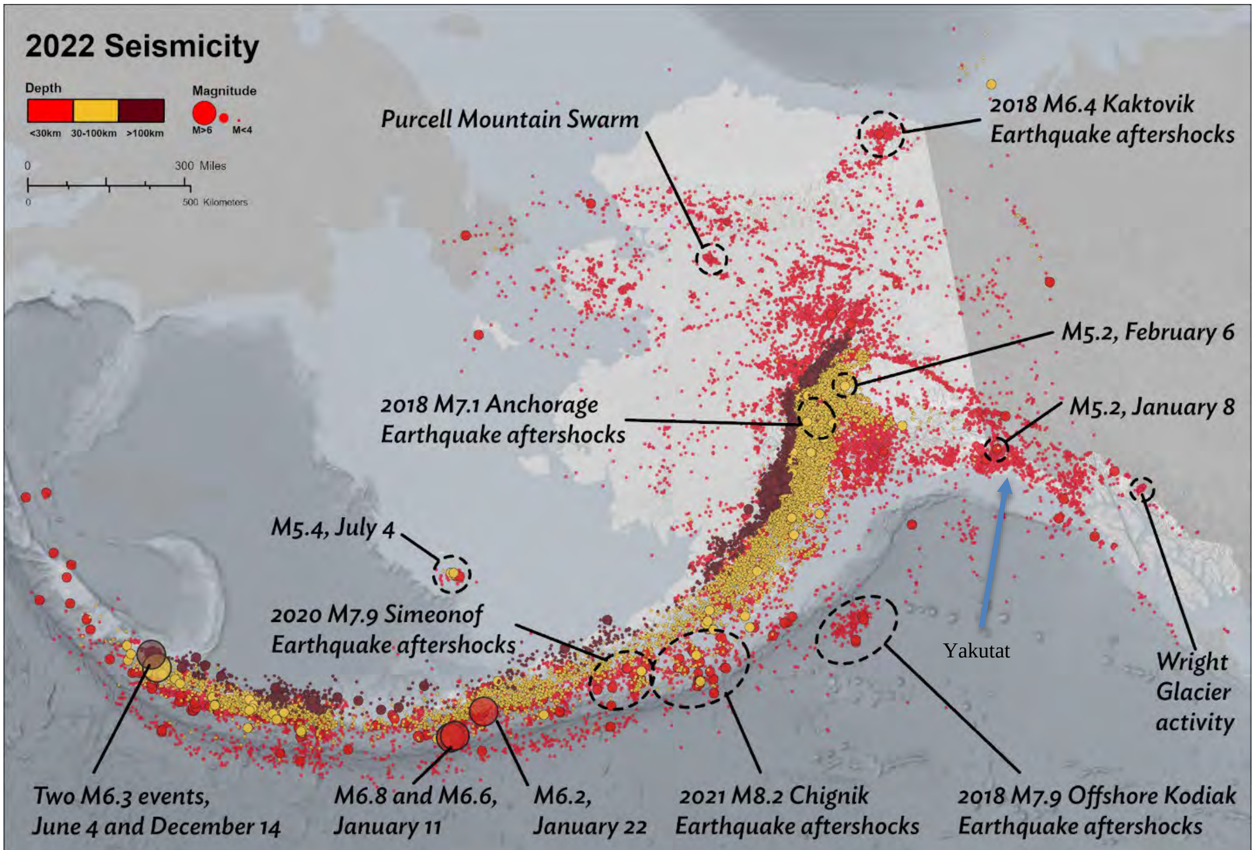
Figure 3-5 shows historical earthquakes from 1900- February 6, 2023, M5.0 and greater statewide.



Source: Global Earthquake Archive, Accessed 4/3/2023

Figure 3-5 Historical Alaska Earthquakes Greater than M5.0, 1900- February 6, 2023

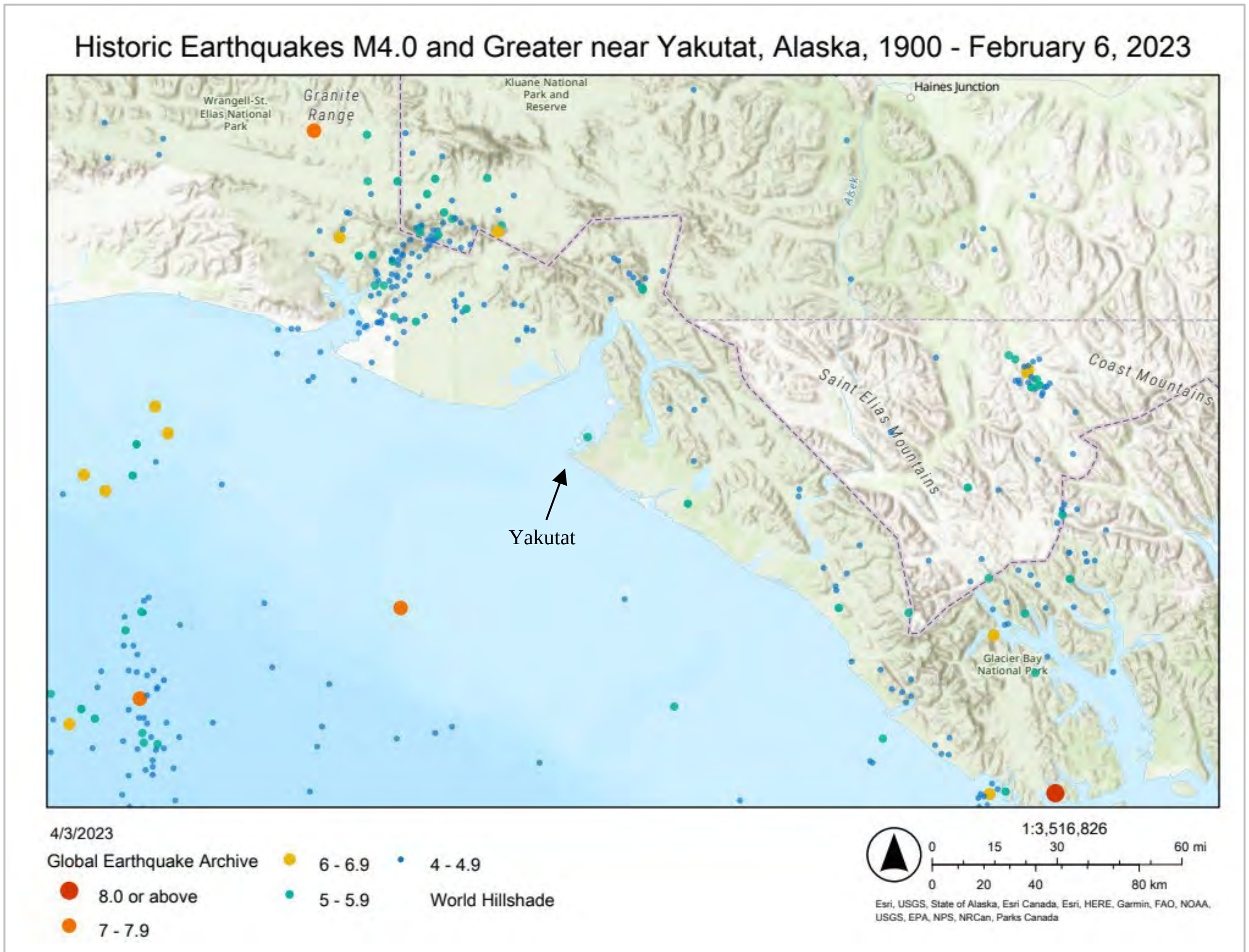
Figure 3-6 depicts one year of earthquake activity in Alaska during 2022. The Alaska Earthquake Center (AEC) states that "Alaska had a relatively quiet 2022 as far as earthquakes go" (AEC 2023). Statewide, there were an average 902 reported earthquakes per week, mostly occurring in the Aleutians (AEC 2023).



Source: AEC 2023- (Note, there is a lack of seismometers deployed in the northern portion of the state.)

Figure 3-6 Map of Alaska's Recorded Earthquakes in 2022

Figure 3-7 depicts historical earthquakes M4.0 and greater within ~100 miles of Yakutat.



Source: Global Earthquake Archive, Accessed 4/3/2023

Figure 3-7 Historical Earthquakes M4.0 and Greater Within 100 miles of Yakutat

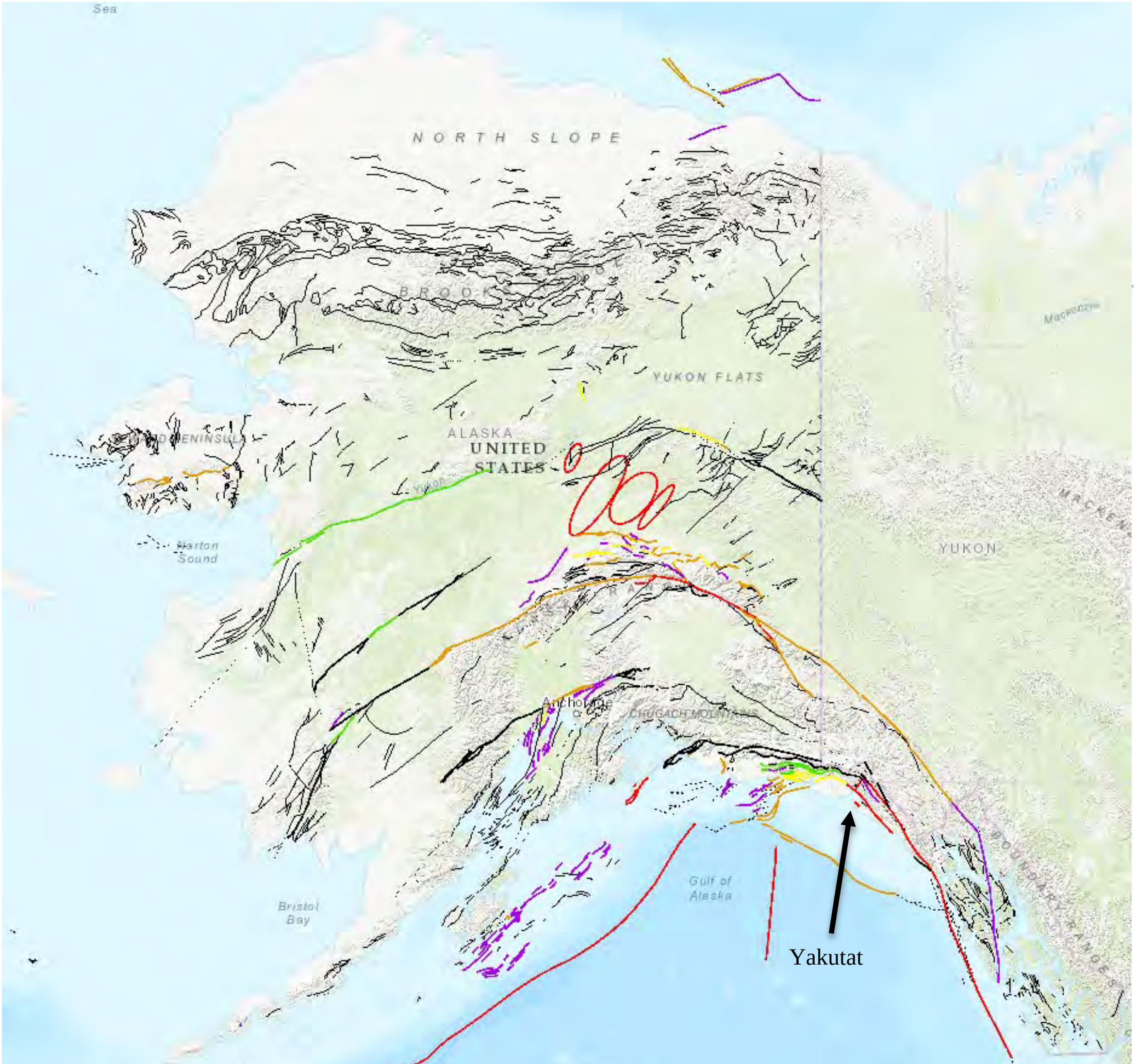
Within ~100 miles of Yakutat, the largest earthquake occurred on November 30, 1987, and measured 7.9 in magnitude, but there was no recorded damage to any infrastructure including critical, residential, and non-residential facilities in Yakutat.

3.3.1.3 Location

Many of the prominent faults in the Yakutat region are thought to be active. An active fault, in general, is considered to be a type of fault along which continuous or intermittent movement is taking place; motion may be abrupt or, in some cases, may be very slow. The active fault nearest to Yakutat on which historic surface displacements have been measured is the Fairweather fault, whose closest segment is about 33 miles to the northeast. From the historic record of earthquakes, other active faults, including those that moved during the September 1899 earthquakes, are inferred to exist, but they have not as yet been located and possibly either have not ruptured the surface or are concealed by glaciers or large bodies of water.

In southeastern Alaska, plate motion is accommodated along the Fairweather fault, a transform fault that extends primarily offshore along the entire southeastern Alaska coastline, becoming the Queen Charlotte fault to the south in British Columbia (DGGS 2016).

Figure 3-8 shows Alaska's earthquake faults and folds. The accompanying legend is below.



Source: DGGS Quaternary Fault and Folds Database (2013)

Figure 3-8 Alaska's Faults and Folds

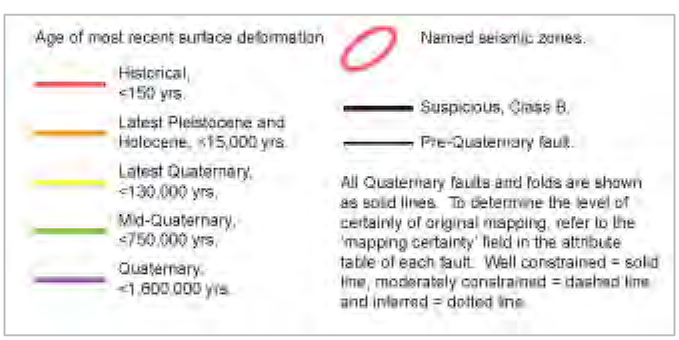
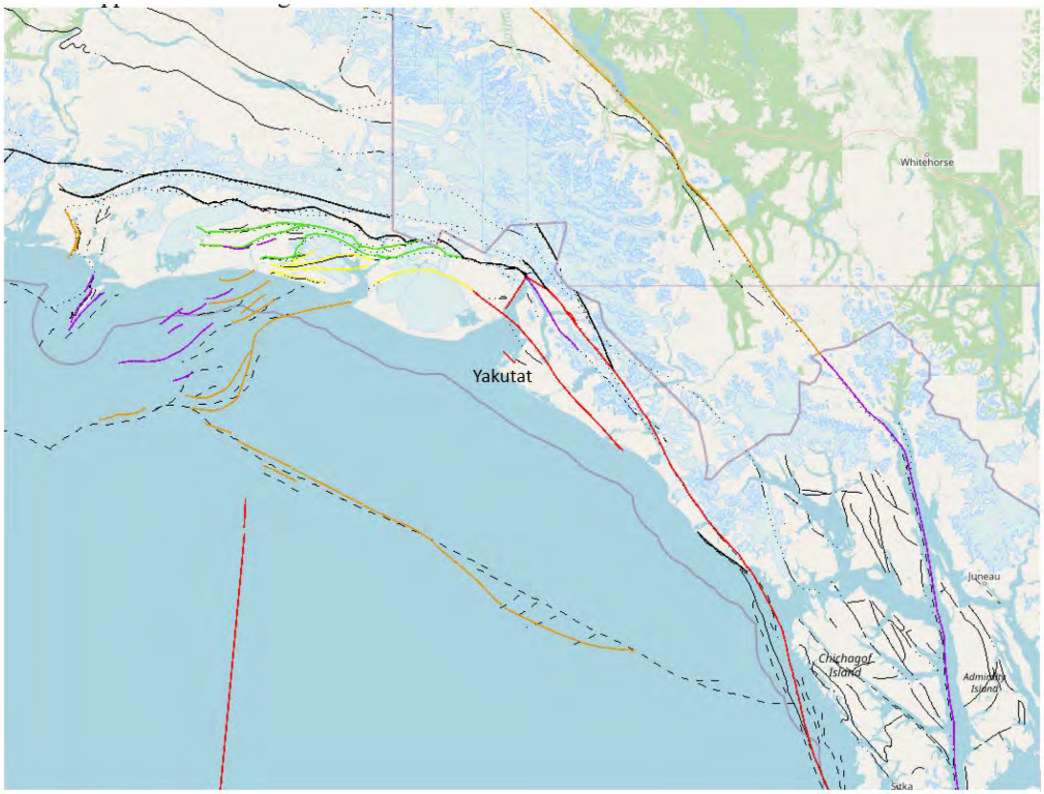


Figure 3-9 is a zoomed in image of the Quaternary Fault and Folds near Yakutat. The legend above is applicable to this figure as well.

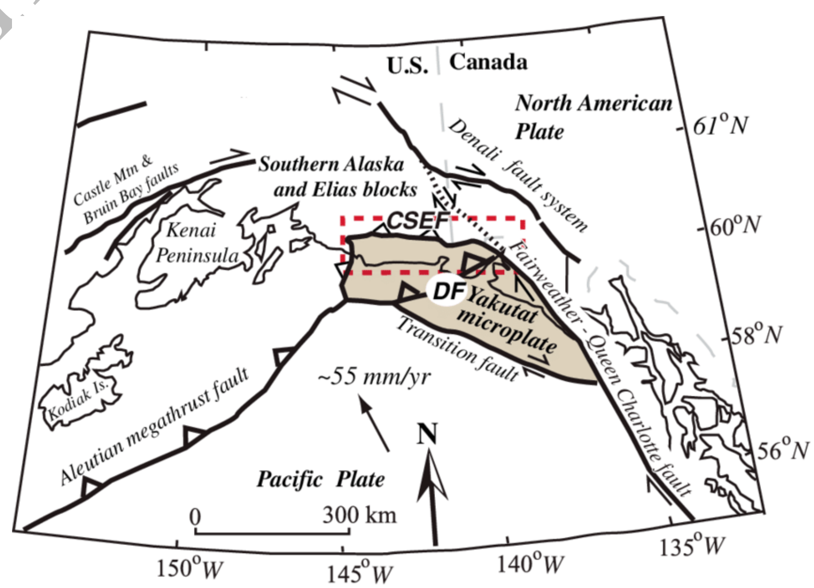


Source: DGGS Quaternary Fault and Folds Database (2013)

Figure 3-9 Faults and Folds in the Planning Area

The Yakutat Microplate

The Yakutat microplate is the latest addition to the assemblage of accreted terranes that make up southern Alaska. The microplate was transported northward along margin-parallel transform faults, including the Queen Charlotte and Fairweather faults. Eventually, the microplate encountered the continental margin of southern Alaska, where the ongoing collision creates complex seismotectonic interactions resulting in a very active seismic belt (AEC 2022). Two great earthquakes in 1899 (M8.1 and M8.2) re-arranged landforms in the Yakutat Bay area, resulting in up to 40 feet of uplift and 6 feet of land subsidence. Another notable event in this region was the 1958 M7.7 Lituya Bay Earthquake, which ruptured from the head of Yakutat Bay along the entire length of the Fairweather Fault. This earthquake caused a massive landslide that crashed into Lituya Bay, creating a tsunami wave 1,720 feet high. The most recent major earthquake in the region was the 1979 M7.1 Saint Elias Earthquake. In the offshore zone, the most notable structures are the

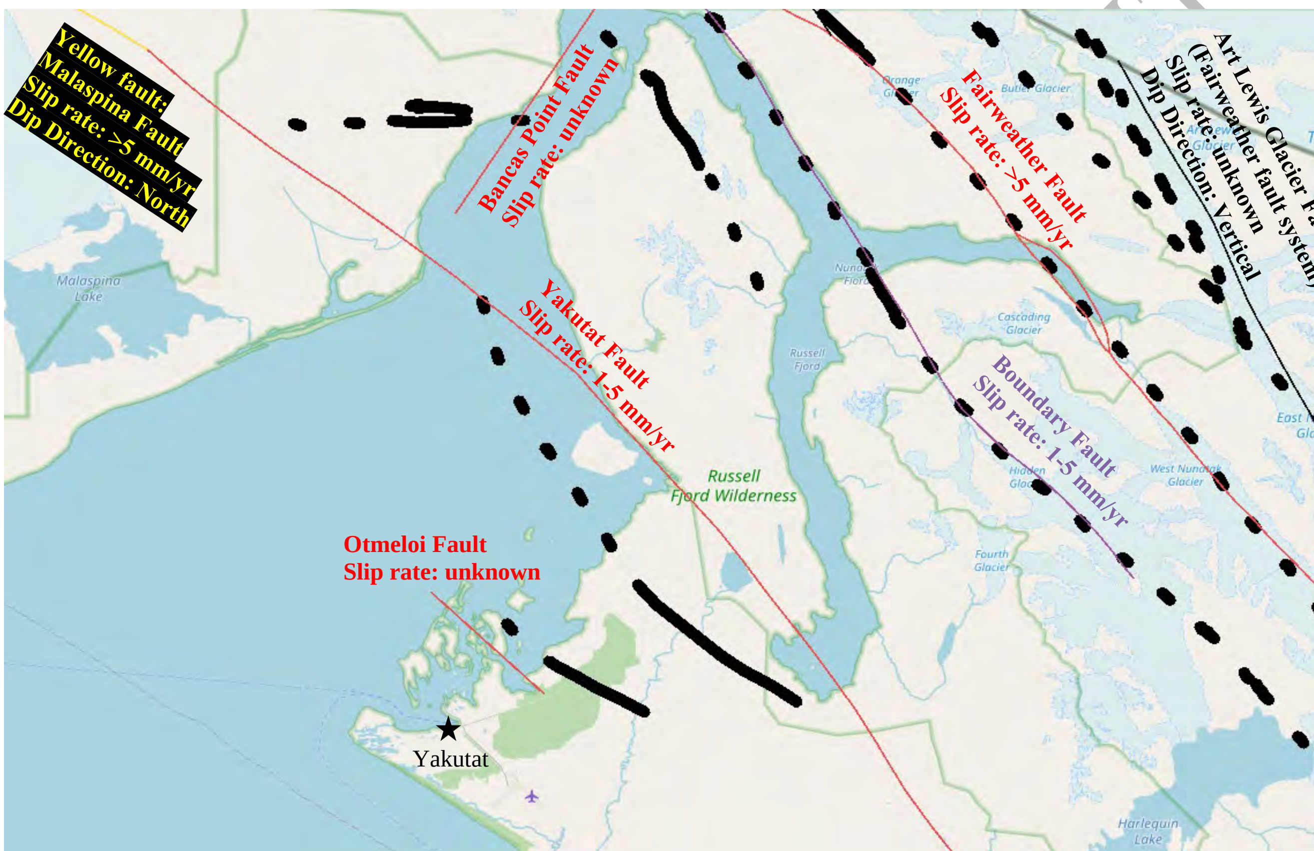


Source: Bruhn et al. (2012)

Figure 3-10 Yakutat Microplate

Transition Fault that separates the Yakutat microplate from the Pacific Plate and the northern Gulf of Alaska fault zone. A sequence of strong earthquakes in the Gulf of Alaska, including a M7.7 in 1987 and a M7.8 in 1988, produced significant ground motions that were felt along the entire southeast and southern Alaska coast. The Transition Fault is not known to have produced significant earthquakes except for a 1973 M6.7 event along the southeastern end of the fault. This region has a high level of background seismicity, with hundreds of earthquakes recorded each year, the majority of which are shallow and located within the 50-mile-wide coastal zone. (AEC 2022)

Figure 3-11 shows the location and names of numerous faults surrounding Yakutat.

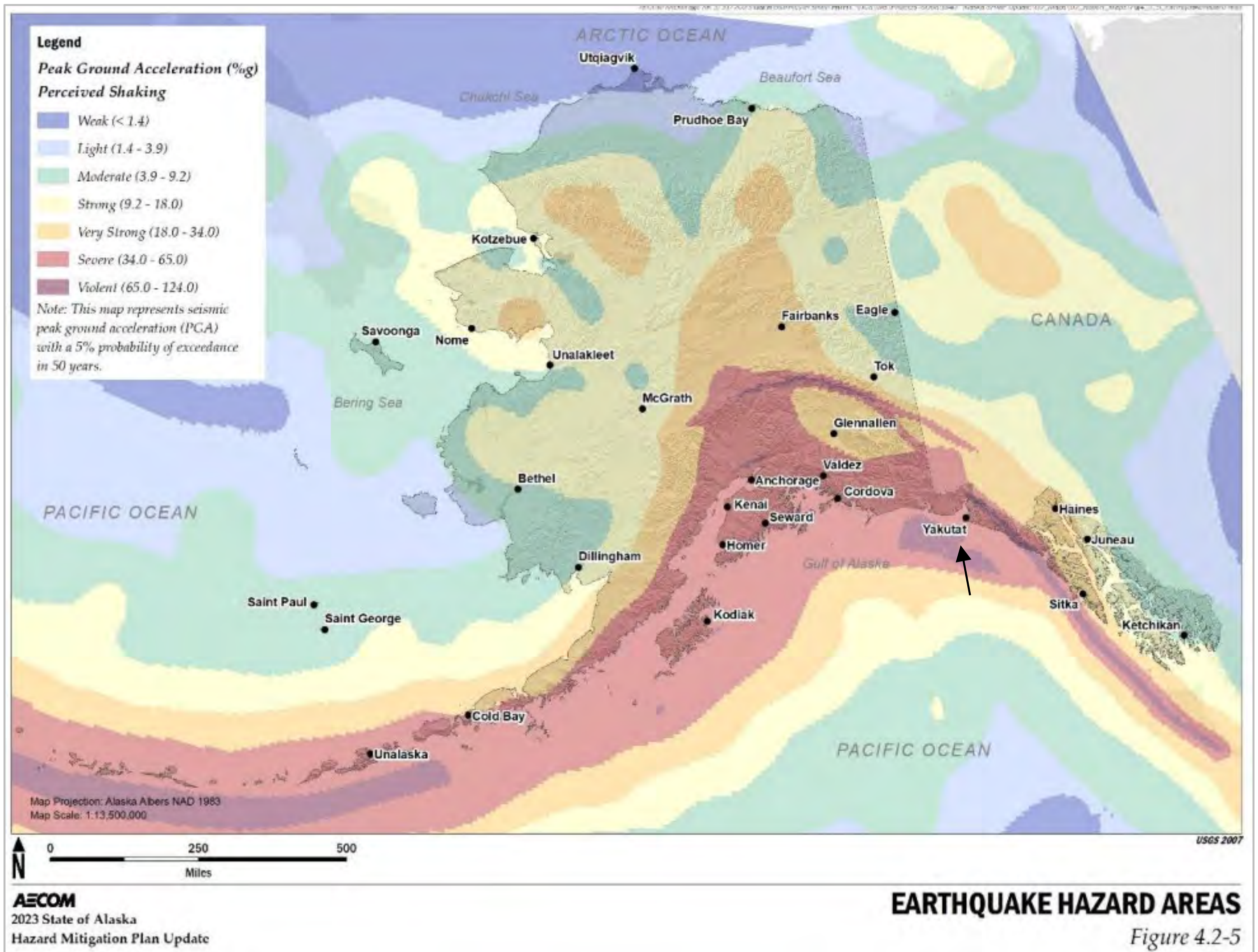


Note: The bold black fault lines are pre-quaternary faults that have not been active in the past 1.6 million years and are not named.
Source: DGGS Quaternary Fault and Folds Database (2013)

Figure 3-11 Major Named Faults Surrounding Yakutat

3.3.1.4 Extent (Magnitude and Severity)

Intensity is a subjective measure of the strength of the shaking experienced in an earthquake. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region depending on the location of the observer with respect to the earthquake epicenter.



Source: 2023 Alaska SHMP

Figure 3-12 Statewide PGA and Perceived Shaking from Earthquakes

The intensity reported at different points generally decreases away from the earthquake epicenter. Local geologic conditions strongly influence the intensity of an earthquake; commonly, sites on soft ground or alluvium have intensities two to three units higher than sites on bedrock. The geologic setting of Yakutat Bay is described as:

> *The head of Yakutat Bay penetrates the St. Elias Mountains, a crystalline complex of Mesozoic and older metasediments with minor mafic and quartz monzonitic intrusions. Upper Mesozoic and Tertiary sediments, unmetamorphosed but extensively deformed by a series of major thrust faults, underlie the coastal plain and possibly the Continental Shelf. The bay and its associated sea valley cross the entire coastal plain and Continental Shelf, possibly in a zone of structural transition.*
>
> *The coastal plain and some of the coastal mountains are separated by the largest of the faults, the Chugach-St. Elias-Fairweather system, a branch of which forms part of the structural control for the fiords at the head of Yakutat Bay. Movement on this system appears to have included both vertical and right-lateral displacement.*
>
> *Another fault, whose presence is inferred from the mapping of a series of uplifted strandlines, was named the Mountain Front and East Shore fault by Tarr and Martin (1912), who noted that the strandlines were uplifted more than 5 m (17 feet) along the east shore of Disenchantment Bay.*

The uplift presumably occurred during the Yakutat earthquake of 1899. A later earthquake with major topographic readjustment occurred in 1958. (USGS 1972)

The Richter scale expresses magnitude as a decimal number. A M2.0 or less is called a microearthquake; they cannot even be felt by people and are recorded only on local seismographs. Events of about M4.5 or greater are strong enough to be recorded by seismographs all over the world. A M5.0 earthquake is a "moderate" event, a M6.0 characterizes a "strong" event, a M7.0 is a "major" earthquake, and a "great" earthquake exceeds M8.0. Great earthquakes occur once a year on average worldwide; some examples of Great earthquakes are British Columbia 1700, Chile 1960, and Alaska 1964. The Richter Scale has no upper limit, but for the study of massive earthquakes, the moment magnitude scale is used. The modified Mercalli Intensity Scale is used to describe earthquake effects on structures (Table 3-4).

As shown in Figure 3-11, numerous major fault zones are close to Yakutat including the Fairweather fault, Boundary fault, Yakutat fault, Esker Creek fault, and the Bancas Pt. fault.

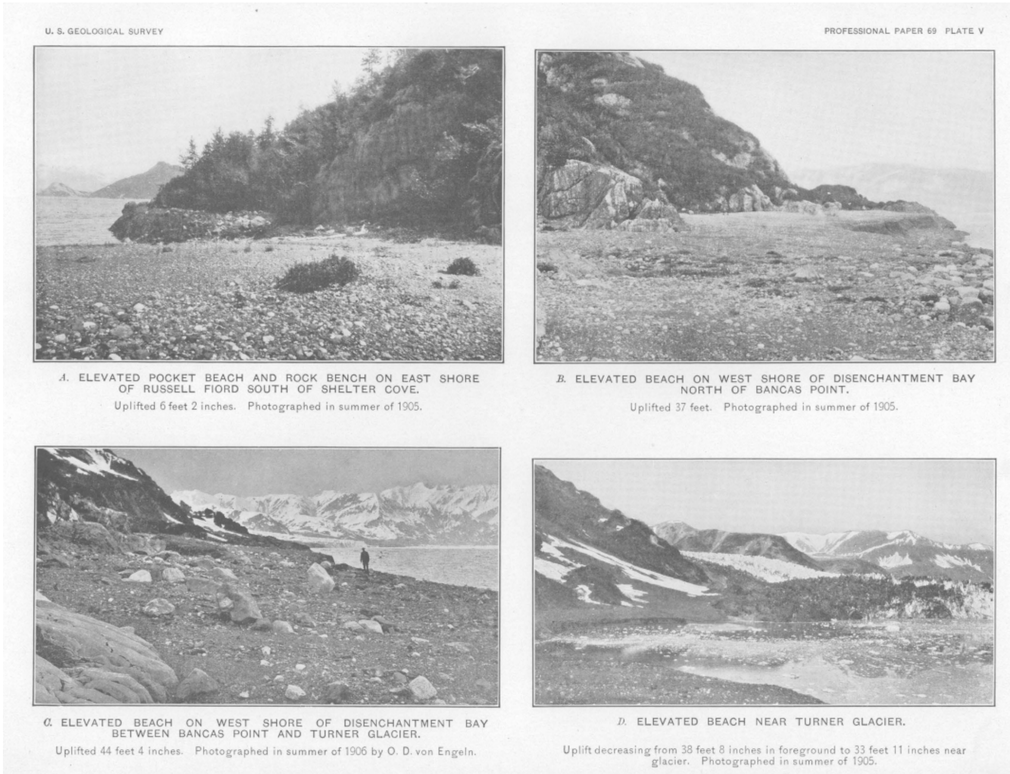
Most earthquake injuries and fatalities occur within buildings from collapsing walls and roofs, flying glass, and falling objects. As a result, the extent of Yakutat's risk depends not just upon its location relative to known faults, and its underlying geology and soils, but also on the design of its structures. Buildings that have not been constructed to meet seismic standards can pose major threats to life and the continued functioning of key public services during an earthquake.

Based on past event history and the criteria identified in Table 3-2, the extent of earthquakes and resultant damages to people and infrastructure in Yakutat are considered Critical where injuries and/or illnesses could result in permanent disability, a complete shutdown of critical facilities may last for at least two weeks, and more than 25% of property would be severely damaged.

3.3.1.5 Impact

An earthquake could affect the entire Planning Area and surrounding areas. The exact number and location of impacted structures would depend on the size, location, and frequency of the earthquake. The type of building would also play a role as some facilities are designed to withstand larger magnitudes earthquakes. Earthquake damage would be area-wide with potential damage to critical infrastructure including the complete abandonment of key facilities.

The 1899 Yakutat Bay Earthquakes resulted in multiple instances of beach uplift throughout the area (Figure 3-13).



Source: USGS 1912

Figure 3-13 Examples of Beach Uplift from the 1899 Earthquakes in Yakutat Bay

A secondary impact of earthquakes is a tsunami. In 2016, DGGS modelled tsunami inundation based on 10 different tectonic scenarios that may impact Yakutat.

- Model 1: 1964 Great Alaska Earthquake rupture + rupture of the Yakataga–Yakutat (YY) segment (scenarios 1-2)
  - The modeling results suggest that tsunami sources built on the **1964 rupture models have only a <u>moderate impact</u>** on Yakutat.
  - The inundation area for these scenarios does not extend far beyond the MHHW in most areas. This result is also supported by observations of the 1964 tsunami at Yakutat, when several waves were observed during and after the earthquake, but none reached above extreme high water level or caused any damage
- Model 2: Various slip distributions on the megathrust between segments SH and YY (scenarios 3-7)
  - **Scenario 5** (A Mw 9.0 multi-segment event in the Gulf of Alaska region: The PWS and KP segments with Tohoku-type slip distribution and uniform slip along strike) predicts the largest inundation area.
  - According to scenario 5, **the Yakutat village subdivision (the area between the first and second streets) would be flooded, as well as the area adjacent to the pier at the Ocean Cape industrial subdivision.**
- Model 3: Near-field hypothetical earthquakes in the area of Yakutat Bay (scenarios 8-10)
  - Scenario 8 (A Mw 7.7 event based on rupture of the Otmeloi fault) predicts large inundation zones.

Scenarios 5 and 8 both result in about the same extent of inundation at the head of Monti Bay, at Sandy Beach Park, and at the dock where the tidal gauge is located.

Overall, scenario 5 (A Mw 9.0 multi-segment event in the Gulf of Alaska region: The PWS and KP segments with Tohoku-type slip distribution and uniform slip along strike) predicts the largest inundation among all considered scenarios. The hypothetical wave might travel farther inland and inundate locations that were not inundated during the 1964 tsunami, and represents the worst-case scenario for the community of Yakutat.

DGGS notes that although the occurrence of a Tohoku-type event such as in scenario 5 is possible, the available geologic evidence suggests that repeated 1964-type events might be a more realistic estimate of future earthquake displacements. (DGGS 2016)

See Figure 3-63 for Yakutat's tsunami inundation mapping.

3.3.1.6 Probability of Future Events

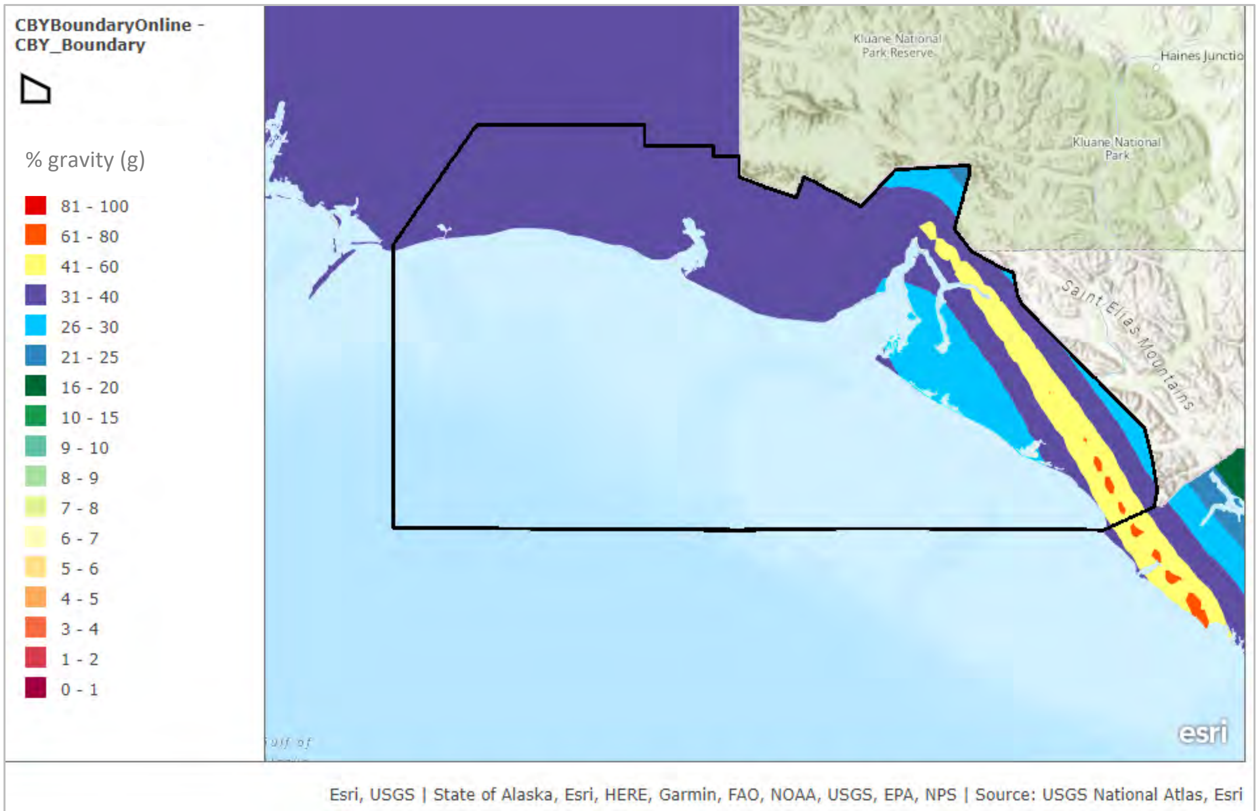
While it is not possible to predict an earthquake, the USGS has developed earthquake probability maps that use the most recent earthquake rate and probability models.

Earthquake probability maps show the PGAs expected at a location with 10%, 5%, and 2% exceedance probabilities in 50 years.

- A 10% chance in 50 years means that statistically this earthquake happens on average every **500 years**.
- A 5% chance in 50 years means that statistically this kind of earthquake happens every **1,000 years**.
- A 2% chance in 50 years, is the rare, large earthquake, and statistically it happens on average every **2,500 years**.

Figure 3-14 shows the earthquake probability/risk for Yakutat. This map layer shows the potential ground shaking intensity from earthquakes and the value that is shown is an estimate of the worst amount of shaking due to earthquakes experienced at a specific location in a 50-year time frame (Esri, USGS 2022).

In Yakutat, the associated earthquake risk categories range from 30%, 40%, 60% to 80% (0.3g, 0.4g, 0.6g, and 0.8g). Based on the MMI scale (Table 3-4), and depending on location, Yakutat could experience very strong to violent shaking and moderate to heavy potential damage.



This layer shows the probability of a 10% chance of exceeding the displayed horizontal ground acceleration within 50 years. A 10% chance in 50 years means that statistically this earthquake happens on average every 500 years.

Source: Esri, USGS- USA Earthquake Risk. Accessed August 7, 2023.

Figure 3-14 Yakutat Earthquake Probability/Risk

Based on previous occurrences and the criteria identified in Table 3-3, it is Highly Likely that there will be an earthquake event M5.0 or greater within 100 miles within the calendar year; there is a 1 in 1 year chance of occurring (1/1=100%); and the history of events is greater than 33% likely per year.

3.3.1.7 Future Conditions Including Climate Change

Climate change is not expected to influence the nature, location, extent, impact, or recurrence probability of future earthquakes on human timescales (DHS&EM 2023).

3.3.2 SEVERE WEATHER

3.3.2.1 Nature

Severe weather is any dangerous meteorological development that has the power to cause damage or disruption, including the loss of human life. Severe weather instances that occur throughout Alaska with extremes experienced by Yakutat's residences includes extreme cold, freezing rain/ice storm, heavy and drifting snow, winter storm, heavy rain, high winds, and drought. Yakutat experiences periodic severe weather events such as the following:

Severe Weather Event	Nature of the Event
Extreme Cold	Extreme cold is generally defined as a prolonged period of excessively cold weather. Extreme cold conditions are often, but not always, part of winter storms. In Alaska, extreme cold usually involves temperatures between -20 to -50°F or more.
Freezing Rain and Ice Storms	Freezing rain and ice storms occur when the layer of freezing air is so thin that the raindrops do not have enough time to freeze before reaching the ground. Instead, the water freezes on contact with the surface, creating a coating of ice on whatever the raindrops contact. These events are noted by accumulation of at least 12 inches in less than 24 hours.
Heavy Snow	Heavy snow generally means snowfall accumulating to four inches or more in depth in 12 hours or less or six inches or more in depth in 24 hours or less.
Drifting Snow	Drifting snow is the uneven distribution of snowfall and snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.
Winter Storm	A winter storm is a combination of heavy snow, blowing snow, and/or dangerous wind chills. A winter storm is life-threatening. A snowstorm is an example of a winter storm. A snowstorm occurs when a mass of very cold air moves away from the polar region and collides with a warm air mass. The warm air rises quickly and the cold air cuts underneath it, causing huge cloud banks to form. As the ice crystals within the cloud collide, snow is formed. However, snow will only fall from the cloud if the temperature of the air between the bottom of the cloud and the ground is below 40 degrees Fahrenheit. A higher temperature will cause the snowflakes to melt as they fall through the air, turning them into rain or sleet. Similar to ice storms, the effects from a snowstorm can disturb a community for a prolonged period of time. Buildings and trees can collapse under the weight of heavy snow.
Heavy Rain	Heavy rain occurs when the precipitation rate is between 0.39 - 2.0 inches per hour.
Atmospheric River	Atmospheric rivers (AR) are relatively long, narrow regions in the atmosphere – like rivers in the sky – that transport most of the water vapor outside of the tropics. While atmospheric rivers can vary greatly in size and strength, the average atmospheric river carries an amount of water vapor roughly equivalent to the average flow of water at the mouth of the Mississippi River. Exceptionally strong atmospheric rivers can transport up to 15 times that amount. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow (NOAA 2020b). Figure 3-15 shows a visual description of an atmospheric river.
High Winds	High winds pose a moderate threat to a community when they reach sustained speeds of 26 to 39 mph, or frequent wind gusts of 35 to 57 mph. High winds pose a high threat to a community when they reach sustained speeds of 40 to 57 mph. High winds pose an extreme threat to a community when they reach sustained speeds greater than 58 mph, or frequent wind gusts greater than 58 mph. While Alaska does not experience hurricanes, it experiences hurricane-force winds. Various wind scales equate wind speed to expected damages. Two widely used wind scales are the Beaufort Scale of Wind Strength and the Saffir-Simpson Hurricane Wind Scale, further explained below in Table 3-6 and Table 3-7.

Table 3-6 Beaufort Scale of Wind Strength

Force	Wind Speed (mph)	Damages
0	<1	Smoke rises vertically.
1	1-3	Direction shown by smoke drift but not by wind vanes.
2	4-7	Wind felt on face; leaves rustle; wind vane moved by wind.
3	8-12	Leaves and small twigs in constant motion; light flags extended.
4	13-18	Raises dust and loose paper; small branches moved.
5	19-24	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38	Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46	Twigs break off trees, generally impedes progress.
9	47-54	Slight structural damage (chimney pots and slates removed).
10	55-63	Trees broken or uprooted.
11	64-75	Trees uprooted; cars overturned.
12	75+	Wide-spread devastation, buildings damaged or destroyed.

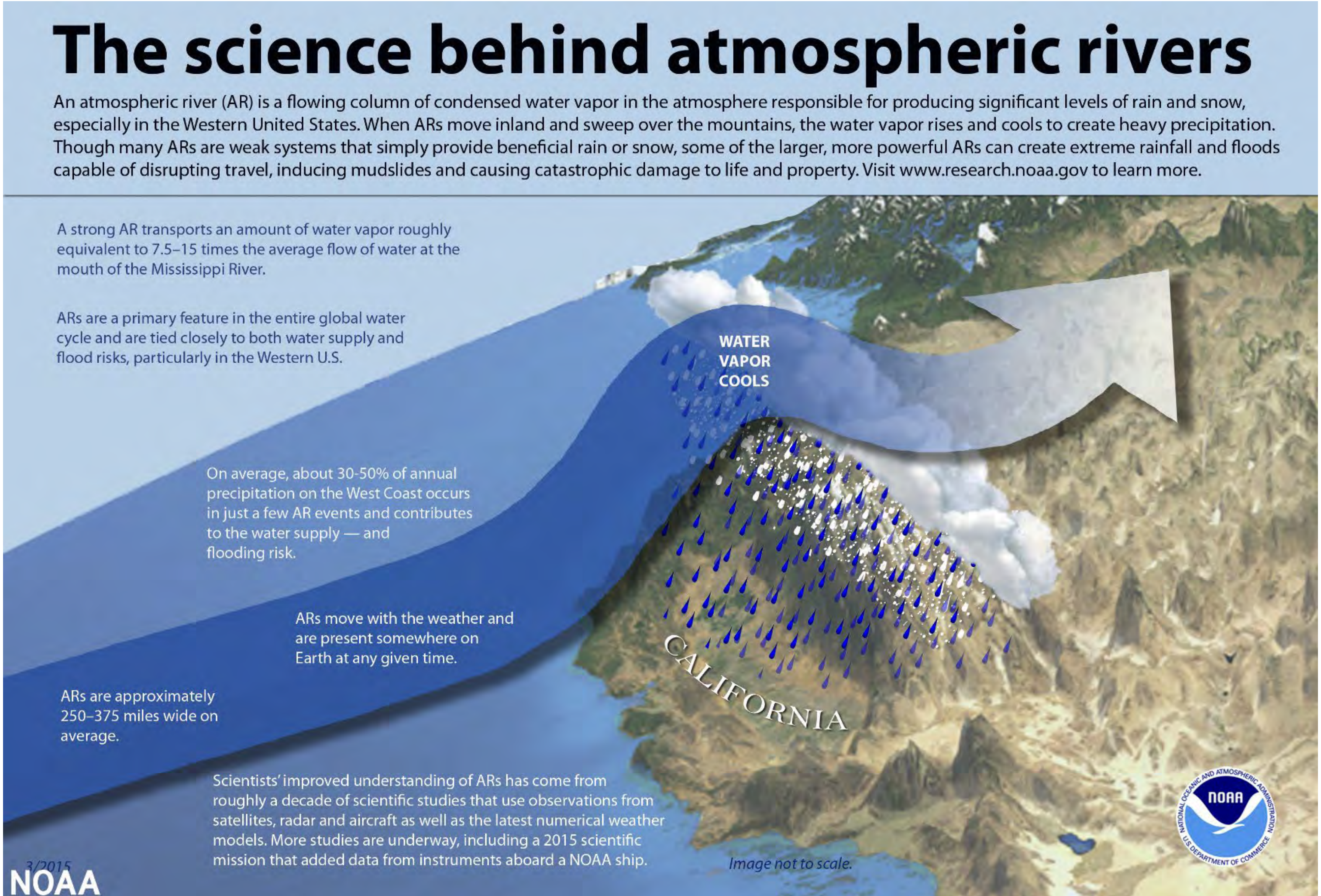
Table 3-7 Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds (mph)	Damages
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.

<table>
<tr><th>Severe Weather Event</th><th>Nature of the Event</th></tr>
<tr><td></td><td>
<table>
<tr><td>3 (major)</td><td>111-129</td><td><u>Devastating damage will occur:</u> Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.</td></tr>
<tr><td>4 (major)</td><td>130-156</td><td><u>Catastrophic damage will occur:</u> Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.</td></tr>
<tr><td>5 (major)</td><td>157+</td><td><u>Catastrophic damage will occur:</u> A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.</td></tr>
</table>
</td></tr>
<tr><td>Drought</td><td>
A drought is a period of time when an area or region experiences below-normal precipitation. Droughts may range in severity but have many effects on the surrounding land and weather conditions. Droughts threaten people’s livelihoods and can result in a water shortage, poor quality drinking water, poor air quality, loss or destruction of aquatic habitat, loss of vegetation or crops, and an increase in infectious diseases. Droughts are a slow-onset hazard and can last weeks, months, or even years. Because of the possible long duration of droughts, the impacts last for years and can ripple through a community over time.

Drought conditions are classified in categories, which are described below:

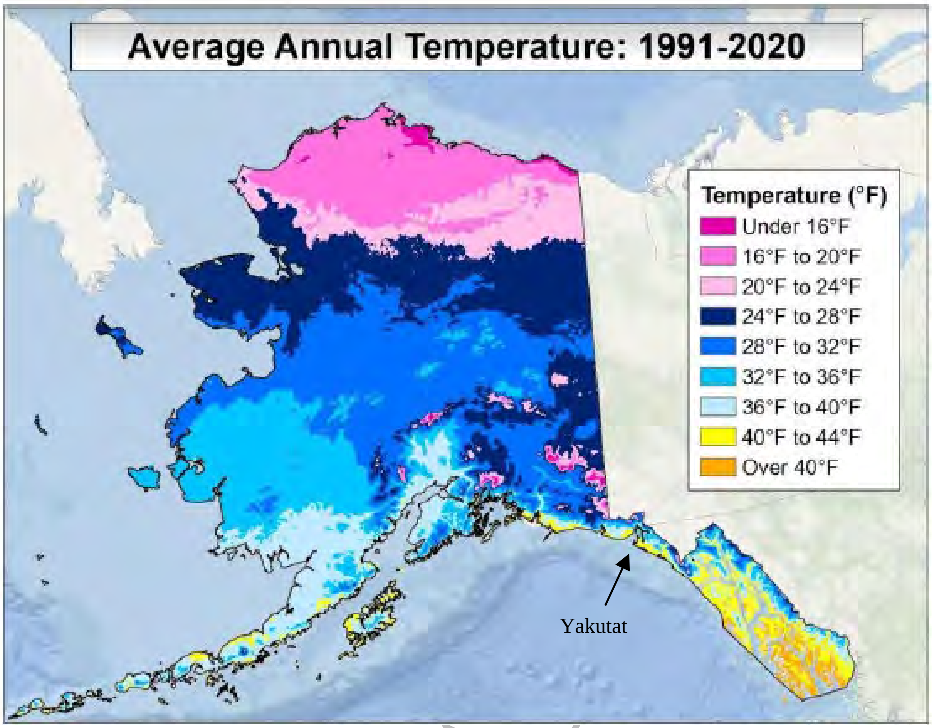
Table 3-8 Classifications of Drought Conditions
<table>
<tr><th>Category</th><th>Description</th><th>Possible Impacts</th></tr>
<tr><td>D0</td><td>Abnormally Dry</td><td>Going into drought:
• short-term dryness slowing planting, growth of crops or pastures
Coming out of drought:
• some lingering water deficits
• pastures or crops not fully recovered</td></tr>
<tr><td>D1</td><td>Moderate Drought</td><td>• Some damage to crops, pastures
• Streams, reservoirs, or wells low, some water shortages developing or imminent
• Voluntary water-use restrictions requested</td></tr>
<tr><td>D2</td><td>Severe Drought</td><td>• Crop or pasture losses likely
• Water shortages common
• Water restrictions imposed</td></tr>
<tr><td>D3</td><td>Extreme Drought</td><td>• Major crop/pasture losses
• Widespread water shortages or restrictions</td></tr>
<tr><td>D4</td><td>Exceptional Drought</td><td>• Exceptional and widespread crop/pasture losses
• Shortages of water in reservoirs, streams, and wells creating water emergencies</td></tr>
</table>
Source: U.S. Drought Monitor (USDM) 2023
</td></tr>
</table>



Source: NOAA 2023a

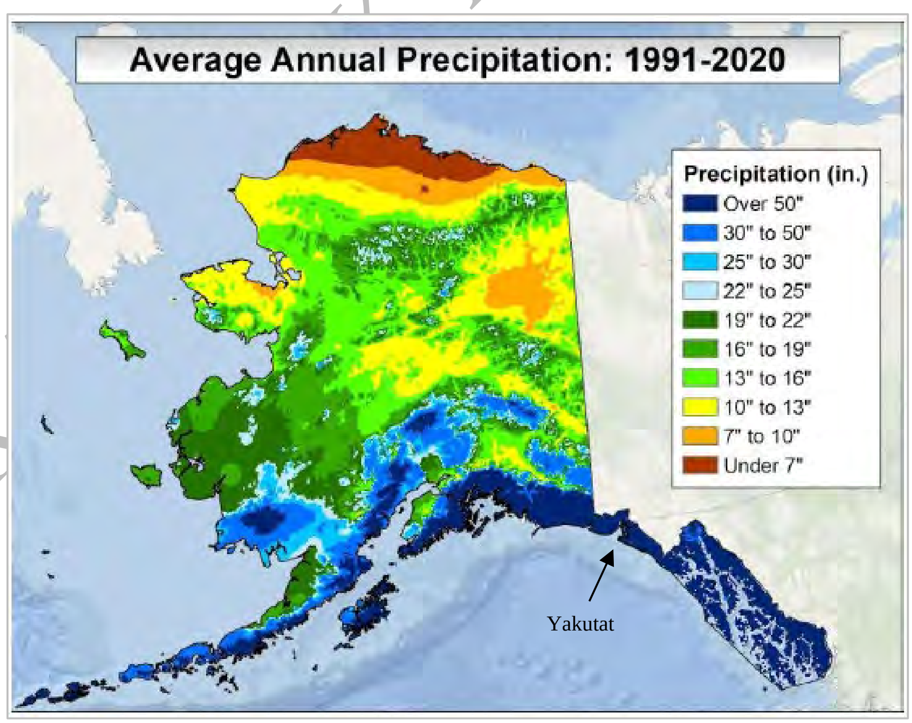
Figure 3-15 The Science Behind Atmospheric Rivers

Figure 3-16 shows Alaska's average annual temperature from 1991-2020 and Figure 3-17 shows Alaska's average annual precipitation from 1991-2020.



Source: NOAA NCEI Gridded Normals

Figure 3-16 Alaska Average Annual Temperature 1991-2020



Source: NOAA NCEI Gridded Normals

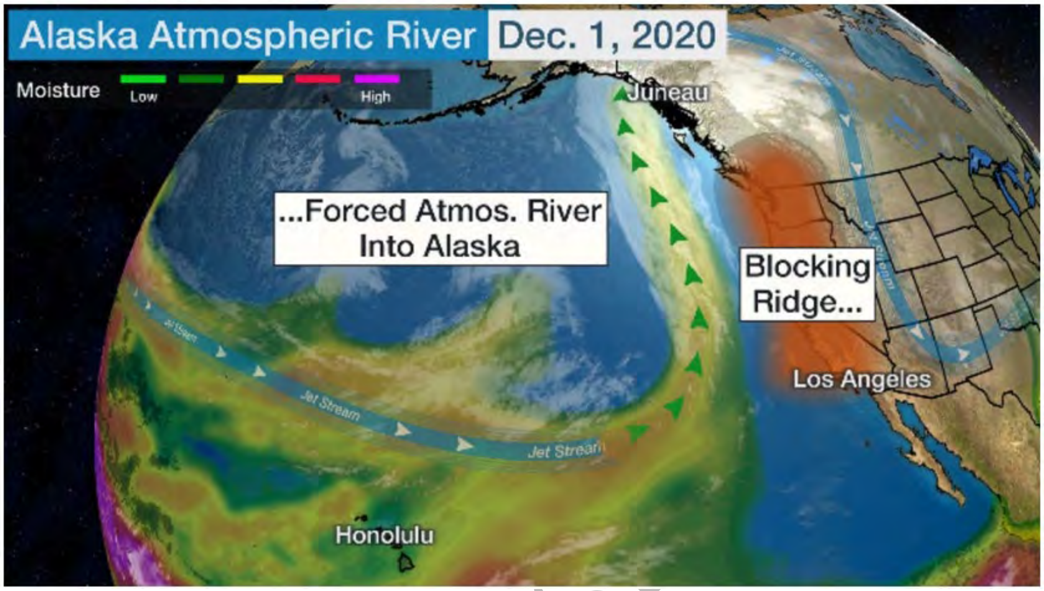
Figure 3-17 Alaska Average Annual Precipitation 1991-2020

3.3.2.2 History

The history of severe weather events documented in Yakutat are described below.

Severe Weather Event	Overview of the Event
Extreme Cold	The coldest month of the year at Yakutat Airport is January, with an average low of 25°F and high of 35°F. The coldest recorded temperature in Yakutat was -22ºF in January 1947.
Freezing Rain and Ice Storms	Freezing rain and ice storms are not commonly reported in Yakutat, but they have historically occurred.
Heavy Snow	Yakutat averages 142 inches of snowfall per year. 10+ inches of snow have fallen with several hours in Yakutat.
Drifting Snow	Drifting snow has occurred in Yakutat during severe storm events with snowfall and accompanying high winds.
Winter Storm	Winter storms are common in Yakutat. Since 2011, 38 winter storms have been recorded in Yakutat. These winter storms have resulted in over 18 inches of snow accumulation over the span of a day, snow and rain mix which caused the existing snow to become compacted and difficult to remove, and overall increased snow removal costs including machinery and labor. In January 2022, CBY declared a local disaster emergency as exceptionally heavy snow, rain and ice piled atop critical buildings and infrastructure. This "very unusual" event resulted in over 6 feet of snow after a rare cold snap (ADN 2022).
Heavy Rain	The Southeast Alaska archipelago is a part of the world's largest temperate rain forest and has the highest rainfall amounts in the state of Alaska. Southeast Alaska receives more than 200 inches of rain per year, while totals drop to 60 inches south of the Alaska Range, 12 inches in the Interior, and less than 6 inches in the North Slope. In Alaska, the year of 2022 was the 17th wettest year to date over the last 98 years, and specifically, July 2022 was the 6th wettest July over the past 98 years (USDM 2023). Yakutat averages 155 inches of rainfall per year. In Yakutat, fall rainfall is projected to increase by 31% by the end of the century (UAF/SNAP 2023a).
Atmospheric River	Atmospheric rivers impact SE Alaska quite often. On December 1, 2020, an atmospheric river event impacted SE Alaska and broke daily rainfall records in many communities. The Pacific jet stream, which typically guides storms from west to east across the Pacific Ocean during that time of year, ran into a roadblock in the form of a ridge of high pressure over the U.S. West Coast. That forced the jet stream to buckle northward, tapping a plume of deep moisture known as an atmospheric river and channeling it into southeastern Alaska (Figure 3-18) (Weather Underground 2020). While ARs impact SE Alaska frequently, this event brought record-breaking rainfall to the panhandle.

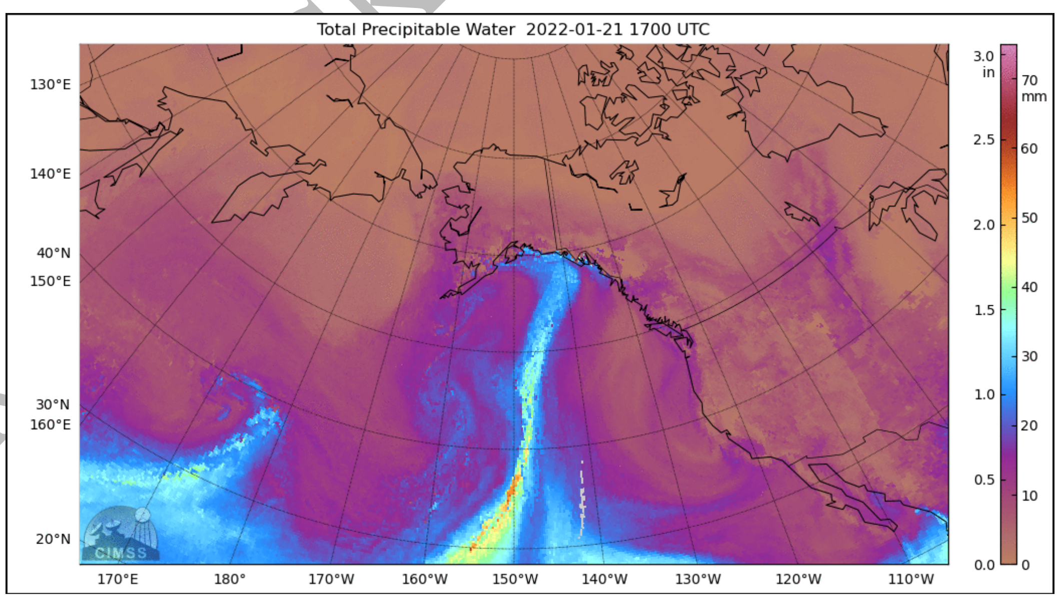
Severe Weather Event	Overview of the Event



Source: Weather Underground 2020

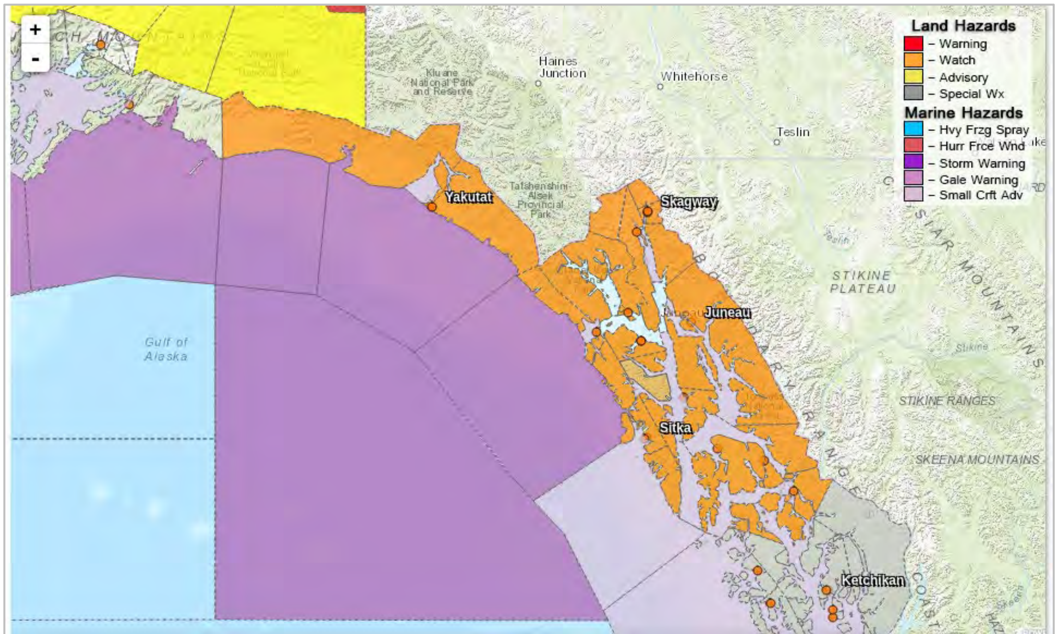
Figure 3-18 Atmospheric River Affecting SE Alaska, December 1, 2020

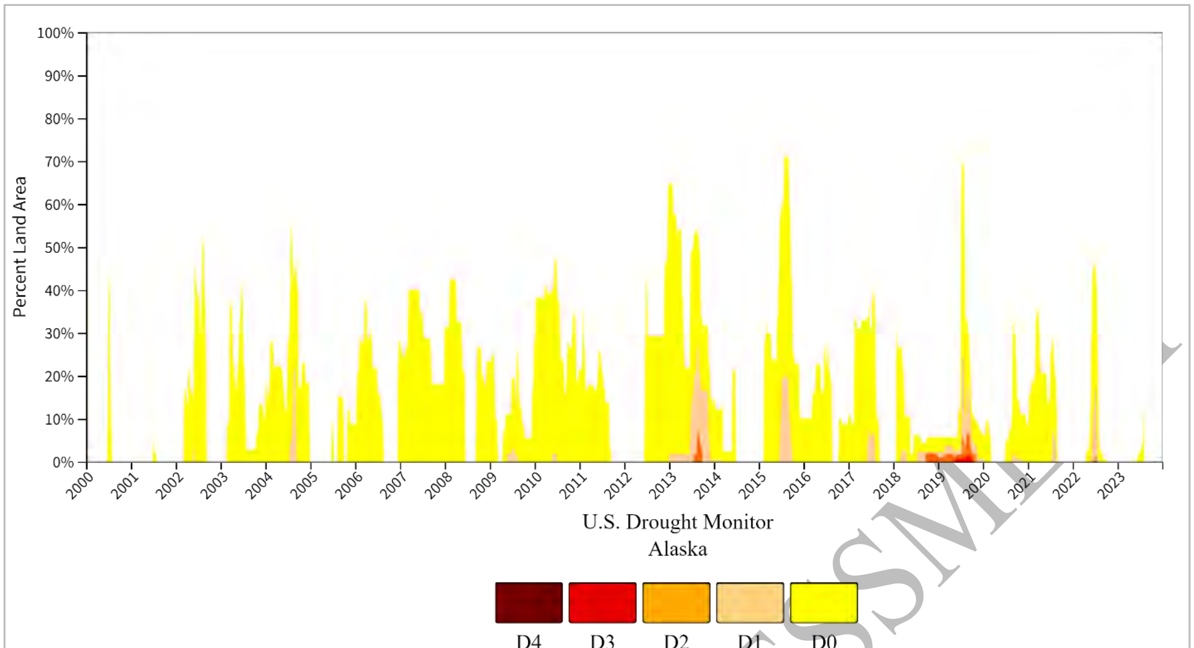
Another AR event affected SE Alaska on January 21, 2022. Hourly satellite imagery showed a large cyclonic circulation to the south and west of Alaska that was helping to draw moisture towards the state (Figure 3-19). The legend represents the total estimated precipitation. Most of SE Alaska was placed under a flood watch (Figure 3-20).



Source: Cooperative Institute for Meteorological Satellite Studies (CIMSS) 2022

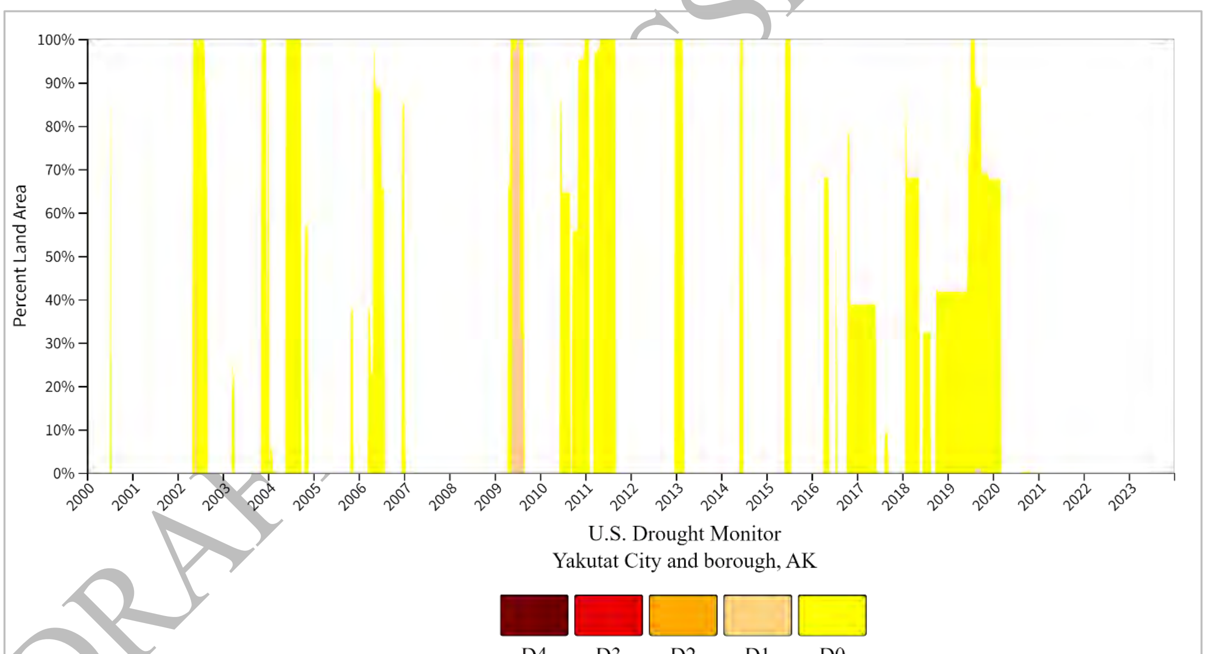
Figure 3-19 Atmospheric River Affecting SE Alaska, January 21, 2022

Severe Weather Event	Overview of the Event
	 Source: Cooperative Institute for Meteorological Satellite Studies (CIMSS) 2022 **Figure 3-20 Weather Warnings Issued Due to an AR Event, January 21, 2022** The Planning Team states that Yakutat experienced 7 atmospheric rivers events from September-December 2022.
High Winds	The windiest places in Alaska are generally along the coastlines. Wind gusts of 71 mph have been recorded in Yakutat.
Drought	The U.S. Drought Monitor (USDM) started in 2000 and is a is an interactive tool/map that is updated each Thursday to show the location and intensity of drought conditions across the country. Since the creation of the USDM, the longest duration of drought conditions (D1–D4) recorded in Alaska lasted for 79 weeks. This drought began on July 17, 2018 and ended on January 14, 2020. This drought intensified to a D3 during the week of August 27, 2019 and affected 1.5% of Alaskan land (USDM 2023). Figure 3-21 shows the historical drought conditions for the State of Alaska (2000-July 2023) and Figure 3-22 shows historical drought conditions for the CBY (2000-2022).



Source: NIDIS 2023

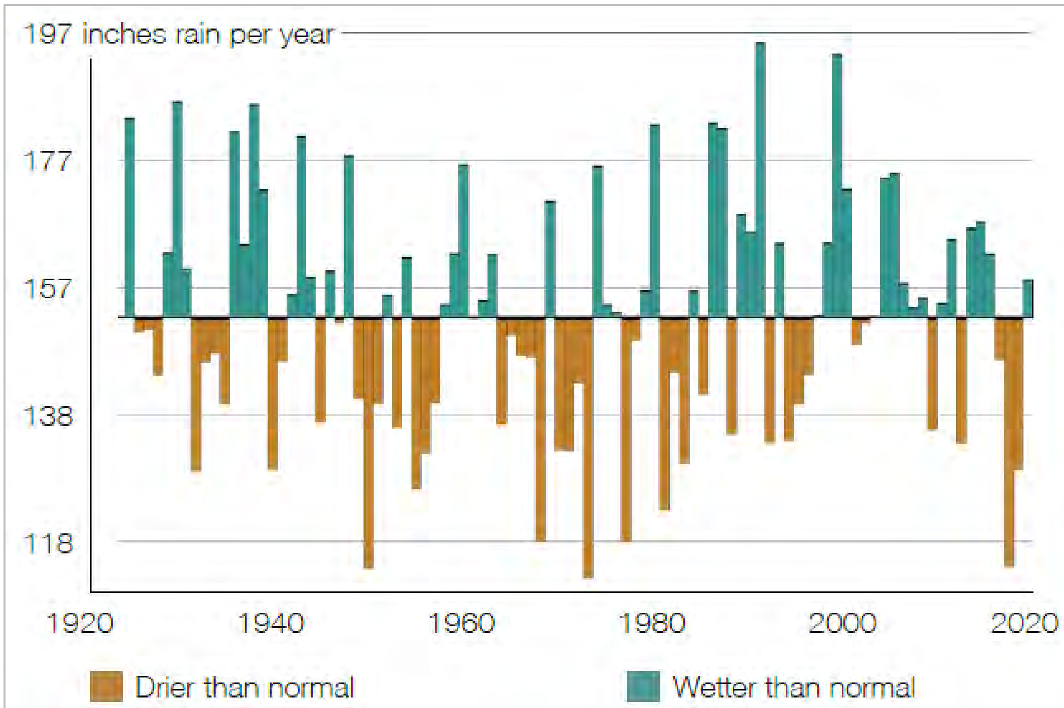
Figure 3-21 Historical Drought Monitor Conditions for Alaska (2000-July 2023)



Source: NIDIS 2023

Figure 3-22 Historical Drought Monitor Conditions for the CBY (2000-July 2023)

From October 2016 to December 2019, southeast Alaska was plagued by a long-lived drought (Hoell et al. 2022). "Extreme drought" was declared by the U.S. Drought Monitor in summer 2019. Dry spells are not unusual in southeast Alaska. Figure 3-23 shows prolonged dry periods in the 1950s, 70s, and 90s. Some of these past droughts were longer and had years with even less rain, but the 2016–2019 drought was particularly jarring to those experiencing it because it followed a decade of much wetter conditions (UAF-IARC 2022a).



Source: UAF-IARC 2022a

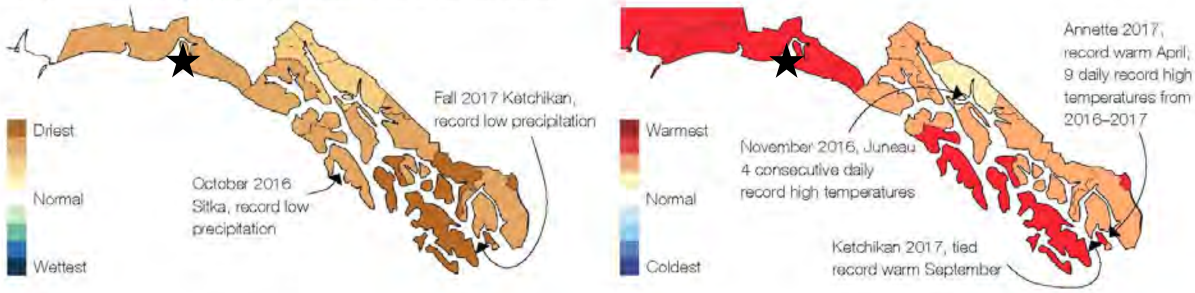
Figure 3-23 Prolonged Dry Periods in SE Alaska, 1950s, 70, 90s, 2000s

The following figure compares historical droughts impacting southeast Alaska to the 2016-2019 drought.

RANKING DROUGHTS

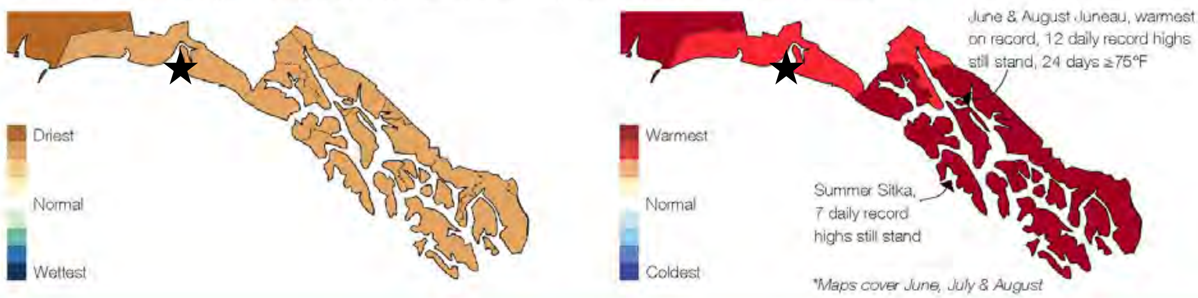
How dry and warm was southeast Alaska during the recent drought? These maps rank temperature and precipitation from October 2016–September 2019 compared to the long-term (1925–2020) average. The drought period was much drier than normal, especially in the southern panhandle. This dryness was persistent in both winter and summer. Even so, there were periods of wetness; for example, summer 2017 was notably wetter than normal.

October 2016–September 2019 was considerably warmer than normal, but not always record breaking. Summers were consistently warmer than normal except for a few months of normal temperatures near Haines. Summer 2019 stood out as exceptionally warm across all of southeast Alaska. Winter temperatures during most of the drought were near normal, until winter 2018–2019 when temperatures throughout the panhandle were far above normal.



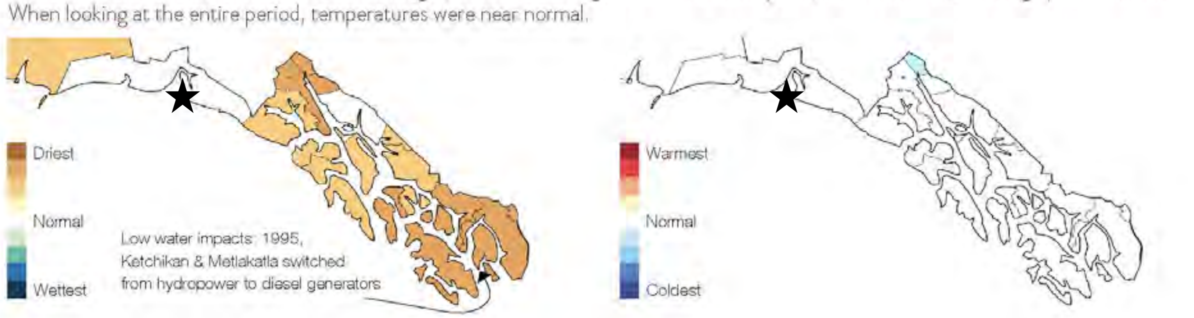
How did the 2004 drought rank?

In summer 2004, southeast Alaska experienced a short duration but very impactful drought. In parts of central and northern southeast, 2004 still holds the record for warmest summer ever. Conditions grew so hot and dry that Tongass National Forest banned timber harvest from noon to 8 p.m. to avoid igniting wildfires when daily humidity was low and temperatures high.



How did the 1990s drought rank?

In 1989, a short but intense drought caused a temporary closure of the Ketchikan Pulp Mill. A longer duration drought took place from 1994–1997. Conditions were drier than normal, but not all regions of the panhandle were impacted. Yakutat and Juneau borough had normal amounts of rain. Unlike the recent drought, the 1990s drought had some warm years, but a cooler than average year mixed in. When looking at the entire period, temperatures were near normal.



Source: UAF-IARC 2022a

Figure 3-24 Historical SE Alaska Droughts Compared to the 2016-2019 Drought

Table 3-9 lists Yakutat's historical severe storm events the National Weather Service (NWS) identified for their Weather Zone (Zone 317- City and Borough of Yakutat) from January 1996 – August 2023. The NWS Storm Events Database has data dating back to January 1950 for many states, but it began collecting data for Alaska in January 1996. Additionally, any events resulting in a flood are addressed in the flood hazard section. See Table 3-14 for a list of these flooding events.

Since the 2019 HMP was adopted, there have been 28 severe weather events in Yakutat. (Updated from August 2023 events- will continue to be updated until final draft)

Table 3-9 Historical Severe Weather Events in Yakutat

Date	Event Type	Magnitude
12/03/97	High Wind	A peak wind of 64 kt occurred at Yakutat airport just before a strong Pacific occlusion passed through the area.
01/03/98	Heavy Snow	Heavy snowfall occurred over the northeastern gulf coast and northern Southeast Alaska due to gulf moisture overrunning an arctic airmass ahead of an approaching frontal system. Snowfall totals during the eight-hour event included 10 inches in Yakutat.
01/25/99	Heavy Snow	Numerous snow showers. Yakutat snowfall of 11 inches.
01/31/99	Heavy Snow	Training echoes moving onshore produced 21 inches of snow at Yakutat in 24 hours.
02/01/99	Heavy Snow	Large scale overrunning snow event forecast. Only Yakutat observed heavy snow with 12.5 inches in 24 hours.
02/05/99	Heavy Snow	Snow showers over a 48-hour period with 2 feet reported at Yakutat.
02/07/99	Heavy Snow	Frequent heavy snow showers. Satellite imagery showed convection developed near Cape Spencer and propagated northwestward to near Yakutat for several hours. Yakutat 12.3 inches in 24 hours.
09/21/99	High Wind	A 949mb bomb in the Southern Gulf of Alaska caused a major wind and rain event across the entire Panhandle. Peak winds included 58tk in Yakutat, 52kt at Kake, 52kt at Cape Spencer, 54kt at Cape Decision, 58kt at Ketchikan, 53kt at Annette Island, 56kt at Skagway, 77kt at Hydaburg, and 52kt at Juneau Federal Building.
10/21/99	High Wind	An intense low moved northeast into the Gulf of Alaska Thursday...reaching a depth of 967 mbs late Thursday morning. The front associated with the storm, tracked northeast to a position just south of Yakutat and Kayak Island at 10 am. Strong easterly winds hit the southeast entrance to Prince William Sound, with Middleton Island recording a peak ASOS adjusted wind of 63 mph between 3 am and 4 am AST. The M/V "Westwood Cleo", in the open Pacific waters southwest of the Gulf of Alaska, reported funnel clouds on the 'back side' of the storm.
11/25/99	Heavy Snow	Heavy snow showers over the North Gulf of Alaska moved onshore. Yakutat received 11.3 inches of snow in 12 hours.
11/30/99	Heavy Snow	Warm air over running cold air snow event. Yakutat received 8.5 inches.
12/08/99	Heavy Snow	Heavy snow warning for Zone 22 West of Yakutat. Satellite data indicated heavy snow showers were over coastal areas where no surface observations were available.
12/11/99	Heavy Snow	Snowfall at Yakutat was 13.2 inches for a 48-hour period. Unknown how much accumulated in any period because the snow was occasionally mixed with rain.
12/14/99	Heavy Snow	Numerous heavy snow showers produced 13 inches at Yakutat.
12/17/99	Heavy Snow	Yakutat received 10.2 inches of snow in 6 hours.
12/18/99	Heavy Snow	Yakutat received 21 inches of snow in about 30 hours.

Date	Event Type	Magnitude
01/04/00	Heavy Snow	Heavy snow shower event mostly west of Yakutat. Satellite imagery estimate west of Yakutat 8 inches or more. Yakutat 4 inches.
01/08/00	Heavy Snow	Frequent snow showers. Yakutat reported 6.8 inches, but satellite indicated possible heavy snow showers elsewhere also.
03/26/00	High Wind	A deep low-pressure system moved through the Gulf of Alaska and inland near Prince William Sound, bringing strong winds to the northeastern gulf coast. The peak wind at Yakutat Airport was 52 kt.
03/28/00	Heavy Snow	Over 8 inches of snow fell in Yakutat due to frequent snow showers over a 6-hour period.
04/20/00	High Wind	A rapidly developing low pressure system moved through the eastern Gulf of Alaska and brought high winds to coastal sections of Southeast Alaska. Peak winds associated with this storm were 52 kt at Hydaburg Seaplane Base, 55 kt at Biorka Island near Sitka, and 50 kt at the Yakutat Airport.
01/03/01	High Wind	An intense North Pacific low-pressure system tracked along the outer coast of Southeast Alaska into the Gulf of Alaska bringing very strong southeast winds to much of the region. A peak wind of 63 mph was recorded at the Yakutat Airport.
01/06/01	High Wind	A rapidly developing low in the northern Gulf of Alaska brought strong winds to the eastern Gulf Coast. Just prior to the frontal passage, the Yakutat Airport reported a peak wind of 60 mph. Winds of 50 to 70 mph were reported in the harbor area.
01/12/01	Heavy Snow	A series of slow-moving snow showers dumped 17 inches of snow at Yakutat in less than 24 hours.
01/17/01	High Wind	Very strong winds of 60 to 70 mph reportedly occurred in the Icy Bay area west of Yakutat as a deep low made landfall over the northern Gulf of Alaska coast.
10/01/06	Frost/ Freeze	Temperatures dropped well below freezing for the outlying areas around Yakutat on October 1st. The first freeze/frost of the season occurred for Zone 017 on October 1st. Inland areas around Yakutat were estimated to have a minimum temperature of around 20F. PAYA ASOS dropped below freezing.
11/28/06	Heavy Snow	The coastal forelands from Cape Fairweather to Cape Suckling had heavy snowfall starting late in the evening on 11/28 until 0900 AKST 11/29. This was due to overrunning warm moist air driven over the area from a moderate Low-pressure system in the Eastern Gulf. The augmented ASOS at the Yakutat Airport (PAYA) included an observation of 7.8 inches of new snowfall at 0900 AKST on 11/29.
12/17/06	High Wind	Surface analyses indicated extreme surface pressure gradients causing gusts around 65 KT between 3 PM and 9 PM Sunday Dec 17th. Strong winds must have persisted into Monday morning. Yakutat NWS wind equipment recorded a gust |to 47 MPH on the 17th although this was not in the official observations. It is locally well known that wind speeds along the coast well exceed all observations at the airport.
12/19/06	High Wind	WSO Yakutat roof partially blew off at 1816 AKST Tue. Dec. 19th with $40K of damage. Interestingly, the PAYA ASOS did not observe the gusts that did this damage. This particular gust was believed to have wind associated with a convective downburst. Surface analyses show extreme surface pressure gradients at 00Z Wed. 12/20.
01/03/07	Heavy Snow	NWS WFO Yakutat (PAYA) measured 10.2 inches of new snowfall from 1500 AKST 1/3 to 0300 AKST 1/4 during this event. An additional 3.8 inches fell after 0300 AKST 1/4 until the next midnight.
01/20/07	High Wind	Yakutat NWS WSO ASOS (PAYA) had a peak wind of 53 KT at 2103 AKST and a measured a gust to 46 KT at 2253 AKST 1/20. It is well known that wind speeds are at least 10 MPH higher along the beach and in outflow regions of the local rivers and Yakutat Bay. Estimated wind speeds were as high as 65 MPH during this storm.
01/26/07	Heavy Snow	A storm died out in the far Western Gulf of Alaska on Thursday, Jan. 25th. A long fetch aloft of warm, tropical, moist air was aimed at Yakutat from due south that persisted through Friday, Jan. 26th. Arctic air remained at the surface near Yakutat during this entire event. Yakutat NWS WFO augmented ASOS: measured 15.7 inches new storm total for this event from midnight AKST 1/26 to 1/27.
03/01/07	High Wind	A High Wind Warning was issued for the Yakutat area for very strong wind out of the interior passes. Although no measurements were made of the intensity of the outflow wind, surface pressure gradients from NCEP analyses were extreme during the period which would have readily caused gusts in excess of 65 KT.

Date	Event Type	Magnitude
03/14/07	Heavy Snow	WSO Yakutat (PAYA ASOS) measured 14.4 inches new snow from midnight to midnight on 3/14. Most of the snowfall accumulated during the morning hours of 3/14. Blowing snow occurred during the afternoon of 3/14 with wind gusts to 22 MPH around noon AKST 3/14.
03/20/07	Heavy Snow	Yakutat WSO augmented ASOS (PAYA) measured 7.5 inches of new snowfall for 12 hours 2100-0300 AKST at 0300 AKST 3/20.
10/05/07	High Wind	Early Friday morning on October 5th, a secondary gale force Low developed to 983 MB near Middleton Island. That afternoon a strong front moved onshore in the Eastern Gulf of Alaska causing strong, gusty winds. The Low center moved over Yakutat at 982 MB late that afternoon. At approximately 6:30 AM AKST on 10/5, several roofs were blown off of cabins at the Situk River Fish Camp with wind gusts of at least 65 mph estimated. Minor roof damage was done in Yakutat City (tar paper blown off a roof).
12/16/07	Heavy Snow	The Yakutat office observed 6.0 inches of new snow beginning at 0340 and ending at 0900 on 12/16.
01/07/08	Heavy Snow	Arctic air along the eastern Gulf coast modified on the sixth as a moderate low-pressure system redeveloped near Middleton Island. This system caused warm moist air to rise over the Yakutat forelands on the night of the seventh. Yakutat measured 9 inches of new snow for twelve hours ending at 0400 on the eighth.
01/25/08	Heavy Snow	Yakutat measured 8.0 inches of new snow from midnight to midnight on the twenty-fifth with 6 inches falling between midnight and noon.
02/03/08	Heavy Snow	The NWS office in Yakutat observed 6.0 inches of new snowfall in four hours starting at 0100 AKST on 2/3.
02/10/08	Heavy Snow	The Yakutat NWS office measured 8.8 inches of new snow between 0600 and 1800 on 2/10. Storm total snowfall was 15.0 inches for this storm, 2/9 through 2/11.
02/13/08	Heavy Snow	A storm force low moved into the western Gulf on the afternoon of Wednesday, 2/13. The associated, very strong front advanced into the eastern Gulf on 2/13 with a triple point just south of Yakutat. The front occluded and became stationary along the entire southeast Alaska coast Thursday morning, 2/14. Yakutat airport measured 5.2 inches of new snowfall between 1500 2/13 and 2100 2/13. It is estimated that outlying areas, especially along the mountains, exceeded 6 to 8 inches of new snow at that time. The snow rapidly changed to rain around 2100 2/13.
02/16/08	Heavy Snow	The NWS office at Yakutat airport measured 7.1 inches of new snow between 1200 2/16 and 1800 on 2/16. The snow became mixed with rain at 1819 2/16.
03/19/08	Heavy Snow	The NWS office at the Yakutat airport measured 8.1 inches of snow from midnight to midnight on 3/19, while reporting snow almost every hour that day. It is estimated that outlying areas, especially near the mountains, may have received up to 16 inches of new snow.
04/07/08	Heavy Snow	The NWS office in Yakutat measured 7.8 inches of new snow between 0954 and 1533 on Monday, 4/7.
10/09/08	Frost/ Freeze	Brief clear skies over the Yakutat Forelands caused the temperatures to drop below freezing for a few hours on the morning of 10/9. The Yakutat AWOS measured below freezing temperatures for several hours between 1 AM and 5 AM on the morning of 10/9. The minimum temperature recorded was 29F. Outlying areas from town had colder temperatures.
12/03/08	Heavy Snow	The NWS office in Yakutat measured 2.4 inches of new snow for 24 hours ending at midnight 12/4 and 7.2 inches for 24 hours ending at midnight 12/5. Most of the snow fell between 2100 AKST 12/3 and noon 12/4 for a storm total of 9.6 inches snowfall.
12/08/08	Heavy Snow	The NWS office in Yakutat measured 5.2 inches of new snowfall during the evening of 12/8 and 4.0 inches of new snow between 0000 and 0600 AKST on 12/9 for a storm total of 9.2 inches in 12 hours.
12/25/08	Heavy Snow	The Yakutat office measured 6.5 inches of new snow during the evening of 12/25, then 15.9 inches of new additional snow midnight to midnight on 12/26. During the early morning of 12/27, Yakutat measured an additional 1.7 inches of new snow. Outlying areas were estimated to have received even greater amounts.
03/29/09	Heavy Snow	Heavy snow developed from the overrunning event in the Yakutat area. The 24-hour total for day was 9.5 inches for the Weather Service Office. The snow total mainly fell during a 12-hour window during the daytime hours.

Date	Event Type	Magnitude
09/29/09	Frost/ Freeze	Yakutat observed the first hard freeze of the season on the morning of September 29th under clear skies on calm winds. Temperatures ranged below 28F from 0500 to 0700 AKST with a minimum of 26F. This freeze ended the growing season for the Yakutat area.
11/01/09	Heavy Snow	A gale-force low-pressure system over the north central Gulf of Alaska on 11/01 was stationary with numerous bands of heavy showers moving east to west associated with minor troughs. The showers continued bring locally heavy snowfall amounts throughout the day. WSO Yakutat reported 7.5 inches of new snowfall for 12 hours ending at 4 pm on 11/01. Heavy snow. WSO Yakutat observed 7.5 inches of new snow for 12 hours ending at 4 PM on 11/01.
11/14/09	High Wind	Yakutat ASOS observed several measured gusts of 45 KT during 11/14. NCEP analyses showed extreme pressure gradients over the Yakutat Forelands with estimated gusts of 70 KT along some headlands. Buoy 46083 (marine) at the Fairweather Grounds measured a SW wind 46 KT with a peak of 56 KT. Seas there were 18 FT.
12/01/09	Heavy Snow	A deep storm moved into the Eastern Aleutians on the afternoon of 11/30. Warm, moist air with the associated front moved over the Eastern Gulf Coast which had cold air at lower levels. The result was heavy snow for Yakutat during the night of 11/30 into the early morning hours of 12/1. Yakutat got nearly six inches of new snow in a few hours around midnight. Snow rapidly changed to rain around 4 AM AKST on 12/1. WSO Yakutat measured 5.8 inches of new snow at 2353 on the night of 11/30. An additional 0.3 inches fell before 0400 on 12/1 for a storm total of over 6 inches for a few hours around midnight. The snow changed rapidly to rain around 0400 on 12/1 and melted away very quickly.
11/16/10	High Wind	A very strong high-pressure cell built over the Yukon causing katabatic and gaps winds for the usual outflow regions in SE Alaska on 11/16 - 11/17. The Dangerous river gap and up Yakutat Bay howled. Juneau had a Taku wind event. Army data from Haenke Island at the head of Yakutat Bay observed hourly wind averages above 60 MPH for most of the day on 11/17. Estimated outflow gusts to 80 KT.
12/30/10	Heavy Snow	WSO Yakutat measured 6.4 inches of new snow on 12/29 followed by 4.3 inches on 12/30. Snow changed to rain on the evening of 12/30.
02/18/11	Winter Storm	The Yakutat NWS office measured 4.3 inches new snow just before midnight 2/18 and 4.4 more inches on the morning of 2/19. Precipitation changed to rain on the morning of 2/19. Minimum visibility during this event was 0.5 SM at the airport with a max gust of 22 KT.
02/26/11	High Wind	A moderate low developed in Prince William Sound on 2/25 and moved into the eastern Gulf of Alaska on the early morning of 2/26 with a cold front. Strong outflow winds developed behind this system as very strong high pressure build into the central interior of Alaska. This system brought both snow and strong winds to Yakutat. The Yakutat WSO observed snow and freezing rain on the morning of 2/26 with visibility down to 1.25 SM. Rain mixed with snow in the afternoon then an arctic blast with outflow winds hit the area causing glaze on 2/27 and 2/28. Peak wind at the airport was NE 47 KT on 2/27 with low temperatures in the teens. Outflow wind in the area was as high as 60 MPH. One hourly average at Haenke Island in Yakutat Bay was 95 MPH.
02/28/11	High Wind	It might be an NWS record that hurricane force winds lasted so long for Juneau and the gaps in terrain near Yakutat. This is a clear case of arctic outflow from strong high pressure over the Yukon and B.C. lasting for days with extreme surface pressure gradients with weak lows in the Gulf of Alaska. Yakutat had a prolonged period of extreme outflow winds starting on the evening of 2/28. Peak gusts at the airport were 41 MPH at this time, but for the Icy Bay, Yakutat Bay, Dangerous River, Alsek River, and Lituya Bay had extreme surface pressure gradients for outflow winds. Hanke Island sonic wind #2 recorded hourly average wind speeds of 40 to 75 MPH for four days. The gusts had to be at least 90 KT.
11/12/11	Winter Storm	A triple point low developed over the Western Gulf of Alaska on the afternoon of Friday 11.11. This system developed to hurricane force wind the strongest winds along the outer coast as the low center moved eastward on Saturday 11.12. Warm moist air was forced aloft over cooler air at the surface causing some heavy amounts of snow for the Yakutat and Haines areas. NWS WSO Yakutat measured 7.1 inches of new snowfall on 11.12 which fell during the morning. The snow changed to rain in the afternoon.
11/15/11	Winter Storm	NWS WSO Yakutat measured 12.3 inches of new snowfall on 11.16. Most of this snow occurred during the early morning hours on 11.16.
11/22/11	Winter Storm	NWS WSO Yakutat measured new snowfall as follows: 4.2 inches on 11.21, 12.5 inches on 11.22, and 4.4 inches on 11.23.

Date	Event Type	Magnitude
11/27/11	Winter Storm	A storm force low in the Western Gulf of Alaska caused a strong warm front to move onto the Eastern Gulf Coast early on the morning of 11.28. The arctic front was stationary over Lynn Canal at the time. This setup caused heavy snow for the Yakutat area, Pelican, Elfin Cove, and Haines. WS WSO Yakutat measured 7.3 inches of new snow on 11.27, most of which fell during the evening. An additional inch fell after midnight. Snow changed to rain early in the morning. Wind gusts were up to 25 KT.
12/14/11	Winter Storm	A front moved onto the Eastern Gulf Coast on the morning of 12/14. Because the low-pressure system in the Western Gulf was weak, wind did not erode the cold air over Yakutat causing heavy snow. The NWS office in Yakutat measured 7.3 inches of new snow at midnight AKST on 12.14. The previous day got 3.6 inches for a storm total of 10.9 inches. Most of the snow fell during the daylight hours on 12.14. Visibility at Yakutat Airport dropped as low as one half mile.
01/01/12	Winter Storm	The NWS office in Yakutat measured 5.9 inches of new snow during the afternoon of 1.1 and a slight amount of snow after midnight on 1.2. The snow became mixed with rain that evening. Peak wind was 31 MPH during this event.
01/05/12	Winter Storm	The arctic front was over the Eastern Gulf Coast on the night of January 5th with warm moist air moving over the front aloft for heavy snow. Yakutat got 10.2 inches of new snow overnight that was measured on the morning of 1/6. The NWS office in Yakutat measured 3.3 inches before midnight and 6.9 inches after midnight for a storm total of 10.2 inches overnight.
01/10/12	Winter Storm	A classic Pineapple Express of strong south flow aloft loaded with moisture was aimed at Prince William Sound on January 10th. Low level cold air remained over the northern sections of SE Alaska which caused heavy snow near Yakutat and Haines on the 10th through the 11th. The NWS office at Yakutat measured 5.9 inches of new snow from noon to midnight on January 10th. The snow changed to heavy rain around midnight which rapidly compacted the snow by measurement time. Snow load considerations were important to the community on the 10th and the 11th.
01/23/12	Heavy Snow	Yakutat WSO measured 7.7 inches of new snow on 1.23 most of which fell during the afternoon. Wind gusts to 20 MPH and visibility was as low as 1/4 mile.
01/24/12	Winter Storm	The NWS office in Yakutat measured 11.3 inches of new snow on 1.24 and 11.2 inches of new snow on 1.25. A storm total of nearly two feet added to the near record snowfall for the season. Snow removal has been a significant problem and cost to Yakutat for the winter of 2011-12.
01/26/12	Winter Storm	The NWS office in Yakutat measured 8.7 inches of new snow on 1.26 and 9.3 inches of new snow on 1.27. Storm total 18 inches which added to the near record snowfall for the season.
02/03/12	High Wind	Yakutat had a measured gust of 81 MPH at 0630 AKST on 2.3. The VHF antenna was blown down at the WSO. Trees were downed with power outages on 2.3. Reports of gusts to 100 MPH unofficial. Luggage carts were blown over at Alaska Airlines. A porch was blown off a house and several roofs were damaged.
02/10/12	High Wind	Yakutat Airport measured a gust to 71 MPH at 0141 AKST on 2.10 with numerous gusts in the 50s early that morning. No damage was reported.
02/26/12	Winter Storm	The NWS office in Yakutat measured 5.8 inches of new snow on 2/26 and 6.5 inches of new snow in 2/27. This fell during a period of 24 hours starting at 0900 on 2/26 and ending at 0900 2/27. Visibility was as low as 1/2 mile at times during this storm and the peak wind was 39 MPH.
03/01/12	Winter Storm	The arctic front had established along the north Gulf coast on 2.29. A gale force low approached from the south sending warm moist air aloft over the colder arctic air on 3.1 into 3.2. Yakutat got another dump of snow adding to the misery already there where the snow depth was 68 inches and no place to put it. The NWS office in Yakutat measured 11.4 inches of new snow from midnight to midnight on March 1st with an additional 3.2 inches on the morning of March 2nd. 68 inches on the ground with no place to put snow removal. No reports of damage with this particular event, but long-term effects and expense of removal were well evident.
03/03/12	Winter Storm	A moderate strength low pressure system remained nearly stationary near Middleton Island on March 3rd & 4th. This system caused some more brief heavy snow over Yakutat on the night of March 3rd. The NWS office in Yakutat measured 5.3 inches of new snow from midnight to midnight on March 3rd but most of the snow was during the evening. An additional inch fell during the early morning hours on the fourth for a storm 6.3 inches and the snow on the ground was 71 inches. Visibility was reduced to 1/4 mile at times in the heavy snow and the peak wind was 26 KT at the airport for near blizzard conditions.

Date	Event Type	Magnitude
03/06/12	Winter Storm	The NWS office in Yakutat measured 2.6 inches of new snow by midnight on March 5th then with temperatures in the teens, and an additional 9.5 inches on the morning of the 6th. The snow then compacted over 3 inches in the afternoon as temperatures warmed into the mid 30s. No damage was reported.
03/08/12	Winter Storm	A frontal system moved onto the coast on the morning of March 7th then stalled over the northern Panhandle into the 8th. Heavy snow was observed for Yakutat and Northern Lynn Canal but there were no reports of damage. The southern Panhandle had some storm force wind with this event. The NWS office in Yakutat measured 8.0 inches of new snow midnight to midnight on March 8th. most of this amount fell in the early morning hours. Temperatures rose into the upper 30s that day which compacted this snow. Visibility was down to 1/4 mile in snow frequently during the day with 1.26 inches of water. The result was 87 inches of snow on the ground at the end of the day near sea level with no place to put it.
03/24/12	Winter Storm	Snow dumped on Yakutat again on March 24th. A weak low-pressure system was stationary in the Central Gulf of Alaska on the 24th, but this system pumped warm moist air aloft over the cold air at the surface. Yakutat got 13.5 inches of new snow by midnight, but there was no report of damage. This resulted in 91 total inches of snow on the ground and no where to put it. The NWS office in Yakutat measured 13.5 inches of new snow midnight to midnight on March 24th. Visibility was frequently down to 1/4 mile in snow during the day but fortunately there was little wind. The result was 91 inches of snow on the ground and no where to put it.
10/17/12	Winter Storm	An upper-level low pressure system combined with moist low level onshore flow from the Gulf of Alaska to bring brief heavy snow to the Eastern Gulf Coast around Yakutat on Wednesday October 17th. This was the first heavy snow of the season for the Yakutat Forelands. The NWS office at Yakutat measured 9.1 inches of heavy wet snow that accumulated during the late morning and afternoon on Wednesday October 17th. An additional 2.7 inches of new snow fell on the 18th the snow changed to rain during the afternoon. No damage or power outages were reported.
12/08/12	Winter Storm	Yakutat measured 7 inches of new snow at midnight on 12/9 most of which fell during the evening. During the night visibility lowered to 1/2 mile in snow. Snow turned to rain with gusts to 30 MPH around 2 AM on the 12/9.
02/17/13	Winter Storm	Relatively cooler air in the low 30s persisted for the Yakutat Forelands on Sunday 2/17 as warm moist air moved over the area from the SW. A complex frontal system moved into the eastern Gulf of Alaska on the evening of 2/17 which provided additional lift for the moisture. Yakutat measured 9.9 inches of new snowfall mainly on the afternoon of 2/17. The snow changed to snow mixed with rain on the morning of 2/18. Due to the warmer temperatures, the snow compacted rapidly and was difficult to remove. The NWS office in Yakutat measured 9.9 inches of new snow midnight to midnight on 2/17. Less than an inch was measured the next day. The snow changed to snow mixed with rain on the morning of 2/18. Due to the warmer temperatures, the snow compacted rapidly and was difficult to remove.
03/29/13	Heavy Snow	Southerly flow aloft brought significant moisture over cold air at the surface for the Eastern Gulf Coast. Yakutat measured 6.9 inches of new snow on the evening of 3/29 in eight hours ending at 0100 on 3/30. Yakutat WSO measured 6.6 inches of new snow on 3/29 and 1.7 inches of new snow during the early morning of 3/30. Storm total was 6.9 inches in 8 hours due to compacting.
04/16/13	Winter Storm	Low pressure persisted in the central Gulf of Alaska on 4/16 which moved warm moist air over colder air near the surface along the Eastern Gulf Coast. This caused a day of heavy snow. Yakutat had a storm total of 10.6 inches of new snow with heavy snow up to an inch an hour occurring during the daytime on 4/16. WSO Yakutat measured 6.4 inches of new snow between 0600 and 1600 on 4/16. The storm total was 10.6 inches measured just before 0500 on 4/17. No damage has been reported, but the snow was wet and heavy therefore difficult to remove.
11/21/13	Winter Storm	Yakutat got 2 to 3 inches of new snowfall before the precipitation changed to freezing rain by the afternoon of 11/21. The NWS Office observed freezing rain from 1300 to 1900 on 11/21. Strong wind increased after midnight to 40 MPH.
12/11/13	Winter Storm	Yakutat received 7.1 inches of new snow by 11 PM AKST on the 12th then the snow changed to moderate rain. Wet snow was difficult to manage.
12/19/13	Winter Storm	A 993 MB gale force triple point low moved into the central Gulf of Alaska on the morning of the 19th forcing warm moist air over cold air at the surface in the Panhandle. This system brought heavy snow to much of SE Alaska including the northern Panhandle, Yakutat, and Hyder. WSO Yakutat measured 13.3 inches storm total on the 19th. Most of the new snowfall was in the morning.

Date	Event Type	Magnitude
02/12/14	Winter Storm	Low pressure (960mb) located over the western Gulf near remained stationary through 2/14 and the associated front drove moisture into the Yakutat area and Northern Panhandle. This warmer, moist air produced significant snowfall across the region and some wind. Travel was impeded. About on 2/13 at 430am Bob Pate called WSO Yakutat to say they had 10 in town... office had about 6around that time. By 745am the WSO had 8 total. WSO Yakutat got 14 inches thus far as of noon 13th WSO Yakutat got 13.2 inches for the storm total which was compacted.
02/14/14	Winter Storm	Low pressure (960mb) located over the western Gulf near remained stationary through 2/14 and the associated front drove moisture into the Yakutat area and Northern Panhandle. This warmer, moist air produced significant snowfall across the region and some wind. Travel was impeded. Yakutat already got a snow dump on 2/14 then got 4 more inches before midnight on 2/15. The snow then changed to rain, and the snowpack rapidly diminished.
11/17/15	Winter Storm	Cold air was in place over the Yakutat Forelands on the morning of Nov 17 as moist warm air aloft moved over the area. The result was heavy snow that had to be plowed. No damage was reported. Juneau also got some significant snow later that day as the warm air continued inland. Storm total for Yakutat midnight to midnight on November 17th was 10.6 inches. No damage was reported.
12/31/15	High Wind	Arctic high pressure up to 1043 MB had moved into British Columbia while a strong front moved up to the outer coast. This combination caused strong wind along the Yakutat Forelands and set up some significant snow along the Klondike Highway. No damage was reported. The approaching front caused a burst of SE wind for the Yakutat Forelands. The ASOS at the airport had a peak gust of 58 MPH. Ocean Cape easily had 65 KT and maybe more. No damage was reported.
12/07/16	Heavy Snow	WSO Yakutat measured 6.5 inches of new snow that fell between 2200 Wednesday 12/7 and 0700 12/8. No damage reported.
01/06/17	High Wind	Yakutat Airport had a peak wind of 50 mph on 1/6 at 0954 and a peak of 52 mph at 0156 on 1/7. Wind chill was in the minus 30s (-30F). So, those are extreme for the airport. Estimated wind 100 mph or more for the Dangerous River outflow. No damage |reported so far.
01/27/17	High Wind	Yakutat ASOS peak wind 60 MPH which is very unusual for that particular ASOS. Some trees were knocked down along with power outages. An Alaska Airlines luggage trailer took off across the ramp propelled by the wind, but fortunately did not damage anything.
02/10/17	Winter Storm	Storm total for Yakutat on this event was 18 inches new snow.
11/17/17	Winter Storm	WSO Yakutat measured 14.0 inches new snow at 0800 on 11/18. Impact was snow removal with no damage or power outages reported.
02/28/18	Winter Storm	Storm total 11.0 inches overnight for Downtown Yakutat for 2/27 to 2/28. Impact was removal of heavy wet snow.
03/06/18	Winter Storm	Storm total snow measured at the Yakutat Airport and Downtown was 7.0 inches in 12 hours. Impact was snow removal.
10/19/18	High Wind	Yakutat had high wind observed on the morning of 10/19, but no damage reported. Peak gust at the Airport was 58 mph. Gusts to 75 mph were measured at Deception Hills near Dry Bay at 0825 on 10/19.
02/21/19	Winter Storm	A low-pressure system moved into the central Gulf on the evening of 2/21 with a warm front moving over the Panhandle. Some cold air was trapped over the Yakutat forelands and the northern Panhandle which caused come moderate snow that eventually had some rain mixed. Impact was snow removal. Yakutat ASOS and observer measured a storm total 9.4 inches. Impact was delayed air travel and snow removal.
10/10/19	High Wind	Yakutat Airport ASOS measured gusts as high as 51 mph. Estimated wind in the area was 60 mph based on known windier areas around town. No damage was reported.
12/03/19	Winter Storm	Yakutat had heavy snowfall on 12/3 with 6 to 10 inches of new snow in showers. Impact was snow removal.

Date	Event Type	Magnitude
12/05/19	Winter Storm	Very heavy snow occurred in Yakutat with a total of 8.5 inches in town and 10 inches at the airport. The Weather Service Office noted rates of 3 inches in just over 2 hours.
12/22/19	Winter Storm	Yakutat measured 6.9 of snow on the ground. Snow fell in Yakutat from 7:40 PM last night until around 2 AM this morning when it changed to rain and temps rose to the upper 30s.
01/25/20	Heavy Snow	Yakutat ASOS had a period of heavy snow on the evening of the 25th followed by freezing rain and rain for a short time. Overnight the rain changed back to heavy snow with spotters reporting 8 to 10 inches of accumulation by morning. Light to moderate snow continued through the daytime on the 26th with a few more inches of accumulation. This event was on top of 5.8 inches falling the previous day, which made it more impactful.
01/28/20	Heavy Snow	Light snow showers fell over the Yakutat area on the 28th, then heavy rates began at 3pm with 3 inches falling by 6pm. Wind backed to the NE due to a strong low in the gulf, keeping colder air in place. Heavy rates aided in snow continuing overnight, despite gradual warming. A wind shift to the S-SW Wednesday morning changed precipitation to all rain. Yakutat COOP measured 5.7 inches of snow at 9am, but it had already changed to heavy rain and likely compacted the snow.
01/31/20	Heavy Snow	Cold advection caused very heavy snow showers in the Yakutat area with quick accumulation during the day on Friday the 31st. Yakutat Weather Service Office reported 6 inches of snow between 8am and noon Friday, then another 4 inches by 4pm for a total of 10 inches in 8 hours. The heaviest rates ever seen by the employee. A Winter Weather Advisory was in place.
02/20/20	High Wind	Yakutat airport ASOS measured a peak wind gust of 62 mph as a strong front moved through.
03/01/20	Heavy Snow	Beginning on leap day, a strong front moved onshore with heavy snow and blowing snow for Yakutat and White Pass. As winds shifted to the south, high winds occurred in Skagway through the morning of the 2nd. Heavy snow fell over Yakutat along with strong wind gusts up to 37 mph and visibility reduced to a mile and a quarter. At 7 am on the 1st, a trained spotter measured 9 inches of snow falling since 7pm on Feb 29th, but had already changed to rain at their location.
04/07/20	Heavy Snow	Low pressure moved NE into the northern Gulf of Alaska. The associated warm front and long fetch of moisture reached the panhandle during the nighttime hours, causing heavy snow over the Yakutat, Haines, and Skagway areas. Dry air in place ahead of the system allowed temperatures to cool enough for snow. Strong southerly winds blew through the Juneau area Wednesday morning and changed the snow to rain in the afternoon for the northern areas. Employee at the Yakutat Weather Service Office measured 7.5 inches of snow by 7 AM and was still snowing at the time and rather windy. Snow knocked out TV and Internet service.
11/03/20	Heavy Snow	A remnant small low over the northern gulf coast caused periodic heavy snow showers to move over the Yakutat area during the 3rd and morning of the 4th. Spotter in Yakutat measured 9 inches of new snow, most of this fell during the morning hours and during periodic heavy snow showers.
11/28/20	High Wind	A strong front moved across the region causing high winds and some damage in Yakutat and Juneau shortly before frontal passage. It also spread moisture over colder air over the northern portion of Lynn Canal with significant snowfall. Yakutat airport measured a peak gust of 64 mph at 1049 AM. Following this, a trained spotter reported multiple trees and branches down. Law enforcement reported damage to a satellite dish and a tent blown over. An additional report of approximately 1 square mile of trees toppled or snapped off near Cannon Beach.
12/22/20	High Wind	Yakutat Airport ASOS reported a wind gust of 58 mph.
01/18/21	High Wind	Yakutat Airport surface observation system recorded gusts up to 63 mph.
02/01/21	Winter Storm	A measurement of 9 inches of snow reported at the weather service office in Yakutat. Snow had stopped at 9 am.
02/17/21	Winter Storm	A report of 7 inches of snow was reported in Yakutat at 1 pm.
03/01/21	Heavy Snow	A front approaching the NE Gulf coast spread precipitation into the Yakutat region. Anticipated offshore flow was forecasted to keep temps cool enough for a significant overrunning event of snow. Trained Spotter in Yakutat reported 6 inches of new snow in 8 hours.

Date	Event Type	Magnitude
03/10/21	Heavy Snow	Trained spotter in Yakutat reported 6 inches of new snow.
03/14/21	Heavy Snow	NWS WSO in Yakutat reported 6 inches of snow at 8 am.
11/16/21	Heavy Snow	AS of 4 pm, 8.1 inches of snow has fallen at the Yakutat Weather Service Office.
11/17/21	Heavy Snow	A member of the general public estimated 6 inches of snow overnight in Yakutat. 10 inches was reported by 1330 AKST.
12/01/21	Heavy Snow	Unstable moist air moved onshore from the Gulf of Alaska creating snow showers. While most locations did not report significant snowfall, Yakutat experienced 8 inches and Sitka saw multiple hours of snowfall with a foot of snow from this event. Trained spotter reported 8 inches of new snow in Yakutat.
12/09/21	Heavy Snow	NWS Employee reports 9.8 inches of snow overnight in Yakutat.
12/10/21	Heavy Snow	Trained spotter in Yakutat reports 12 inches of fresh snow since 6 pm last night. Snow total on the ground is 50 inches. A garage roof collapsed likely due to snow loading.
12/31/21	Heavy Snow	A trained spotter in Yakutat reported 6 inches of new snow at 8:45 in the morning.
01/09/22	Heavy Snow	A strong low-pressure system in the Gulf of Alaska brings Taku winds to Juneau ahead of the storm, and widespread winds and snow across Southeast Alaska. Heavy snow transitioned to rain across much of the area. This along with antecedent snowfall created roof load issues across the area with structural collapses in Juneau and Yakutat. Rain on snowpack and frozen ground created icy conditions across the area that impacted transportation for days following the event. Damage to multiple structures including the medical clinic in Yakutat due to snow loading. National Guard was mobilized to help clear roofs from vulnerable structures. New Snow from the storm was estimated to be at least an additional 2 feet leading to snow depths around 5-6 feet across the area.
02/01/22	Winter Storm	NWS employee in Yakutat reported 7 inches of snow at 8 am on February 2nd.
12/23/22	Heavy Snow	Spotter reported 12 inches of snow, but winds were blowing the snow with drifts considerably higher than the measured total. The Yakutat airport ASOS measured wind gusts of 30 -40 mph with visibility down to a half mile periodically between 9pm and 5am.
03/01/23	Heavy Snow	A strong low pressure developed over the northern Gulf of Alaska bringing significant moisture to Southeast Alaska. Cold air entrenched over the region at low levels ahead of the event allowed for significant snow to fall across the area in two major pulses. The first being along the warm front, with a period of blizzard conditions over Juneau, and the second pulse occurred as the cold front moved across the region. Snow began in Yakutat in the afternoon of February 28th and continued to fall for the next two days. Around 8am on the 1st, WSO Yakutat estimated 6 to 8 inches of snow had fallen while a retired NWS employee nearby measured 9 inches with a quarter mile visibility at the time. By 11am another 8 inches had fallen. The quarter mile visibility lasted from 544am to 136pm on the 1st, with winds of 15 to 20 mph. The storm total by 446pm had reached 22 inches, but post frontal snow showers continued through the following morning with around 7 inches of additional accumulation.
03/15/23	Winter Storm	A broad area of low pressure over the Gulf resulted in waves of precipitation moving into Southeast Alaska, initiating an overrunning snow event. The greatest snowfall totals were largely in parts of the northern panhandle. In Yakutat, a retired NWS employee reported a period of heavy snow between noon and 3pm on March 15th where 4 to 5 inches fell. Additional periods of heavy snow fell through the night on the 15th with winds gusting to around 25 mph. It is unknown what the storm total was.
05/06/23	Frost/ Freeze	A ridge of high pressure over the eastern Gulf of Alaska and light winds during the overnight hours allowed temperatures to fall across the Yakutat area. The Yakutat airport recorded temperatures at or below 32 degrees with a minimum of 28 degrees at 510am local time. The nearby CRN site recorded temperatures at or below 32 degrees for just over 6 hours. No impacts were shared.

Source: NWS 2023b- Storm Events Database and Storm Prediction Center Product

Additionally, the DHS&EM October 2022 DCI lists the following severe weather disaster events which may have affected the area:

83. Omega Block Disaster, January 28, 1989 & FEMA declared (DR-00826) on May 10, 1989. The Governor declared a statewide disaster to provide emergency relief to communities suffering adverse effects of a record-breaking cold spell, with temperatures as low as -85°F. The State conducted a wide variety of emergency actions, which included: emergency repairs to maintain & prevent damage to water, sewer & electrical systems, emergency resupply of essential fuels & food, and DOT/PF support in maintaining access to isolated communities.

12-238 2012 Prince William Sound Winter Storm declared by Governor Parnell on February 9, 2012: Beginning in mid-December 2011 and continuing through January 2012, the City of Cordova and Prince William Sound area began receiving snowfall that put them on a pace to approach or break record seasonal precipitation accumulations. On December 12, the City of Cordova began working in emergency snow removal status. The Cities of Valdez and Yakutat had been facing similar challenges. Avalanches across roadways and extreme conditions have limited or cut off access to airports and other critical infrastructure and endangered public, private and commercial facilities throughout the communities.

AK-22-279 2022 January Southeast Storm declared by Governor Dunleavy on January 11, 2022: 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.

3.3.2.3 Location

The entire Planning Area experiences periodic severe weather impacts.

The Yakutat area is historically impacted by severe weather events due to their location within a maritime climate area, which is characterized by cool summers, mild winters, and heavy year-round precipitation. This type of climate is typical of the southeastern and southern coastal areas of Alaska where the ocean exerts a modifying influence and causes relatively low seasonal and diurnal temperature variations.

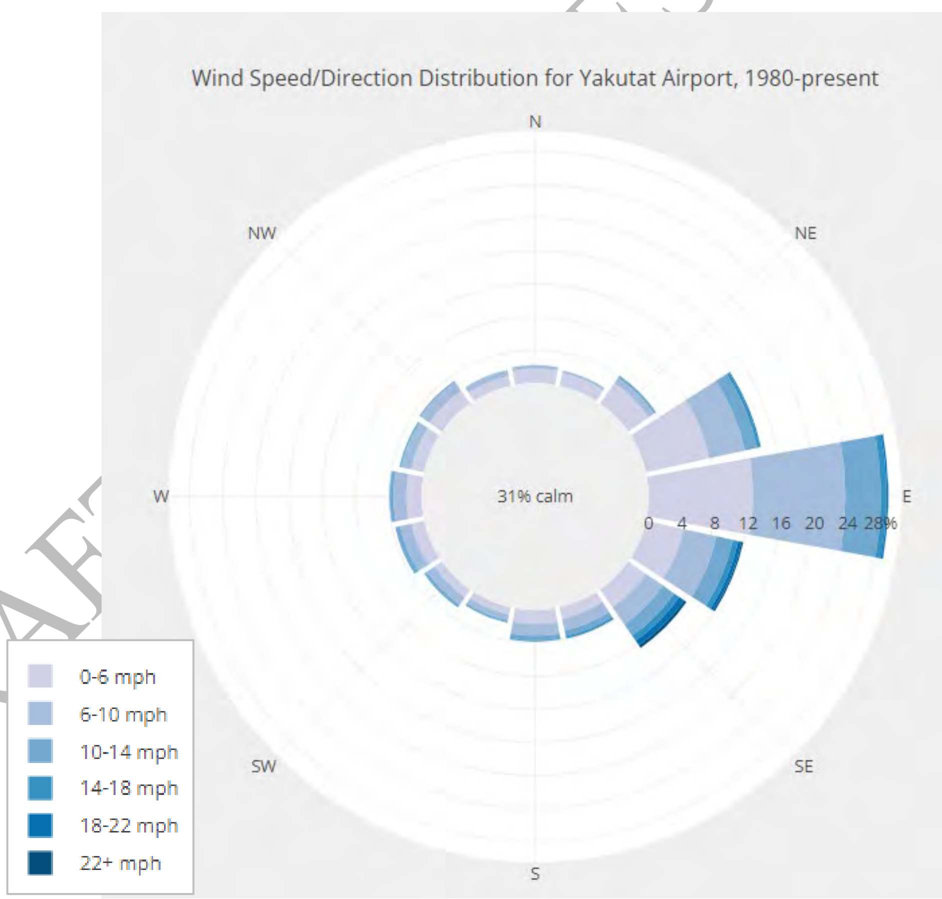
The proximity to the ocean and the frequent lows, which develop or move out of the Gulf of Alaska result in heavy precipitation in the Yakutat area. According to the USACE, the design snow load factor for Yakutat should be 100 pounds per square foot, which is the highest in the state. In anecdotal information from weather forecasters who study Yakutat, the **snow load factor should actually approach closer to 150 pounds per square foot**. In practical terms, it means that people must guard against excessive snow accumulations on roofs, boats, and airplanes.

3.3.2.4 Extent (Magnitude and Severity)

Yakutat is vulnerable to the impacts from severe weather. The extent (magnitude and severity) of each severe weather event is listed below.

Severe Weather Event	Extent (Magnitude and Severity) of the Event
Extreme Cold	The lowest temperature in Yakutat was recorded in January 1947, where temperatures reached -21.6°F.

Severe Weather Event	Extent (Magnitude and Severity) of the Event
Freezing Rain and Ice Storms	Yakutat experiences periodic freezing rain and ice storms that have damaged utility lines. The airport has been impacted by frost heaving, resulting in cracks, separations, and uplift/settling at the end of the runway (Figure 3-25).  Source: AKDOT 2022- Site Visit to Yakutat (July 14, 2022) **Figure 3-25 Cracks, Separations, and Uplift/Settling at the Airport (July 2022)**
Heavy Snow	Yakutat experiences severe storm conditions accumulating over 10-20 inches of snowfall within several hours.
Drifting Snow	Yakutat experiences periodic drifting snow events that have caused blockages on roads and snow buildup on the sides of larger buildings.
Winter Storm	Yakutat experiences periodic winter storms that have caused blizzard conditions, heavy snowfall, high winds, and flooding.
Heavy Rain	Yakutat receives some of the heaviest precipitation in the state, averaging 155 inches of rainfall and 142 inches of snowfall. In 2013, 7.31 inches of rain fell at the Yakutat airport and 9.96 inches fell at the Situk River gauge in just under 2 days. Heavy rain has led to localized flooding of creeks and rivers.
Atmospheric River	Due to its location on the western side of the North American continent, SE Alaska is often the target for powerful ocean storms that form over the western and central Pacific Ocean and move eastward, steered by the prevailing westerly upper-level jet stream. These powerful low-pressure systems often have strong fronts associated with them. Fronts act like a conduit to channel warm, moist air northward and eastward ahead of the low-pressure system in what is called the "warm conveyor belt" (NOAA 2020b).

Severe Weather Event	Extent (Magnitude and Severity) of the Event
	The strongest fronts are also regions of strong winds in the lower portions of the atmosphere. The stronger the winds, the more moisture that can be transported. If the lower-level winds blow from a southerly or southwesterly direction, they are also perpendicular to the steep terrain of SE Alaska. As this happens, the warm moist air is forced to rise, and rainfall amounts are enhanced. These fronts often slow down or even stall over the eastern Gulf of Alaska as they encounter the higher terrain to the east. This can cause the duration of the heavy rainfall to be extended to a many as 1 to 3 days (NOAA 2020b).
High Winds	Yakutat experiences severe storm conditions with wind speeds and gusts exceeding 100 mph. In Yakutat, wind speeds are at least 10 mph higher along the beach and in outflow regions of the local rivers and Yakutat Bay. Figure 3-26 shows annual wind speed and direction distribution at the Yakutat Airport from 1980-current. • Spokes in the rose point in the compass direction from which the wind was blowing (i.e., a spoke pointing to the right denotes a wind from the east). • Colors within each spoke denote frequencies of wind speed occurrence. • Size of the center hole indicates the % of calm winds.  Source: UAF/SNAP 2023b **Figure 3-26 Annual Wind Speed/Direction Distribution in Yakutat, 1980-Present**

Severe Weather Event	Extent (Magnitude and Severity) of the Event
Drought	Although southeast Alaska is one of the rainiest areas in North America, it was plagued by drought from October 2016 to December 2019. An “extreme drought” was declared by the U.S. Drought Monitor in summer 2019. Dry spells are not unusual in southeast Alaska- prolonged dry periods occurred in the 1950s, 70s, and 90s. Some of these past droughts were longer and had years with even less rain, but the 2016–2019 drought was particularly jarring to those experiencing it because it followed a decade of much wetter conditions (Hoell et al. 2022). Unlike other communities in southeast Alaska, Yakutat was not severely impacted by this drought. Yakutat has not been severely impacted by historical droughts. The Planning Team states that the Situk River, the main fishing river that supports Yakutat’s economy, sustains impacts when drought occurs. A drought during the summer of 1987 may have been at least partially responsible for the reduced numbers of Situk River steelhead noted from 1990 through 1992 (ADF&G 2003).

Based on past severe weather events and the criteria identified in Table 3-2, the extent of overall severe weather in Yakutat is considered Limited to Critical, where injuries and/or illnesses could result in temporary to permanent disability; with potential for critical facilities to be shut down for more than a week, and 10-25% of property would be severely damaged.

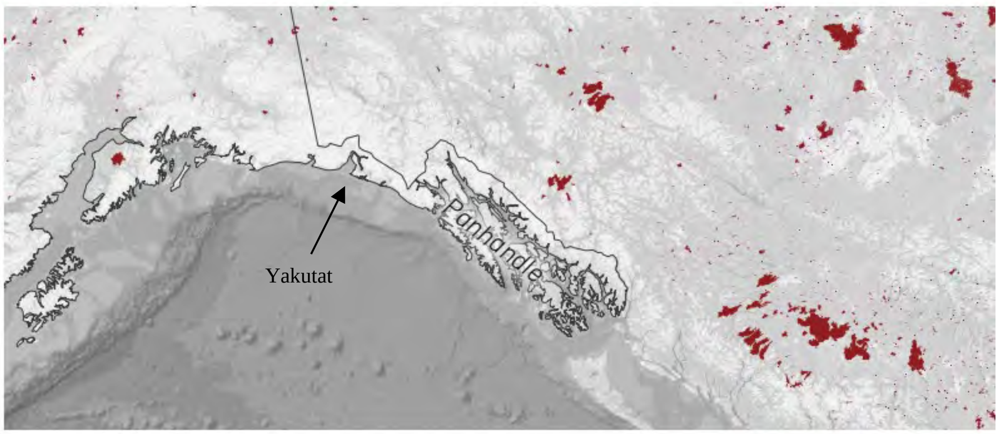
3.3.2.5 Impact

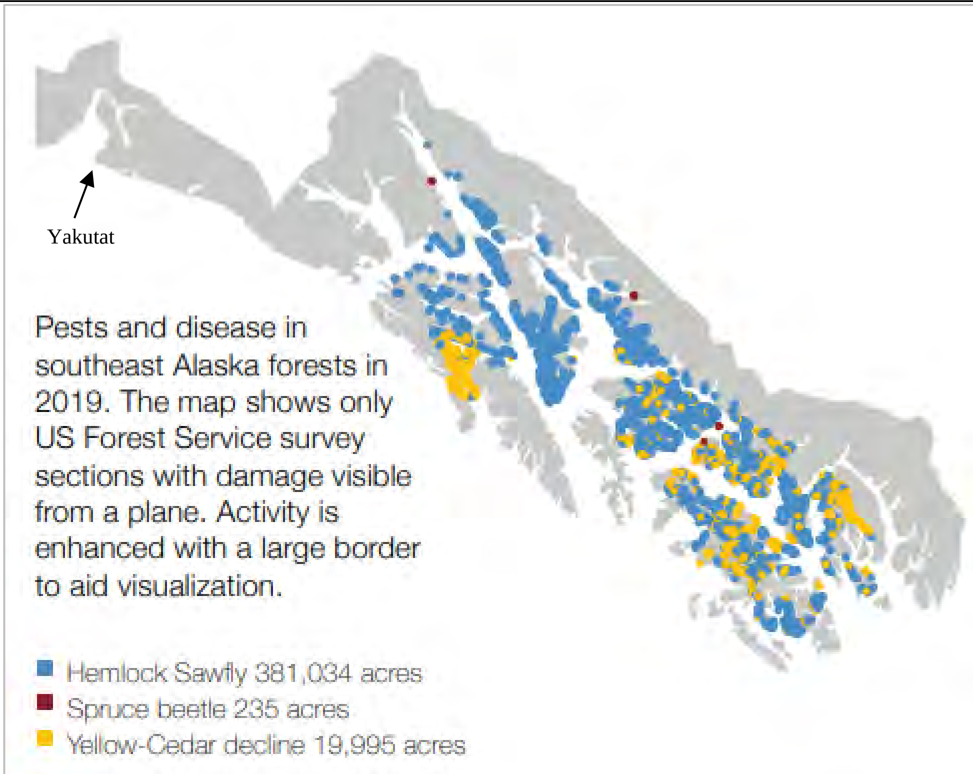
The location, land topography, and intensity influence the severity of a severe weather event impact within a community. Below are the impacts of various historical severe weather events in Yakutat.

Severe Weather Event	Impact of the Event
Extreme Cold	Extreme cold may also impact a community by disrupting the flow of transportation within the community. With extreme cold temperatures, comes ice fog, which may ground an aircraft carrying supplies until conditions improve. Prolonged periods of cold can cause large bodies of water to freeze, disrupting shipping and increasing the likelihood of ice jams and associated flooding. While Alaskans have engineered ways to stay warm during extreme cold, infrastructure can only withstand and function within a certain temperature range. Extreme cold can cause electric generation to malfunction or cause fuel to congeal in supply lines and storage tanks. Without electricity, heaters and furnaces do not work, and water/sewage pipes can freeze or rupture. A combination of extreme cold and little to no snow cover, increases the ground’s frost depth, which can disturb pipes beneath the ground. While extreme cold can impact a community’s infrastructure, the greatest danger from extreme cold is its impact on humans. Prolonged exposure to extreme cold can cause frostbite or hypothermia and become life-threatening very quickly. Infants and elderly people are most susceptible to these conditions. Carbon monoxide poisoning is another threat as people use supplemental heating devices without proper ventilation. Extreme cold accompanied by wind intensifies life-threatening exposure injuries such as hypothermia and frostbite. Southeast Alaska does not experience extreme cold temperatures that the western, northern, and interior regions experience. Impacts from extreme cold in Yakutat have included loss of utilities.

Severe Weather Event	Impact of the Event
Freezing Rain and Ice Storms	Ice accumulations can damage trees, utility poles, and communication towers. Ice on communication towers can disrupt transportation, power, and communications within the community. Ice storms are often the cause of automobile accidents, power outages, and personal injury. Impacts from freezing rain and ice storms in Yakutat have included loss of utilities.
Heavy Snow	Heavy snow can impact a community by halting transportation in and out of a community. Until the snow can be removed, roadways and airports are impacted, even closed completely. With these services out of commission, supplies are not able to be brought into the community, and emergency and medical services are halted. Excess weight from accumulated snow on roofs, trees, and powerlines can cause them to collapse. Heavy snow can also damage light aircraft and cause small boats to sink. Once temperatures reach above freezing, the heavy snow will begin to thaw, and can cause substantial flooding. The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts on the community. Heavy snow can lead to injury or death as a result of vehicle and or snow machine accidents. Other causalities can occur due to hypothermia caused by prolonged exposure to cold weather or overexertion while shoveling snow. Impacts from heavy snow in Yakutat have included structural damages to buildings including the Yakutat clinic, dangerous road conditions, loss of utilities, snow removal, and have resulted in disaster declarations (January 2022). The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts on the CBY and the Tribe. On January 9, 2022, there was damage to multiple structures including the medical clinic and school in Yakutat due to snow loading. The National Guard was mobilized to help clear roofs from vulnerable structures. New snow from the storm was estimated to be at least an additional 2 feet leading to snow depths around 5-6 feet across the area.
Drifting Snow	The most common hazard caused by blowing and drifting snow is quickly reduced visibility while driving. The combination of near-zero visibility and drifting snow can cause unexpected travel difficulties and accidents in remote areas during dangerously cold winter weather situations. Impacts from drifting snow in Yakutat have included loss of visibility and dangerous road conditions.
Winter Storm	A winter storm can last a few hours or several days, cut off utilities, and put older adults, children, sick individuals, and pets are at greater risk. Winter storms create a higher risk of car accidents, hypothermia, frostbite, carbon monoxide poisoning, and heart attacks from overexertion. Winter storms can also cause property damage. Some impacts to homes and other infrastructure may include roof damage or collapse, water damage from frozen or busted pipes, cracks in caulking due to extreme cold, damage to building foundations. Winter storms and cold temperatures can also impact vehicles (cars, snowmachines) that the community relies upon for transportation. These impacts may include slowing the battery, hurting the cooling system, thickening fluids, damaging the engine, and increasing the potential for vehicular accidents. Impacts from winter storms in Yakutat have included loss of visibility, loss of utilities, snow load considerations, school closures, damage to critical facilities and infrastructure, and hindered snow removal efforts. In January 2022, CBY declared a local disaster emergency as exceptionally heavy snow, rain and ice piled atop critical buildings and infrastructure. This “very unusual” event resulted in over 6 feet of snow after a rare cold snap (ADN 2022). The town’s newly completed Yakutat Clinic Health Center was forced to close as 4 to 5 feet of heavy snow caused an estimated millions of dollars in water damage to the building and equipment (ADN 2022). Damages included: a carport at the City’s public safety building collapsed into a trailer set up for emergency management, a broken pipe flooded the

Severe Weather Event	Impact of the Event
	community's Head Start building, local crews scrambled to clear snow off the roof of elementary school and gym. The borough-owned fish processing facility, power plant, as well as stores and private residences, were also in danger of roof collapse and damage (ADN 2022). To aid in snow removal, the CBY hired 10 people on top of their usual 4 to help clear snow from buildings and raised the hourly rate of pay by 50%. This additional help was still not enough capacity to meet the community's needs. The CBY declared a local disaster and the State sent in the Alaska National Guard to provide emergency snow removal and building safety assessment to the community.
Heavy Rain	The potential impacts of heavy rain include crop damage, erosion, and an increased flood risk. Floods onset from heavy rain can result in road washouts, injuries/loss of life, or drowning. Impacts from heavy rain in Yakutat have included localized flooding of local rivers and streams.
Atmospheric River	Not all atmospheric rivers cause damage; most are weak systems that often provide beneficial rain or snow that is crucial to the water supply. Atmospheric rivers are a key feature in the global water cycle and are closely tied to both water supply and flood risks (NOAA 2023a). While atmospheric rivers are responsible for great quantities of rain that can produce flooding, they also contribute to beneficial increases in snowpack (NOAA 2023a). Impacts from atmospheric river events in Yakutat have included visible erosion on roads following AR events.
High Winds	High winds can result in downed trees and power lines, flying debris, building collapses, transportation disruptions, damage to buildings, damage to vehicles, and injury or death. High winds can cause power outages, resulting in lack of heating, running water, refrigeration loss, and damage to electronics and/or medical equipment. Impacts from high winds in Yakutat have included loss of utilities, downed trees, damage to buildings and residences, and damage to the Yakutat airport. On October 5, 2007, several roofs were blown off of cabins at the Situk River Fish Camp with wind gusts of at least 65 mph estimated. Minor roof damage was done in Yakutat City (tar paper blown off of a roof). On February 3, 2012, high winds lead to the VHF antenna being blown down at the WSO. Trees were downed with power outages on 2.3. Reports of gusts to 100 MPH unofficial. Luggage carts were blown over at Alaska Airlines. A porch was blown off a house and several roofs were damaged.
Drought	Droughts can severely impact a community by causing shortages in safe drinking water, reducing air quality by increasing the risk of wildfires and dust storms, increasing the potential of illness and disease, and increasing economic burdens. Droughts can also impact the environment by reducing soil quality for vegetation, reduction or degradation of fish and wildlife habitat, and lowering the water level of lakes, ponds, or reservoirs which can hinder salmon spawning abilities. Lakes and reservoirs across southeast reached record lows during the 2016–2019 drought. Several communities experienced water restriction. Others that rely on local hydroelectric companies for power switched to diesel generators and electricity costs rose for many SE Alaska communities as a result (UAF-IARC 2022b). Warm water and low stream flows in 2019 kept salmon in deeper, cooler offshore waters and delayed their movement into streams to spawn. At least one salmon mortality event was recorded when pre-spawning fish moved into a slough that later dried up. Late in the drought, hatcheries struggled to supply enough fresh, cool water to incubators. These salmon impacts were much less severe than other parts of Alaska where 2019's unprecedentedly warm river and ocean surface waters caused massive die-offs (UAF-IARC 2022b).

Severe Weather Event	Impact of the Event
	For 64 weeks, starting on October 2, 2019, Alaskan salmon were unable to enter many streams due to low flow conditions and drought conditions throughout Alaska caused many pre-spawn mortality events of salmon. All species of salmon were affected by the drought conditions statewide, leading to widespread mortality (USDM 2023). On June 27, 2019, there was a statewide ban of purchasing fireworks due to the high to very high fire danger as a result of hot, dry weather. At the time, there were 130 active wildfires burning 273,521 acres across the state (USDM 2023). Figure 3-27 shows wildfires surrounding southeast Alaska during the extreme drought summers from 2016-2019. Several large fires especially in Yukon and British Columbia sent smoke into southeast Alaska.  Source: Hoell et al. 2022 **Figure 3-27 Wildfires Surrounding SE Alaska During the Drought of Summers 2016-2019** Additionally, the 2016-2019 SE Alaska drought caused outbreaks of bugs and invasive species (Figure 3-28) (UAF-IARC 2022b). A hemlock sawfly outbreak across southeast Alaska began in 2018, ultimately defoliating 530,000 acres of forest. The warm and dry conditions in 2018 and 2019 were indirectly tied to the outbreak. Sawfly are always present in southeast, but in normal, cool, and wet summers, fungal diseases keep sawfly numbers down. The drought limited this fungal growth, allowing sawfly larval populations to grow to outbreak status (UAF-IARC 2022b).

Severe Weather Event	Impact of the Event
	 Source: UAF-IARC 2022b **Figure 3-28 Bug Outbreaks in SE Alaska During the 2016-2019 Drought** Yakutat was not severely impact by the 2016-2019 drought compared to other communities in southeast Alaska that were impacted. Yakutat has not been severely impacted by historical droughts. The Planning Team states that the Situk River, the main fishing river that supports Yakutat's economy, sustains impacts when drought occurs. A drought during the summer of 1987 may have been at least partially responsible for the reduced numbers of Situk River steelhead noted from 1990 through 1992 (ADF&G 2003).

The following images show damage from the January 2022 southeast storm that caused the CBY to declare a local disaster emergency. The National Guard was called in to assist with snow removal and damage assessments.

Source: Alaska's News Source 2022, Photo Credit: Yakutat Manager Jon Erickson

Figure 3-29 Heavy Snow Load on the Roof of the New Clinic, January 2022

Source: Alaska Public Media 2022, Photo Credit: Casey Mapes

Figure 3-30 Dangerous Snow Accumulation at the Yakutat School, January 2022

Source: Alaska Public Media 2022, Photo Credit: Casey Mapes

Figure 3-31 Collapsed Car Port at the Public Safety Building, January 2022

Source: Alaska Air National Guard, 176th Wing 2022

Figure 3-32 National Guard Removing Snow from Rooftops in Yakutat, January 2022

Source: Alaska Air National Guard, 176th Wing 2022

Figure 3-33 National Guard Shoveling Snow in Yakutat, January 2022

Photo Credit: Submission from the public survey

Figure 3-34 Snow Buildup on the Side of a House in Yakutat

3.3.2.6 Probability of Future Events

The probability of future events for each severe weather event is outlined below.

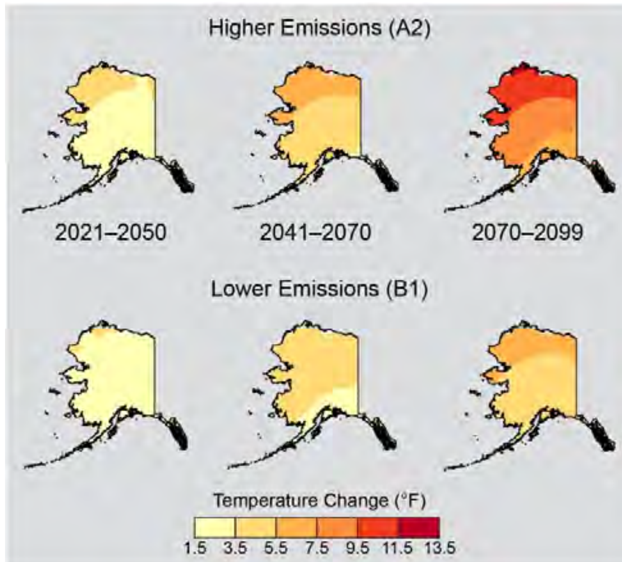
Severe Weather Event	Probability of the Event
Extreme Cold	Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience an extreme cold event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

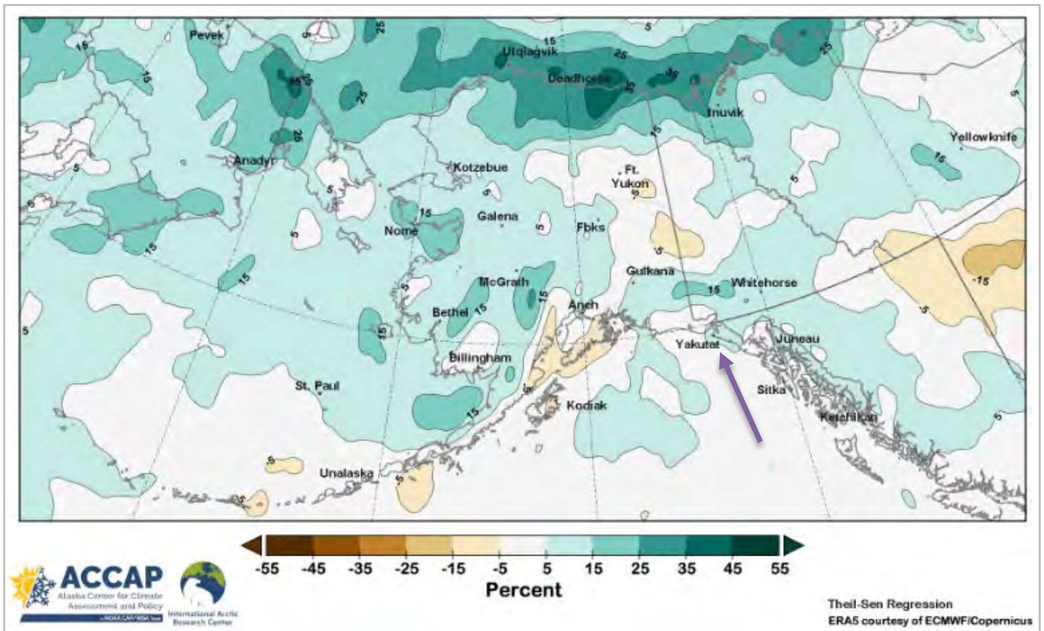
Severe Weather Event	Probability of the Event
Freezing Rain and Ice Storms	Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a freezing rain/ice storm event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.
Heavy Snow	Based on previous occurrences and the criteria identified in Table 3-3, it is Highly Likely that Yakutat will experience a heavy snow event within the calendar year; there is a 1 in 1 year chance of occurring (1/1=100%); and the history of events is greater than 33% likely per year.
Drifting Snow	Based on previous occurrences and the criteria identified in Table 3-3, it is Likely that Yakutat will experience a drifting snow event in the next three years; there is a 1 in 3 years chance of occurring (1/3=33%); and the history of events is greater than 20% but less than or equal to 33% likely per year.
Winter Storm	Based on previous occurrences and the criteria identified in Table 3-3, it is Highly Likely that Yakutat will experience a winter storm event within the calendar year; there is a 1 in 1 year chance of occurring (1/1=100%); and the history of events is greater than 33% likely per year.
Heavy Rain	Based on previous occurrences and the criteria identified in Table 3-3, it is Highly Likely that Yakutat will experience a heavy rain event within the calendar year; there is a 1 in 1 year chance of occurring (1/1=100%); and the history of events is greater than 33% likely per year.
Atmospheric River	Based on previous occurrences and the criteria identified in Table 3-3, it is Likely that Yakutat will experience an atmospheric river event in the next three years; there is a 1 in 3 years chance of occurring (1/3=33%); and the history of events is greater than 20% but less than or equal to 33% likely per year.
High Winds	Based on previous occurrences and the criteria identified in Table 3-3, it is Highly Likely that Yakutat will experience a heavy wind event within the calendar year; there is a 1 in 1 year chance of occurring (1/1=100%); and the history of events is greater than 33% likely per year.
Drought	Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience drought conditions in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

3.3.2.7 Future Conditions Including Climate Change

The nature or location of severe weather events in Yakutat are not anticipated to change due to climate change. However, the extent of severe weather events is expected to change due to climate change. The anticipated changes for each event are described below.

Severe Weather Event	Projected Changes in Extent (Magnitude and Severity) due to Climate Change
Extreme Cold	Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018). If global emissions continue to increase during this century, temperatures can be expected to rise 10°F to 12°F in the north, 8°F to 10°F in the interior, and 6°F to 8°F in the rest of the state (USGCRP 2018). In Southeast Alaska, surface temperatures are projected to increase by 1.8-5.4°F depending on season and projection model (Lader et al. 2020). In Yakutat, average annual temperatures may increase by about 9°F by the end of the century (UAF/SNAP 2023a). Summer temperatures are increasing the most (+11°F) and spring may transition from below freezing to above freezing temperatures in the future (UAF/SNAP 2023a).

Severe Weather Event	Projected Changes in Extent (Magnitude and Severity) due to Climate Change
	Figure 3-35 shows Alaska's predicted temperature changes under a higher emissions scenario and a lower emissions scenario through 2099. See Figure 3-37 for historical and projected temperatures for Yakutat.  Source: USGCRP 2018 **Figure 3-35 Alaska's Predicted Temperature Changes Through 2099**
Freezing Rain and Ice Storms	Alaska has experienced an 11% increase in the amount of precipitation falling in very heavy events from 1958 to 2012 (EPA 2016). As global temperatures continue to rise, freezing rain and ice storm events may be less severe as historical storms.
Heavy Snow	In southern and coastal parts of Alaska, large decreases in spring snowpack are expected by the mid-21st century, even with more winter precipitation because temperatures warm to above freezing, causing a shift from snow to rain or more melt during the winter (NPS 2020). Yakutat experiences severe storm conditions accumulating over 10-20 inches of snowfall within several hours.
Drifting Snow	Yakutat experiences periodic drifting snow events that have caused snow buildup and blockages on roads. Blowing and drifting snow in Yakutat have caused school delays and closures.
Winter Storm	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 droughts, floods, and winter storms (Dixon et al. 2018).
Heavy Rain	Alaska has experienced an 11% increase in the amount of precipitation falling in very heavy events from 1958 to 2012 (EPA 2016). Extreme precipitation events have occurred throughout Alaska with increasing frequency. Using climate models, scientists explored whether precipitation is likely to increase, decrease, or remain the same in southeast Alaska. There likely won't be a noticeable change in the next few decades, but by 2050 precipitation may increase by as much as 14% in some areas (UAF-IARC 2022c). The change will occur in both summer and winter. Even so, there will continue to be years with less rain or snow than the past, and years with much more. In Yakutat, fall rainfall may increase by 31% in the next century (UAF/SNAP 2023a). Yakutat averages 155 inches of rainfall per year, which is some of the heaviest precipitation in the state.

<table>
<tr><th>Severe Weather Event</th><th>Projected Changes in Extent (Magnitude and Severity) due to Climate Change</th></tr>
<tr><td></td><td>Figure 3-36 shows the percent change in annual average precipitation from 1973–2022 in Alaska. Based off this figure, average precipitation in Yakutat has increased by 5-15%.


Source: USDA 2023
Figure 3-36 Percent Change in Annual Average Precipitation Statewide (1973-2022)
See Figure 3-38 for historical and projected precipitation amounts for Yakutat.</td></tr>
<tr><td>Atmospheric River</td><td>With rising sea surface temperatures and increased vertically integrated horizontal vapor transport (IVT), ARs are projected to increase in intensity, a process which appears to have already started (Corringham et al. 2022).

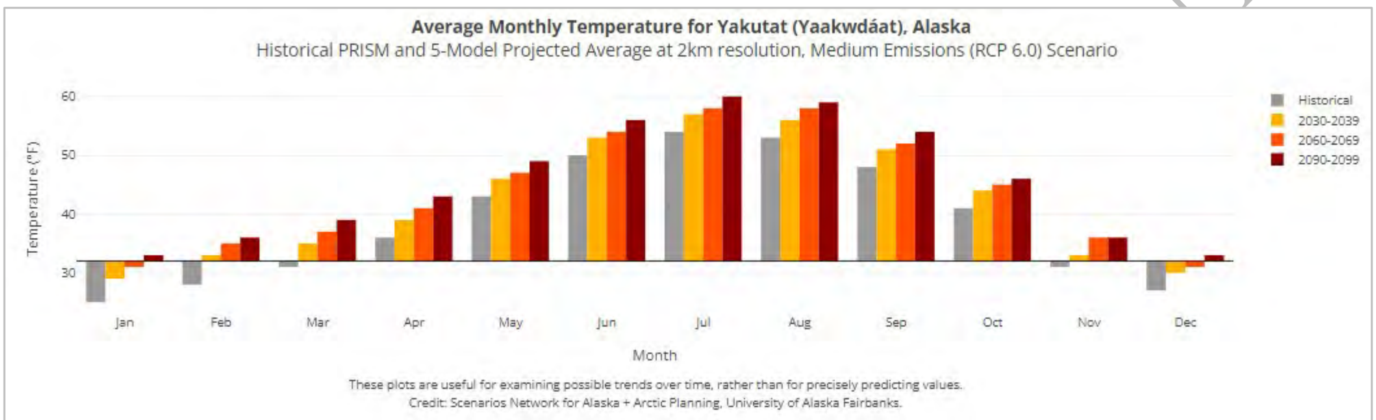
Atmospheric rivers generate most of the economic losses associated with flooding in the western United States and are projected to increase in intensity with climate change (Corringham et al. 2022). This is of concern as flood damages have been shown to increase exponentially with AR intensity (Corringham et al. 2022).</td></tr>
<tr><td>High Winds</td><td>High-wind events are projected by models to become more frequent in Alaska, with changes most noticeable in the northern and western coastal regions of Alaska (Redilla et al. 2019).</td></tr>
<tr><td>Drought</td><td>Climate change is increasing the intensity and length of severe weather events including droughts. Increased exposure to extremes will surpass the resilience of ecological and human systems. Already vulnerable communities may be unable to adapt, laying bare systemic inequalities and requiring emergency assistance (IPCC 2019).

The U.S. Drought Monitor started in 2000. Since 2000, the longest duration of drought (D1–D4) in Alaska lasted 79 weeks beginning on July 17, 2018 and ending on January 14, 2020. The most intense period of drought occurred the week of August 27, 2019, where D3 affected 1.5% of Alaska land (USDM 2023).

Although southeast Alaska is one of the rainiest areas in North America, it was plagued by drought from October 2016 to December 2019. An “extreme drought” was declared by the U.S. Drought Monitor in summer 2019. Yakutat was not severely impacted by this drought.</td></tr>
</table>

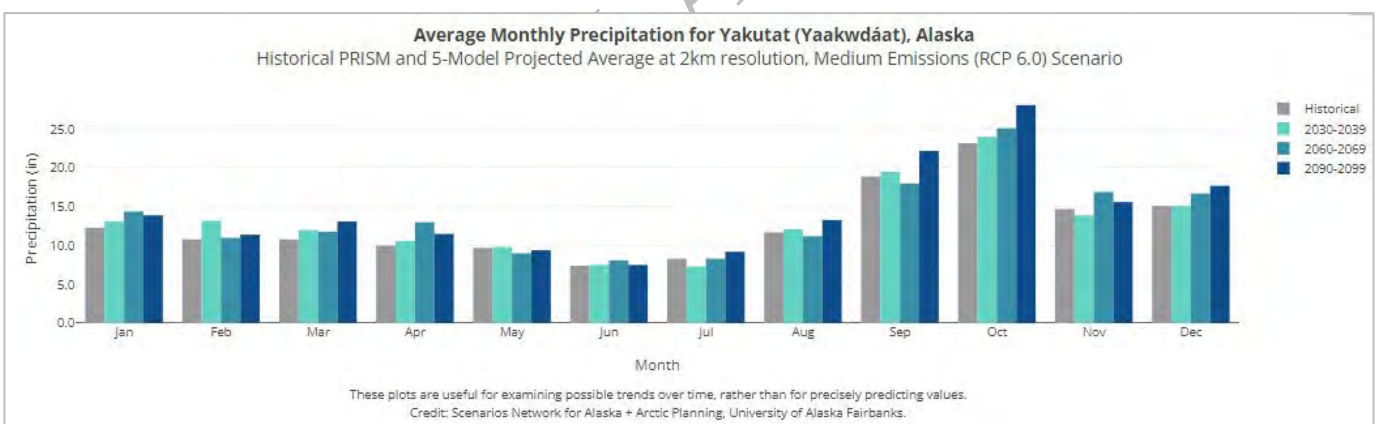
Severe Weather Event	Projected Changes in Extent (Magnitude and Severity) due to Climate Change
	Historically, Yakutat has not been severely impacted by droughts. Initial impacts from past droughts were first noticed in fish population decline of the Situk River, a large economy base for fishing and tourism in Yakutat.

The University of Alaska Fairbanks's (UAF) Scenarios Network for Alaska and Arctic Planning (SNAP) depicts Yakutat's historical and future projected temperatures and precipitation amounts under a medium emissions (RCP 6.0) scenario (Figure 3-37 and Figure 3-38).



Source: UAF/SNAP 2023c

Figure 3-37 Historical and Projected Temperatures for Yakutat



Source: UAF/SNAP 2023c

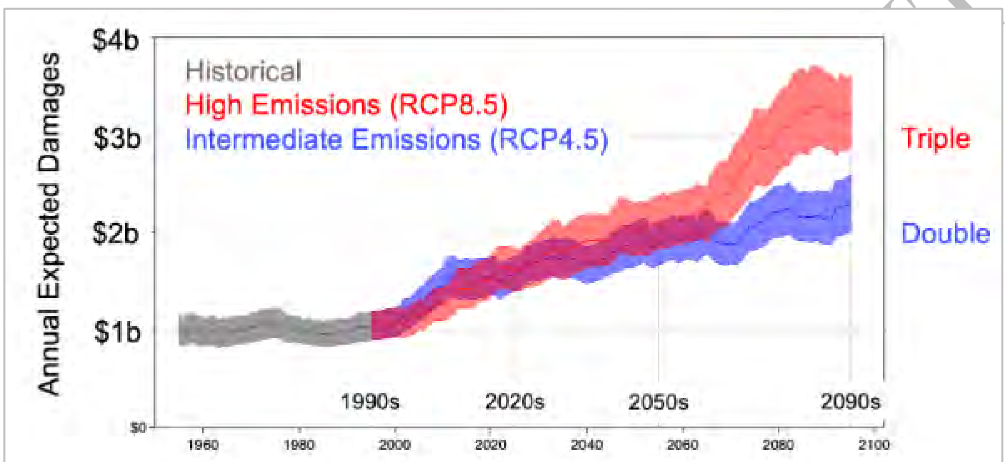
Figure 3-38 Historical and Projected Precipitation Amounts for Yakutat

Due to climate change, the impacts of severe weather events to the community of Yakutat are expected to change. Projected impacts of each event are outlined below.

Severe Weather Event	Projected Changes in Impact due to Climate Change
Extreme Cold	Due to climate change, average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018). In Yakutat, average annual temperatures may increase by about 9°F by the end of the century (UAF/SNAP 2023a). Summer temperatures are increasing the

Severe Weather Event	Projected Changes in Impact due to Climate Change
	most (+11°F) and spring may transition from below freezing to above freezing temperatures in the future (UAF/SNAP 2023a). Extreme cold may also impact a community by disrupting the flow of transportation within the community. With extreme cold temperatures, comes ice fog, which may ground an aircraft carrying supplies until conditions improve. Prolonged periods of cold can cause large bodies of water to freeze, disrupting shipping and increasing the likelihood of ice jams and associated flooding. While Alaskans have engineered ways to stay warm during extreme cold, infrastructure can only withstand and function within a certain temperature range. Extreme cold can cause electric generation to malfunction or cause fuel to congeal in supply lines and storage tanks. Without electricity, heaters and furnaces do not work, and water/sewage pipes can freeze or rupture. A combination of extreme cold and little to no snow cover increases the ground's frost depth, which can disturb pipes beneath the ground. While extreme cold can impact a community's infrastructure, the greatest danger from extreme cold is its impact on humans. Prolonged exposure to extreme cold can cause frostbite or hypothermia and become life-threatening very quickly. Infants and elderly people are most susceptible to these conditions. Carbon monoxide poisoning is another threat as people use supplemental heating devices without proper ventilation. Extreme cold accompanied by wind intensifies life-threatening exposure injuries such as hypothermia and frostbite. Reduced snow cover and winter precipitation in the form of snow, along with increased air temperature, are expected to increase stream water temperature (NPS 2020). During winter and spring, warmer waters could hasten development and growth of salmon eggs and fry, possibly leading to earlier life stage transitions (NPS 2020). Additionally, ecological impacts to spawning salmon from rising temperatures may be seen. During summer, warmer waters could increase physiological stress on adult salmon migrating to spawning grounds, potentially reducing spawning rates (NPS 2020). Higher temperatures in spring and fall could also result in longer a growing season (UAF/SNAP 2023d). See Figure 3-40 below for the historical and projected length of the growing season in Yakutat. Impacts from extreme cold in Yakutat have included loss of utilities.
Freezing Rain and Ice Storms	Due to climate change, average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018), while the intensity and frequency of winter storms and other storm events is projected to increase (Dixon et al. 2018). How these factors will affect the impact of freezing rain and ice storm events in Yakutat is unknown. Impacts from freezing rain and ice storms in Yakutat have included loss of utilities.
Heavy Snow	Within the next century, climatically-driven changes in snow characteristics (decreasing snowfall, snowpack, and snowmelt) will affect hydrologic and ecological systems in Alaska (Littell et al. 2018). Impacts from reduced snowpack and less frequent snowfall will directly affect the spawning habitats for salmon. Reduced snow cover and winter precipitation in the form of snow, along with increased air temperature, are expected to increase stream water temperature (NPS 2020). During winter and spring, warmer waters could hasten development and growth of salmon eggs and fry, possibly leading to earlier life stage transitions (NPS 2020). Additionally, ecological impacts to spawning salmon from rising temperatures may be seen. During summer, warmer waters could increase physiological stress on adult salmon migrating to spawning grounds, potentially reducing spawning rates (NPS 2020). A shift from snow to rain impacts water storage capacity and surface water availability (UAF/SNAP). Impacts from heavy snow in Yakutat have included structural damages to buildings including the Yakutat clinic, dangerous road conditions, loss of utilities, snow removal, and have resulted in

Severe Weather Event	Projected Changes in Impact due to Climate Change
	disaster declarations (January 2022). The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts on CBY and the Tribe. On January 9, 2022, there was damage to multiple structures including the medical clinic in Yakutat due to snow loading. The National Guard was mobilized to help clear roofs from vulnerable structures. New snow from the storm was estimated to be at least an additional 2 feet leading to snow depths around 5-6 feet across the area.
Drifting Snow	Projected climate change impacts are expected to reduce snowpack (NPS 2020), while high-wind events are projected to become more frequent, with the highest increases in the northern and western Alaska coastal regions (Redilla et al. 2019). How these competing factors will affect the impact of drifting snow events in Yakutat is unknown. Impacts from drifting snow in Yakutat have included loss of visibility and dangerous road conditions.
Winter Storm	Climate scientists have suggested that warming global temperatures may be enabling longer and more intense cycles of winter storms (Dixon et al. 2018) resulting in worsening impacts to the community. A winter storm can last a few hours or several days, cut off utilities, and put older adults, children, sick individuals, and pets are at greater risk. Winter storms create a higher risk of car accidents, hypothermia, frostbite, carbon monoxide poisoning, and heart attacks from overexertion. Winter storms can also cause property damage. Some impacts to homes and other infrastructure may include roof damage or collapse, water damage from frozen or broken pipes, cracks in caulking due to extreme cold, damage to building foundations. Winter storms and cold temperatures can also impact vehicles by draining the battery, damaging the cooling system, thickening fluids, damaging the engine, and increasing the potential for vehicular accidents. Impacts from winter storms in Yakutat have included loss of visibility, loss of utilities, snow load considerations, school closures, damage to critical facilities and infrastructure, and hindered snow removal efforts. In January 2022, CBY declared a local disaster emergency as exceptionally heavy snow, rain and ice piled atop critical buildings and infrastructure. This “very unusual” event resulted in over 6 feet of snow after a rare cold snap (ADN 2022). The town’s newly completed Yakutat Clinic Health Center was forced to close as 4 to 5 feet of heavy snow caused an estimated millions of dollars in water damage to the building and equipment (ADN 2022). Damages included: a carport at the City’s public safety building collapsed into a trailer set up for emergency management, a broken pipe flooded the community’s Head Start building, local crews scrambled to clear snow off the roof of elementary school and gym. The borough-owned fish processing facility, power plant, as well as stores and private residences, were also in danger of roof collapse and damage (ADN 2022). To aid in snow removal, the CBY hired 10 people on top of their usual 4 to help clear snow from buildings and raised the hourly rate of pay by 50%. This additional help was still not enough capacity to meet the community’s needs. The CBY declared a local disaster and the State sent in the Alaska National Guard to provide emergency snow removal and building safety assessment to the community.
Heavy Rain	In Yakutat, fall rainfall is projected to increase by 31% by the end of the century (UAF/SNAP 2023a). With increased precipitation, the impact of heavy rain in Yakutat may increase. These impacts may include increased flooding and road washouts throughout the community. Impacts from heavy rain in Yakutat have included localized flooding.
Atmospheric River	Flood damages associated with ARs have been found to increase exponentially with AR intensity so even a modest shift towards higher-intensity ARs could have significant impacts on flood damages (Corringham et al. 2022).

<table>
<tr><th>Severe Weather Event</th><th>Projected Changes in Impact due to Climate Change</th></tr>
<tr><td></td><td>
A research team at Scripps Institution of Oceanography at UC San Diego found that under different emission scenarios using the CMIP5 global climate model, the annual expected AR-related flood damages in the western United States could increase from $1 billion in the historical period to $2.3 billion in the 2090s under the RCP4.5 scenario or to $3.2 billion under the RCP8.5 scenario by the end of the century (Figure 3-39) (Corringham et al. 2022).
Note: only counties in California, Nevada, Oregon, and Washington state were evaluated for this study and estimated losses were not calculated for Alaska.


Source: Corringham et al. (2022)
Figure 3-39 Estimated National Annual Damages from ARs due to Climate Change (1960-2100)
NOAA researchers found that models predicted increased low-elevation precipitation, but less high-elevation precipitation due to ARs (NOAA 2023b). Yakutat sits at 69 feet elevation, which is considered low elevation, therefore, may experience increased precipitation due to climate change's influence on atmospheric rivers.
</td></tr>
<tr><td>High Winds</td><td>
As high wind events are projected to increase (Redilla et al. 2019), impacts from high wind events may increase.
Impacts from high winds in Yakutat have included loss of utilities, downed trees, damage to buildings and residences, and damage to the Yakutat airport.
On October 5, 2007, several roofs were blown off of cabins at the Situk River Fish Camp with wind gusts of at least 65 mph estimated. Minor roof damage was done in Yakutat City (tar paper blown off of a roof).
On February 3, 2012, high winds lead to the VHF antenna being blown down at the WSO. Trees were downed with power outages. Unofficial gusts up to 100 MPH were reported. Luggage carts were blown over at Alaska Airlines. A porch was blown off a house and several roofs were damaged.
</td></tr>
<tr><td>Drought</td><td>
Climate change-driven effects upon hydrology, seasonal snowpack, and days above freezing temperatures will alter the water supply in snowmelt/glacier runoff fed streams and rivers in turn affecting the water supply for Alaskan communities, wildlife, and landscapes. In conjunction with lower ground-water levels, droughts can drive salinization in soil, estuaries, and wetlands along coastlines as sea-water fills voids formerly occupied by fresh water. Indirect effects of climate change-induced droughts include threats to the tourism industry, food insecurity, and threats to the Alaskan subsistence lifestyle (IPCC 2019).
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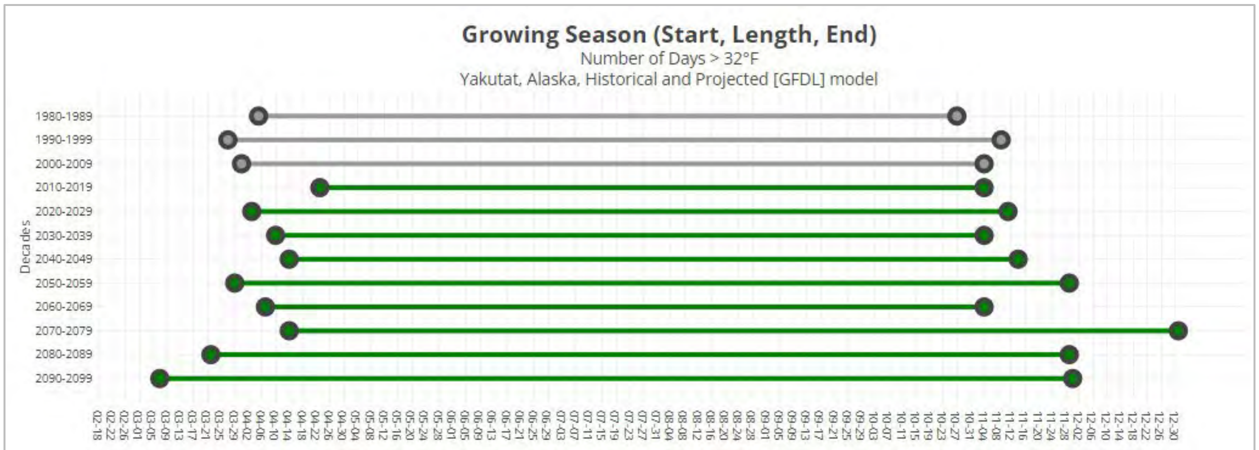


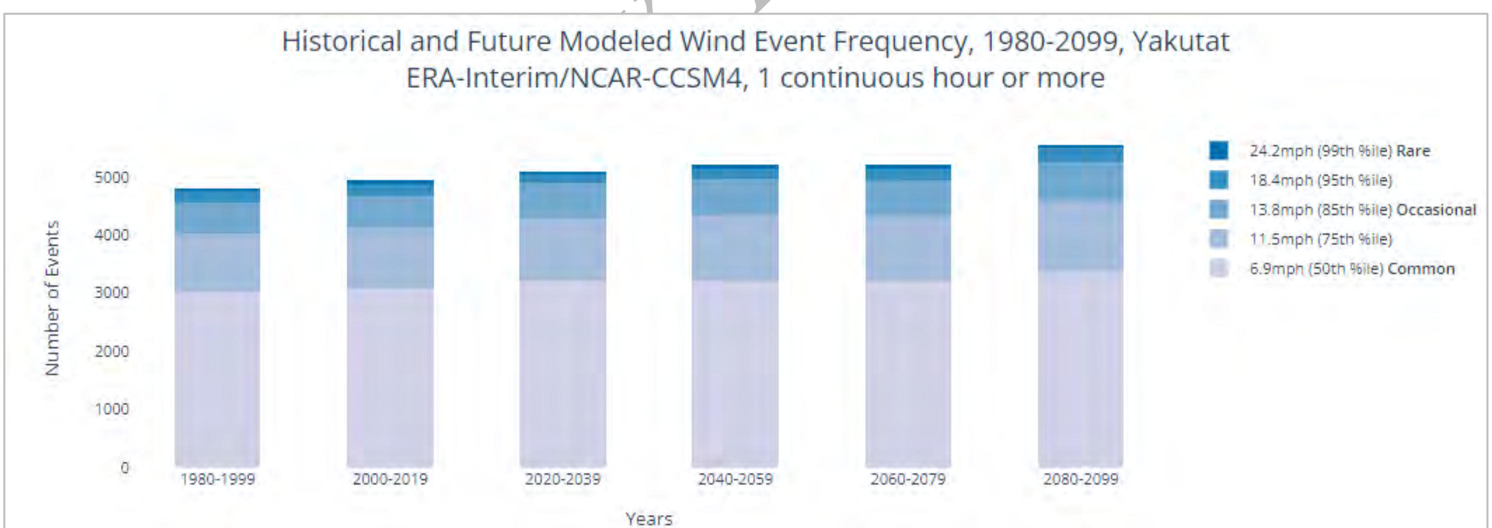
Source: UAF/SNAP 2023d

Figure 3-40 Historical and Projected Length of Growing Season in Yakutat

The frequency of severe weather events is dependent on the event and climate change will impact each differently. The projected changes in event frequency are outlined below.

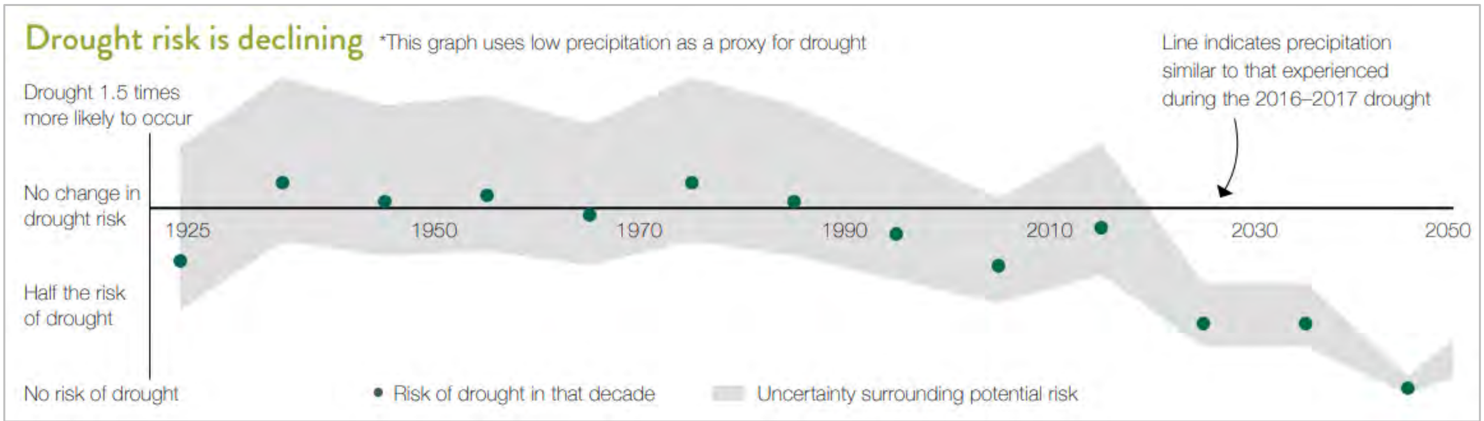
Severe Weather Event	Projected Changes in Probability of Future Events due to Climate Change
Extreme Cold	Due to climate change, average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018; UAF/SNAP). In Yakutat, average annual temperatures may increase by about 9°F by the end of the century (UAF/SNAP 2023a). Summer temperatures are increasing the most (+11°F) and spring may transition from below freezing to above freezing temperatures in the future (UAF/SNAP 2023a). Statewide, by 2046, the number of nights with below freezing temperatures is expected to decrease by at least 20 nights per year (USGRCP 2018).
Freezing Rain and Ice Storms	Freezing rain and ice storm events are dependent on the ambient air mass temperature. Average annual temperatures in Alaska are projected to rise by an additional 2°F to 4°F by 2050 (USGCRP 2018; UAF/SNAP). As global temperatures continue to rise, freezing rain and ice storm events may become less frequent as in previous decades.
Heavy Snow	The amount of precipitation that falls as snow and the length of the snow-cover season both decrease as temperatures exceed 32°F more frequently (NPS 2020). Projected climate change impacts are expected to reduce snowpack and promote glacial melt, reducing salmon habitat quality and diversity (NPS 2020). Models indicate a broad switch from snow-dominated to transitional annual hydrology across most of Southern and Coastal Alaska (Littell et al. 2018). Therefore, as winter temperatures continue to increase, the amount of snowfall will decrease and precipitation in the form of rain will be more common in winter months.
Drifting Snow	Projected climate change impacts are expected to reduce snowpack (NPS 2020), while high-wind events are projected to become more frequent, especially in northern and western Alaska coastal regions (Redilla et al. 2019). How these competing factors will affect the probability of drifting snow events in Yakutat is unknown. While unknown, the probability of drifting snow events will depend on the geography of the area and predisposition for snowfall.
Winter Storm	Climate scientists have suggested that warming global temperatures may be enabling longer, more frequent, and more intense cycles of winter storms (Dixon et al. 2018).

Severe Weather Event	Projected Changes in Probability of Future Events due to Climate Change
Heavy Rain	In Yakutat, fall rainfall may increase by 31% in the next century (UAF/SNAP 2023a).
Atmospheric River	NOAA researches atmospheric rivers to improve forecasting capabilities as well as to improve our understanding of atmospheric river impacts and how they may change over time with climate change (NOAA 2023b). NOAA's Modeling, Analysis, Predictions, and Projections (MAPP) and Climate Variability and Predictability (CVP) Programs support research to improve the capability to predict atmospheric rivers weeks to months in advance (NOAA 2023b). Atmospheric rivers are natural parts of our global weather systems, and could potentially begin to change in frequency due to climate change (NOAA 2023b). Researchers found that models predicted increased low-elevation precipitation, but less high-elevation precipitation. Studies like these, that model potential changes in atmospheric river events within the next century, are important tools for decision makers in areas where water supply might already be strained (NOAA 2023b).
High Winds	High-wind events are projected to become more frequent as global climate change continues (Redilla et al. 2019). Figure 3-41 shows historical and future modeled wind frequency for Yakutat from 1980-2099.
Drought	Scientists assessed whether the risk of drought in southeast Alaska is likely to increase or decrease in the future. The analysis examined the future risk of a low precipitation event like what drove the 2016–2019 drought. Based on this proxy, there is a declining chance of drought in the next three decades. In both summer and winter, drought will become about half as likely to occur by 2050, compared to the risk of a similar precipitation event during 1925–2020 (Figure 3-42) (UAF-IARC 2022c).



Source: UAF/SNAP 2023b

Figure 3-41 Historical and Future Modeled Wind Frequency in Yakutat, 1980-2099



Source: UAF-IARC 2022c

Figure 3-42 Future Drought Risk in SE Alaska due to Climate Change

3.3.3 WILDLAND FIRE AND COMMUNITY FIRE

Fires can be divided into the following categories:

- **Prescribed fires**: ignited under predetermined conditions to meet specific objectives, to mitigate risks to people and their communities, and/or to restore and maintain healthy, diverse ecological systems.
- **Wildland fire**: any non-structure fire, other than prescribed fire, that occurs in the wildland.
- **Wildland Fire Use**: a wildland fire functioning in its natural ecological role and fulfilling land management objectives.
- **Wildland-Urban Interface Fires (Community Fire)**: fires that burn within the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. The potential exists in areas of wildland-urban interface for extremely dangerous and complex fire burning conditions which pose a tremendous threat to public and firefighter safety.

Both wildland and community fires pose a risk to the residents and infrastructure in Yakutat.

3.3.3.1 Nature

Wildland Fire

Wildland fires are types of fires which spread via the consumption of vegetation, and they often spread very quickly due to the amount of vegetation available. They begin sometimes unnoticed and cause dense smoke that is usually visible from several miles or tens of miles around. Two principal causes for them are natural (e.g., lightning) and human activity (campfires, cigarettes, unattended burns). They more usually happen in forests or other areas with sufficient vegetation (e.g., prairies). Wildland fires are usually classified as to a specific type or locale such as: urban, tundra, interface or intermix fires, as well as prescribed fires.

There are four significant variables which contribute to the behavior and extent of wildland fires, and these can be used to identify potential areas that are more susceptible to wildland fires. These are:

- **Topography**: the amount and aspect of slopes influence how wildland fires spread and how quickly. Slopes that face south are subject to more solar radiation which makes them generally drier and more prone for wildfires. Sometimes ridge lines or ridge tops become a natural barrier to wildfires as fires spread more slowly downhill.
- **Fuel**: Wildland fires are heavily dependent on the type and extent of fuel, i.e., vegetation, present for their spread and occurrence. Certain species of plants are much more ignitable and will burn with greater intensity. The amount of combustible material available is referred to as the fuel load,

and the denser the vegetation the more intense the wildland fire can become. The amount of dead matter, e.g., leaf litter, compared to living matter also considerably effects the nature of these fires. Periods of prolonged droughts cause a decrease in the moisture of both living and dead matter and significantly increase the odds of wildland fire occurrence and extent. Climate change is now a factor as well. Lastly, the continuity of the fuel load is a main factor in both horizontal and vertical planes. The more continuous the fuel, the easier a fire will spread.

- **Weather**: Of all the factors which affect wildfires, weather is the most variable. The ignition and spread of a wildfire are dependent on humidity, temperature, winds, and lightning. Extreme bouts of weather, such as heat waves or droughts, can lead to extensive wildfire activity. Dry seasons are generally becoming longer due to climate change, and this has led to an increase in wildfires. Conversely, periods of increased rain and cooling decrease the odds of wildland fires and ease their containment as well.
- **Season**: The seasons with more vulnerability for wildfires are late summer and early autumn. This is generally the time when the fuel (vegetation) dries out. The moisture content drops sharply and the ratio to dead to living material increases. Though there are many factors which contribute to the extent and intensity if wildfires such as: wind speed and direction, fuel load and type, humidity, and topography. The most common causes of wildfires in Alaska, historically, have been lightning or human negligence.

Other hazards do have an effect on the extent and frequency of wildland fires. These are, for example: infestations, lightning, and drought. If a wildland fire is not quickly and properly controlled, it can grow rapidly into a disaster or emergency. The smallest of wildfires can even threaten lives, resources, and destroy properties. Livestock and pets are also susceptible to wildfires. Some wildfires can precipitate the need for emergency food and water, evacuation, and temporary shelters.

Sometimes the effects of wildland fires can be catastrophic. They can destroy large swathes of forest and other vegetation, damage the soil, waterways, and the land itself. Some soils may lose their capacity to keep moisture and support life for years after an intense wildfire.

Community Fire

A community fire is a large destructive fire that is widespread throughout a community and involves one or more developed areas in the community. Community fires are different from individual property fires as community fires involve a larger portion of the community's-built environment. However, structure fires can quickly spread and result in a community fire.

A community fire is quick-moving and can become out of control in less than 30 seconds and can engulf a house within minutes. The heat alone from fire is deadlier than the actual flames with temperatures ranging from 100ºF at the floor to 600ºF at eye level. The heat can burn one's lungs and can melt one's clothes to their skin. If a room becomes hot enough from fire, it can create a flashover in which everything in the room ignites at once. Smoke and toxic gases, both products of fire, kill more people than the flames themselves. Oxygen is consumed, creating an atmosphere of colorless and odorless fumes that can cause drowsiness, disorientation, and shortness of breath and can lull a person into a deeper sleep without allowing enough time to escape. Fire itself may be bright, but the smoke that it produces can make evacuation from a building difficult or impossible.

The ignitability and spread ability of structure fires is largely dependent on the type of construction the building and surrounding builds are. There are five basic groups of building construction used throughout the United States and are outlined below (Table 3-10).

Table 3-10 Types of Building Construction

Construction Type	Description
Type I (fire resistive) - Least combustible	Fire-resistive 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.
Type II (non-combustible)	Non-combustible 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.
Type III (ordinary)	Ordinary 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."
Type IV (heavy timber)	Heavy-timber 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.
Type V (wood frame) - Most combustible	Wood-frame 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: Vincent Dunn, Deputy Chief FDNY (retired)- Structural Fire Spread

3.3.3.2 History

Wildland Fire

Wildland fires occur in every state in the country, including all regions of Alaska. Each year, between 600 and 800 wildland fires, mostly between March and October, burn across Alaska causing extensive damage.

According to the Alaska Interagency Coordination Center (AICC), 9 wildland fires have occurred within 100 miles of Yakutat in an 83-year period (1939-2022).

In 2019, an ATV with firefighting equipment was added to Situk River Estuary Camp at Strawberry Point. Twice in recent years, grass has caught on fire there, and the fires have been contained quickly before a forest fire could start.

Since the 2019 HMP, there have been 2 wildland fire events within 100 miles of Yakutat. The largest burned 7.2 acres in May 2020.

Table 3-11 Historical Wildfires within 100 miles of Yakutat (1939-2022)

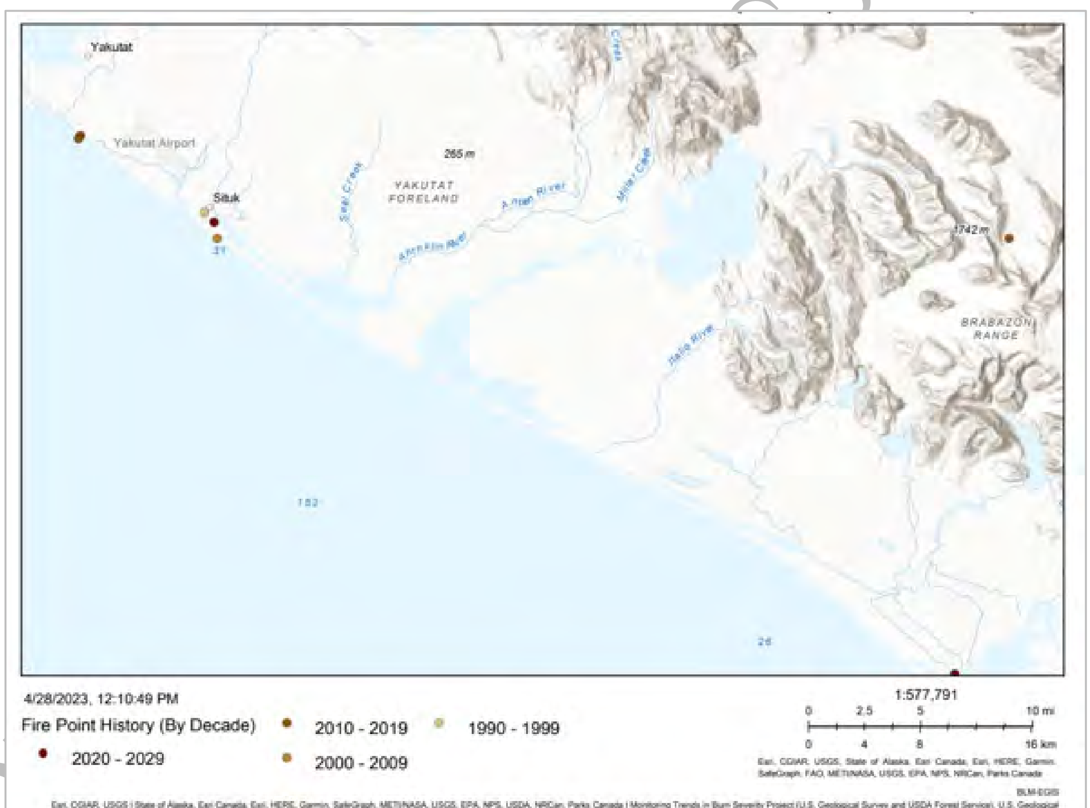
Discovery Date	Fire Name	Latitude	Longitude	Total Acres Burned	Cause
08/13/1968	Road #2	60.7833	-141.0167	0	Human, Recreation
05/31/1982	Impossible Dream	60.0167	-141.9333	0	Human, Equipment
05/08/1993	Strawberry Point	59.4500	-139.5833	0	Human, Campfire

Table 3-11 Historical Wildfires within 100 miles of Yakutat (1939-2022)

Discovery Date	Fire Name	Latitude	Longitude	Total Acres Burned	Cause
05/21/2002	Strawberry Point	59.4333	-139.5667	0	Human, Cooking
05/16/2010	Strawberry Point	59.4333	-138.5667	0	Human, Trash Burning
07/09/2011	Camp 1	59.4994	-139.7406	0	Human, Campfire
06/14/2016	Camp 1 Beach Fire	59.4978	-139.7422	0	Human, Under Investigation
05/22/2020	Muddy Creek	59.1520	-138.6350	7.2	Undetermined
06/06/2020	Situk River	59.4439	-139.5708	0.2	Human, Structure

Source: AICC 2023

Figure 3-43 depicts the locations of historic wildfire fires in the Planning Area. Due to the size of the Planning Area, two maps were generated to show all historic wildland fire locations. The only recorded wildland fire events within 100 miles of Yakutat occurred near the city center, as shown in the figure below. There are no historical wildland fire perimeters in the Planning Area since 1940.



Source: AICC 2023

Figure 3-43 Historical Wildfire Locations near Yakutat (1939-2022)

Community Fire

The Alaska State Fire Marshal's office tracks statewide top dollar loss by year and there have been 0 top dollar loss events in Yakutat between 2004-2022.

In 2016, a Yakutat resident was killed in a house fire likely as a result of unattended cooking (ADN 2016). The Planning Team states that several other house fires have started from diesel stoves or incorrectly installed wood stoves. Boat fires have also started at the harbor due to fuel leaks.

The Alaska State Fire Marshal's office records of fatalities due to community fires, and there have been 0 fatalities in Yakutat from structure fires between 2018-2022.

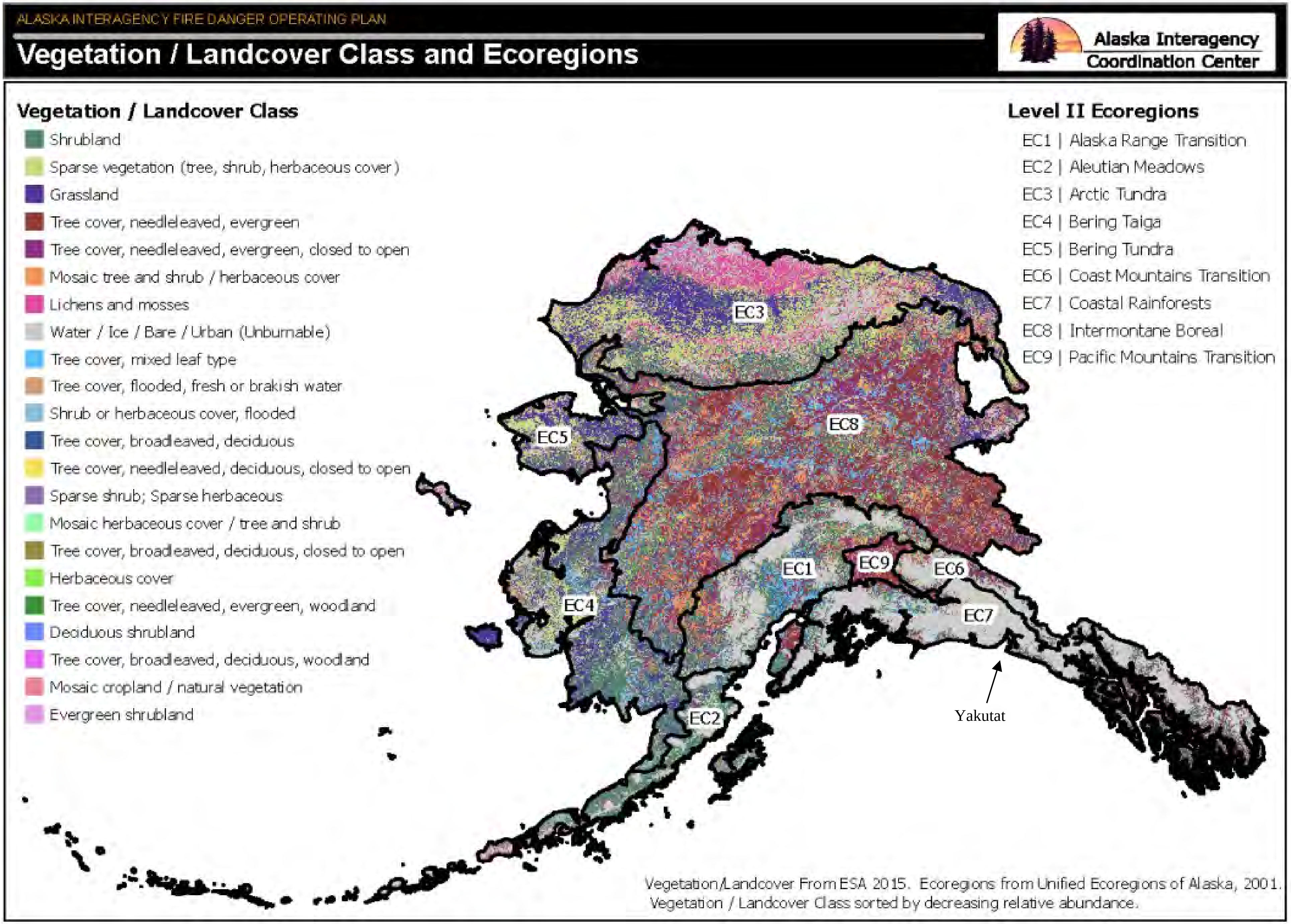
3.3.3.3 Location

Wildland Fire

Figure 3-44 depicts the Level II Ecoregion classifications for the State of Alaska as well as the vegetation/landcover classes found throughout the State.

Yakutat is located in the EC7 Level II Ecoregion which is classified as Coastal Rainforests. This area is normally quite wet, but fires can occur in the Panhandle under dry conditions, which may become more frequent due to climate change (BLM 2020).

Under certain conditions, fires may occur near Yakutat when weather, fuel availability, topography, and ignition sources combine. For the purposes of this MJHMP Update, all areas of the CBY are considered to be vulnerable to wildland fire impacts.



Source: BLM 2020

Figure 3-44 Vegetation/Landcover Class and Ecoregions of Alaska

If there is a fire in Yakutat, there is a volunteer fire department that will respond to fire calls. The US Forest Service will get involved if the fire is on federal lands and is available to assist on private/state land as needed.

Community Fire

Community fires can occur in areas where a community interfaces with the surrounding forest or vegetation or as a result of a spreading structure fire. Yakutat is surrounded by temperate rainforest, normally quite wet, but fires can occur in the region under dry conditions.

The residential areas of Yakutat are limited to the area of the City of Yakutat as the majority of surrounding areas within the Planning Area are owned by the State of Alaska, Federal government, or private entities that do not allow residential construction. However, there are subsistence hunting and fishing camps located outside of City limits.

Figure 3-48 shows the historical and future flammability of Yakutat. This region has historically had Very Low flammability and is projected to continue to have Very Low flammability through 2099 under both emissions scenarios.

3.3.3.4 Extent (Magnitude and Severity)

Wildland Fire

Due to the few recorded historical wildland fire events as well as the criteria listed in Table 3-2, the extent of wildland fire events in Yakutat have been Negligible with minor injuries, the potential for critical facilities to be shut down for less than 24 hours, less than 10% of property or critical infrastructure being severely damaged, and little to no permanent damage to transportation or infrastructure or the economy.

Community Fire

Yakutat has not had a long history of structure fires impacting the community, but historical structure fires have resulted in building destruction and fatalities.

Due to the recorded community fires resulting in fatalities as well as the criteria listed in Table 3-2, the extent of community fires in Yakutat are considered to be Critical, where injuries and/or illnesses could result in permanent disability; a complete shutdown of critical facilities may last for at least two weeks; and more than 25% of property would be severely damaged.

3.3.3.5 Impact

Wildland Fire

If wildfires are not adequately controlled, the impacts from them could become an emergency or considerable disaster. Even smaller wildfires can threaten lives, resources, and destroy properties. Livestock and pets are susceptible to wildfires as well. Wildfires can precipitate the need for emergency food and water, evacuation, and temporary shelters.

The effects of wildland fires can become catastrophic. They can destroy large swathes of forest and other vegetation, damage the soil, waterways, and the land itself. Some soils may lose their capacity to keep moisture and support life for years after an intense wildfire. Exposure of the land also leads to increased erosion and add to the siltation of rivers and streams. This increases the chances of flooding, degrades water quality, and can significantly harm aquatic life.

For many ecosystems, wildfires are actually critical features of the natural history. They can serve to help maintain renewal, biodiversity, and the ecological health of the land in general. This essential role which they serve for the local ecology has been incorporated into the planning process for fire management. Hence, the full range of fire management activities has been implemented in Alaska. This helps achieve the sustainability and health of the ecosystem. This includes the social consequences on firefighters in addition to ecological and economic factors. The natural and cultural resources that are potentially threatened, and other important values, all dictate the level and nature of the management response during a wildfire.

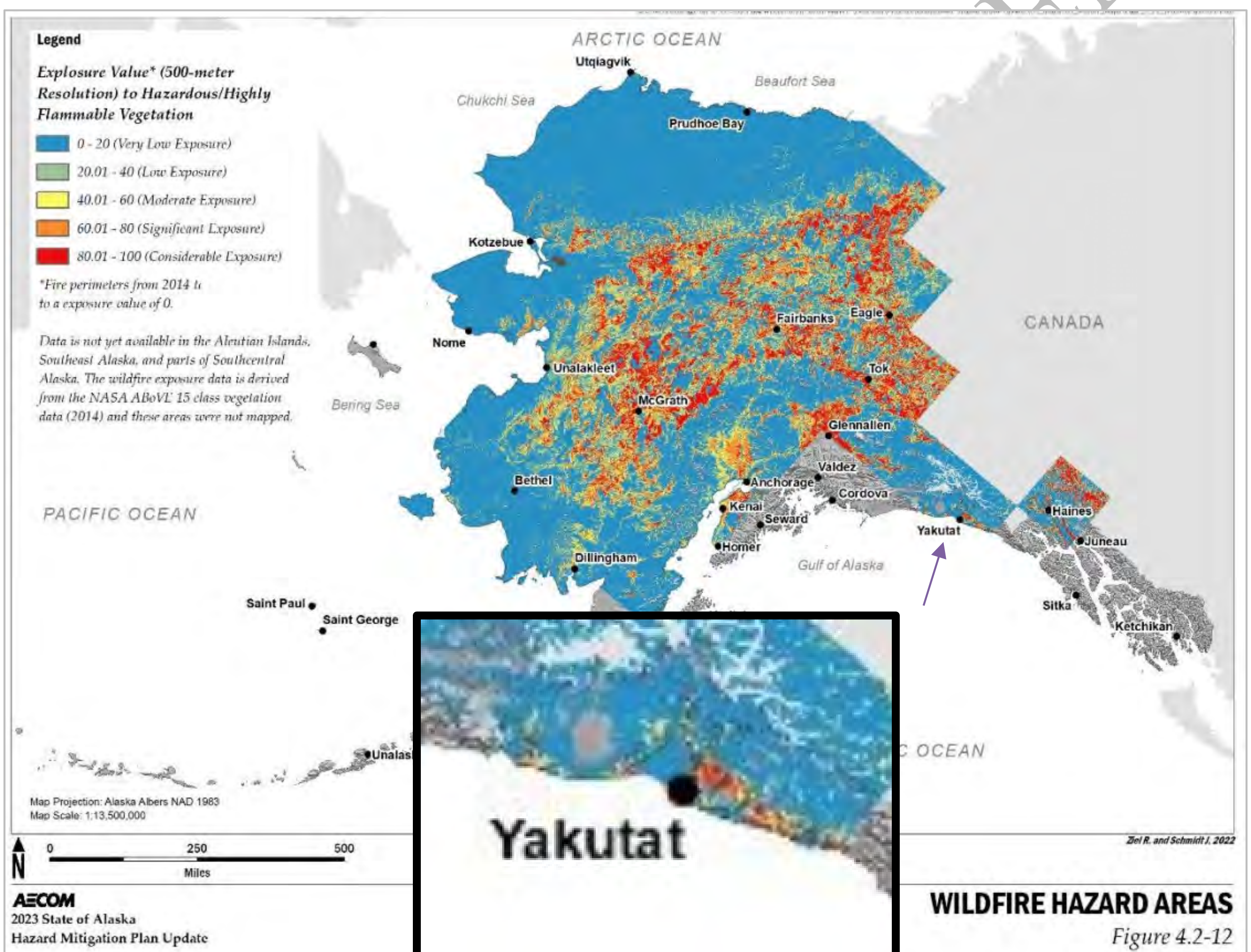
Community Fire

All structures in Yakutat are vulnerable to community fires. Yakutat has a team of volunteer firefighters that respond to calls for structure fires and for natural vegetation fires. Past community fires have resulted in a fatality of a community member.

3.3.3.6 Probability of Future Events

Wildland Fire

The 2023 State of Alaska SHMP identifies wildfire hazard areas across the state. Yakutat is located in an area with a moderate to extreme wildfire fuel ranking.



Source: 2023 Alaska SHMP

Figure 3-45 Statewide Wildfire Hazard Areas

Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a wildland fire event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

Community Fire

Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a community/structure fire event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

3.3.3.7 Future Conditions Including Climate Change

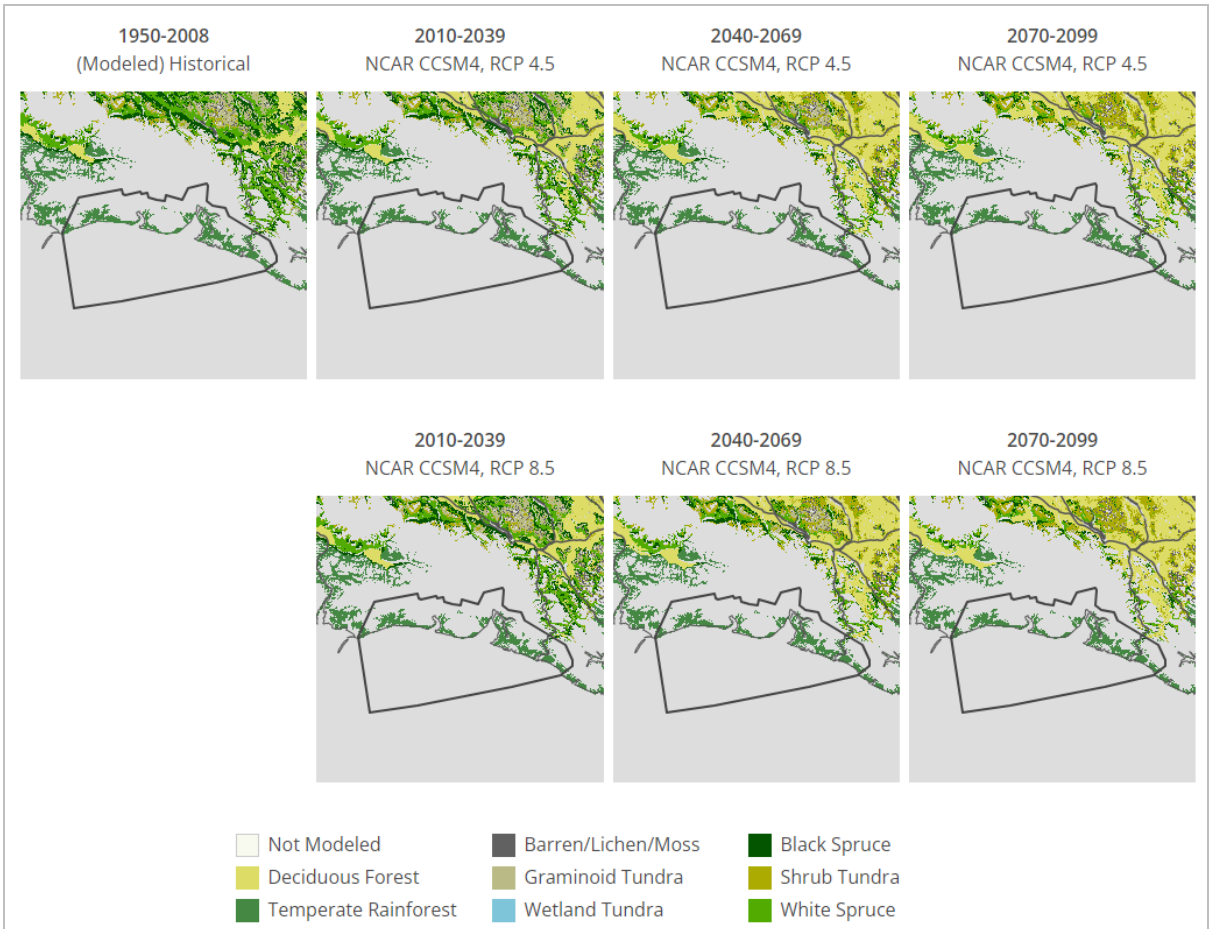
Wildland and Community Fire

Due to climate change, the nature or location of future wildland or community fires in Yakutat are not anticipated to change.

Changing Factor due to Climate Change	Description of Future Changes due to Climate Change
Extent (Magnitude and Severity)	Due to climate change, the extent (magnitude and severity) of wildland fires is expected to increase. Large wildfires have consumed more boreal forest in Alaska in the last ten years than in any other decade recorded, and the area burned annually is projected to double by 2050 (EPA 2022).
Impact	Due to climate change, the impact of wildland fires to Yakutat is expected to increase. Climate change and increasing fire frequency will result in shifts in forest species composition as projections suggest that deciduous vegetation will soon be as abundant in the Alaskan boreal forest as spruce vegetation (IPCC 2019). Additionally, a warmer, drier spring weather may increase fire risk and resulting impacts (UAF/SNAP).
Probability of Future Events	Large wildfires have consumed more boreal forest in Alaska in the last ten years than in any other decade recorded, and the area burned annually is projected to double by 2050 (EPA 2022). Warmer temperatures are also expected to worsen 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 (EPA 2022). Climate change within Alaska is likely to result in increased drought and longer fire seasons and shifts in vegetation will influence the intensity and frequency of fires (IPCC 2019). A warming climate is also projected to increase the frequency and size of wildfires, potentially changing the type and extent of wildlife habitat favorable for some important subsistence species (USGCRP 2018).

In Yakutat, the predominant vegetation type is Temperate Rainforest (UAF/SNAP 2023a). Figure 3-46 shows historical and projected changes in vegetation in Yakutat from 1950 through year 2099 using the NCAR CCSM4 model. Future projections (2010-2099) are shown under two different scenarios of differing Representative Concentration Pathways (RCP), which is the trajectory of greenhouse gas concentrations in the atmosphere. Compared to current emissions, RCP 4.5 is a scenario representing a reduction in global emissions, while RCP 8.5 represents a scenario similar to, or possibly higher than, current global emissions trajectories.

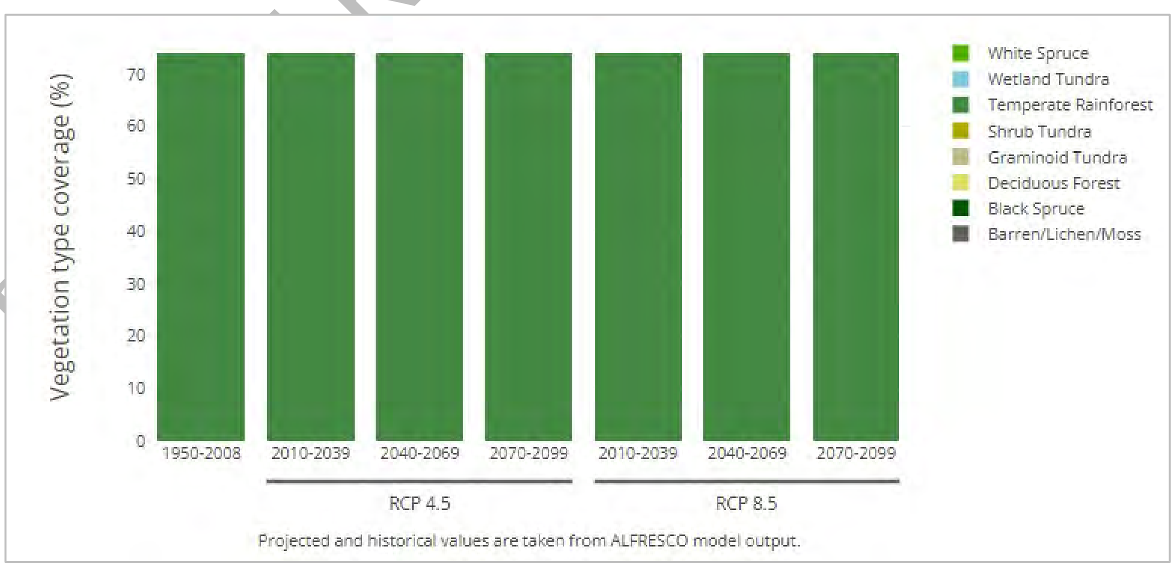
This model does not predict a change in vegetation type in Yakutat.



Source: UAF/SNAP 2023a

Figure 3-46 Projected Changes in Vegetation in Yakutat

Figure 3-47 shows historical and projected changes in vegetation type coverage in Yakutat from 1950 through year 2099 using the NCAR CCSM4 model.



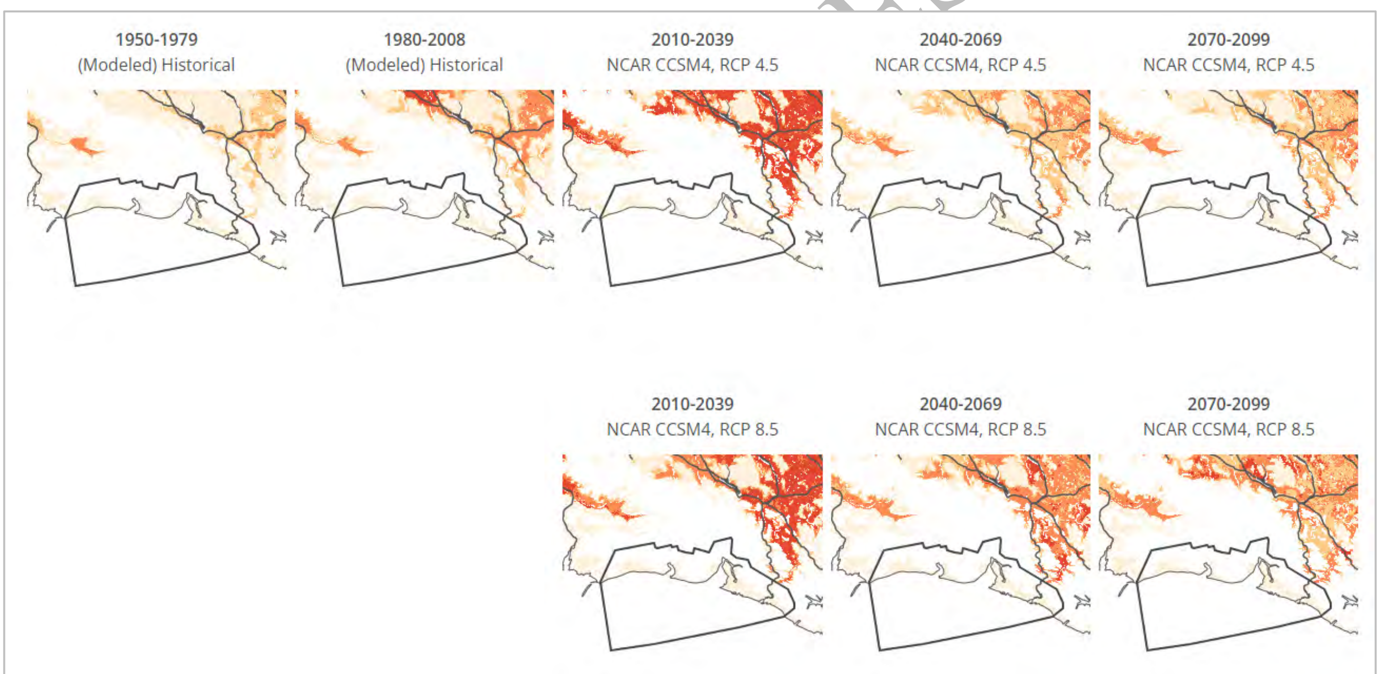
Source: UAF/SNAP 2023a

Figure 3-47 Historical and Projected Changes in Vegetation Type Coverage in Yakutat

Figure 3-48 depicts historical and future projections of the flammability in Yakutat using the NCAR CCSM4 model. This region has historically had Very Low flammability and is projected to continue to have Very Low flammability through 2099 under both emissions scenarios.

The accompanying legend for this figure is below.

Category	Flammability	Interpretation
Not modeled or no data	-	This pixel was not modeled or is not included in the dataset
Very Low	<0.2%	Fire is absent or very rare
Low	≥0.2%, <0.5%	Fire is rare, and unlikely to be the primary driver of vegetation patterns on this landscape
Moderate	≥0.5%, <1%	Fire is frequent enough to partially define the vegetation patterns on this landscape
High	≥1%, <2%	Fire is more frequent and more dominant in determining vegetation patterns on this landscape
Very High	≥2%	Fire is highly frequent and dominates the vegetation patterns on this landscape



Source: UAF/SNAP 2023a

Figure 3-48 Historical and Projected Flammability Conditions for Yakutat

3.3.4 GROUND FAILURE (LANDSLIDE)

This section focuses on ground failure in terms of landslides- both submarine (underwater) and subaerial (on land), and landslide induced tsunamis. See Section 3.3.8- Changes in the Cryosphere for information on snow avalanches.

Yakutat is participating in the Kutí Southeast Alaska Regional Landslide Research project which includes the communities and Tribal representatives from Sitka, Yakutat, Klukwan, Craig, Skagway, Hoonah, and Kasaan; Central Council Tlingit Haida Indian Tribes of Alaska (Tlingit & Haida), RAND Corporation, University of Oregon, Oregon State University, Scripps Institution of Oceanography, as well as Sitka Tribe of Alaska (STA), USDA Forest Service, National Weather Service (NWS), Alaska Division of Geology and Geophysical Services (DGGS) and U.S Geologic Survey (USGS).

The National Science Foundation grant from the Coastlines and People program will develop a co-produced regional system for warning residents of events that might lead to flooding, avalanches, and landslides. The new five-year, $5 million project is based on distributed sensors and predictive models of the impacts of extreme weather events in Southeast Alaska.

More information on the Project can be found here: https://sitkascience.org/research-projects/khuti-southest-alaska-regional-landslide-research/#:~:text=In%20considering%20unresolved%20questions%20about,with%20Tribal%20entities%20in%20six.

3.3.4.1 Nature

Ground failure is a blanket term used to describe any ground movement mechanisms including avalanche, landslide, subsidence, and unstable soils gravitational or other soil movement. Soil movement may be caused by activities such as rain, snow, and/or water saturation induced avalanches or landslides. Seismic activity, melting permafrost, river or coastal embankment undercutting, or in combination with steep slope conditions are also conditions for soil movement.

Landslides are a dislodgment and fall of a mass of soil or rocks along a sloped surface, or for the dislodged mass itself. The term is used for varying phenomena, including mudflows, mudslides, debris flows, rock falls, rockslides, debris avalanches, debris slides, and slump-earth flows. The susceptibility of hillside and mountainous areas to landslides depends on variations in geology, topography, vegetation, and weather. Landslides may also be triggered or exacerbated by indiscriminate development of sloping ground, or the creation of cut-and-fill slopes in areas of unstable or inadequately stable geologic conditions.

Additionally, landslides often occur secondary to other natural hazard events, thereby exacerbating conditions, such as:

- Earthquake ground movement can trigger events ranging from rock falls and topples to massive slides.
- Intense or prolonged precipitation can cause slope over-saturation and subsequent destabilization failures such as avalanches and landslides.
- Climate change-related drought conditions may increase wildfire conditions where a wildland fire consumes essential stabilizing vegetation from hillsides significantly increasing runoff and ground failure potential.

The USGS identifies six landslide types, distinguished by material type and movement mechanism including:

1. **Slides**, the more accurate and restrictive use of the term landslide, refers to a mass movement of material, originating from a discrete weakness area that slides from stable underlying material. A *rotational slide* occurs when there is movement along a concave surface; a *translational slide* originates from movement along a flat surface.
2. **Debris Flows** arise from saturated material that generally moves rapidly down a slope. A debris flow usually mobilizes from other types of landslides on a steep slope, and then flows through confined channels, liquefying and gaining speed. Debris flows can travel at speeds of more than 35 miles per hour (mph) for several miles. Other types of flows include debris avalanches, mudflows, creeps, earth flows, debris flows, and lahars.

3. **Lateral Spreads** are a type of landslide that generally occurs on gentle slopes or flat terrain. Lateral spreads are characterized by liquefaction of fine-grained soils. The event is typically triggered by an earthquake or human-caused rapid ground motion.
4. **Falls** are the free-fall movement of rocks and boulders detached from steep slopes or cliffs.
5. **Topples** are rocks and boulders that rotate forward and may become falls.
6. **Complex** is any combination of landslide types.

Submarine Landslide-Induced Tsunami

The most common trigger of submarine landslides is slope over-steepening due to high rates of sediments being deposited on already steep slopes (AEC 2020). O\ther triggering factors include earthquakes, large tidal ranges that can expose unstable sediments and weaken their hold on the slope, construction activities (blasting, dredging) in coastal areas, or some combination of these (AEC 2020). When the water rebounds back up towards the surface, it produces a local tsunami. Water can be displaced in front of or behind the moving landslide (AEC 2020).

In a fjord environment, where deltaic sediment is deposited rapidly, the sediment builds up pore-water pressures and could liquefy under extreme low tide conditions or ground shaking during an earthquake, because of low static shear strength (DGGS 2016). Thus, while ground shaking is one of the most common triggering mechanisms for submarine slope failures, a close relationship has been demonstrated between coastal landslides and extreme low tides (DGGS 2016).

One of the principal triggering mechanisms for slope instability in southeastern Alaska is ground shaking associated with earthquakes. Slope failures can occur immediately during an earthquake, but they also frequently occur after shaking stops, due to creep, reduction of shear stress, or an increase in pore pressure (DGGS 2016).

Subaerial Landslide-Induced Tsunami

Subaerial landslide-induced tsunamis are the easiest to visualize. These are caused by a massive amount of material directly impacting the water surface from above. The water is displaced, forcing a wave outward from the impact point. These landslides are most often caused by steep slopes rising directly out of the water, rapid erosion caused by glacial retreat or calving, heavy rains in coastal areas, and frequent earthquakes (AEC 2020). They have also occurred because of volcanic eruptions. Subaerial landslides usually produce the largest waves because of the extra volume of material impacting the surface and causing a leading crest wave (AEC 2020). The largest tsunami wave heights ever recorded were caused by subaerial landslides.

3.3.4.2 History

Tsunamis caused by submarine (underwater) and subaerial (above the water) landslides are a serious hazard in bays and fjords of coastal Alaska, particularly in Southeast and Southcentral Alaska (AEC 2020). This region has a long history of tsunami waves generated by submarine and subaerial landslides, avalanches, and rockfalls. These have produced some of the largest tsunami waves recorded and, unlike earthquake-induced tsunamis, they can strike with no warning (AEC 2020).

Submarine Landslide

Yakutat experienced underwater/submarine landslides following earthquakes in 1899, 1958, and 1964 that caused waves and resulting impacts in Yakutat.

1899 Yakutat Bay Earthquakes

In September 1899, three earthquakes were strongly felt in Yakutat: the Mw 8.1 event on September 4, and two earthquakes on September 10, the second of which had a magnitude of Mw 8.2.

Strong ground motion caused by the September 4th earthquake lasted about 2–5 minutes, causing violent rocking and shaking of buildings. Shaking from the first earthquake of September 10th lasted about 3 seconds, while the second earthquake that day was the most severe event of the series, probably causing most of the effects. Yakutat reported the largest uplifts in land ranged from 30 ft to about 47.5 ft on the west coast of Disenchantment Bay. There were two large submarine landslides—one along the south end of Khantaak Island, and the other at the northern end of the island. During the earthquake, high waves and great changes in water level were observed in Monti Bay, including three large waves at intervals of about 5 minutes. The waves washed out some houses located about 6.5–9.8 ft above present high tide. The total change in water level in Monti Bay was about 16.4 ft.

According to Lander (1996), "…the schooner (vessel) Crystal, lying in the mud, rocked from side to side, and the bay was full of whirlpools, spinning trees, lumber, and driftwood moving around so fast that the eye could hardly follow; the water churned into a seething mass." (DGGS 2016).

<u>1958 Lituya Bay Earthquake</u>

In 1958, a Ms 7.9 earthquake, with an epicenter ~135 miles SE of Yakutat, was strongly felt in the Yakutat area, with prolonged ground shaking for about 3-4.5 minutes. Several airport facilities and the runway were damaged, but at Yakutat damage to most residential and commercial buildings was slight due to wood-frame type construction. The 3 ft waves reported in Monti Bay were probably due to a submarine landslide at the southern end of Khantaak Island, in the same area that slid in 1899 (DGGS 2016).

According to Lander (1996), several people had gone to Khantaak Island to pick berries on this day. At around 9 pm, part of the group decided to take a boat back to Yakutat. As they set off, they noticed trees swaying. Looking back to sea they saw a huge wave approaching but were able to outrun the wave in the boat. The three people left on the island were never found. A section of the island tip (150 × 1,000 ft) had slumped into the water; the nearly vertical cliff left by the slide was about 13 ft high. The water was 90 ft deep over what had been land. The wave, observed by a resident on the shore at Yakutat, had an estimated height of 15–20 ft initially. It was estimated to have been 3 ft at the head of Monti Bay. The submarine landslide at the northern end of Khantaak Island left a cliff estimated to be 10–15 ft high (DGGS 2016).

<u>1964 Great Alaska Earthquake</u>

On March 27, 1964, a M9.2 earthquake, with an epicenter ~280 miles NW of Yakutat, was strongly felt throughout the Yakutat area, with rolling and swaying ground motion that lasted about 6 minutes. A single wave was observed in Monti Bay during the earthquake. Roiled and muddy water was reported in the Bay, and slumping of a beach was observed near Point Turner. These observations suggest the possibility that an underwater landslide occurred at the southern end of Khantaak Island, probably in the same area where previous slides were triggered by the 1899 and 1958 earthquakes (DGGS 2016).

<u>Subaerial Landslide</u>

<u>2015 Taan Fjord Landslide and Tsunami</u>

On October 17, 2015, 180 million tons of rock slid into Taan Fiord, an arm of Icy Bay, 65 miles northwest of Yakutat, generating a tsunami that stripped forest from 8 square miles of Wrangell St.-Elias National Park and Preserve and reached as high as 633 feet above the fjord, the fourth-highest tsunami ever recorded. It had almost no human impacts- nobody was close enough to be harmed, and the only damage to infrastructure was rocks scattered on a beach used for landing bush planes (NPS 2019). The slope failure occurred from rapid ice loss from a tidewater glacier in a tectonically active setting (Higman et al. 2018).

<u>1986 Slide and Ongoing Slope Instability and Slippage of Max Italio Dr. (formerly Bayview Dr.)</u>

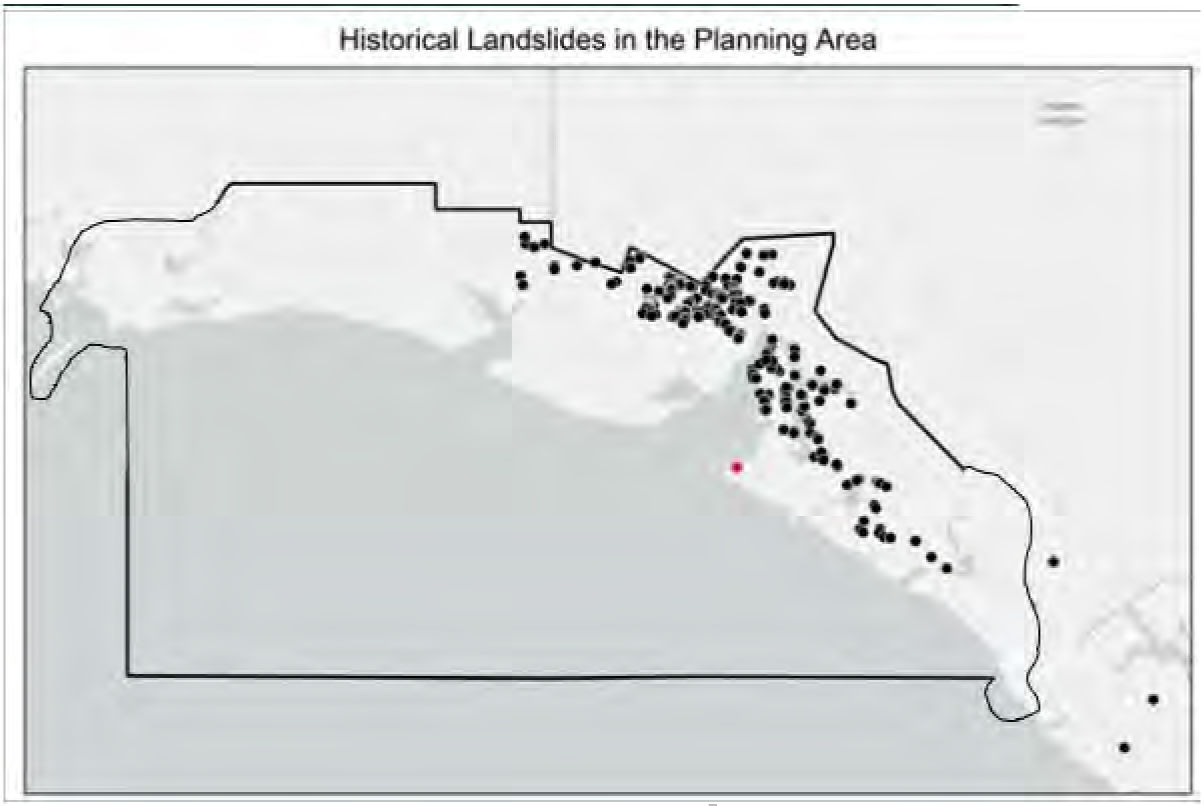
In 1987, the City of Yakutat contracted an engineering firm to investigate the slope stability of Bayview Dr. (now Max Italio Dr.) and port access problems, from the Alaska Native Brotherhood (ANB) Hall to Ocean

Cape Road. The firm published a final report (Corwin & Associates 1987), and their findings are described below:

> *Over the years, the steep slope shoreline in Yakutat, Alaska around Monti Bay, has seen many instances of slope instability. One of the most recent cases involves ground slippage* ***that carried an existing home into the Bay****. The home was a total loss along with personal injury to its occupants.*
>
> *The city of Yakutat has experienced a continuing soil slide problem along the Bayview Drive area. The problem became critical due to the recent "Latham" slide which involved the loss of one home along with individual bodily harm.*
>
> *Based upon the past slide experiences, interviews with various local officials and homeowners, and a review of the existing field surface conditions, the major causes of the failures were determined to be 1) the soil types (Glacial Morraine) and 2) the large groundwater flows.*
>
> *<u>Slope Stability Findings</u>*
>
> *The field reconnaissance revealed a varied array of soil groups within the area of study. These ranged from very fine grain clay and silts to sand, sand and gravel mixtures, cobbles, and rather large boulders. This type of mixed material is very typical of glaciated deposits. In this area there was ground surface evidence of till and outwash deposits and is probably the remnants of a terminal moraine. Typically, these types of deposits exhibit varying degrees of compactness and permeability, often within very short distances.* ***Unfortunately, with this type of soil conditions, there is not an absolute way to gauge when failures will occur.*** *The soils can fail very slowly over a long period of time or very rapidly over an extremely short period of time. The failure mechanism in the soils is directly related to the soil materials and gradation along with the presence of the high groundwater flows.*
>
> *There is a continual history of slope failure throughout the entire area of this study. Surface level soils show some of the failures exhibited soil creep prior to failure. Other surface soils show an almost instantaneous type of failure. From existing evidence and interviews with witnesses to some of these failures, an external load was induced in some of the failure areas. These loads would include seismic activity, construction of new structures, heavy traffic induced vibration, large amounts of rainfall, and even the natural ground movement which occurs in almost every sloped ground environment.*
>
> *An example of this sliding process can be seen in the recent "Latham" slide. Two days prior to the actual slide, NOAA reported a total of 10 inches of snow on the ground. This was followed by a rainfall of approximately 14 inches. Several of those interviewed for this study reported a noticeable movement of the Latham residence uphill crib wall prior to the slide. The rain and snow combined to provide an increased slide potential which dissipated itself through the slide.*

The Planning Team states that residents that live between Ocean Cape Road and Sandy Beach Road refer to this report when concerned about slope stability due to construction, saturation, and/or earthquake. One home has actually moved their house back from the edge of the hillside to mitigate the threat of the home being damaged by instability of hillside sloughing.

Figure 3-49 shows historical landslides in the Planning Area. Since the 2019 HMP was adopted, there have been 0 documented landslides (submarine or subaerial) in the Planning Area.



Note: The red labeled event is the only historical landslide that occurred near critical facilities and residences (Max Italio Dr.)
Source: USGS Landslide Hazard Program 2023- ArcGIS Online

Figure 3-49 Historical Subaerial Landslides in the Planning Area

Of the landslide events above, the only one that could have directly impacted critical facilities is the one shown in red, which occurred on Max Italio Dr. on August 30, 2016 (Figure 3-50). This area is noted by AKDOT as a routine-minor landslide/ embankment failure. Additional details from AKDOT state that "Creeping slope failure-still moving as of Dec 2016. Slope hasn't failed but there has been sealing by AKDOT Maintenance and Operations. It is unknown whether or not the road has been coned off for any length of time or just when the photo was taken" (AKDOT 2016).

Source: AKDOT 2016

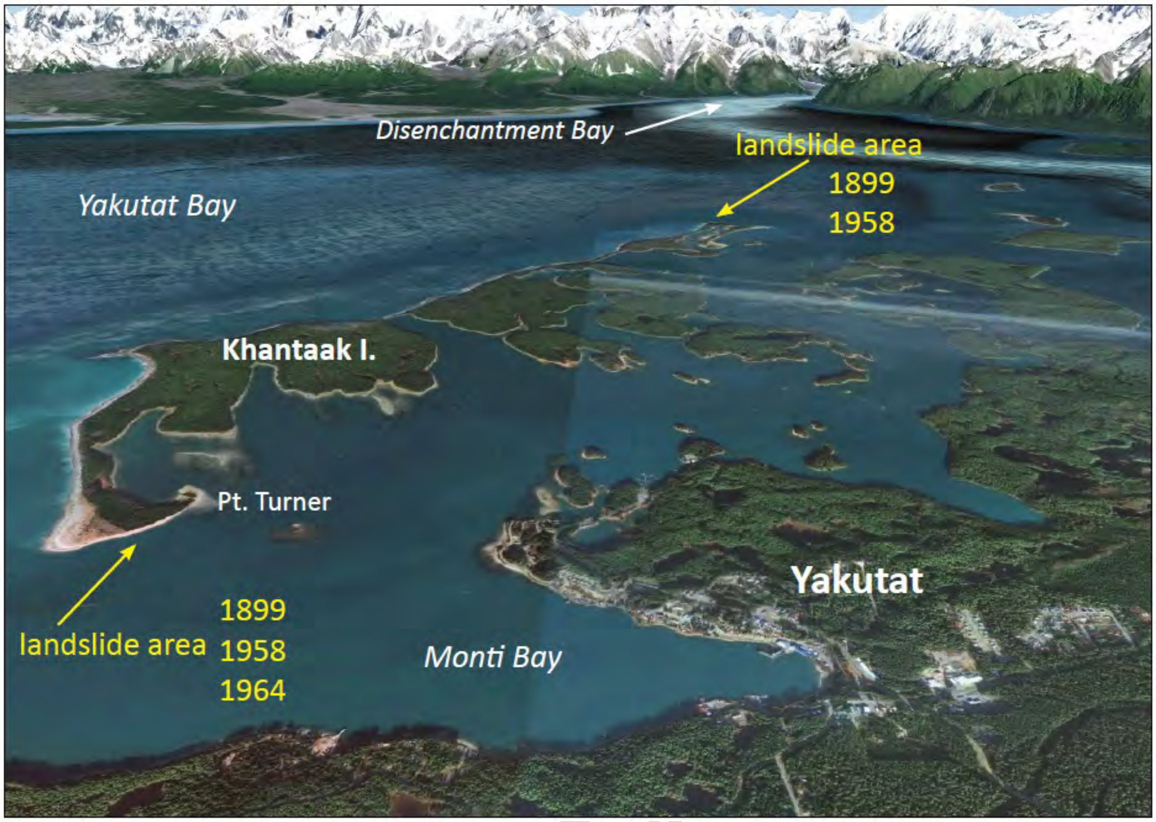
Figure 3-50 Creeping Slope Failure of Max Italio Dr. (August 29, 2016)

3.3.4.3 Location

Submarine Landslide

Yakutat Bay has a long history of underwater landslides. An engineering-geologic study of the Yakutat area concluded that both slide areas of Khantaak Island were locations of rapid deposition of loose, sandy beach sediments, which are unstable during earthquakes (DGGS 2016).

The locations of historical underwater landslides, which occurred after earthquakes, are shown below (Figure 3-51).



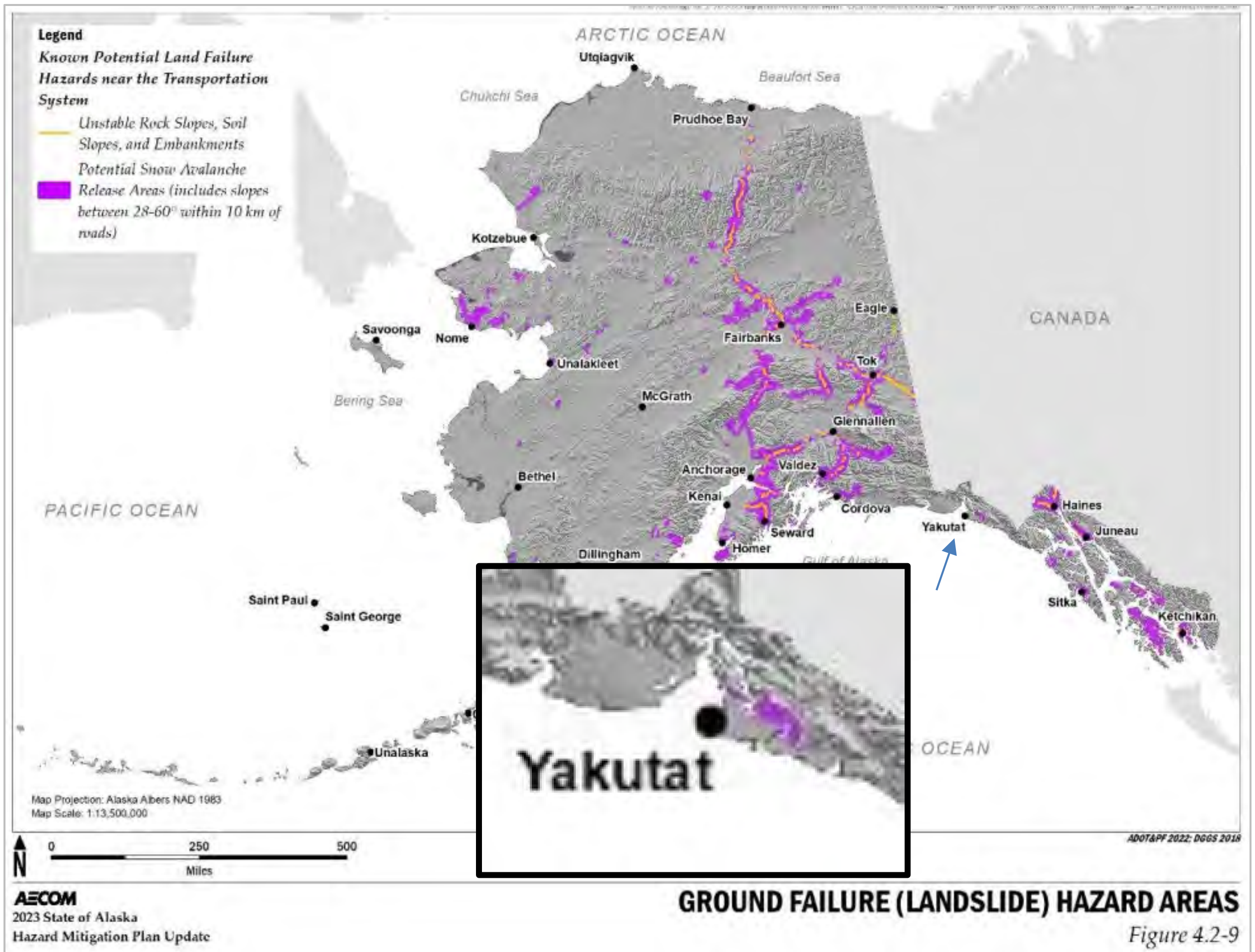
Source: DGGS 2016

Figure 3-51 Locations of Underwater Landslides After the Earthquakes in 1899, 1958, and 1964

<u>**Subaerial Landslide**</u>

Ongoing ground movement has been documented at Max Italio Dr. and the Norwegian Hill area of Yakutat.

The 2023 State of Alaska SHMP identifies land failure hazard locations across the state (Figure 3-52). These hazard areas are defined by any slopes greater than 28º. The submarine landslide areas from past earthquakes (Figure 3-51) are not identified in this figure.



Source: 2023 Alaska SHMP

Figure 3-52 Land Failure Hazard Areas in Alaska

3.3.4.4 Extent (Magnitude and Severity)

Damage from ground failure or landslides ranges from minor with minimal repairs required to a massive economic impact with the possible destruction of critical community infrastructure such as transportation or critical structures.

Submarine Landslide

A landslide (both submarine and subaerial) has the ability to trigger a tsunami. In 2016, DGGS produced tsunami inundation maps based off landslide and earthquake scenarios. Submarine landslides on the southern end of Khantaak Island pose a threat to Yakutat. DGGS does not consider potential slides at the northern end of Khantaak Island because the community of Yakutat is well protected from waves that could originate there.

See Figure 3-63 for Yakutat's tsunami inundation map.

Based on available data and modelling, historical events, and the criteria identified in Table 3-2, the extent of submarine landslides and resultant damages to people and infrastructure in Yakutat is considered to be Critical, where injuries and/or illnesses could result in permanent disability, a complete shutdown of critical facilities may last for at least two weeks, and more than 25% of property would be severely damaged.

Subaerial Landslide

Subaerial landslides on mountains (away from bodies of water) in the Planning Area do not pose a threat to critical facilities or human life in the Planning Area (Figure 3-52), but a subaerial landslides near bodies of water do pose a threat to critical facilities or human life in the Planning Area as they may trigger a tsunami.

As shown in Figure 3-49, landslides have been documented near bodies of water in the Planning Area, but these events did not produce a tsunami. Ongoing monitoring and modelling of these areas is needed to identify if future subaerial landslides have the potential to trigger a tsunami.

In 2021, DGGS began the Alaska Landslide Hazards Program. This 5-year project begins USGS support for DGGS landslide hazard data collection and assessment activities within the Alaska Landslide Hazards Program (DGGS 2023a). In this cooperative agreement, DGGS will identify, assess, and monitor unstable slopes in Prince William Sound (PWS) and begin developing a database to hold statewide information on Alaska landslides. The project will increase our understanding of landslide hazards across the state and, in particular, increase the preparedness and resilience of Southcentral and Southeast Alaska coastal communities and deliver critical information for stakeholder decision making (DGGS 2023a).

As part of this project, DGGS completed a landslide study for the community of Wrangell, and published the preliminary landslide inventory for parts of the Fairbanks North Star Borough in 2022 (DGGS 2023a). DGGS is currently working on projects for Barry Arm (landslide and tsunami, began in 2020), Haines (landslide, began in 2021), Cordova (avalanche and landslide, began in 2022), and Haines STATEMAP (engineering geology, began in 2022).

The Planning Team states that they have concerns that a future landslide may occur at Logan Bluffs, which is near Hubbard Glacier- northeast of the city, and if a slide there could trigger a tsunami (Figure 3-53).

Note: The red color indicates that USGS has a High Confidence in extent or nature of a future landslide at this location. Past landslides at Logan Bluffs occurred in 1948, 1998, and four events in 2003.
Source: USGS Landslide Hazard Program 2023- ArcGIS Online

Figure 3-53 Location of Logan Bluffs with Past Landslides

Scars from past landslides are still visible at Logan Bluffs (Figure 3-54).

Source: ShoreZone 2023

Figure 3-54 Landslide Scars at Logan Bluffs

The following images show the condition of Max Italio Dr- with cracks in the pavement and sloping of the road. This road is also impacted by frost heaves that further threaten the structural integrity of the road.

Source: Yakutat 2022 Transportation Improvement Plan

Figure 3-55 Pavement Cracking on Max Italio Dr. (2022)

Source: Yakutat 2022 Transportation Improvement Plan

Figure 3-56 Cracking and 6 Inch Hole on Max Italio Dr. (2022)

Based on available data and modelling, historical events, and the criteria identified in Table 3-2, the extent of subaerial landslides and resultant damages to people and infrastructure in Yakutat is considered to be Limited, with potential for critical facilities to be shut down for more than a week, and more than 10 percent of property or critical infrastructure being severely damaged.

3.3.4.5 Impact

Impacts associated with landslides include tsunamis, surface subsidence, infrastructure, building, and/or road damage, and potential human injury or death.

Submarine Landslide

Underwater landslides generated by earthquakes have been documented in Monti Bay and Yakutat Bay (Figure 3-51). Past submarine landslides on Khantaak Island have triggered localized tsunamis that resulted in 3-foot waves, runup, damage to homes, and deaths. Submarine and subaerial landslides have the potential to trigger a tsunami, which may inundate the community and threaten critical facilities and infrastructure, people, and residences.

Subaerial Landslide

Subaerial landslides on mountains in the Planning Area have not impacted any critical facilities or residences as the populated portion of the Planning Area is not situated near these hazard areas. It is possible that historical landslides have gone undetected due to the remote location and vastly unpopulated areas of the Planning Area.

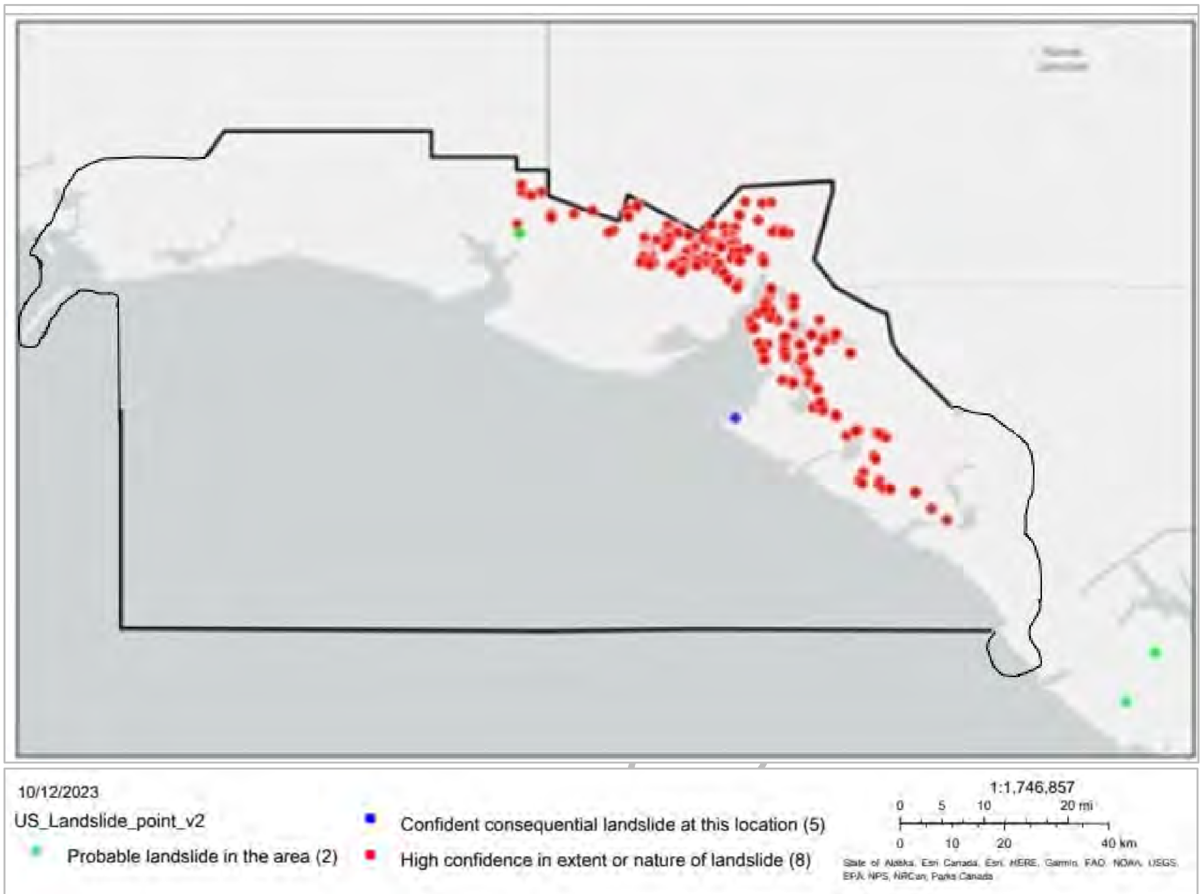
Subaerial landslides of bluffs near bodies of water in the Planning Area have resulted in tsunamis (2015 Taan Fjord). This event occurred in a remote portion of the Planning Area and had almost no human impacts- nobody was close enough to be harmed, and the only damage to infrastructure was rocks scattered on a beach used for landing bush planes (NPS 2019).

3.3.4.6 Probability of Future Events

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 (DHS&EM 2023).

Figure 3-57 shows the confidence level of future landslides at locations where landslides have historically occurred in the Planning Area. Only one of these historical landslide locations are located near critical facilities and residences (on Max Italio Dr.), which is labeled in blue as USGS is confident that there will be a consequential landslide at this location. This dataset does not provide an estimate for when the next landslide will occur.

Note: This dataset only identifies past subaerial landslide events in the Planning Area and does not provide confidence for probability of future submarine landslides.



Source: USGS Landslide Hazard Program 2023- ArcGIS Online

Figure 3-57 Confidence in Probability of Future Landslides in the Planning Area

<u>Submarine Landslide</u>

To forecast which part of the underwater slope in Monti Bay will be more likely to fail during the next earthquake, and what volume of material could be involved, site-specific geotechnical information and local slope-stability analyses are needed to better constrain the potential submarine slides (DGGS 2016).

Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a submarine landslide event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

<u>Subaerial Landslide</u>

Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a subaerial landslide event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

3.3.4.7 Future Conditions Including Climate Change

Changing Factor due to Climate Change	Description of Future Changes due to Climate Change
Nature	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

Changing Factor due to Climate Change	Description of Future Changes due to Climate Change
	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 (DHS&EM 2023).
Location	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 (DHS&EM 2023).
Extent (Magnitude and Severity)	Landslides are expected to increase in magnitude with increased areas of effect as glaciers continue to retreat and permafrost thaws (IPCC 2019). 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 (DHS&EM 2023).
Impact	Landslides are projected to occur in areas where there is no history of previous events due to the destabilization of mountain slopes from thawing permafrost and glacial decline (IPCC 2019), which could increase future tsunami events and resultant impacts to Yakutat.
Probability of Future Events	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 (DHS&EM 2023). 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 (DHS&EM 2023).

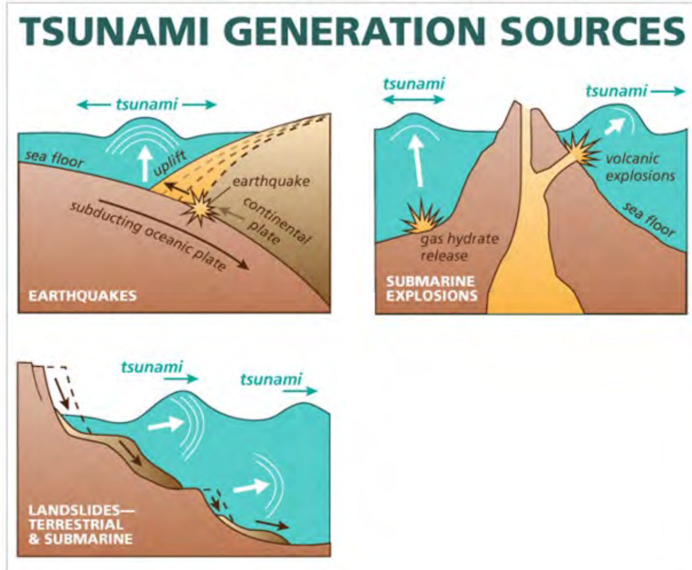
3.3.5 TSUNAMI

3.3.5.1 Nature

A tsunami is a series of traveling waves of extremely long wavelength and period generated by a sudden vertical displacement of water. This displacement of water can be triggered by underwater volcanic eruptions, large landslides, or earthquakes at or below the ocean floor. In Alaska, seismically generated earthquakes near the subduction zone pose the primary tsunami threat to coastal communities. A seiche is an oscillating wave occurring within a partially or totally enclosed water body.

The different types and generation sources of tsunamis are described below:

- **Seismically generated tsunamis** are generated by an earthquake event. Seismically-generated tsunamis in Alaska most commonly occur along the subduction zone in the Aleutian Islands. Earthquakes have also generated tsunamis in the back arc area in the Bering Sea and the eastern boundary of the Aleutian Arc plate. Seismically-generated tsunamis typically reach land 20 to 45 minutes after starting. 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 and may require immediate evacuation.



- **Landslide-generated tsunamis** can be generated by subaerial (land) or submarine (underwater) landslides. Landslides may be triggered by an earthquake and one earthquake may trigger multiple landslides and resulting tsunamis. These events are particularly dangerous because they can form the largest tsunami events as they possess the largest amount of kinetic energy, and they do not typically provide any warning before generating.
  An earthquake usually, but not always, triggers this type of landslide, and they are usually confined to the originating bay or lake location such as the historical 1958 Lituya Bay event and the more recent October 2015 700-foot-high landslide wave Taan Fjord event in Icy Bay. Very large landslide areas have been observed in surrounding mountains frequently in the past five years. Some have been notable enough to register on earthquake monitoring equipment thousands of miles from Yakutat.

- **Volcanic-generated tsunamis** are the least common type of tsunamis in Alaska, as only one volcanic eruption event has been confirmed in the state. In 1883, the Saint Augustine volcano triggered a tsunami when the north side of the mountain collapsed. The resulting tsunami inundated Port Graham with waves that were 30 feet high. On January 15, 2022, a large submarine volcano in Tonga erupted, which triggered a widespread Pacific-wide tsunami. The eruption was heard throughout parts of Alaska, as far north as Fairbanks, nearly 6,000 miles away. The National Tsunami Warning Center issued a tsunami advisory for much of the Alaskan coastline, as unusual and strong currents with waves up to 3 feet were predicted. The community of King Cove recorded waves of just over 2 feet, but no significant damage was reported. The National Tsunami Warning Center stated that an evacuation warning would have been issued if waves reached 3.2 feet.

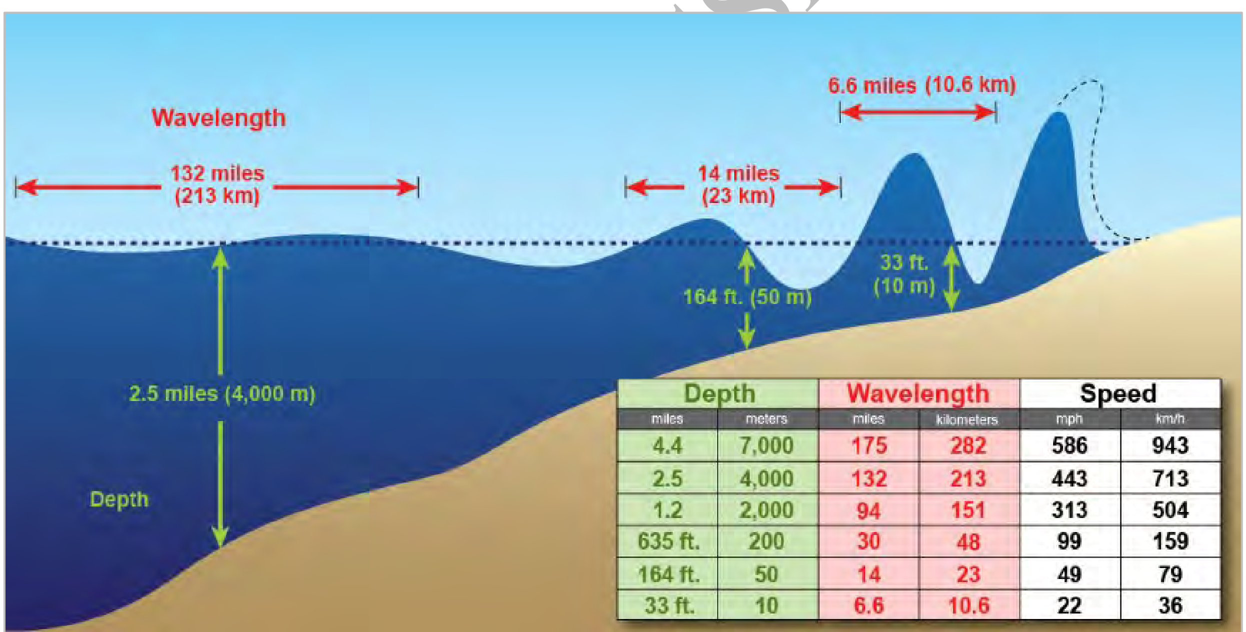
- **Teletsunamis**, also called **ocean-wide tsunamis** or **distant tsunamis**, originate at a distant location, and are observed at or impact locations 620 miles (>1,000 km) away or over 3 hours travel time from their source. In many cases, tele-tsunamis can allow for sufficient warning time and evacuation. There is a slight risk in the western Aleutians and some parts of Southeast Alaska. Most tele-tsunamis that reached Alaska have not caused damage. Massacre Bay on Attu Island has historically received tele-tsunamis with less than one-ft recorded amplitudes. The 1960 Chilean tsunami caused damage to pilings at MacLeod Harbor, Montague Island (Prince William Sound area) and on Cape Pole, Kosciusko Island (southeast Alaska) where a log boom broke free.

- **Seiche** waves oscillate in partially or totally enclosed water bodies. They are caused by earthquakes, underwater landslides, atmospheric disturbances, or avalanches and can last from a few minutes to a few hours. The first wave can occur within a few minutes, giving virtually no warning time. The resulting effect is similar to bathtub water sloshing repeatedly from side to side. The reverberating water continually causes damage until the activity subsides. The factors for effective warning are similar to a local tsunami. Communities near large lakes, such as Lake Iliamna, may be vulnerable to seiche activity following an earthquake.

Many tsunamis are often undetected because of their long wavelengths. Some wavelengths are hundreds of miles long and only 3 feet high, and cannot be felt by mariners as it passes beneath their vessel. The wavelength of the tsunami waves and their period will depend on the generating mechanism and the dimensions of the source event. If the tsunami is generated from a large earthquake over a large area, its initial wavelength and period will be greater. If the tsunami is caused by a local landslide, both its initial wavelength and period will be shorter.

The speed that a tsunami will travel will depend on the depth of the water it is travelling through. The tsunami will travel faster in deeper water and will begin to slow down once the depth of the water decreases. In the deep ocean, they can travel at speeds over 500 mph and have the capacity to cross entire oceans in one day.

As a tsunami enters shallow waters and nears land, it begins to slow down, the wavelengths decrease, waves grow in height, and currents intensify (Figure 3-58). Once the tsunami makes landfall, its speeds slow down to 20-30 mph.



Source: NWS 2023c

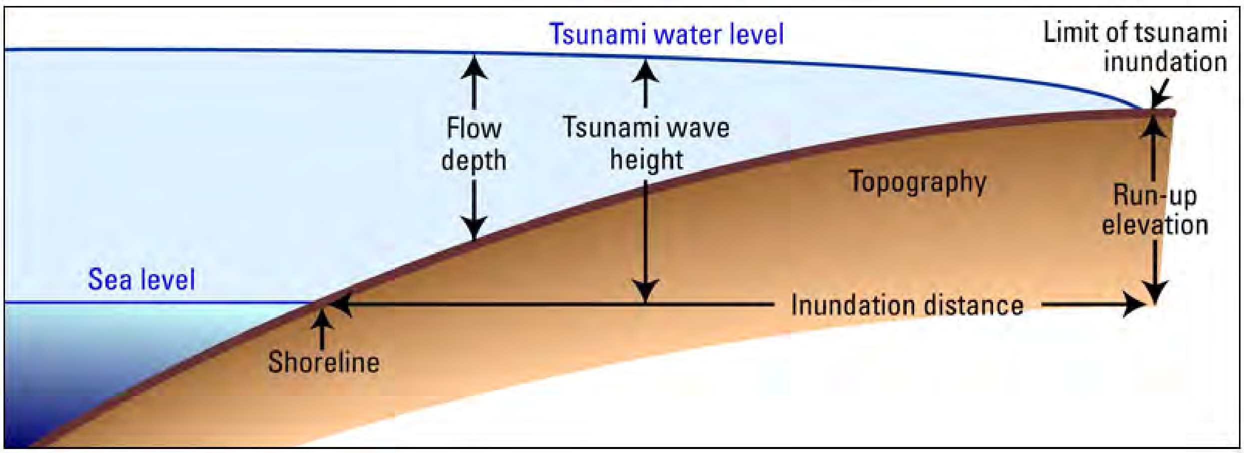
Figure 3-58 Cross Section of a Tsunami Propagation

Some terms commonly used when describing tsunamis are below.

- **Inundation:** The horizontal distance inland that a tsunami penetrates, generally measured perpendicularly to the shoreline.
- **Inundation line:** Inland limit of wetting, measured horizontally from the mean sea level (MSL) line. The line between living and dead vegetation is sometimes used as a reference. In tsunami science, the landward limit of tsunami runup.

- **Runup:** Difference between the elevation of maximum tsunami penetration (inundation line) and the sea level at the time of the tsunami. In practical terms, runup is only measured where there is a clear evidence of the inundation limit on the shore.

  Elevation reached by seawater measured relative to some stated datum such as mean sea level, mean low water, sea level at the time of the tsunami, etc., and measured ideally at a point that is a local maximum of the horizontal inundation. Where the elevation is not measured at the maximum of horizontal inundation this is often referred to as the inundation-height.
- **Run-up elevation:** The elevation above sea level of a tsunami at the limit of penetration
- **Flow depth:** Flow depth relates to the depth of the water from a tsunami, measured on shore in different locations; flow direction relates to the direction of this flow.
- **Tsunami wave height:** Difference between the elevation of the highest local water mark and the elevation of the sea level at the time of the tsunami. This is different from maximum runup because the water mark is often not observed at the inundation line, but maybe halfway up the side of a building or on a tree trunk.



Source: USGS 2010

Figure 3-59 Illustration of Common Tsunami Terms

3.3.5.2 History

Yakutat has not been impacted by a damaging tsunami in recent history; however, like several southeast Alaska communities, Yakutat experienced debris from distant tsunamis such as the 2011 Japan tsunami. Tsunamis are unpredictable and can occur with little warning. All communities with a tsunami risk listed should be considered at risk whether they have a recorded instance of tsunami damage or not.

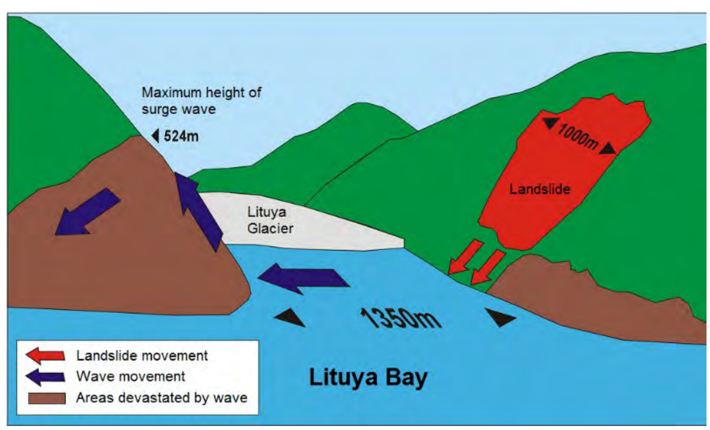


Figure 3-60 Diagram of the 1958 Lituya Bay Landslide and Megatsunami

1958 Lituya Bay Landslide and Megatsunami

On July 9, 1958, a 7.8-8.3 magnitude earthquake occurred in Lituya Bay, 100 miles southeast of Yakutat. The earthquake was caused by a strike-slip on the Fairweather fault and triggered a landslide of 30 million cubic meters and 90 million tons of rock/land was displaced in the narrow inlet of Lituya Bay. The sudden displacement triggered a megatsunami that was felt throughout the region.

This tsunami was so powerful that water marks and cleared trees were recorded at over 1,700 feet in elevation in the fjord (a height taller than the Empire State Building). A total of 5 people were killed from this tsunami and many others injured and displaced from their homes. In Yakutat, the only permanent outpost close to the epicenter at the time, infrastructure such as bridges, docks, and oil lines all sustained damage. A wave tower collapsed, and a cabin was damaged beyond repair. Sand boils and fissures occurred near the coast southeast of Yakutat, and underwater cables that supported the Alaska Communication System were cut.

2011 Tohoku Earthquake

On March 11, 2011, the M9.1 Tohoku earthquake produced a small wave in Yakutat. The maximum wave amplitude recorded by the tide gauge in Yakutat was 13.8 in (DGGS 2016). The far-field Tohoku tsunami did not result in a significant wave at Yakutat due to its distance from the tsunami source and directivity patterns of the energy propagation (DGGS 2016). The waves were directed primarily to the northwest, toward the coast of Japan, and to the southeast, in the Pacific Ocean. There are no accounts of any observations of this tsunami at Yakutat, likely because the wave arrived at 4:25 a.m. (DGGS 2016).

2015 Taan Fjord Landslide and Tsunami

On October 17, 2015, 180 million tons of rock slid into Taan Fiord, an arm of Icy Bay, 65 miles northwest of Yakutat, generating a tsunami that stripped forest from 8 square miles of Wrangell St.-Elias National Park and Preserve and reached as high as 633 feet (193 m) above the fjord, the fourth-highest tsunami ever recorded. It had almost no human impacts—nobody was near enough to be harmed, and the only damage to infrastructure was rocks scattered on a beach used for landing bush planes (NPS 2019). The slope failure occurred from rapid ice loss from a tidewater glacier in a tectonically active setting (Higman et al. 2018).

2018 Kodiak Earthquake

On January 23, 2018, a 7.9 magnitude earthquake occurred near Kodiak, and a tsunami warning was issued. However, a tsunami did not occur in Yakutat. The community did successfully evacuate using a door-to-door notification system as well as the police chief driving throughout the community notifying residents with a bullhorn- only one person was missed. A tsunami evacuation center was set up at the airport.

2021 Chignik Earthquake

On July 29, 2021, a powerful 8.2 magnitude earthquake occurred 60 miles southeast of Chignik. As a result of this earthquake, a tsunami advisory was issued for southeast Alaska, including the area from the inner/outer coast from Cape Decision (85 miles southeast of Sitka) to Cape Fairweather, which is 80 miles southeast of Yakutat. The community was on alert for orders to evacuate, but the advisory was cancelled shortly after with no impact to the community.

Table 3-12 describes historical tsunami events that impacted Yakutat (1800-August 2023). Since the 2019 HMP was adopted, there was 1 tsunami event that affected Yakutat. The 8.2 Chignik earthquake (discussed above), resulted in 0.11 meters of runup in Yakutat, but no damages or injuries were reported.

Table 3-12 Historical Tsunami Events with Runup Recorded in Yakutat (1800-August 2023)

Date	Cause*	M	Origin	Location of Effects	Max. Water Height (m)	Comments
1845–1847	L		Alaska	Yakutat Bay		100 Natives died near Haenke Island. Date uncertain.

Date	Cause*	M	Origin	Location of Effects	Max. Water Height (m)	Comments
9/4/1899	EQ	8.2	Cape Yakataga, Alaska	Yakutat	3.1	Water ran out of bay below lowest tide and returned as swell, flooding an Indian village.
9/10/1899	EQ + L	8.6	Southeastern Alaska	Yakutat	4.6	Whirlpools formed
9/10/1899	EQ + L	8.6	Southeastern Alaska	Western shore of Yakutat Bay	9	Water inundated 0.5 km (0.3 mi) inland
9/10/1899	EQ + L	8.6	Southeastern Alaska	Yakutat Bay	3	Sawmill damaged, huts flooded. Part of Khantaak Island slid into the bay, multiple deaths.
4/1/1946	EQ	7.3	Eastern Aleutian Islands, Alaska	Yakutat	0.37	Uplift occurred
11/4/1952	EQ	8.2	Kamchatka Peninsula, Russia	Yakutat	0.2	No comments
3/9/1957	EQ	8.3	Central Aleutian Islands, Alaska	Yakutat Bay	0.34	No comments
7/10/1958	L	7.9	Lituya Bay, Alaska	Yakutat	0.9	Mooring lines torn loose
7/10/1958	L	7.9	Lituya Bay, Alaska	Yakutat Bay	6.1	Slumping of land on Khantaak Island, 3 deaths
5/22/1960	EQ	8.6	Chile	Yakutat	0.76	No comments
3/28/1964	EQ + L	8.5	Gulf of Alaska	Yakutat Bay	1.5	No comments
11/29/1975	EQ	7.2	Hawaii	Yakutat	0.05	No comments
2/28/1979	EQ + L	7.1	Gulf of Alaska	Yakutat	0.05	No comments
3/3/1985	EQ	7.8	Chile	Yakutat		No comments
11/17/1987	EQ	6.9	Gulf of Alaska	Yakutat	0.06	No comments
11/30/1987	EQ	7.6	Gulf of Alaska	Yakutat	0.43	Boats bumped together
3/6/1988	EQ	7.6	Gulf of Alaska	Yakutat	0.2	No comments
7/30/1995	EQ	7.8	Chile	Yakutat	0.06	No comments
6/23/2001	EQ	8.2	Peru	Yakutat	0.03	No comments
12/26/2004	EQ	8.8	Sumatra, Indonesia	Yakutat	0.08	No comments
11/15/2006	EQ	7.8	Kuril Islands, Russia	Yakutat	0.13	No comments
1/13/2007	EQ	8.2	Kuril Islands, Russia	Yakutat	0.05	No comments
9/29/2009	EQ	8.1	Samoan Islands	Yakutat	0.08	No comments
2/27/2010	EQ	8.5	Chile	Yakutat	0.36	No comments
3/11/2011	EQ	8.3	Honshu, Japan	Yakutat	0.35	No comments
10/28/2012	EQ	7.5	Haida Gwaii, Canada	Yakutat	0.15	No comments
2/6/2013	EQ	7.4	Solomon Islands	Yakutat	0.07	No comments

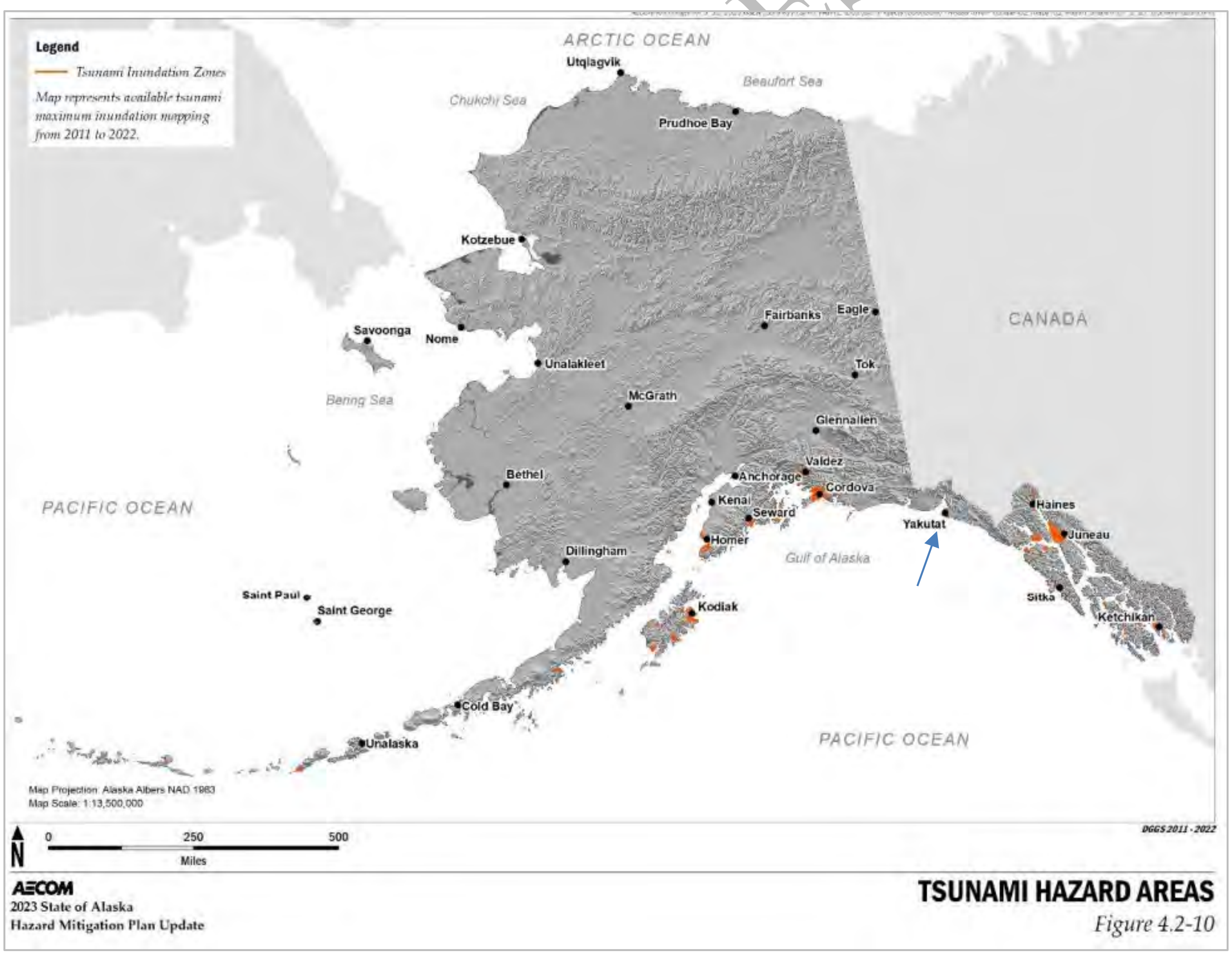
Date	Cause*	M	Origin	Location of Effects	Max. Water Height (m)	Comments
10/18/2015	L	-	Icy Bay, Alaska	Yakutat	0.18	The estimated 200 million metric tons of rock spilled onto the toe of Tyndall Glacier and into Taan Fjord, in Icy Bay, Alaska.
1/23/2018	EQ	7.9	Kodiak Island, Alaska	Yakutat	0.14	15 cm observed max tsunami height is the highest recorded water level above the tide level, up to the time of this message.
7/29/2021	EQ	8.2	Alaska Peninsula-Chignik	Yakutat	0.11	No comments

*Cause of tsunami: EQ= earthquake only, L=landslide only, EQ+L: earthquake and resultant landslide

Source: DGGS 2016, NCEI/WDS 2023

3.3.5.3 Location

The 2023 Alaska State HMP identifies tsunami hazard areas across the state (Figure 3-61). Yakutat is in an identified tsunami hazard area as they have completed tsunami inundation mapping.

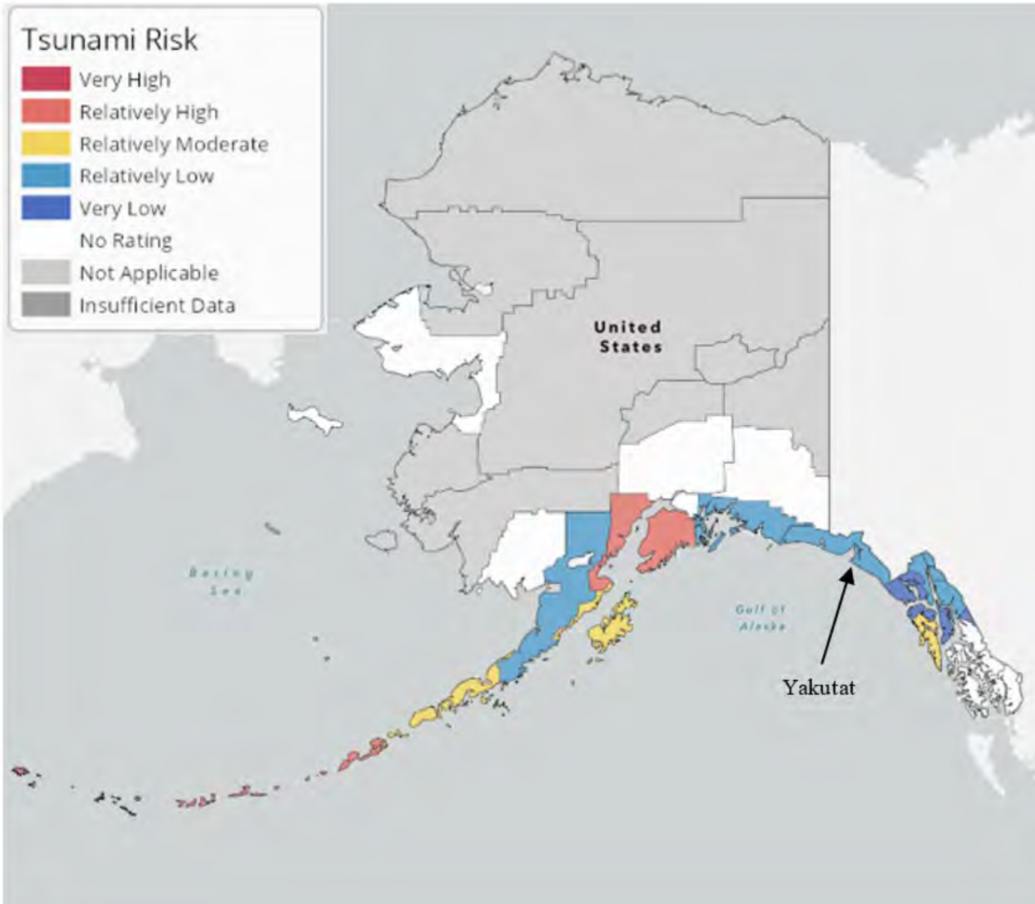


Source: 2023 Alaska SHMP

Figure 3-61 Statewide Tsunami Hazard Areas

FEMA's National Risk Index provides the following map for Tsunami Risk in Alaska (Figure 3-62). The tsunami risk for Yakutat is labeled as Relatively Low.

DGGS states that in Southeast Alaska, the likelihood of a tsunami is low, but impacts would be critical (DGGS 2023b).



Source: FEMA 2023- National Risk Index

Figure 3-62 Alaska Tsunami Risk Map

TsunamiReady Community

Yakutat is a NOAA recognized TsunamiReady Community and StormReady Community. Being a part of these programs means that Yakutat has taken the proactive step of being a TsunamiReady Community and StormReady Community and may potentially lessen the damage to the community and reduce the risk to area residents and visitors. These requirements were updated in 2015 and are outlined below.

Table 3-13 Summary of Guidelines for TsunamiReady Program

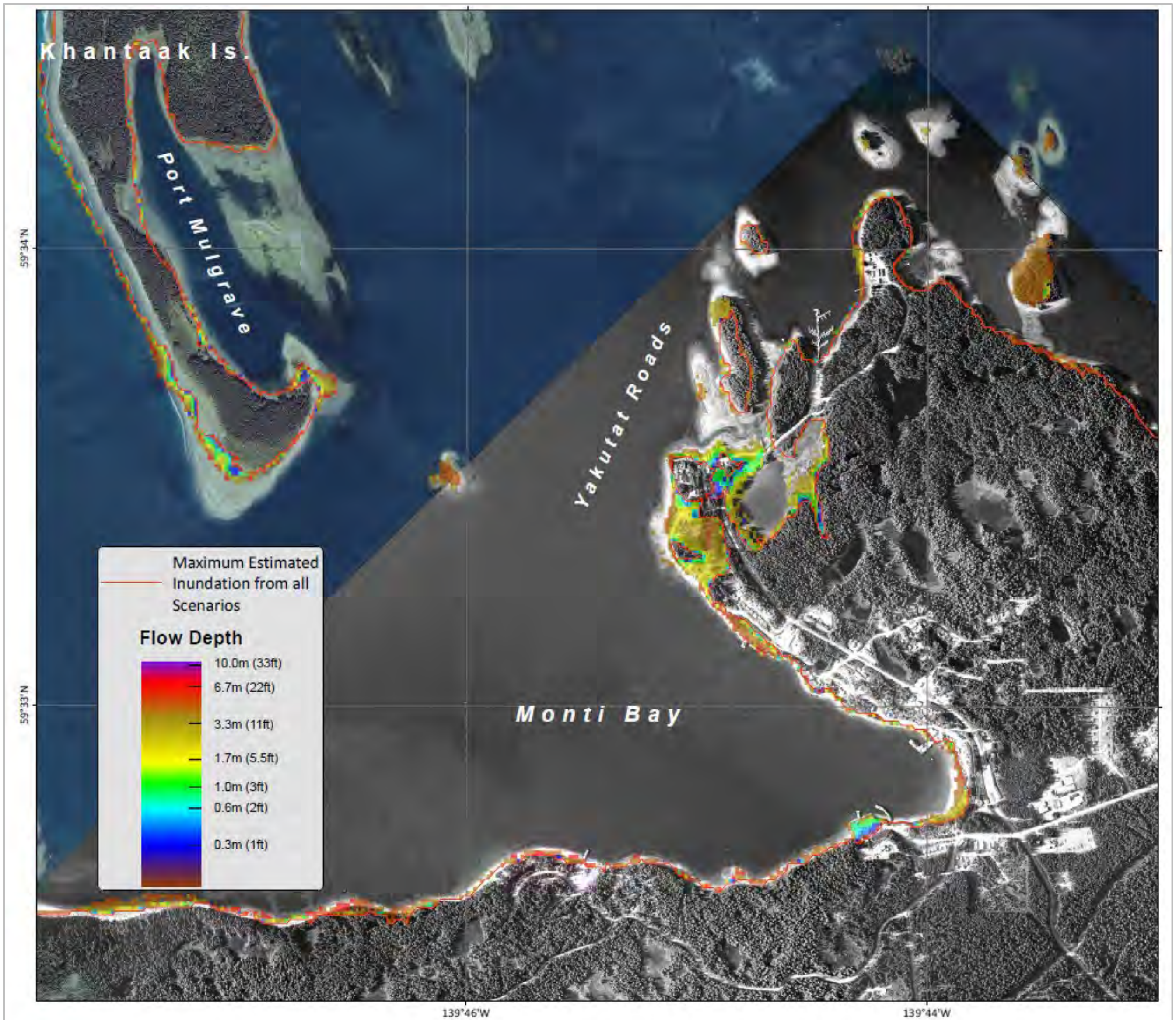
Guideline ID	Guideline Description
MIT-1	Have designated and mapped tsunami hazard zones.
MIT-2	Include tsunami hazard and community vulnerability information in the community's FEMA-approved multi-hazard mitigation plan.

Guideline ID	Guideline Description
MIT-3	Install signage, as needed, that identifies for example: (1) tsunami danger area and/or hazard zone (entering and leaving signs), evacuation routes, and assembly area; and (2) provides tsunami response education (go to high ground).
PREP-1	Produce easily understood tsunami evacuation maps as determined to be appropriate by local authorities.
PREP-2	Support an ongoing sustained tsunami public education effort. This effort should include the development and distribution of outreach materials.
PREP-3	Support an ongoing sustained tsunami education effort specific to public schools in coastal community pursuing TsunamiReady® recognition.
PREP-4	Hold at least one community-wide outreach or education activity annually.
PREP-5	Conduct community exercises that reinforce the concepts contained in PREP-1 through PREP-4.
PREP-6	Conduct evacuation drills for all public schools in the mapped tsunami evacuation zone to reinforce the concepts contained in PREP-1 through PREP-4.
RESP-1	Address tsunami hazards in the community's emergency operations plan (EOP).
RESP-2	Address tsunami hazards in the emergency operations plans (EOP) for all public schools in the tsunami hazard zone.
RESP-3	Commit to supporting the emergency operations center (EOC) during tsunami incidents if an EOC is opened and activated.
RESP-4	Have redundant and reliable means for a 24-hour warning point (and EOC if activated) to receive official tsunami watch, advisory, and warning alerts.
RESP-5	Have redundant and reliable means for 24-hour warning point and/or EOC to disseminate official tsunami watch, advisory, and warning alerts to the public.
RESP-6	Have Public Alert-certified NOAA Weather Radio (NWR) receivers in critical facilities and public venues.
RESP-7	Conduct emergency operations plan exercises that test at least one component of the community's EOP or one item from RESP-4 through RESP-6

MIT= Mitigation, PREP= Preparedness, RESP= Response
Source: NWS 2015

3.3.5.4 Extent (Magnitude and Severity)

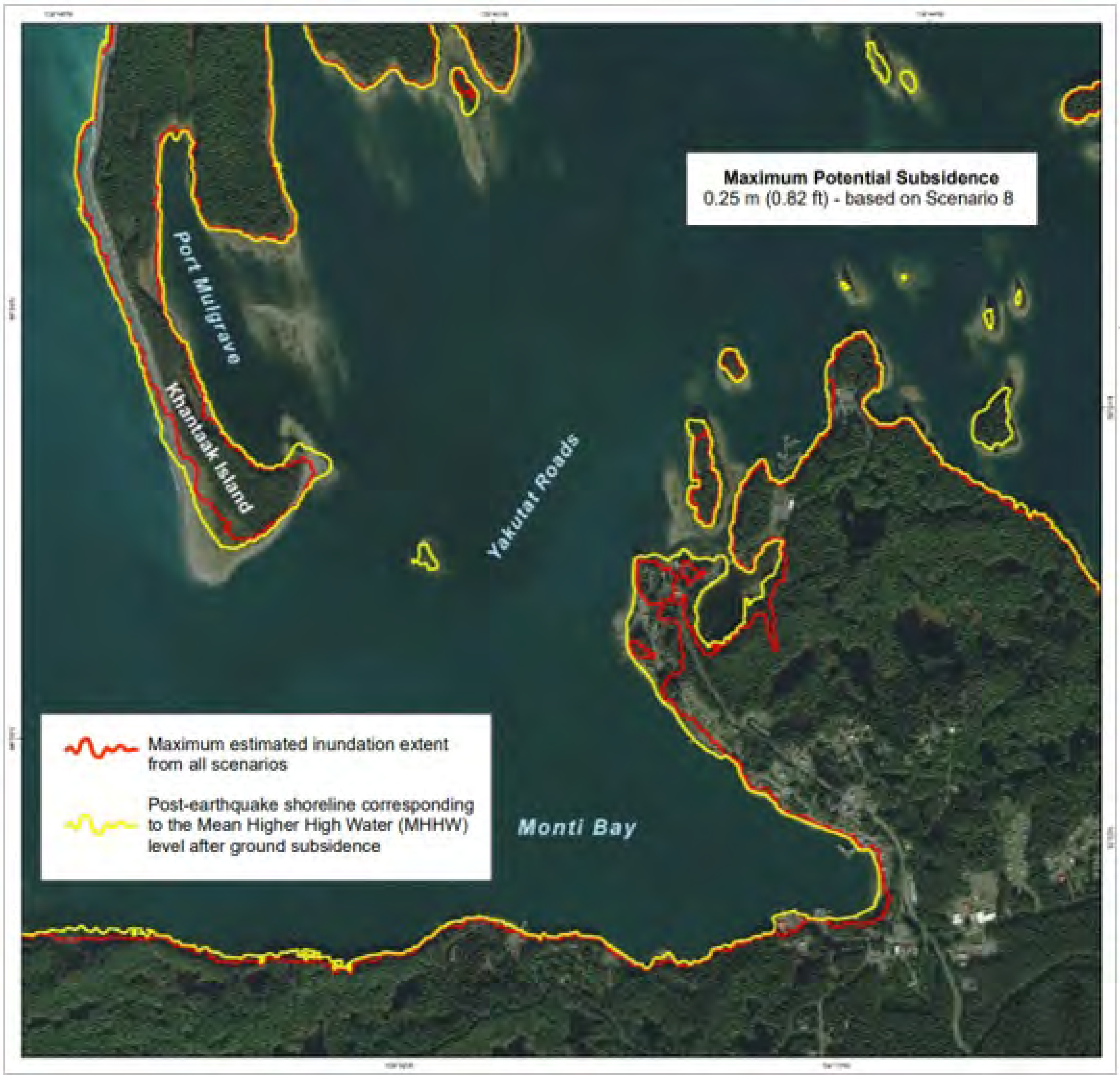
DGGS has a library of tsunami inundation maps for many coastal communities that are threatened by tsunamis. The maximum estimated tsunami inundation and maximum flow depths in Yakutat are shown below. This map combines the maximum inundation for both seismically generated and landslide induced tsunamis.



Source: DGGS 2016

Figure 3-63 Maximum Estimated Tsunami Inundation and Flow Depth in Yakutat

Tsunami researchers examine historical earthquakes and study geologic records from prehistoric tsunamis to develop maximum credible earthquake and tsunami scenarios. The permanent flooding maps focus on near-shore dry land that may subside during the earthquake and be prone to flooding (DGGS 2018). This information is visualized in a map showing potential permanent flood zones (Figure 3-64).



Source: DGGS 2018

Figure 3-64 Potential Maximum Permanent Flooding Extent

Based on historical events and the criteria identified in Table 3-2, the extent from historical tsunamis have been Limited, but based on tsunami inundation mapping, the extent of future tsunamis may be Critical, where injuries and/or illnesses could result in permanent disability, a complete shutdown of critical facilities may last for at least two weeks, and more than 25% of property would be severely damaged.

3.3.5.5 Impact

Potential impacts from a tsunami will vary and are dependent on many factors, but impacts range from barely detectable to completely destructive. Tsunamis have an effect on beaches once they hit the shore, and may also affect mouths of bays, tidal flats, and the shoreline of large coastal rivers. Tsunamis can diffract around islands and land masses and since they are asymmetrical, the waves may be much stronger in one direction than the other, further affecting the surrounding coastal features. Tsunamis propagate outward from their source, so coasts in the "shadow" of land masses are typically safe from the effects of the tsunami.

Inundation extent and impacts may differ depending on the mechanism driver of the tsunami. DGGS provides information on the potential impact in Yakutat for the different drivers of tsunamis.

For a **seismically generated tsunami**, DGGS states:

> *"The modeling results suggest that tsunami sources built on the 1964 earthquake rupture models have only a* <u>*moderate*</u> *impact on Yakutat. The inundation area for these scenarios does not extend far beyond the MHHW in most areas. This result is also supported by observations of the 1964 tsunami at Yakutat, when several waves were observed during and after the earthquake, but none reached above extreme high-water level or caused any damage.*
>
> *The available geologic evidence indicates that repeated 1964-type events provide the most realistic estimate of future earthquake displacements, but the occurrence of Tohoku-type events is possible. Thus, a* <u>*Tohoku-type source mechanism*</u>*, is considered the* <u>*worst-case scenario*</u> *for the community of Yakutat. Additionally, the short arrival time and high tsunami wave amplitudes estimated for a* <u>*local earthquake along the Otmeloi fault*</u> *or other proximal structures present a* <u>*significant tsunami hazard*</u> *for Yakutat."*

For a **landslide induced tsunami**, DGGS states:

> *"The effects of landslide tsunami scenarios are site-specific.*
>
> *[Figure 3-63] shows that the coastal areas most affected by these scenarios are either adjacent to the landslide-generation areas, or across the bay from them. At the same time, there are areas that have not experienced any tsunami runup.*
>
> *If a future landslide occurs along the southern side of Khantaak Island similar to the slides of 1899, 1958, and 1964, then the majority of the tsunami energy will be directed across the bay toward the southern shore of Monti Bay, resulting in flow depths up to 7 m (23 ft). If a future slide is generated along the northern shore of Monti Bay, then the areas most affected by the waves will be those along the shoreline next to the landslide area, where Yakutat Cold Storage and the sewage plant are located.*
>
> *Although underwater slides occurred repeatedly at the northern end of Khantaak Island, we do not consider potential slides in that area because the community of Yakutat is well protected from waves that could originate there. The energy of the waves generated at the northern tip of the island would be directed mostly to the north, and the waves would be scattered by multiple islands before they reach Monti Bay.*
>
> *"Landslides produce much shorter waves and more focused tsunami energy flux than earthquakes, therefore landslide tsunami effects along the coast are not uniform. Areas with high flow depth values could be just a hundred feet away from areas that are not affected at all."*

3.3.5.6 Probability of Future Events

A primary cause of submarine landslides in fjords is the accumulation of sediments on steep underwater slopes (DGGS 2016). Subaerial landslides can be initiated in slopes already on the verge of movement by rainfall, snowmelt, changes in water level, stream erosion, changes in ground water, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors. Earthquake and landslide-induced tsunamis have been documented in Yakutat.

Based on FEMA's Tsunami Risk Map, DGGS inundation mapping, and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a tsunami event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

When a tsunami warning is issued for Yakutat, a dedicated member of the community goes door-to-door to ensure that vulnerable populations, such as the deaf, are aware of the warning and assist them with getting to an evacuation area. This system has worked for Yakutat in past tsunami warnings and is a valuable tool to ensure all members of the community are informed of the hazard and safely evacuate. In the public survey for this HMP Update, multiple responders stated that this one of the ways they receive communication about hazard events in Yakutat.

3.3.5.7 Future Conditions Including Climate Change

Due to climate change, the nature of tsunami events in Yakutat are not anticipated to change.

Changing Factor due to Climate Change	Description of Future Changes due to Climate Change
Location	Local tsunamis are anticipated to become more of a concern in Southeast Alaska due to glacier retreat in fjords associated with climate change (DHS&EM 2023). Landslides that may induce a tsunami are protected to occur in areas that have not historically had landslides.
Extent (Magnitude/ Severity)	Local tsunamis are anticipated to become more of a concern in Southeast Alaska due to glacier retreat in fjords associated with climate change (DHS&EM 2023). Glacier ice provides lateral support for over steepened, ice-scoured slopes; when glaciers retreat, these slopes can destabilize (DHS&EM 2023).
Impact	As tsunami events become more frequent in a changing climate, the potential impacts to Yakutat increase. Yakutat has not been severely impacted by a recent tsunami event, but as the population has grown and more infrastructure has been developed, the potential for greater loss has increased.
Probability of Future Events	Local tsunamis 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 (DHS&EM 2023). The 2015 Taan Fiord slope failure occurred from rapid ice loss from a tidewater glacier in a tectonically active setting (Higman et al. 2018). The Taan Fiord event provides warning that Icy Bay may see similar, potentially more deadly events in the future. Lituya Bay produced at least five giant tsunamis over the course of three centuries and Icy Bay could well rack up a similar record. A century ago, Icy Bay was filled with glaciers. It wasn't until the 1960s that four steep-walled fjords began to open at the head of the bay. The 2015 tsunami was the largest to occur in this narrow window of time, but it likely wasn't the only tsunami. At least two sites along the fjord have fresh landslide deposits extending into the ocean, and a ridge opposite the 2015 slide is laced with fissures that may produce future failures. Other fjords at the head of Icy Bay have steep slopes that haven't yet been surveyed for potential landslide hazards (Higman et al. 2018). Adventure kayakers, trophy bear hunters, commercial and sport fishers, and even cruise ships visit Icy Bay. Though logging along its shore has ended, plans for a large-scale mine are being explored, potentially creating another vulnerable facility. When the tsunami occurred in October 2015, workers were present in Icy Bay Lodge just 20 miles away, fortunately beyond damaging waves. However, many similar situations might have had greater impact: A landslide might occur at a busy time of year; a small landslide or tsunami might impact a beach campsite; or a large landslide might occur in one of the other fjord arms of Icy Bay. Due to the geometry of the bay, a tsunami in a different arm would more directly impact the outer part of Icy Bay, where there is more human activity (Higman et al. 2018).

3.3.6 FLOOD

3.3.6.1 Nature

Flooding is the accumulation of water in areas that typically do not hold water, or it can result from surplus water from streams, rivers, lakes, reservoirs, glaciers, or coastal water bodies overflowing onto the surrounding floodplains. Floodplains are the adjacent low-lying grounds adjacent to water bodies, formed mainly of sediment deposits from past flooding events.

Though floods are natural events, they can be considered hazardous when people and property are affected. Sediment transport is another damaging aspect of flooding that can impact infrastructure, barge, and other river vessel access. Infrastructure may be protected or maintained from these events by dredging.

There are three types of flood hazards in Yakutat: rainfall-runoff, snow and glacier melt, and glacier-dammed lake release flooding. Due to the sheltered location of Yakutat, residents have reported that storm surges do not occur in Yakutat.

Rainfall-Runoff Flooding: The most common type of flood, rainfall runoff magnitude is determined by rainfall intensity, duration, distribution, and geomorphic characteristics of the watershed. Weather systems that bring strong persistent rainfall differentiate rainfall runoff from the other categories of flooding. Rainfall runoff flooding is more likely to occur in late summer to early fall.

Snowmelt Floods: Spring weather patterns and snowpack depths determine the immensity of this flooding occurrence. Snowmelt takes place in the spring, usually between the months of April through June.

Glacial Dam Outburst Flood: Glaciers are dynamic, growing and receding with changing climate conditions, and pose a significant threat to Alaska's communities. They generate large avalanches and glacial lake dam outburst flooding.

> *"The major hazard presented by glacier dammed lakes is catastrophic flooding which occurs when the ice dams fail. In many places, flooding occurs annually; there are many exceptions, and the situations change rapidly from one year to the next. It should be noted that large quantities of water can also be stored in or under glaciers and may create serious floods even though no surface lake is visible."* (Post and Mayo 1971)

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. While flooding is a hazard itself, coastal flooding can also result in coastal erosion, which can impact residences and critical facilities and infrastructure if they are built near the shoreline.

3.3.6.2 History

In the Yakutat area, as well as most coastal areas of Southcentral and Southeast Alaska, the floods due to snowmelt are typically lower in magnitude than those due to rainstorms in late summer or fall. Glacier melt is typically largest in late summer, increasing the potential magnitude of late summer rainfall floods in glacial streams.

Glacier Lake Flooding

In late May or early June 2002, the Hubbard Glacier pushed a moraine across the seaward entrance to Russell Fiord and began to restrict the tidal exchange between Disenchantment Bay and Russell Fiord. By early June, the moraine formed Russell Lake. The lake level rose at an average rate of more than 0.8 feet per day due to large amounts of runoff and glacial melt in the basin. By late July, the dam completely sealed off the lake and by 3 a.m., August 14, real-time USGS water gage data revealed the water level in the lake had peaked at about 61 ft above sea level and had begun to drop rapidly, creating the second largest glacial lake outburst in recorded world history.

Perhaps the greatest hazard associated with Russell Lake will result if the Hubbard Glacier dam does not fail, and Russell Lake fills indefinitely. Eventually, the lake will overtop the saddle separating Russell Fiord from the Situk River basin. If the outflow from Russell Fiord basin drains through the Situk River, erosion of a new, larger channel will influence the landscape and aquatic habitat downstream.

Hubbard Glacier, Alaska 1986 and 2002

Unlike many glaciers in Alaska and around the world, Hubbard Glacier is thickening and advancing. Hubbard Glacier has a large accumulation area, like a river with a large watershed. This large area of snow in the mountains upstream either melts or flows down to the end of the glacier, and Hubbard steadily grows. In fact, Hubbard Glacier has advanced 1.5 miles, or about 2.4 kilometers, since 1895.

Russell Fiord is the narrow body of saltwater connected to the bay and extending southeast. The Hubbard Glacier lies where Russell Fiord meets the bay. In 1986 and 2002, the Hubbard Glacier surged down from the mountains, blocking the outlet of Russell Fiord, and creating Russell Lake (Figure 3-65). During both summers, the new lake filled with runoff; its water level rose 82 ft (in 1986), and the decrease in salinity threatened its sea life. During the 1986 event, an estimated 187.1 billion cubic ft of water rushed through the gap, and the fjord was reconnected to the ocean at its previous level.

Source: Gubernick et al. 2007

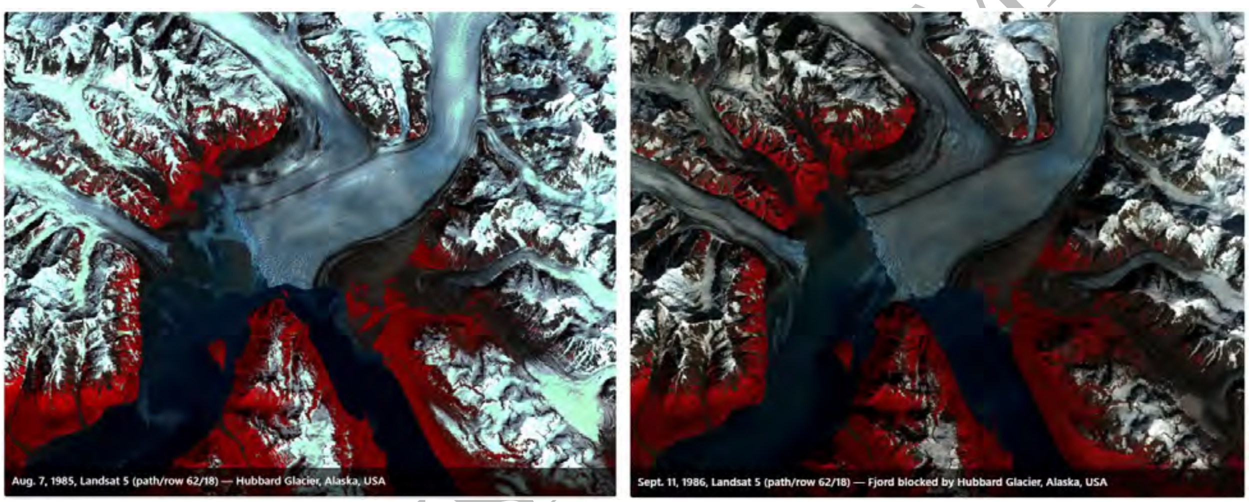
Figure 3-65 Russell Lake (circa 1986)

The following excerpt from an USDA publication explains this phenomenon:

> *"In 1986 and 2002, the advance of the Hubbard Glacier blocked the northern area of the Russell Fiord from Yakutat Bay, temporarily creating Russell Lake. The subsequent failure of the ice or moraine dams in 1986 and 2002, respectively, produced the two largest glacial outburst floods in historic times. Both of these dams failed before the lake had risen to an elevation that would*

> *have caused it to spill over the terminal moraine at the southern end of Russell Fiord into the Situk River drainage. In 2002, the Tongass National Forest commissioned an interagency technical team to investigate the implications of the Hubbard Glacier completely closing Russell Fiord and rising lake levels overtopping the moraine at the southern end of Russell Fiord, forcing flow into the historic Situk River channel. The complete closure of Russell Fiord has major economic and safety issues affecting the City of Yakutat. The Situk River provides world class sport, subsistence, and commercial fishing, which drives and supports the majority of the Yakutat economy. A sustained closure of the Hubbard-Russell ice dam will increase average daily flows in the Situk River from the current 3 to 11 cubic meters per second (cm/s) to over 566 cm/s if Lake Russell overtops the moraine, resulting in significant short and long-term changes to the river ecosystem."* (Gubernick and Paustian 2007)

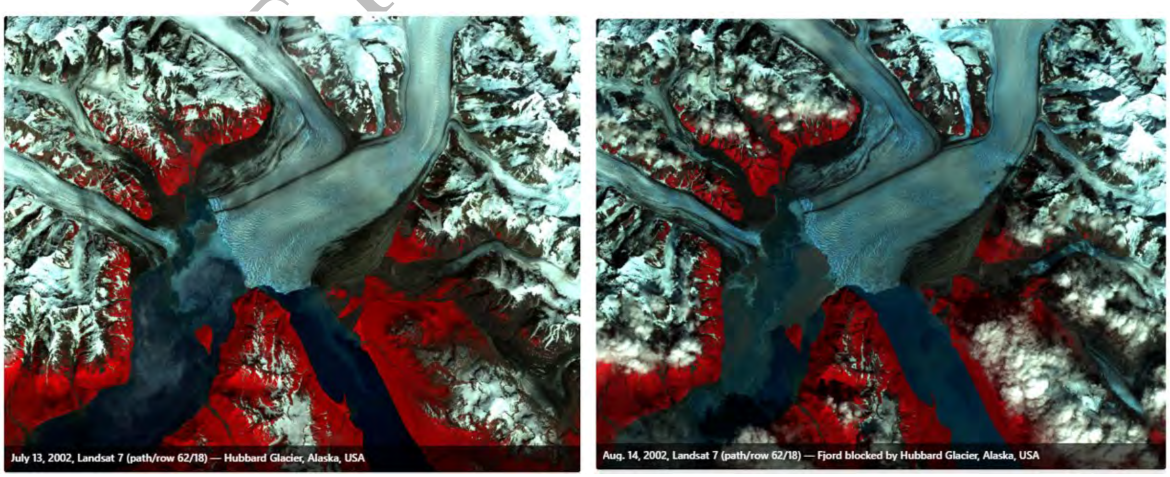
These Landsat images illustrate an unusual event that was observed twice at the terminus of Hubbard Glacier (1985 and 2002). Hubbard temporarily blocked Russell Fiord (a long, narrow inlet of the sea) from the rest of Disenchantment Bay and the Gulf of Alaska (USGS 2023b).



August 7, 1985 September 11, 1986

Source: USGS 2023b

Figure 3-66 Hubbard Glacier Ice Dam Satellite Imagery (1985)



July 11, 2002 August 14, 2002

Source: USGS 2023b

Figure 3-67 Hubbard Glacier Ice Dam Satellite Imagery (2002)

The Upper and Lower Situk Roads and the Dangerous River Road have historically flooded. These roads are used for fishing access and are maintained by AKDOT. Flooding on the Lower Situk Road have cut fishermen off from being able to drive back to town for 3-4 days. The Upper Situk Road flooding comes from the foothills and has blown out culverts and turns the basin into a 6-foot trench. On Dangerous River Road, a culvert washed out and people were stuck and unable to drive back to town. When they were stranded, they overnighted at their location and no injuries were reported. The same culvert was washed out over 20 years ago and a car drove into void where the culvert blew out and the driver was injured, but no deaths occurred. In both instances of the culvert washing out, someone who was on the other side of the washout site had to travel back to town to get service to call for emergency services.

The National Weather Service's Storm Events and River Notes Databases provides details of historic flood events (January 1996 – August 2023) and their impacts to Yakutat (Table 3-14). The NWS Storm Events Database has data dating back to January 1950 for many states, but it began collecting data for Alaska in January 1996.

Since the 2019 HMP, there have been 0 flooding events in Yakutat.

Table 3-14 Historic Flood Events in Yakutat

Date	Location/Event Type	Description/Magnitude of Event
06/01/1986	Glacial Lake Flooding/ Hubbard Glacier	In May 1986, a weak surge of the Valerie tributary of Hubbard Glacier caused the glacier to block the fiord entrance, converting the body of water into a large glacier-dammed lake. This lake filled to a height of 86.7 ft and stored 1.3 mi^3 of water before it burst out on October 8, 1986, producing a peak flow of 3,708,040 ft^3 per second, averaged for 1 hour (Mayo 1989).
12/13/1999	Flood	Minor flooding of small creeks and streams began after 2 inches of rain fell in Yakutat in less than 6 hours. Rain continued, moderate to heavy at times through the following 36 hours causing additional flooding of low-lying areas.
08/14/2002	Glacial Lake Flooding/ Hubbard Glacier	The 2002 moraine dam began to fail when the lake surface altitude reached about 49 feet above sea level. A rainstorm caused a rapid lake to rise that increased the volume of water flowing over the moraine dam, which also increased the rate of erosion of the dam. The growth of the moraine dam by glacier flow did not keep pace with erosion and the dam progressively failed. Dam failure released a flood that reached a maximum discharge of 1,850,000 ft^3/s about 21 hours later (about midnight on August 14) (USGS 2003).
12/23/2013	Flood	A persistent anomalous high amplitude upper-level ridge over the eastern Pacific and western North America started to build to the north and cutoff over Southeast Alaska in mid-January. The series of atmospheric rivers that affected Southeast Alaska from the mid December through the end of January shifted to the west by the third week. This shift refocused the stream of moisture from the tropics to the west and was pointed right at the Northern Gulf of Alaska coast. This atmospheric river was evident from satellite imagery. When the warm front moved over the Yakutat area in the morning hours of the 23rd the weather sounding recorded the highest ever precipitable water value for that time of year, one point zero seven inches. There was about 36 hours of moderate to heavy precipitation as the front was slow to move across the area. The large amount of rain during that time period produced minor to moderate flooding over the Yakutat area. The persistent onshore flow with numerous weather systems moving over the Yakutat area from mid-December through the end of January produced 34.45 inches in 44 days with only 2 days of no rain. It was the 5th wettest 44-day period on record for that time period with a daily average rainfall amount greater than 3/4 of an inch. January was also the 4th wettest on record with 3 daily records on the 5th (3.61 inches), 22nd (3.36 inches) and the 23rd (3.95 inches). Minor to moderate flooding was reported across the Yakutat area on the 23rd and 24th after 7.31 inches of rain fell at the airport and 9.96 inches fell at the Situk River gauge in just under 2 days. The combination of record rainfall amounts, and very moist antecedent soil conditions produced a lot of runoffs into streams and drainage ditches. The massive amount of runoff caused the Situk River to crest at 72.71 feet which is the second highest crest in the 26-year record. The campground, trail, and boat launch near the nine-mile bridge along the Situk River flooded significantly. Forest Highway #10 going out to the upper Situk River and to the Harlequin Lake was flooded in certain areas with some spots along the road totally

Date	Location/Event Type	Description/Magnitude of Event
		washed out. There was also flooding that took place along the lower portions of the Situk River with portions of the established trail system destroyed. The road going out to the lower Situk River landing near mile marker 4.2 was flooded and the road going out to Canon Beach was flooded with about a foot of water. The road going out to Tawa Creek and Lost River was also flooded.
12/29/2014	Coastal Flood	A storm force low developed in the Western Gulf of Alaska on the morning of Tuesday the 29th. A strong cold front approached the Eastern Gulf coast on the afternoon of the 29th that included a very long fetch for seas and strong winds. This coincided with Spring tides which got to 13 FT near Yakutat. Damage occurred for the fish camps near Strawberry Point which persistent high winds swept through Skagway all the way though Wed the 30th. A long fetch of building sea impacted the Eastern Gulf Coast near Yakutat on the afternoon of the 29th. This coincided with one of the highest astronomical tides of the year. Damage to the fish camps at Strawberry Point was documented by a survey with photos. The estimates were around $20,000.
10/24/2017	Situk River	Moisture associated with a very deep and sharply defined upper-level trough is located south and west of the Panhandle of Alaska as of Monday night. Upper-level winds will transport this moisture towards Southeast Alaska over the next 48 hours and arrive over the northeast gulf coast Thursday morning. Heavy rain will spread inland over the following 24 hours and then spread southeast through Friday afternoon. Precipitable water values nearly 4 standard deviations above normal are forecast, which will result in 48-hour rainfall totals in excess of 6 inches near Yakutat. This much rain will cause significant rises on area rivers and streams.
12/07/2017	Tawah Creek	Water went over the road to Cannon Beach near Yakutat (Tawah Creek). Also, the cops said that water went over the road to the Situk River near the Airport (stream into Tawah Creek)
03/09/2019	Situk River	No flood impacts in the Yakutat area reported after recent high-water event on the Situk River.

Source: River Notes Database (NWS 2023a) and Storm Events Database- Storm Prediction Center Product (NWS 2023b)

3.3.6.3 Location

There are multiple water bodies located in the Planning Area and surrounding the City of Yakutat. Some of these include the Gulf of Alaska, Yakutat Bay, Monti Bay, Disenchantment Bay, Russell Fiord, Situk River, Tawah Creek, Harlequin Lake, Alesek River, Icy Bay, among others. The Planning Team states that Yakutat does not commonly experience flash flooding.

3.3.6.4 Extent (Magnitude and Severity)

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of recurrence.

The following factors contribute to coastal flooding frequency and severity:

- Time of year
- Atmospheric pressure
- Wind speed/strength
- Wind direction

During the last 7,000 years, Russell Fiord in southeast Alaska has experienced cyclical ice damming by the Hubbard and Nunatak glaciers, forming a large lake that redirects outflow into the Situk River near Yakutat, Alaska. A sustained closure of the Hubbard-Russell ice dam will increase average daily flows in the Situk River from the current 3 to 11 cubic meters per second (cm/s) to over 566 cm/s if Lake Russell overtops the moraine, resulting in significant short and long-term changes to the river ecosystem (Gubernick and Paustian 2007).

100-year flood zone maps have not been created for Yakutat, but tsunami inundation maps have been.

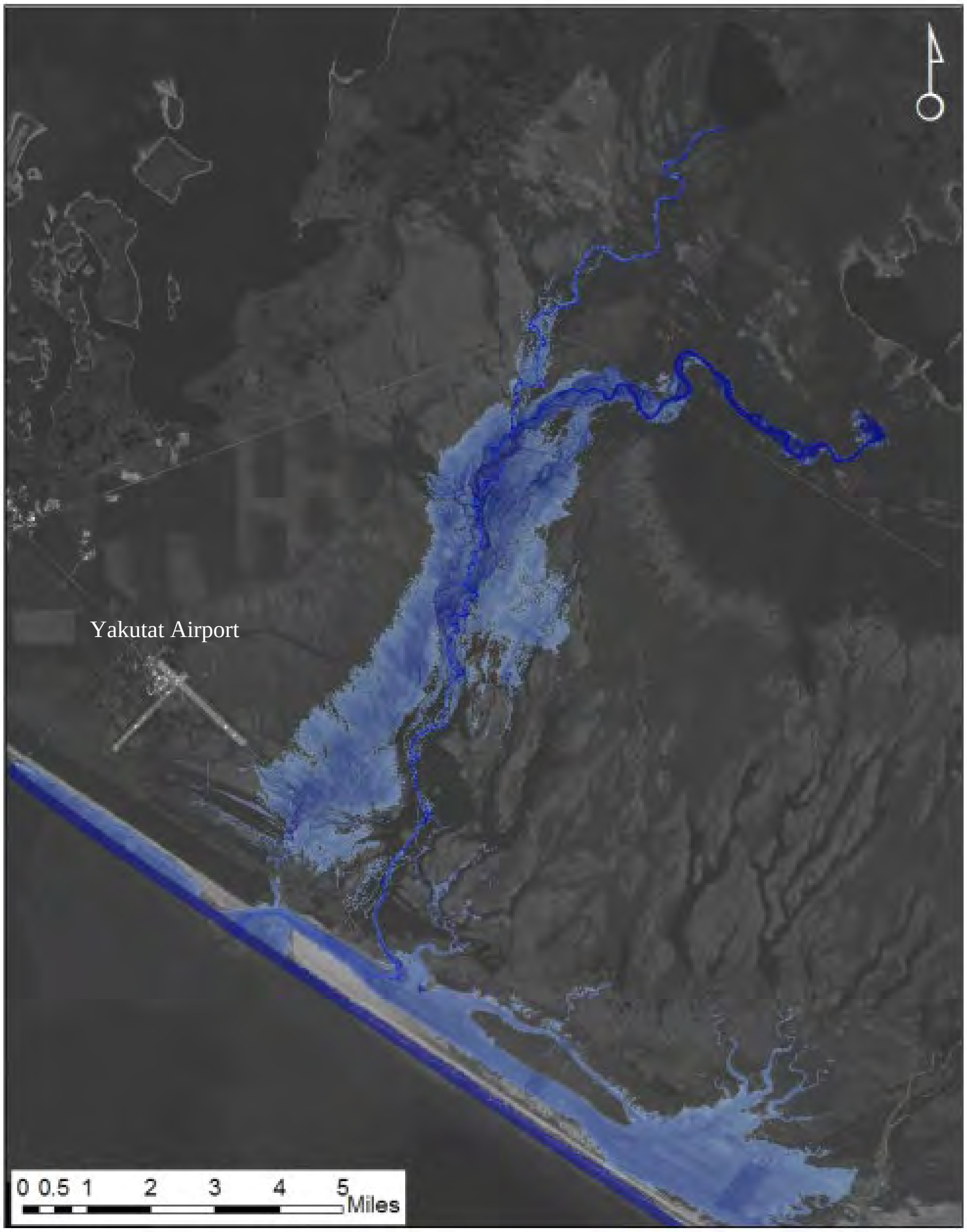
A floodplain inundation map for the Situk River was made by the US Forest Service through the USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling system (Figure 3-68). The model found that floodwaters inundate the floodplain to varying widths, depending on magnitude of the flood, and river channels are projected to change from scour due to high velocities and water surface slopes (Gubernick and Paustian 2007).

All hydraulic modeling indicates minor impacts on the Yakutat airport area (Gubernick and Paustian 2007). However, the uncertainty related to debris dams formed during initial overflow or long-term lateral migration of the new Situk channel would increase the risk to the airport. **These risks can be mitigated by revetment protecting the airport** (Gubernick and Paustian 2007). All cabins or improvements along the Situk River would be lost during the initial flood.

Source: Gubernick and Paustian (2007)

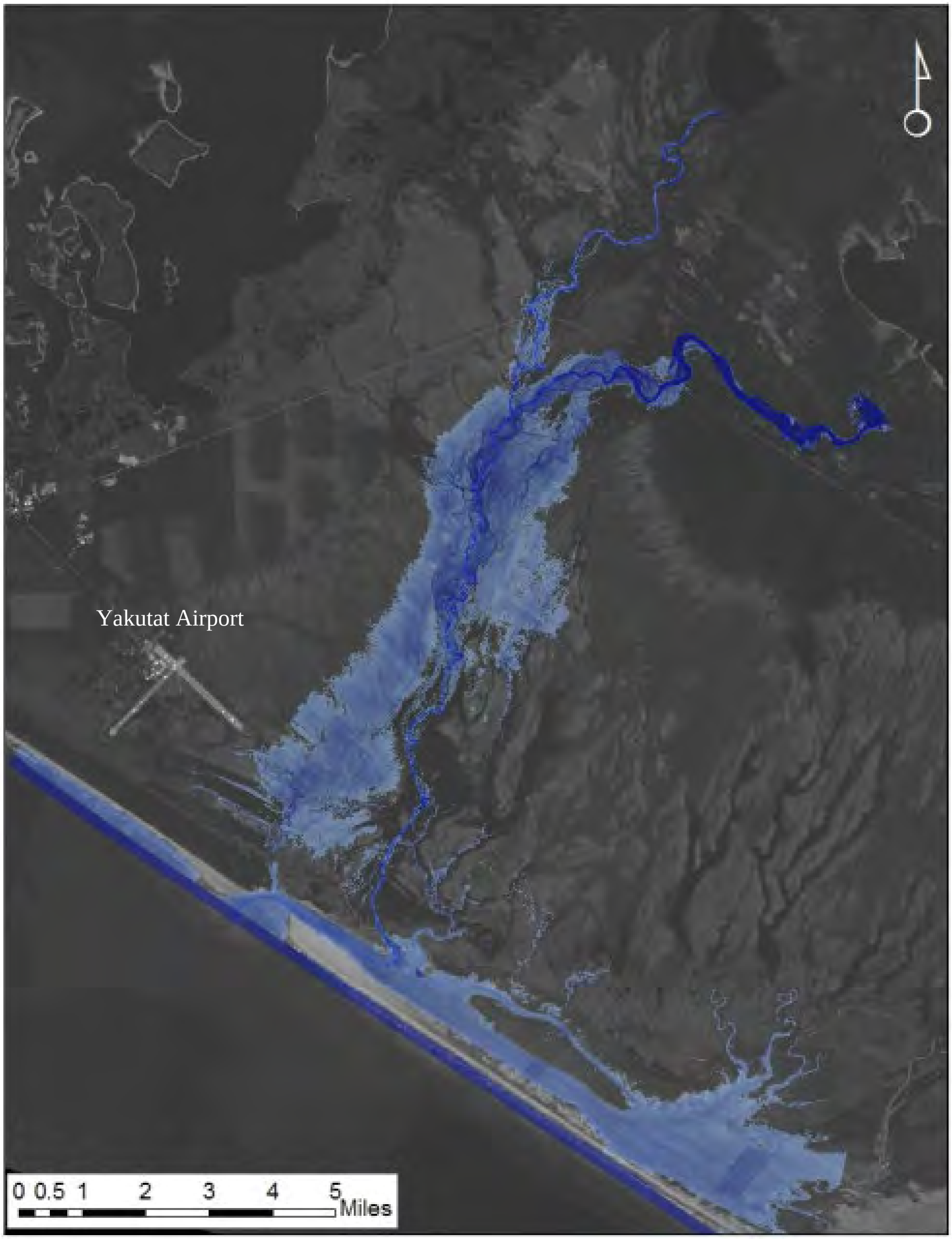
Figure 3-68 Situk River Floodplain Inundation Map Based on HEC-RAS Modeling

A 2011 USACE report analyzed how the hydrology of the Situk River would be affected following the closure of the Russell Fiord by the Hubbard Glacier. The following maps show the estimated flood inundation in the scenario that there are no trees in the Old Situk channel versus trees present in the Old Situk channel.



The flow depth is indicated by the shade of blue: the darker the shade, the greater the flow depth.
Source: USACE 2011

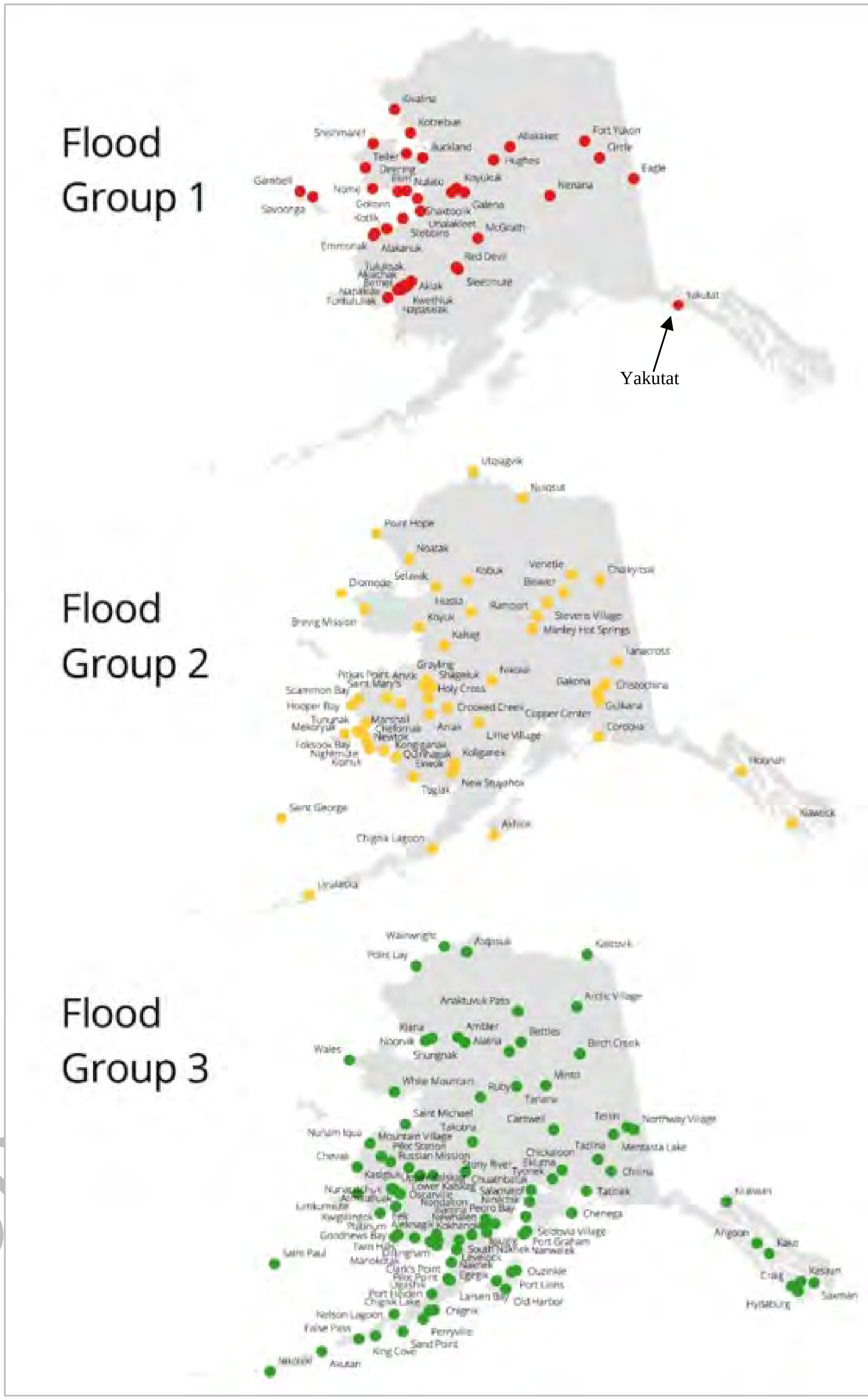
Figure 3-69 Flood Inundation Map of the Situk River for the Case When There Are No Trees in the Old Situk Channel



The flow depth is indicated by the shade of blue: the darker the shade, the greater the flow depth.
Source: USACE 2011

Figure 3-70 Flood Inundation Map of the Situk River for the Case When There Are Trees in the Old Situk Channel

The Denali Commission 2019 Statewide Threat Assessment provides statewide risk ratings for flooding (Figure 3-71). Yakutat is located in Group 1, which are the communities that are most threatened by flooding. Most communities in Group 1 are located along Yukon and Kuskokwim rivers, or along the coast which may flood due to storm surges (Denali Commission 2019). Out of the communities assessed in Southeast, Yakutat was the only one that was placed into Group 1.



Source: Denali Commission 2019

Figure 3-71 Statewide Flooding Threat Risk Map

Based on past flooding events and the criteria identified in Table 3-2, the magnitude and severity of flooding in Yakutat is considered Limited, with potential for critical facilities to be shut down for more than a week, and more than 10 percent of property or critical infrastructure being severely damaged.

3.3.6.5 Impact

Floods may disrupt the normal function of a community by placing excessive pressure on emergency response and can bring a heavy economic burden to communities through the closure of vital infrastructure, communications, utilities, and transportation services. Additionally, floods can negatively impact subsistence activities, such as berry harvesting locations, that the community relies upon when these locations remain flooded for extended periods of time, topsoil layers become eroded, or locations become inundated with debris.

Flooding causes more deaths than any other natural hazard nationwide. Damage to infrastructure from floods may include the following:

- Floodwaters overtaking structures, causing water damage to structural elements and contents
- High-velocity flooding carrying debris and causing damage to structures, roads, bridges, culverts, and other features. Debris accumulation may create blockage to water movement and cause feature overtopping or backwater damages
- Flooding can inundate wastewater treatment plants of sewage lagoons causing the release of sewage, hazardous or toxic materials release. Storage tanks may be damaged, and pipelines severed all of which could be catastrophic to rural remote communities

The USACE Erosion Assessment states that:

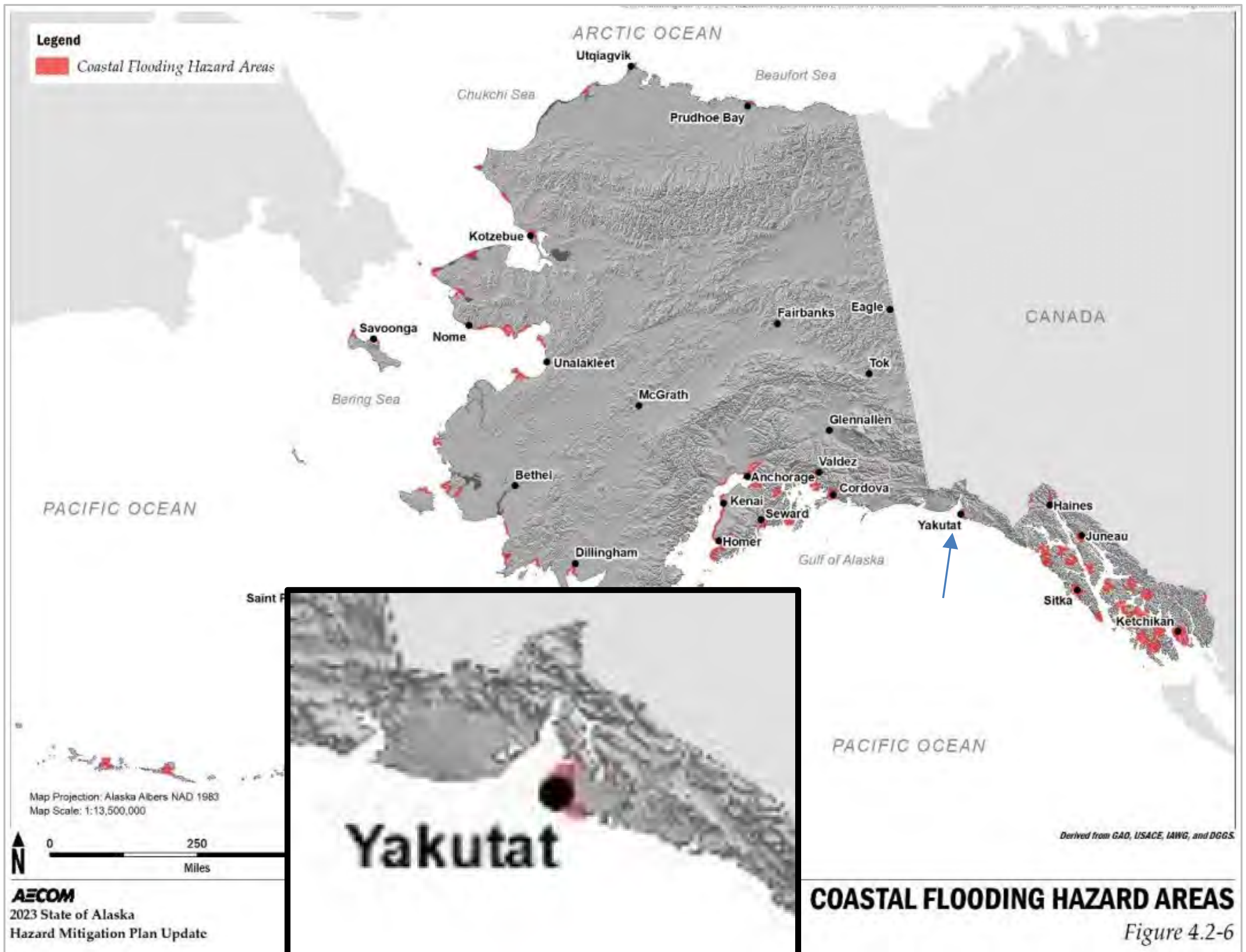
> *"If Hubbard Glacier causes the Russell Fiord to overflow into the Situk River and nearby waterways, the resultant flooding and erosion could substantially impact the ecology and economy of the area. Fishing, timber resources, recreation, and tourism economy in this area, including large native allotment parcels and a fishing lodge in the Situk River watershed would be threatened."* (USACE 2007)

Historic flood events in Yakutat have caused road washouts, destroyed trails, damaged fish camps (damages totaling around $20,000), and flooded campgrounds, trails, and boat launches.

3.3.6.6 Probability of Future Events

Many flood damages are predictable based on rainfall and seasonal thaw patterns. Most of the annual precipitation is received from April through October with August being the wettest. This rainfall leads to flooding in early/late summer and/or fall. Spring snowmelt increases runoff, which can cause excessive surface flooding.

The 2023 State of Alaska SHMP identifies coastal flooding hazard areas across the state (Figure 3-72). Yakutat is located in an identified coastal flooding hazard area, but not in a riverine flooding hazard area.



Source: 2023 Alaska SHMP

Figure 3-72 Statewide Coastal Flooding Hazard Areas

Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that Yakutat will experience a flood event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20%); and the history of events is greater than 10% but less than or equal to 20% likely per year.

3.3.6.7 Future Conditions Including Climate Change

Due to climate change, the nature or location of flooding events in Yakutat are not anticipated to change.

Changing Factor	Description of Future Changes due to Climate Change
Extent (Magnitude/ Severity)	Due to climate change, the extent of flooding events is expected to increase. Flooding and erosion of coastal and river areas affect over 87% of the Alaska Native communities (USGCRP 2018). A study by Melvin et al. (2016) projects that increases in floods will result in the largest climate-change related damages in Alaska. According to the States at Risk Climate Change Preparedness Report Card, Alaska's coastal floodplain is expected to expand by over 15,000 square miles, which accounts for the greatest increase of any state (States at Risk 2015). As heavy rainfall and atmospheric river events become more frequent, the extent of flooding in Yakutat will likely increase.

Changing Factor	Description of Future Changes due to Climate Change
Impact	Due to climate change, the impact of flooding events is expected to increase. According to the States at Risk Climate Change Preparedness Report Card, Alaska's coastal floodplain is expected to expand by over 15,000 square miles, which accounts for the greatest increase of any state (States at Risk 2015). This will lead to a greater impact by flooding on Alaska's coastal communities, including damage to critical roadways and infrastructure, damage to homes and critical facilities, and increased loss of life. The largest and most costly impact of climate change-related flooding events in the state will be to Alaska's roadways, according to Melvin et al. (2016). Throughout the end of the 21st century, coastal communities are projected to experience serious changes in tidal amplitudes and increased annual local sea levels, which were once 100-year events (IPCC 2019).
Probability of Future Events	Due to climate change, the frequency of flooding events is expected to continue to increase. According to the EPA and NOAA records, coastal flooding events are increasing in frequency in Alaska (EPA 2022). Atmospheric river events are increasingly common, as are rain on snow events, which increase the potential for localized flooding in Yakutat (DHS&EM 2023). According to the States at Risk Climate Change Preparedness Report Card, Alaska's coastal floodplain is expected to expand by over 15,000 square miles, which accounts for the greatest increase of any state (States at Risk 2015). This will lead to a higher probability of flooding events in the future.

3.3.7 EROSION

3.3.7.1 Nature

Erosion is defined as the wearing away of the ground surface as a result of the movement of wind, water, or ice. Erosion is a gradual process, but it can occur rapidly as the result of storms, floods, permafrost degradation, or another event. The effects from erosion can be seen over time as the result of long-term environmental changes such as melting permafrost. Erosion may cause the destruction of property, development, and infrastructure, but is rarely linked to direct human death or injury.

Erosion poses a threat to communities where disappearing land threatens infrastructure and development. Yakutat is threatened by coastal erosion and man-made erosion from logging.

Coastal erosion

Coastal erosion is described as the wearing or washing away of coastal lands. Coastal erosion occurs over the area near the top of the bluff out into the near-shore region to about the water depth of 30 feet. Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. Bluff recession is the most visible aspect of coastal erosion because of the dramatic change it causes to the landscape. As a result, this aspect of coastal erosion usually receives the most attention from the community.

Coastal erosion can occur from rapid, short-term, daily, seasonal, or annual natural events such as wind, waves, storm surge, coastal storms, and/or flooding. Human activities such as boat wakes and dredging may also play a factor. The most intense erosion often occurs during storms, particularly because the highest energy waves are generated under storm conditions.

Coastal erosion may also be attributed to multi-year impacts and long-term climatic change. These impacts may include sea-level rise, subsidence, lack of sediment supply, or long-term human factors such as the construction of shore protection structures and dams, or aquifer depletion.

Groins, jetties, seawalls, or revetments are human attempts to control shoreline erosion. As a result, these structures may actually lead to increased erosion on the opposite side of the structure.

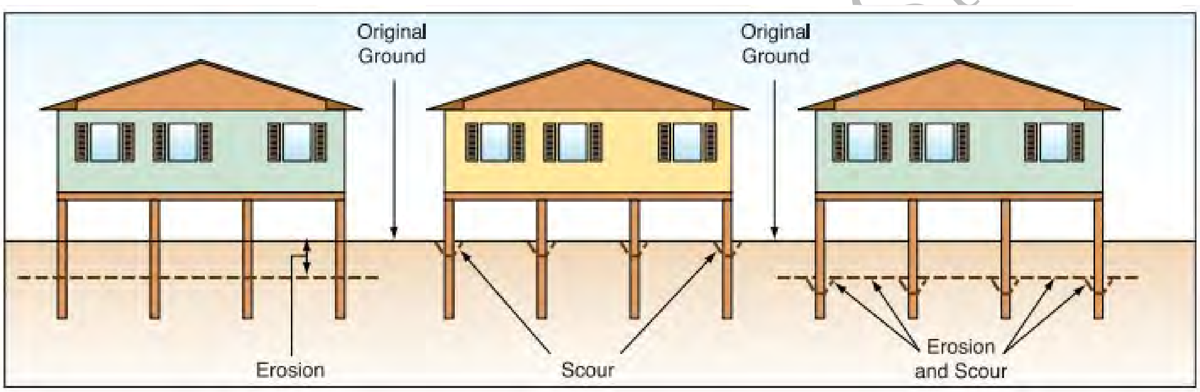
Damage from coastal erosion is typically a gradual event. However, significant storm events can cause the Earth beneath infrastructure and homes to weaken. In extreme but not unheard-of cases, homes built near the coast have fallen into the sea due to eroded cliffs.

Coastal scour

Scour occurs when floodwater passes around obstructions in the water column. As the water flows around an object, it must change direction and accelerate. Soil can be loosened and suspended by this process or by waves striking the object, and be carried away.

Scour effects are generally localized, ranging from small to large shallow conical depressions in the sand around individual structures. Effects from scour increase with increasing flow velocity and turbulence, and with increasing soil erodibility.

Figure 3-73 shows the differences between coastal erosion and scour. A building may be subject to either or both, depending on the building location.



Source: FEMA 2009- Erosion, Scour, and Foundation Design

Figure 3-73 Distinguishing Between Coastal Erosion and Scour

A combination of natural and human-induced factors influences the erosion process in Yakutat. For example, shoreline orientation and exposure to prevailing winds, open ocean swells and waves all influence erosion rates. These can be altered by human development by the addition of jetties, groins, and seawalls/revetments. Beach composition also influences erosion rates. A beach comprised of primarily large rocks and boulders is more resistant to erosion compared to a beach comprised of silt and sand. Other factors that may influence coastal erosion include:

- Geomorphology
- Nature of coastal topography
- Embankment or shoreline type
- Embankment and shoreline exposure to wind and waves
- Structure types along the shoreline
- Proximity to erosion-inducing structures
- High hazard zone encroachment
- Development density
- Elevation of river embankment; or coastal dunes and bluff

Soil Erosion from Logging

Logging operations can cause crucial changes in the characteristics of the soil; it can remove the fertile topsoil and herbaceous cover, alter soil characteristics, hinder forest regeneration, and reduce root growth (Clemson University 2022). Trees act as a natural anchor or barrier for soil and protect it from the elements and from erosion. Tree roots act to hold the soil together, and their leaves and branches form canopies that prevent the impacts of the harsh elements. Logging or clear-cutting trees removes the soil's protection and exposes it to the elements which can lead to soil erosion. The time of the year when logging occurs impacts soil compaction potential as it correlates with soil moisture and rainfall frequency (Clemson University 2022).

3.3.7.2 History

The USACE completed an erosion assessment for Yakutat during their 2009 Alaska Baseline Erosion Assessment. The Erosion Information Paper dated September 20, 2007, states that

> *"Erosion and flooding have recently become an important issue in the community."*

Yakutat's 2010 Comprehensive Plan provides a brief background of historical logging operations in Yakutat, which have resulted in erosion in Yakutat.

> *"Timber has been commercially harvested in the Borough since the late 1960s, with major timber sales taking place at White River, on Chugach Alaska Corporation land in east Icy Bay, on Alaska Mental Health Trust lands between the Cape and west Icy Bay Icy Bay and in various locations near the Yakutat town site. Much of the timber harvest in the Borough was centered in the western borough and was supported by the Icy Bay logging camp, airstrip, Log Transfer Facility, and a 45+ mile road system. There is currently very little timber harvest taking place or planned for the near future due to changes in the world timber markets. The Icy Bay logging camp is closed, as are many of the logging roads in the area. Road closure usually involves pulling out bridges and culverts, water barring or cross ditching the roads or leaving them in a condition suitable to control erosion. This reduces maintenance costs but is also makes vehicle access to these areas difficult or impossible."*

3.3.7.3 Location

Coastal erosion and soil erosion from logging pose a threat to Yakutat.

The USACE Erosion Assessment states that in Yakutat, erosion is reported at four locations, which are described below.

> *"The first is at nearby Russell Fiord which is dammed periodically by the Hubbard Glacier. When the Hubbard Glacier advances enough to cross Russell Fiord, it forms an ice dam that can fill Russell Fiord until the ice dam breaks or the rising water overtops the low mountains that form the western wall of the fiord. Either conclusion to the ice damming process can cause outburst flooding and erosion. Ice damming closed Russell Fiord in 1996 and 2002.*
>
> *A second area of concern is the Monti Bay coast near developed areas of Yakutat. The low-lying sand-silt beaches of the south shoreline are susceptible to erosion. Islands and navigation improvements shelter part of the community, but even the sheltered beaches can be eroded by locally generated waves. The community survey reports the active erosion area is 5 to 15 feet wide and 6 to 30 feet high and estimates the rate of erosion is ½ to 2 feet per year. Erosion is also occurring by the Ocean Cape dock next to the fish camp buildings and in a section of washed-out road.*
>
> *A third erosion area is inland from Yakutat, where unnamed streams in the Lost River basin, the Situk River basin, and Ahrnklin River basin are eroding the Forest Highway about 3 miles before its terminus at Harlequin Lake and at other locations from mile 12 to 24. There also is a subdivision development where the sides of the roads are washing out from local run off.*

> *A fourth erosion area is the beaches from Dry Bay to Ocean Cape. As glaciers recede, the glaciers leave behind large lakes which are catching sediment as it is transported downriver. This is what is happening at Alsek Lake on the Alsek River. Alsek River, along with the Dangerous River, is likely the major contributors of sediments to Yakutat's beaches. If the beaches fail to accumulate, they will erode back which appears to have begun occurring three years ago. If the erosion cuts into the beach dunes it will eventually being the process of saltwater intrusion into several important estuaries drastically cutting local salmon production."* (USACE 2007)

The Planning Team states that erosion is currently occurring on Max Italio Drive and portions of the Forest Highway. Rip rap has been installed as a temporary fix until funding can be acquired for a more permanent solution. Figure 3-74 highlights the damaged portions of Max Italio Dr due to erosion.

Source: Yakutat 2022 Transportation Improvement Plan

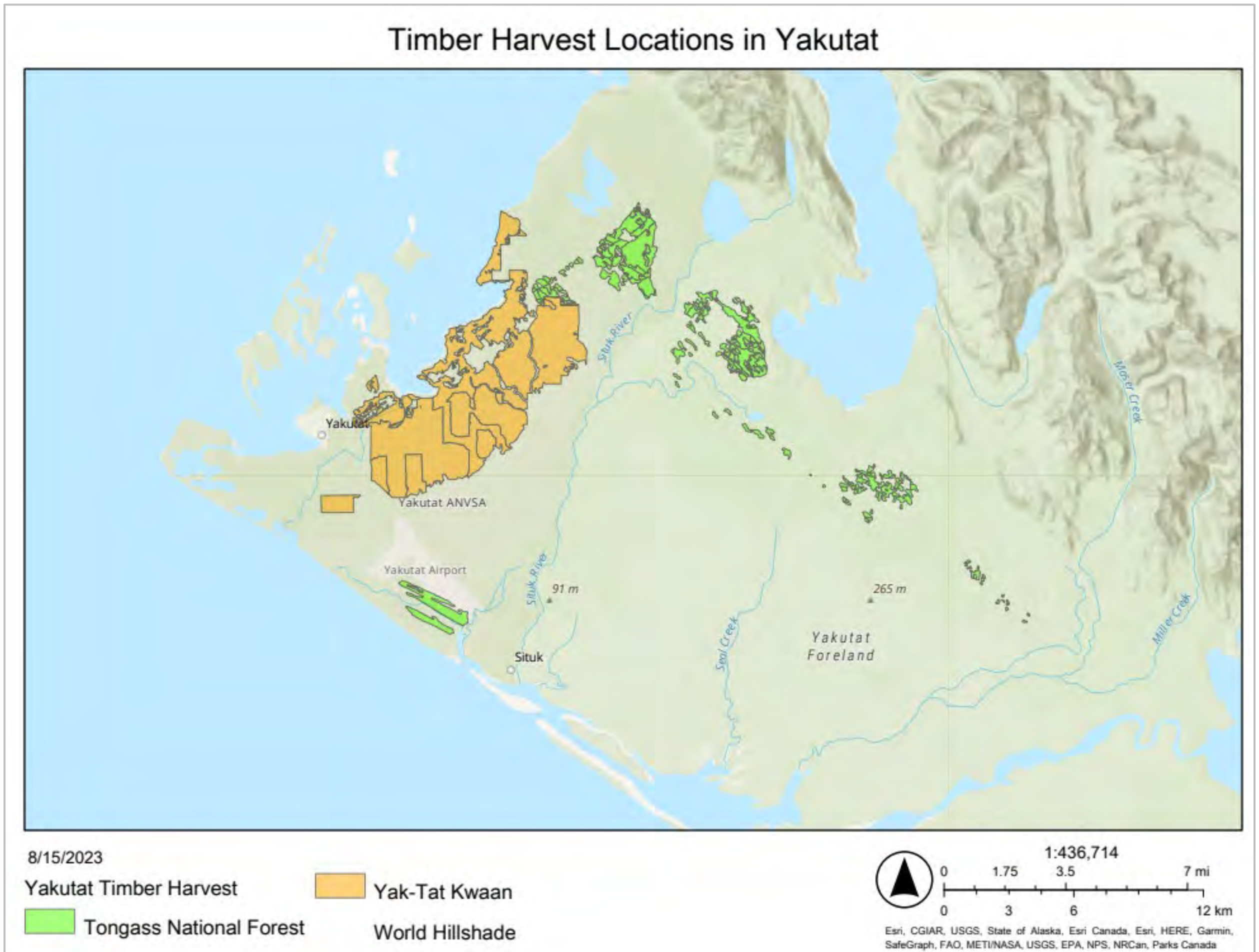
Figure 3-74 Damaged Areas of Max Italio Dr (2019)

Yakutat's 2022 Transportation Improvement Plan states:

> *There are four areas of the road with the most damage which are sloping towards the ocean. This road gives access to 33 homes, 14 commercial properties, and 4 public buildings. Max Italio Road is at risk of failure. When that happens, the families that live near the road will lose the only road access to their homes. They will lose road access to the health clinic, schools, businesses, and all other services in the community. The fire department and EMTs would only be able to reach these people on foot.*

Bare and compacted soils from logging operations are potential sites for erosion and surface runoff. Timber harvest (logging) in SE Alaska began in the early 1900s and became a major economic influence in the 1950s. In Yakutat, logging has taken place around the Yakutat townsite and in the Tongass National Forest

(Figure 3-75). Due to recent increase logging efforts in Yakutat, the Planning Team is now concerned about erosion from harmful logging practices (buffer strips are not being practiced nor enforced). Buffer strips are often left along both sides of rivers or along bodies of water to protect wildlife from the impacts of timber harvest in adjacent upslope areas and aim to prevent erosion and runoff. The Planning Team states that buffers have not been practiced near culverts, streams, and cultural and sacred sites.



Source: Yakutat Layers for Field Map- ArcGIS Online

Figure 3-75 Timber Harvest Locations in Yakutat

The YTT has identified the following areas where erosion from logging is occurring (Figure 3-76). There are many small gravesites and other areas of cultural significant to the Tribe that are located in these erosion areas.

Source: YTT 2023

Figure 3-76 Locations Impacted by Logging Erosion in Yakutat

1. **Humpback Creek (Land owned by Yak-tat Kwaan)-** This area that was logged was evaluated by the Alaska Fish & Game and was given violations on the salmon streams and not leaving buffer zones. Now that the beach is logged, the ocean side of the land, which is filled with freshwater springs, is washing away.
2. **Canoe Pass (Land owned by Yak-tat Kwaan)-** This area has been logged and many salmon streams are left unrestored and there is no barrier- the trees that are left have fallen over into the ocean. The area has been clear cut, and the roads are put in for subdivision plans.
3. **Broken Oar (Land owned by Yak-tat Kwaan)-** This area has been logged in the same style as the Humpback Creek and Canoe Pass. Clear cut and poor barrier line of trees. Trees are falling into the ocean and the salmon streams are not restored to a natural habitat.
4. **Ankau RCA Point (Land owned by Yak-tat Kwaan)-** This area was covered in trees and alders keeping the soil in place. During WWII, there were a few buildings and tanks in this area and has been cleaned up by a YTT Brownfield grant from the EPA. To keep the erosion at bay, alders and trees were kept as a weather barrier. Now that it has all been cleared, this area and the hill are at high risk for runoff and slides with no material stabilizing the hill during Yakutat's massive storms.
5. **Lost River (Land owned by USFS)–** Lost River is a salmon spawning location and is eroding and the rivers are changing at a fast rate. This area has been logged and dead log stumps are now floating down into the Situk River where commercial and subsistence fishing take place.

Other Concerns:

6. **Ankau-Khantaak Channel**- YTT has been observing and tracking the amount of sand that is coming through the channel between Ankau and Khantaak. Since 1999, the point of the Ankau shore was at least 150 yards from the road, now the distance from the road is at least 1200 yards. There are concerns about the larger boats, such as barges, that this channel will close, and the barge cannot come into the bay to deliver supplies. There is an alternative route- to take the barge to the "Logdump" but the AML Forklift cannot make it onto the pavement due to the very low powerlines and the barge would have unload on a high tide.

3.3.7.4 Extent (Magnitude and Severity)

The linear extent of erosion in Yakutat is shown below. These areas were identified by members of the community. The map is intended to show areas of erosion in Yakutat and does not provide rates or severity of erosion (USACE 2007).

Source: USACE 2007

Figure 3-77 Linear Extent of Erosion in Yakutat (2007)

Yakutat's 2022 Transportation Improvement Plan states:

> *The Max Italio Road is failing. Two miles of road needs to be repaired by replacing soil and sediments of silt, clay, and sand with stronger, more durable materials that will make the road more resilient, better than it was before the natural damage, break the cycle of damage, and make a long-term positive impact on the communities' transportation infrastructure system. There are four areas of the road with the most damage which are slopping towards the ocean. This road gives access to 33 homes, 14 commercial properties, and 4 public buildings. These include Yakutat Seafoods LLC., the Community Hall, the Yakutat General Store, the Wastewater Treatment Facility, and a public playground. With more seismic activity and weather damage, the road will soon fail completely. As*

the glaciers continue to melt at an alarming rate near Yakutat, the water continues to rise, which puts the Max Italio Road at a greater risk of failure as it follows the shoreline.

With the amount of seismic, extreme weather, erosion, and ground failure damage Yakutat gets on an annual basis, this road is damaged beyond small repair. The Borough has attempted to fix the road on several occasions. Three and a half years ago the CBY spent $50,000. repairing this road, only to have it continue to crack and slide down the hillside. A road improvement project will save the Max Italio Road which will have a direct beneficial impact on the community, and have a long-term effect on Yakutat's transportation infrastructure, saving the road from total destruction and collapse.

Source: Yakutat 2022 Transportation Improvement Plan

Figure 3-78 Max Italio Dr. Drainage Erosion (Winter 2022/2023)

Source: AKDOT 2022- Site Visit to Yakutat (July 14, 2022)

Figure 3-79 Sinkhole at the End of Max Italio Dr. (July 2022)

The following images show examples of erosion at different locations in Yakutat in 2007.

Photo 1: Erosion on Forest Highway, September 2007.

Photo 2: Erosion by Ocean Dock, September 2007.

Photo 3: Erosion on inland subdivision road, September 2007.

Photo 4: Erosion on inland subdivision road, September 2007.

Source: USACE 2007

Figure 3-80 Erosion Locations in Yakutat (2007)

The following images below were taken in 2023 and show downed trees and erosion from logging.

Photo Credit: Guy Miyagishima

Figure 3-81 Downed Trees from Logging (2023)

Photo Credit: Guy Miyagishima

Figure 3-82 Downed Trees from Logging (2023)

Photo Credit: Guy Miyagishima

Figure 3-83 Downed Trees from Logging (2023)

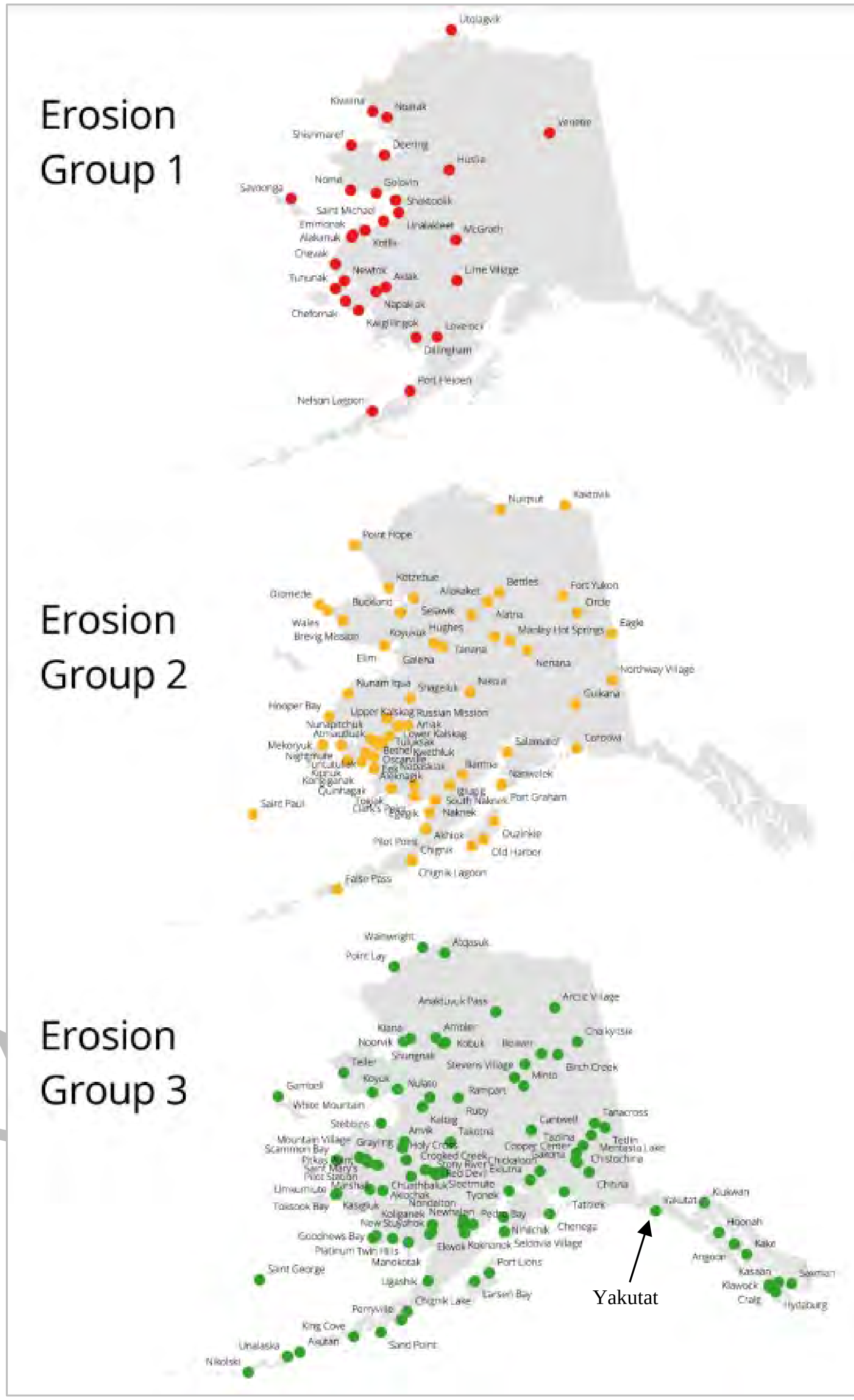
Photo Credit: Guy Miyagishima

Figure 3-84 Downed Trees from Logging (2023)

Photo Credit: Melena Lekanof

Figure 3-85 Post-Logging Conditions in Yakutat

The Denali Commission 2019 Statewide Threat Assessment provides statewide risk ratings for erosion (Figure 3-86). Yakutat is located in Group 3, which are the communities that are least threatened by erosion. Group 3 also indicates that there is no information available that indicates a threat to critical infrastructure or to the viability of a community, or there is low likelihood that a threat will detrimentally impact the community in the near term (Denali Commission 2019).



Source: Denali Commission 2019

Figure 3-86 Statewide Erosion Threat Risk Map

Max Italio Dr., Forest Hwy No. 10, the water treatment plant, and sacred sites are the primary infrastructure being threatened by erosion in Yakutat. Shoreline along areas of improper timber removal are also threatened generally and impact the overall loss of lands in the Yakutat planning area.

Based past erosion events, past erosion mitigation efforts, and the criteria identified in Table 3-2, the magnitude and severity of erosion impacts in Yakutat are considered Limited with potential for critical facilities to be shut down for more than a week, and more than 10 percent of property or critical infrastructure being severely damaged.

3.3.7.5 Impact

Impact

Impacts from erosion can range in severity and include loss of land and potentially any infrastructure built on the land. Other impacts include damage to public utilities (fuel headers and electric and water/wastewater utilities), loss of the Native aquatic habitats, high sediment loads reducing water quality, and economic impacts associated with the costs of trying to mitigate the impacts from erosion.

The USACE Erosion Assessment describes potential damages from erosion in Yakutat:

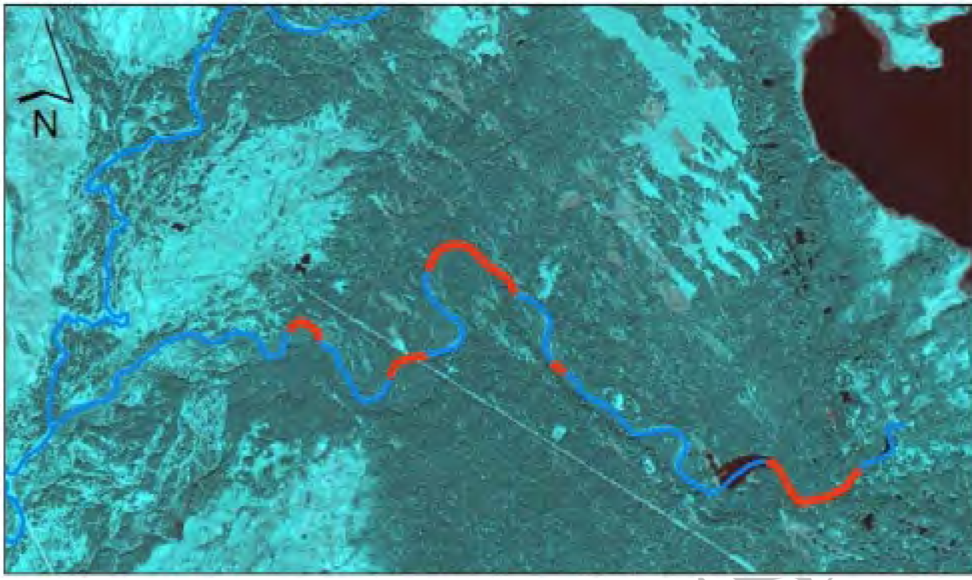
> *"If Hubbard Glacier causes the Russell Fiord to overflow into the Situk River and nearby waterways, the resultant flooding and erosion could substantially impact the ecology and economy of the area. Fishing, timber resources, recreation, and tourism economy in this area, including large native allotment parcels and a fishing lodge in the Situk River watershed would be threatened.*
>
> *Wind and wave action are eroding the cast in front of the city hall during winter storms. Erosion threatens a home and an adjacent outbuilding 30 to 50 feet from the shore and another home 80 to 100 feet from shore. The road past the inland subdivision is eroded during heavy rains and could be washed out. There is no alternative access to the subdivision. If the Forest Highway was lost to advancing erosion, rivers in the area and Harlequin Lake would be inaccessible, causing an economic loss of revenue generated by recreational and personal-use fisheries."*

One resulting impact from not having vegetation along the shoreline (barrier) due to clear cutting is that the channels that fisherman in Yakutat used for protection are now flat and unprotected. The trees that were previously along the shoreline acted as a windbreak and reduced the speed of blowing wind. Now that the shoreline is bare, and high winds travel through the channels- the Planning Team states that the channels are now just as dangerous as open seas.

3.3.7.6 Probability of Future Events

Climate changes, such as more frequent and intense rain events, can increase erosion and result in greater amounts of sediment loss. There has not been an updated erosion assessment in Yakutat since 2007 and no forecasted rates of erosion have been made. The Planning Team states that erosion is currently occurring on Max Italio Drive and portions of the Forest Highway.

The 2011 USACE study that estimated flood inundation of the Situk River following the closure of the Russell Fiord by the Hubbard Glacier, identified potential erosion sites as the hydrology of the River changes.



Potential erosion locations are shown in red. This view is of the Old Situk River. The Upper Situk River is visible on the left, and Russell Fiord is visible in the upper right.
Source: USACE 2011

Figure 3-87 Potential Erosion Locations in the Old Situk River Following the Closure of the Russell Fiord by the Hubbard Glacier

Based on the 2007 USACE baseline erosion assessment, historical impacts, erosion mitigation measures implemented, and the criteria identified in Table 3-3, it is Likely that Yakutat will experience an erosion event in the next three years; there is a 1 in 3 years chance of occurring (1/3=33%); and the history of events is greater than 20% but less than or equal to 33% likely per year.

3.3.7.7 Future Conditions Including Climate Change

Climate change is not anticipated to influence the nature of future erosion events in Yakutat.

Changing Factor due to Climate Change	Description of Future Changes due to Climate Change
Location	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 (DHS&EM 2023).
Extent (Magnitude/Severity)	Increased severity and magnitude of winter storms, loss of coastal sea ice, and increased precipitation are already increasing the severity and magnitude of erosion events in Alaska, and the trend is expected to continue. This will lead to increased damage to infrastructure, especially in Alaska's coastal villages (Larsen et al. 2008).
Impact	The primary climatic forces affecting erosion are changes in temperature, water levels, precipitation, vegetation loss/changes, and storms. All of these factors are anticipated to be affected by climate change, which will result in increased localized impacts from erosion in Alaska.
Probability of Future Events	Increased precipitation and increased frequency and intensity of winter storms will continue to increase erosion events in Alaska (Larsen et al. 2008).

3.3.8 CHANGES IN THE CRYOSPHERE

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 3-88). The components of the cryosphere play an important role in climate. Snow and ice reflect heat from the sun, helping to regulate the Earth’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 change.

Hazards of the cryosphere can be subdivided into four major groups:

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

Of these four major groups, all but sea ice impact areas of the Planning Area, outside of the populated area of Yakutat.

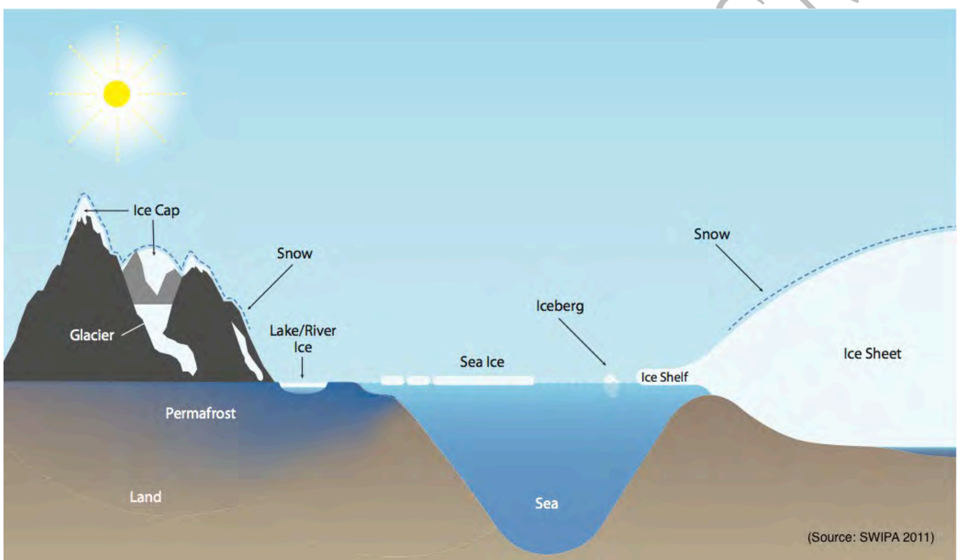
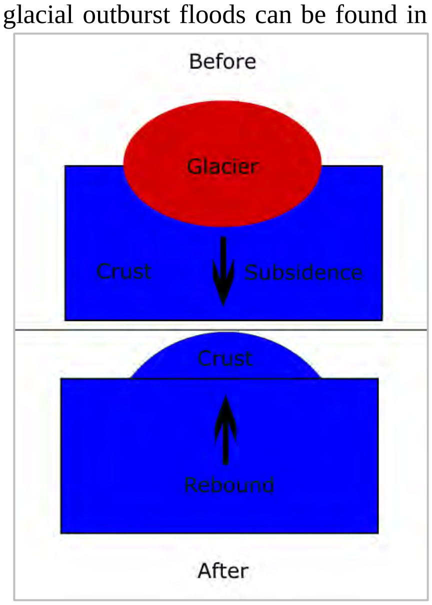


Figure 3-88 Components of the Cryosphere

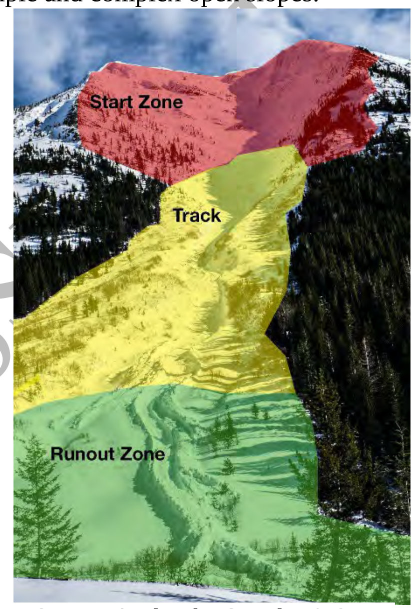
3.3.8.1 Nature

The nature of each cryosphere hazard is described below.

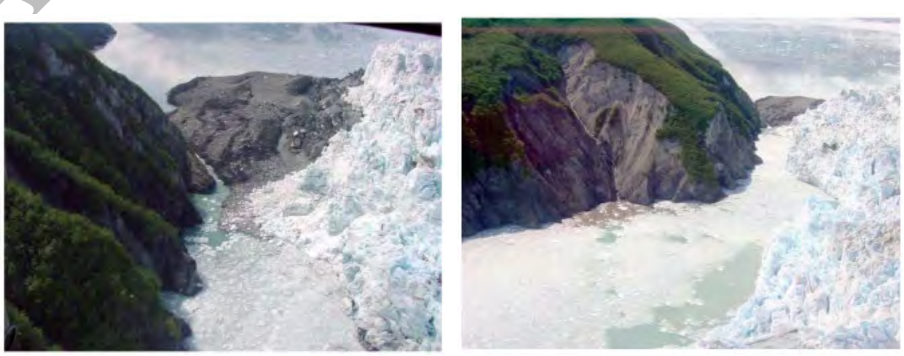
Hazard	Nature of the Hazard
Glacier	Glaciers are made of compressed snow, which has survived summer, and transformed into ice. Over many years, layers of accumulated ice build into large, thickened ice masses. Due to the sheer mass of the accumulated ice, glaciers flow like very slow rivers. Most glaciers lie within mountain ranges that show evidence of a much greater extent during the ice ages of the past two-million years, and recent retreat in the past few centuries. Hazards related to glaciers include ice collapse (e.g., glacial calving and ice fall avalanche), glacial lake outburst flood, and glacial surge. **Ice Collapse** hazards result from large ice chunks breaking off from a glacier, either through glacial calving or as an ice fall avalanche. These hazards are almost impossible to predict and, in contrast to most other hazards in the cryosphere environment, they can happen independently of weather (e.g., heavy precipitation and rapid warming). In Alaska, ice collapses have on multiple occasions been triggered by earthquakes. Depending on the volume of ice collapse, these hazards can have tremendously devastating effects and can cause additional hazards, such as flooding and snow avalanches.

Hazard	Nature of the Hazard
	Glacial 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. 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 M 6.3 earthquake occurred 120 miles west of Bear Glacier in Kenai Fjords, triggering a one-mile swath of ice to calve from the glacier and generating waves (a local tsunami) throughout the lagoon. **Ice Fall Avalanches** are triggered by new or existing cracks (crevasses) in the glacier ice that allow chunks of a glacier to detach and fall down the slope as a mass of broken ice. Similar to cornice collapses (see Snow Avalanche), the mass of these ice falls often triggers snow avalanches on the slope below as they hit the snowpack. Ice fall avalanches are unrelated to precipitation, temperature, or other typical snow avalanche factors. **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 to water overtopping the dam as a result of waves caused by mass wasting (landslide) of nearby unstable slopes that cause a landslide-generated tsunami. In the glacial system, ponds may form wherever water can be retained, and drainage restricted, resulting in five glacial lake types: 1. 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 2. Proglacial lake: forms at the terminus of a valley glacier or outlet glacier 3. Supraglacial lake: forms in depressions on top of a glacier 4. Englacial lake: forms within a glacier in enlarged conduits and cavities in the ice 5. Subglacial lake: forms underneath a glacier in a topographic depression, or by damming of subglacial debris; 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 near CBY, and the Suicide Basin at Mendenhall Glacier in the Coast Range. More information of glacial outburst floods can be found in Section 3.3.6. **Glacier Surge** is when a glacier periodically undergoes a brief phase (typically lasting one to four years) of rapid flow, called a surge. Surges are generally interspersed with longer periods (typically 10–100 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). A surging glacier can advance quickly and override the ground in front of it, destroying anything in its path and potentially damming water flow to create a glacial lake that is a potential source of outburst flooding. Surging glaciers can also be particularly dangerous after surging because highly crevassed glacier snouts are unstable and subject to a higher incidence of calving and ice fall avalanches.  **Figure 3-89 Illustration of Glacial Rebound** **Glacial Rebound** is the rise of land masses after the removal of the huge weight of ice (glaciers). This results in land filling in the gap of where the glacier was and rising up relative to its previous elevation.

Hazard	Nature of the Hazard
Permafrost and Periglacial	Permafrost, defined as ground with a temperature that remains at or below freezing (32°F or 0°C) for two or more consecutive years, can include rock, soil, organic matter, unfrozen water, air, and ice. Periglacial refers to a cold-climate environment in which the effects of freezing and thawing drastically modify the ground surface. Types of modification include displacement of soil materials, migration of groundwater, and formation of unique landforms. Many periglacial regions are underlain by permafrost that strongly influences geomorphic processes acting in these parts of the world. 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. Permafrost is found in nearly 85% of the state, but is virtually absent in Southeast Alaska, with the exception of pockets of high-elevation alpine permafrost. In the U.S., the presence of widespread permafrost results in classes of geologic hazards, which are largely unique to Alaska. Permafrost is structurally important to the soils of Alaska, and thawing causes landslides, ground subsidence, and erosion as well as lake disappearances, new lake development, and saltwater encroachment into aquifers and surface waters.
Snow Avalanche	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. Avalanches reach speeds of up to 200 mph 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 high mountains of Alaska during the winter and spring as the result of heavy snow accumulations on steep slopes. Large avalanches have the potential to kill people and wildlife, destroy infrastructure, level forests, and bury entire communities. 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. 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 in Alaska that occur under varying snowpack and weather conditions. Each avalanche type is named based on its snow release characteristics. **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. **Loose Snow Avalanches**, also known as point releases, initiate with a small amount of non- cohesive (loose) snow and quickly grow larger as they move downhill and entrain 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. **Slush Avalanches** are fast-moving mixtures of snow and water. They release 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

Hazard	Nature of the Hazard
	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, they can reach speeds over 40 mph. Smaller, more fluid avalanches with higher water content are commonly referred to as slush flows. An avalanche path comprises three main parts: starting zone, track, and run-out zone (Figure 3-90). 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 is the upper part of the avalanche path, where snow accumulates (creating a slab or point source release area), and 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). 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 be comprised of 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.  Source: Avalanche Canada 2023 **Figure 3-90 Path of an Avalanche**

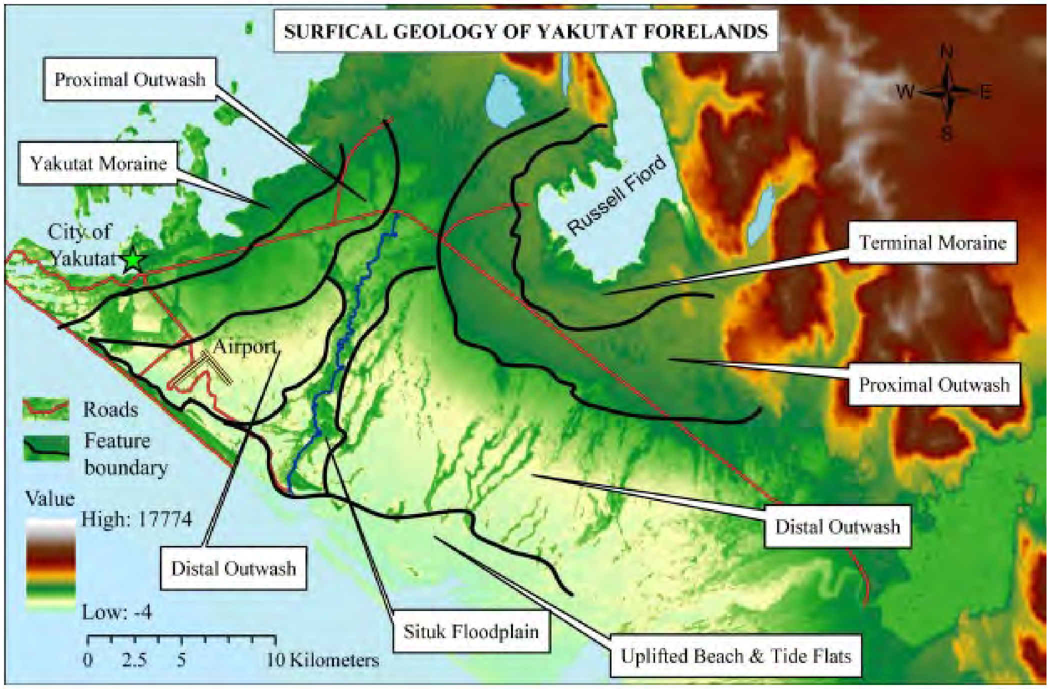
3.3.8.2 History

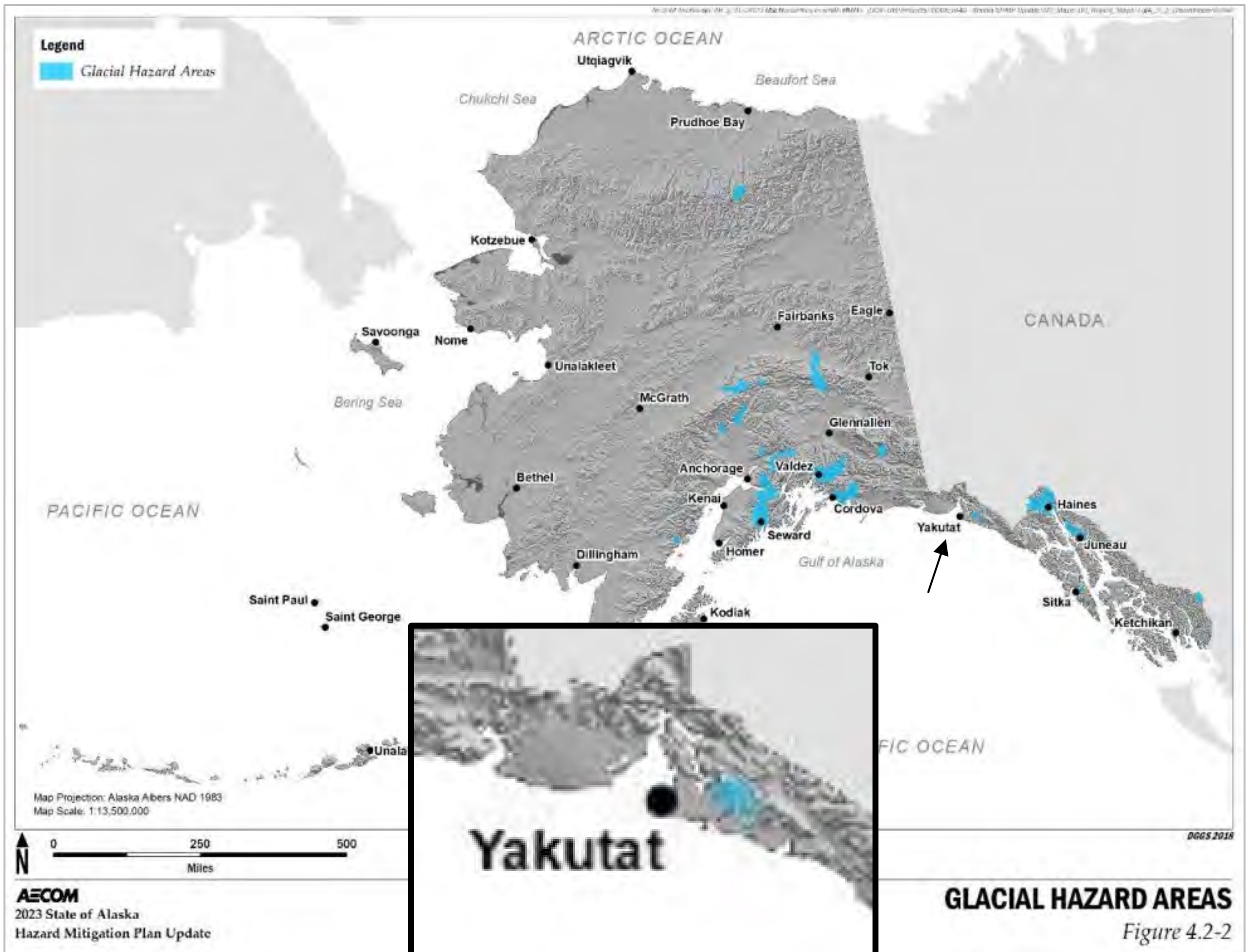
Hazard	History
Glacier	In 1986 and 2002, the advance of the Hubbard Glacier blocked the northern of the Russell Fiord from Yakutat Bay, temporarily creating Russell Lake. The subsequent failure of the ice or moraine dams in 1986 and 2002, respectively, produced the two largest glacial outburst floods in historic times. Both of these dams failed before the lake had risen to an elevation that would have caused it to spill over the terminal moraine at the southern end of Russell Fiord into the Situk River drainage (Gubernick and Paustian 2007).  Source: Gubernick and Paustian (2007) **Figure 3-91 Oblique Aerial View of 2002 Moraine Dam and Outflow Channel from Russell Fiord**

Hazard	History
Permafrost and Periglacial	Permafrost does not underlie the populated area of Yakutat, so permafrost thaw or subsidence have not impacted critical facilities in Yakutat.
Snow Avalanche	There were many documented avalanches in the Planning Area following the Yakutat Bay Earthquakes in 1899. The following is an excerpt from a USGS publication regarding the event: *"Avalanche tracks are far more abundant in the Yakutat Bay region than in any part of the thousand-mile mountainous Inside Passage from Seattle to Sitka. The most abundant avalanche tracks are near main fault lines- along the mountain front near Knight Island, on the east side of outer Yakutat Bay, and northward along the mountainous face of the east side of Yakutat Bay to Point Latouche."* (USGS 1912) There have been 0 documented avalanches impacting Yakutat in recent years, but there is potential of snow avalanches to occur within the Planning Area, northeast of the City center.

3.3.8.3 Location

Hazard	Location
Glacier	There are multiple glaciers and ice fields in and surrounding Yakutat- some include the Malaspina Glacier (largest piedmont glacier in the world), which is located to the west of the City, Turner Glacier, and Hubbard Glacier (and icefield) are to the north, and Yakutat Glacier is to the east. Hubbard Glacier, Russell Fiord, and the Situk River near Yakutat are glacial terrains and forelands in a constant state of motion (Gubernick and Paustian 2007). The area is an extremely active and dynamic landscape with an advancing tidewater glacier (10 km wide at tidewater), two major seismic faults, and a maximum net isostatic uplift rate of 0.17 in/yr. The southern end of Russell Fiord is confined by a terminal moraine whereas the northern end of the fiord flows into Yakutat Bay (Gubernick and Paustian 2007). The Yakutat-Lituya Forelands is a low relief coastal plain formed by unconsolidated glacial outwash, moraine, and recent fluvial deposits (Figure 3-92). This area has also been heavily influenced by isostatic (glacial) rebound, tectonic uplift and subsidence, and long-shore ocean sediment transport and deposition (Gubernick and Paustian 2007).

Hazard	Location
	 Source: Gubernick and Paustian (2007) **Figure 3-92 Geologic Map of Glacial Deposition, Uplifted Beach, and Moraine Features of the Yakutat Forelands** The 2023 State of Alaska SHMP identifies statewide glacial hazard areas (Figure 3-93). There are glacial hazard areas in the Planning Area, northeast of the City limits.

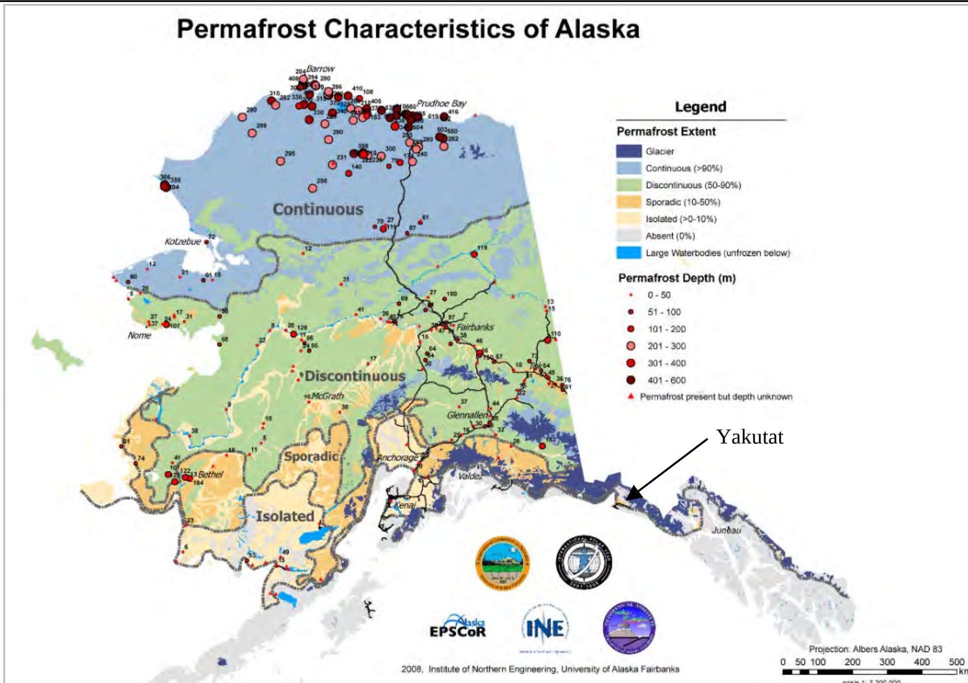


Source: 2023 Alaska SHMP

Figure 3-93 Statewide Glacial Hazard Areas

Hazard	Location
Permafrost and Periglacial	Permafrost is found beneath nearly 85% of Alaska. It is thickest and most extensive in arctic Alaska north of the Brooks Range, present virtually everywhere and extending as much as 2,000 feet below the surface of the Arctic Coastal Plain. Southward from the Brooks Range it becomes increasingly thinner and more discontinuous, broken by pockets of unfrozen ground known as taliks, until it becomes virtually absent in Southeast Alaska except for patches of high-elevation alpine permafrost. According to Permafrost Characteristics Map of Alaska (Figure 3-94) developed for the National Snow and Ice Data Center/World Data Center for Glaciology, Yakutat has **isolated** or **sporadic permafrost** (Jorgensen et al. 2008). Permafrost does not underlie the populated area of Yakutat.

Hazard	Location

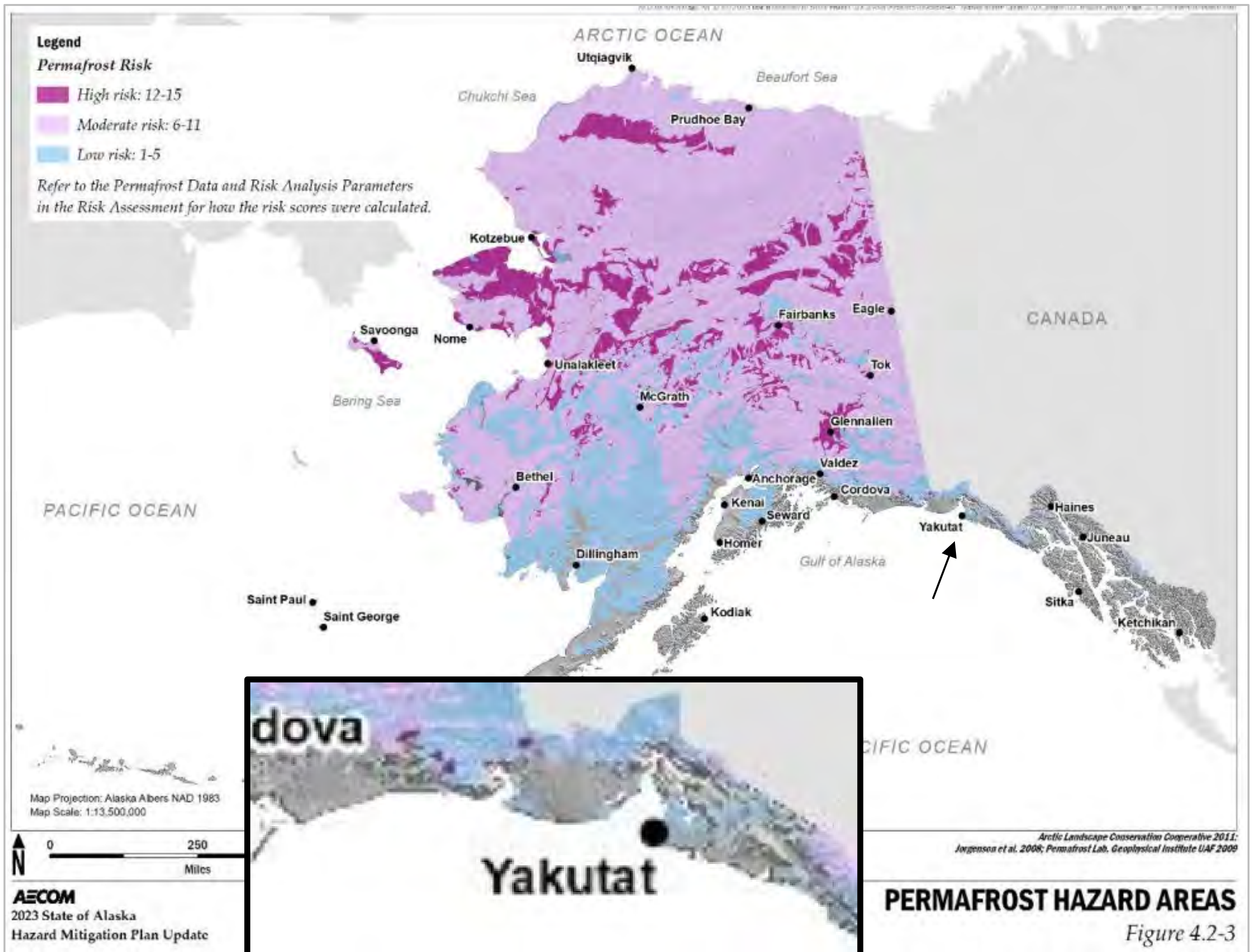


Source: Jorgenson et al. (2008)

Figure 3-94 Permafrost Characteristics of Alaska

The 2023 State of Alaska SHMP identifies statewide permafrost hazard areas (Figure 3-95). The Planning Area is identified as having low to moderate permafrost risk, depending on location.

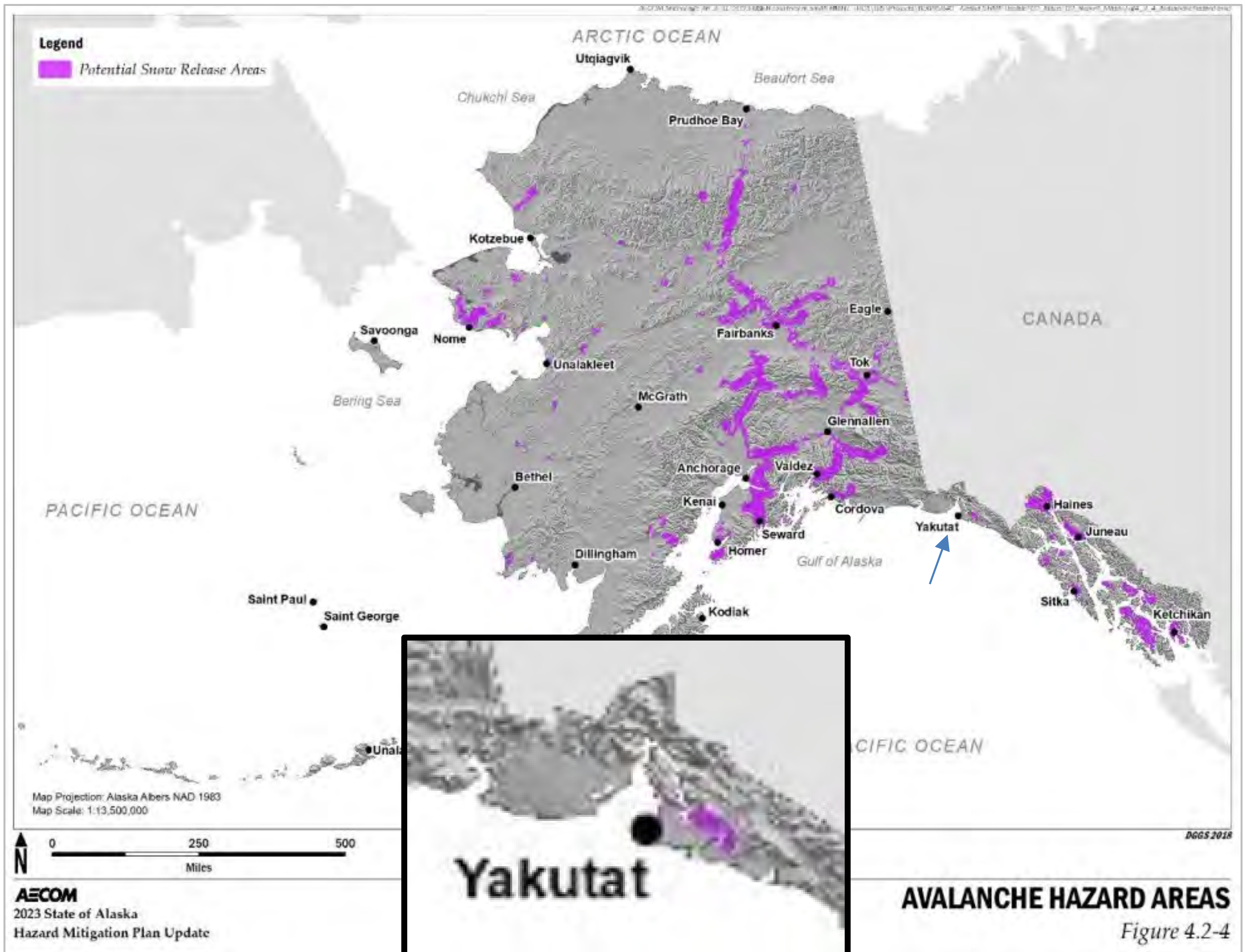
Melting permafrost nor subsidence have been documented near the populated areas of Yakutat.



Source: 2023 Alaska SHMP

Figure 3-95 Statewide Permafrost Hazard Areas

Hazard	Location
Snow Avalanche	The 2023 State of Alaska SHMP identifies statewide avalanche hazard areas (Figure 3-96). There are avalanche hazard areas in the Planning Area, northeast of the City limits. Snow avalanches do not pose a threat to the infrastructure or residents in the populated area of Yakutat.



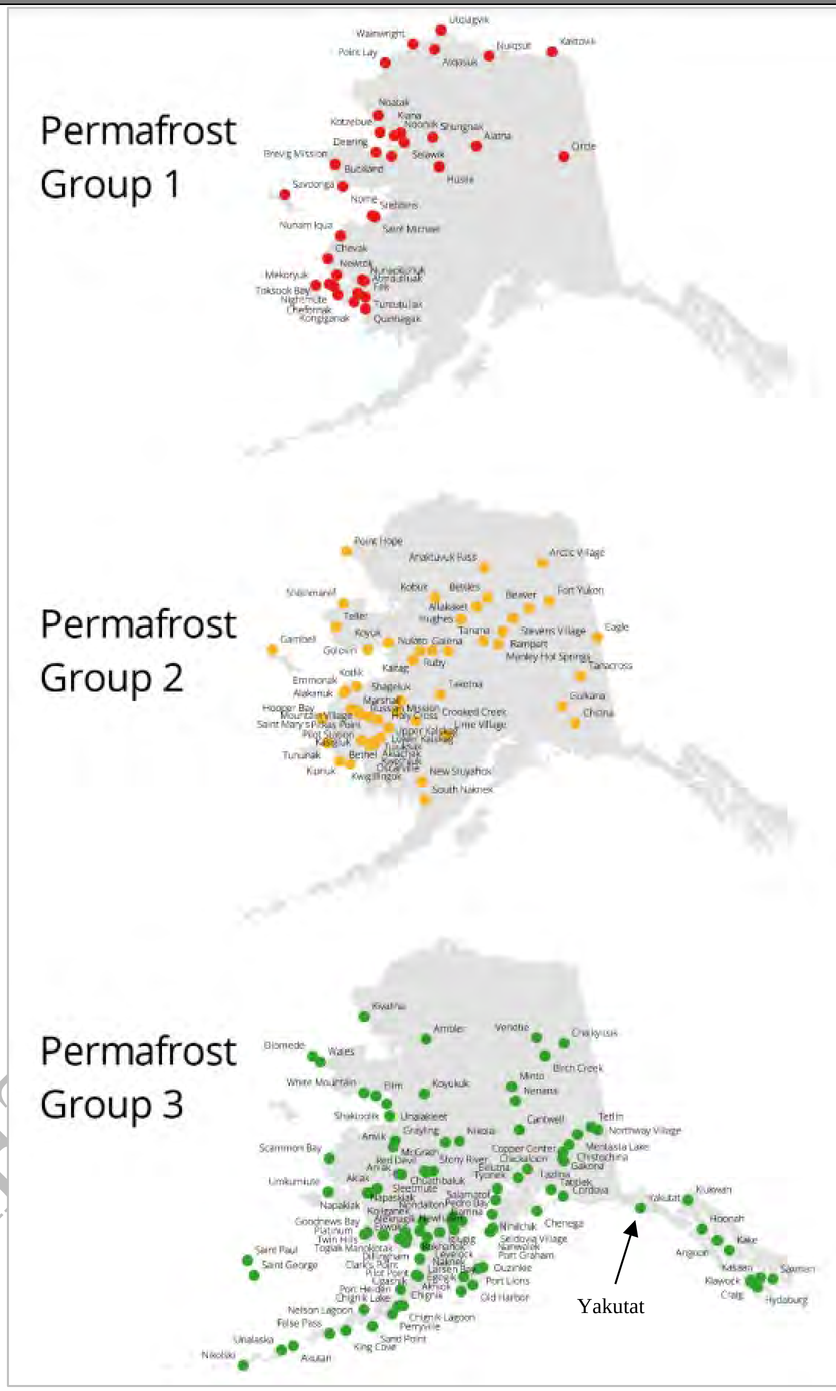
Source: 2023 Alaska SHMP

Figure 3-96 Statewide Avalanche Hazard Areas

3.3.8.4 Extent (Magnitude and Severity)

Hazard	Extent
Glacier	In a rapidly changing climate, abrupt changes in, for example, the occurrence of glacial lake outburst floods are typical (DGGS 2023c). In Yakutat, glacier hazard locations are outside of the City limits where critical facilities are located and where the majority of residents live. Therefore, based on past event history and the criteria identified in Table 3-2, the extent of glacier hazards and resultant damages to people and infrastructure in Yakutat are considered Negligible with minor injuries, the potential for critical facilities to be shut down for less than 24 hours, less than 10% of property or critical infrastructure being severely damaged.
Permafrost and Periglacial	The Denali Commission 2019 Statewide Threat Assessment provides statewide risk ratings for thawing permafrost (Figure 3-97). Yakutat is located in Group 3, which are the communities that are least threatened by permafrost thaw. The distribution of communities in Group 1 for thawing permafrost tend to be located either along the western coastline or in areas of continuous permafrost. Yakutat is located in a region with isolated or sporadic permafrost.

Hazard	Extent



Source: Denali Commission 2019

Figure 3-97 Statewide Thawing Permafrost Threat Risk Map

Based on past event history and the criteria identified in Table 3-2, the extent of permafrost and periglacial hazards and resultant damages to people and infrastructure in Yakutat are considered Negligible with minor injuries, the potential for critical facilities to be shut down for less than 24 hours, less than 10% of property or critical infrastructure being severely damaged.

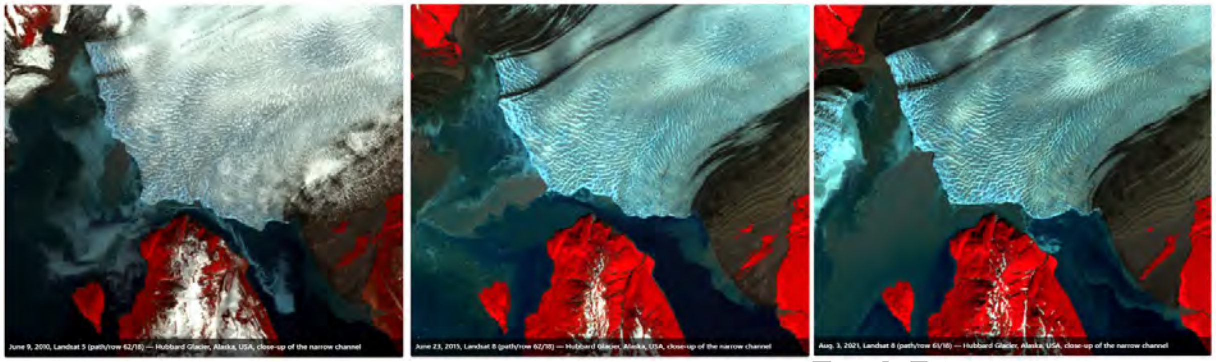
Hazard	Extent
Snow Avalanche	Avalanches can be incredibly destructive and have the potential to destroy everything in its path, and result in human deaths every year. Over the last 10 years (2012-2022), 27 people died in avalanches each winter in the United States (CAIC 2023). The number of people caught or buried in avalanches each year because most non-fatal avalanche incidents are not reported (CAIC 2023). In Yakutat, avalanche hazard locations are northeast of the City limits where critical facilities are located and where the majority of residents live. Therefore, based on past event history and the criteria identified in Table 3-2, the extent of avalanches and resultant damages to people and infrastructure in Yakutat are considered Negligible with minor injuries, the potential for critical facilities to be shut down for less than 24 hours, less than 10% of property or critical infrastructure being severely damaged.

3.3.8.5 Impact

Hazard	Impact
Glacier	As Hubbard Glacier continues to advance into Disenchantment Bay, it is possible that the glacier could one day permanently block Russell Fiord. If the glacier permanently blocks Russell Fiord, the fjord would turn into a 39.8-mile-long lake. This lake would eventually drain into the Situk River at the lake's southern end. This would disrupt the river's fisheries and potentially threaten the tourism and economy of Yakutat (USGS 2023b). Yakutat's police station has been damaged from glacial rebound. The Planning Team states that the CBY is in the process of applying for funding to replace the police station and a design project has been funded. In June 2022, a 2,000-passenger cruise ship hit a large iceberg (growler) near Hubbard Glacier. No injuries were reported, and the ship docked in Juneau for 2 days to assess the damages before returning to Seattle for repairs.
Permafrost and Periglacial	Impacts associated with permafrost degradation include surface subsidence, and infrastructure, building, and/or road damage. In developed areas, ground failure as a result of thawing permafrost can be a result of improperly designed and constructed buildings, or buildings built on top of permafrost, and may impact buildings, communities, pipelines, airfields, roads, and bridges. This has the potential for extensive structure loss or costly repairs. Permafrost does not underlie the populated area of Yakutat, so permafrost thaw or subsidence have not impacted residents of Yakutat.
Snow Avalanche	Avalanches can be incredibly destructive and have the potential to destroy everything in its path, and result in human deaths every year. Over the last 10 years (2012-2022), 27 people died in avalanches each winter in the United States (CAIC 2023). The number of people caught or buried in avalanches each year because most non-fatal avalanche incidents are not reported (CAIC 2023). There have been no recent impacts from snow avalanches in Yakutat.

3.3.8.6 Probability of Future Events

Hazard	Probability of Future Events
Glacier	Unlike many glaciers in Alaska and around the world, Hubbard Glacier is thickening and advancing into Disenchantment Bay. Since Hubbard Glacier has been continuously advancing since 1895 and given the rate of the glacier's advance over the past few decades, it's unlikely that the channel will remain open by the end of this century (USGS 2023b). The 2010 and 2015 images show an open channel from Russell Fiord to Disenchantment Bay- even

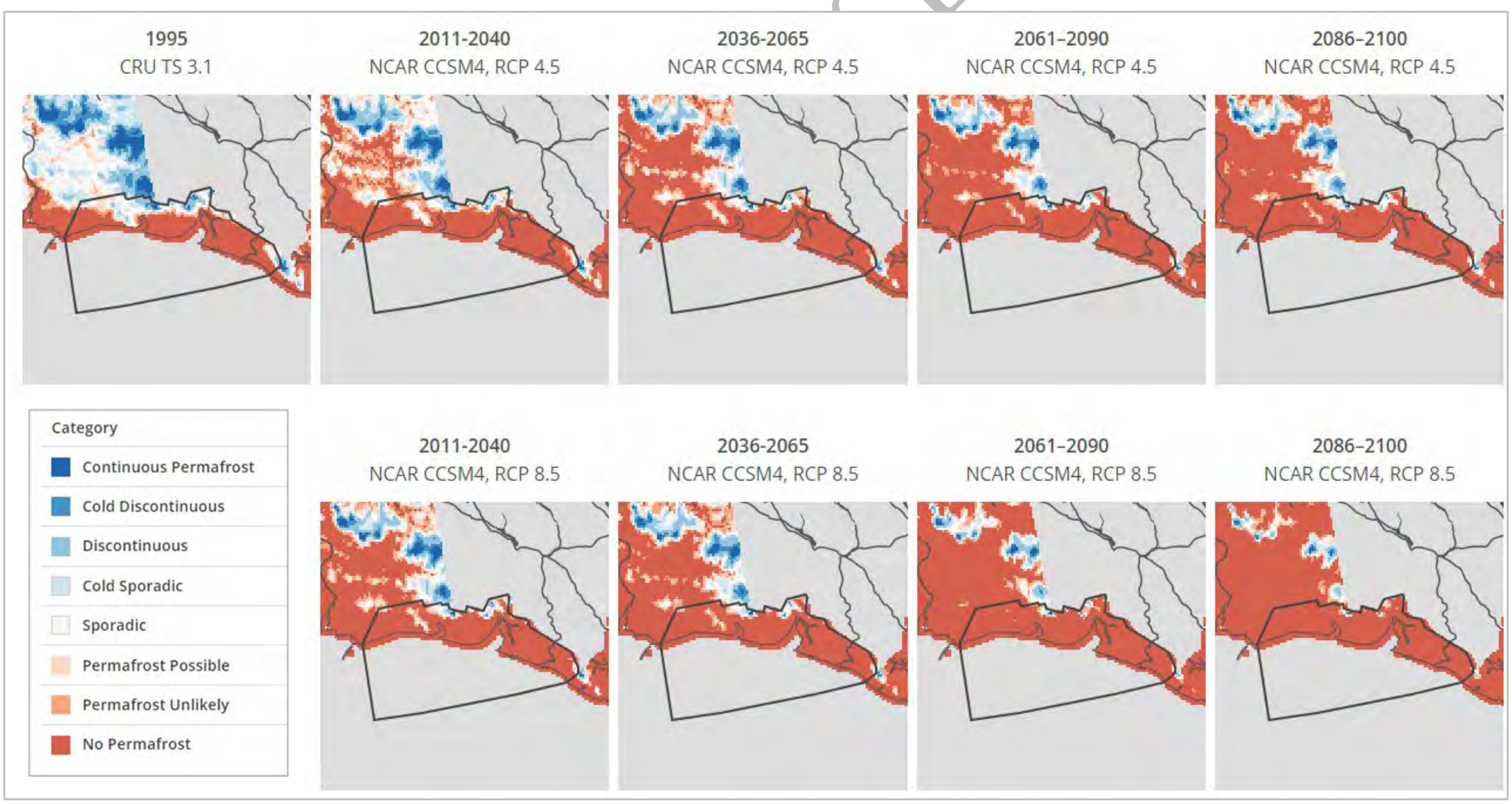
Hazard	Probability of Future Events
	when the channel is open, the opening is narrow. In the 2015 Landsat image, the channel is about 540 meters (1,772 feet or 0.34 miles) wide. The channel width also varies annually (USGS 2023b).  June 9, 2010 June 23, 2015 August 3, 2021 Source: USGS 2023b **Figure 3-98 Satellite Imagery of Hubbard Glacier (2010, 2015, and 2021)** Due to documented changes and ongoing climate change, it is Likely that glaciers in the Planning Area will experience changes (glacial melt, retreat, advancement, etc., depending on the glacier) in the next 3 years, but it is Possible that glaciers will threaten critical facilities in Yakutat in the next five years; there is a 1 in 5 years chance of occurring (1/5=20 percent); and the history of events is greater than 10 percent but less than or equal to 20 percent likely per year. Ongoing monitoring of Hubbard Glacier is needed to measure the glacier's rate of advancing and to determine when the glacier will close the channel in Disenchantment Bay. Ongoing monitoring on Malaspina Glacier has found that the continued loss of Malaspina's coastal barrier may provide pathways for ocean waters to access large areas of the glacier's bed along these channels. Assuming this leads to large-scale calving and the glacier's retreat, Malaspina has the potential to contribute 560 km3 of ice, or 1.4 mm, to global sea-level rise (Tober et al. 2023).
Permafrost and Periglacial	Climate models project that permafrost in Alaska will continue to thaw, and some models project that near-surface permafrost will be lost entirely from large parts of Alaska by the end of the century (USGCRP 2018). See Figure 3-99 for projections of future ground temperature and permafrost conditions in Yakutat. The Planning Area has **isolated** or **sporadic permafrost** throughout the area (Jorgensen et al. 2008), but permafrost does not underlie the populated area of Yakutat.
Snow Avalanche	As climate warming continues, there is an expectation of an increase in Alaska's vulnerability to snow avalanche hazards (DGGS 2023d). DGGS's CCHP is working on projects that focus on quantifying changes in future snow avalanches in Southeast Alaska and understanding the impacts of these changes on natural resources, and people in their natural and built environments (DGGS 2023d). Ballesteros-Canovas et al. (2018) predicts an increase in avalanche activity in the 2nd half of the 21st century, largely wet-snow avalanches due to increased air temperature and precipitation. However, as snow cover retreats upwards due to these same factors, the impacted area will also change to higher elevations (Ballesteros-Canovas et al. 2018). Based on previous occurrences and the criteria identified in Table 3-3, it is Possible that there will be a snow avalanche in the Planning Area event in the next five years; there is a 1 in 5 years chance of occurring (1/5=20 percent); and the history of events is greater than 10 percent but less than or equal to 20 percent likely per year. Snow avalanche hazards are identified northeast of the populated areas of Yakutat, and do not pose a threat to infrastructure or residents in the community.

3.3.8.7 Future Conditions Including Climate Change

Glacier	
Changing Factor	**Description of Changes Due to Climate Change**
Nature	Climate change is not anticipated to influence the nature of glacier hazards in Alaska.
Location	Climate change is anticipated to impact glaciers throughout Alaska. As global temperatures increase due to climate change, retreating glaciers are melting more rapidly than in documented history. As climate change continues, more ice-dammed lakes are anticipated to form as new ice-dammed lakes are already forming at locations of retreated glaciers.
Extent	Much is still unknown on how climate change will impact Alaska's glaciers. There are many climate models to predict these changes, but it is still uncertain which model will come to fruition. Alaska DGGS has a Climate and Cryosphere Hazards Program (CCHP) that works to identify and predict the frequency and magnitude of new hazards that result from climate change's impact on our glaciers in Alaska (DGGS 2023c).
Impact	Alaska's glaciers are in steep decline and are among the fastest melting glaciers on Earth. Retreating glaciers increases the potential of coastal erosion and elevated storm surge during coastal storms and a loss of habitat for many plants and animals. Increased glacier melt will also affect Alaskan hydroelectric production, positively at first with greater stream flow but negatively over time as glaciers diminish (USGCRP 2018).
Probability of Future Events	During the last several decades, Alaska has warmed twice as fast as the rest of the United States, with the Arctic warming nearly four times as fast. Alaska's glaciers are in steep decline and are among the fastest melting glaciers on Earth. Glaciers in the Southeast Alaska region are experiencing record high snow lines and an increasing rate of mass balance loss (Lader et al. 2020). Continual rising global temperatures will continue to threaten glaciers and associated hazards. In a rapidly changing climate, abrupt changes in, for example, the occurrence of glacial lake outburst floods are typical (DGGS 2023c).

Permafrost and Periglacial	
Changing Factor	**Description of Changes Due to Climate Change**
Nature	Climate change is not anticipated to influence the nature of permafrost or periglacial hazards in Alaska.
Location	Climate change will impact permafrost locations across Alaska, but the most drastic changes will be seen in the northern/Arctic regions of the state.
Extent	Climate models project that permafrost in Alaska will continue to thaw, and some models project that near-surface permafrost will be lost entirely from large parts of Alaska by the end of the century (USGCRP 2018).
Impact	Impacts associated with permafrost degradation include surface subsidence, infrastructure, building, and/or road damage. Subsidence can be a result of improperly designed and constructed buildings, or

Permafrost and Periglacial	
Changing Factor	**Description of Changes Due to Climate Change**
	buildings built on top of permafrost, and may impact buildings, communities, pipelines, airfields, roads, and bridges. This has the potential for extensive structure loss or costly repairs. Additionally, in areas with permafrost degradation, the frequency and potential of rock falls or rock avalanches has increased (IPCC 2019). Landslides are projected to occur in areas where there is no history of previous events due to the destabilization of mountain slopes from thawing permafrost and glacial decline (IPCC 2019). There is no permafrost underlying the populated areas of Yakutat, and therefore, future impacts due to thawing permafrost may not directly impact the community.
Probability of Future Events	Climate models project that permafrost in Alaska will continue to thaw, and some models project that near-surface permafrost will be lost entirely from large parts of Alaska by the end of the century (USGCRP 2018). Figure 3-99 shows historic and projected average annual ground temperature in Yakutat. Yakutat has isolated or sporadic permafrost and is projected to be completely permafrost free under both emission scenarios.



Source: UAF/SNAP 2023a

Figure 3-99 Mean Annual Ground Temperature in Yakutat (1995-2100)

Snow Avalanche	
Changing Factor	**Description of Changes Due to Climate Change**
Nature	Climate change is not anticipated to influence the nature of snow avalanche hazards in Alaska.
Location	Climate change is not anticipated to influence the location of snow avalanche hazards in Alaska.
Extent	Avalanche activity is determined by a number of factors, including snowpack type, internal liquid volume, air temperature, precipitation, elevation, slope, ground cover, etc. An increase in liquid content within snowpack, from increased December-March air temperature and January-February increased precipitation, will lead to greater occurrence of wet snow avalanches, especially in late winter/early spring (Wever et al. 2016; Ballesteros-Canovas et al. 2018).
Impact	As snowpack experiences greater liquid volume, avalanche risk will increase (Ballesteros-Canovas et al. 2018). As snowpack retreats to higher elevations due to reduced snowpack and quickened melt from climate change, the impacted area will also shift upwards. Impacts in this scenario will likely be due to loss of water supply, affecting agriculture, culture, and tourism (IPCC 2018).
Probability of Future Events	As climate warming continues, there is an expectation of an increase in Alaska's vulnerability to snow avalanche hazards (DGGS 2023d). DGGS's CCHP is working on projects that focus on quantifying changes in future snow avalanches in Southeast Alaska and understanding the impacts of these changes on natural resources, and people in their natural and built environments (DGGS 2023d). Ballesteros-Canovas et al. (2018) predicts an increase in avalanche activity in the 2nd half of the 21st century, largely wet-snow avalanches due to increased air temperature and precipitation. However, as snow cover retreats upwards due to these same factors, the impacted area will also change to higher elevations (Ballesteros-Canovas et al. 2018).

3.4 SUMMARY OF VULNERABILITY

This section outlines the risk and vulnerability processes from various hazard impacts in determining potential losses for the community.

This section addresses the remaining portion of Element B of the Local and Tribal Mitigation Plans regulation checklists.

Regulation Checklist- 44 CFR § 201.6 Local Mitigation Plans
ELEMENT B. Risk Assessment
B2. Does the plan include a summary of the jurisdiction's vulnerability and the impacts on the community from the identified hazards? Does this summary also address NFIP-insured structures that have been repetitively damaged by floods? (Requirement 44 CFR § 201.6(c)(2)(ii)) B2-a. Does the plan provide an overall summary of each jurisdiction's vulnerability to the identified hazards? B2-b. For each participating jurisdiction, does the plan describe the potential impacts of each of the identified hazards on each participating jurisdiction? B2-c. Does the plan address NFIP-insured structures within each jurisdiction that have been repetitively damaged by floods?
Source: FEMA 2022 (Local)

Regulation Checklist- 44 CFR § 201.7 Tribal Mitigation Plans
ELEMENT B. Hazard Identification and Risk Assessment
B3. Does the plan include an overall summary of the vulnerability of the tribal planning area? [44 CFR § 201.7(c)(2)(ii)]
Source: FEMA 2017 (Tribal)

3.4.1 OVERVIEW

A vulnerability analysis estimates the exposure extent that may result from a hazard event, within a given area and with a given intensity. This analysis provides quantitative data that may be used to identify and prioritize potential mitigation measures. This then allows the communities to focus their efforts and attention on areas with the greatest risk of damage.

The City and Borough of Yakutat and the Yakutat Tlingit Tribe are located in the same geographic area and thus experience the same vulnerability to hazards.

Table 3-15 shows the overview of the City and Borough of Yakutat and Yakutat Tlingit Tribe's infrastructure hazard vulnerability.

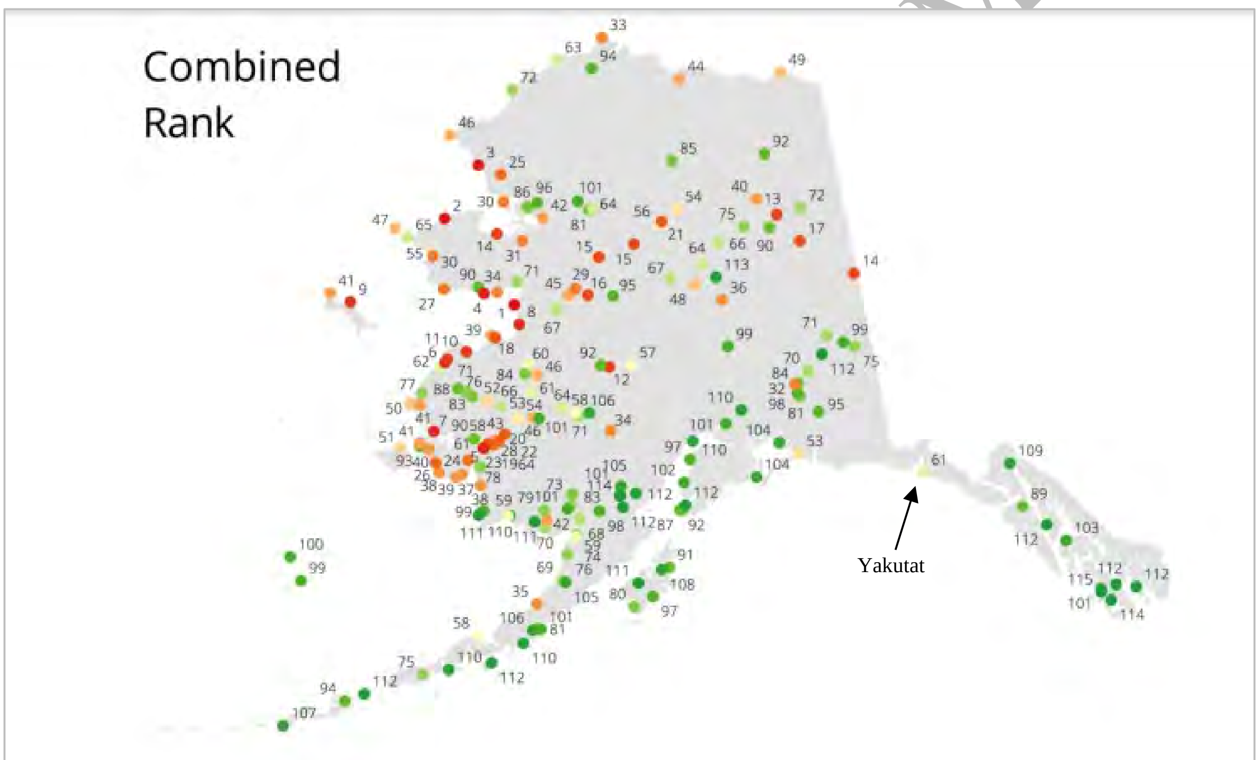
Table 3-15 Vulnerability Overview

Hazard	Area's Hazard Vulnerability			
	Percent of Jurisdiction's Geographic Area	Percent of Population	Percent of Building Stock	Percent of Critical Facilities and Utilities
Earthquake	100	100	100	100
Severe Weather	100	100	100	100
Wildland and Community Fire	100	100	100	100
Ground Failure (Landslide)	30	10	10	10
Tsunami	5	10	10	10
Flood	10	10	10	15

Table 3-15 Vulnerability Overview

Hazard	Area's Hazard Vulnerability			
	Percent of Jurisdiction's Geographic Area	Percent of Population	Percent of Building Stock	Percent of Critical Facilities and Utilities
Erosion	5	0	0	5
Changes in the Cryosphere	80	0	0	0

The 2019 Denali Commission 2019 Statewide Threat Assessment provides a map of the combined threat for the 187 rural communities evaluated in the study (Figure 3-100). The communities with the greatest combined threat are dark red while the communities with the lowest combined threat are shown in dark green. The color gradient shown in the legend depicts the relative ranking of all communities. Overall, Yakutat ranked 61 out of 115 (yellow-green).



Source: Denali Commission 2019

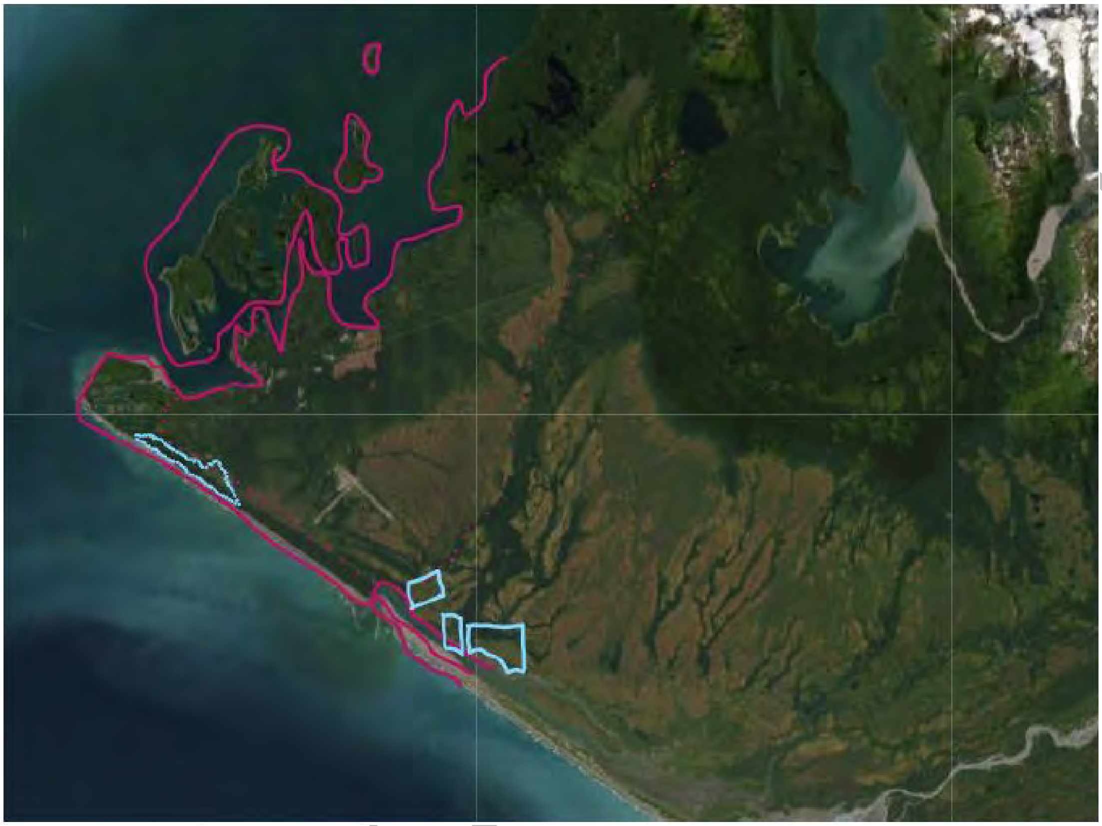
Figure 3-100 Statewide Combined Threat Risk Map

3.4.2 CULTURAL AND SACRED SITE SENSITIVITY

The Yakutat Tlingit Tribe has in-office resources to access any area in the Yakutat area- from Icy Bay to Dry Bay in the State Historical Preservation Office. Yakutat has a rich history with the tribes migrating from above Yakataga all the way down to Dry Bay, and there may be places that have not yet been discovered. The Tribe will process all items found on their land under the Yakutat Tlingit Tribe Preservation Plan.

The YTT has many sacred sites throughout the Planning Area, which are not shared outside the Yakutat Tlingit Tribes office. Some of these areas include old village sites, ceremonial sites, homes of clans, and gathering areas.

The YTT provided the map below which gives an overview of culturally significant areas near the Yakutat Townsite. The pink areas are sacred sites along the coast and rivers. The blue areas are accessible Native Allotments that are close to the community. These landowners still allow the tribal community to access it to gather or for ceremony.



Source: YTT 2023

Figure 3-101 Culturally Significant Areas/Native Allotments near Yakutat Townsite

NOTE: Anyone desiring information concerning their respective culturally sensitive information must contact the tribal office for assistance.

3.4.3 POPULATION AND BUILDING STOCK

Population data for Yakutat was obtained from the 2020 US Census and the DCCED. The 2020 US Census reports that the Yakutat's 2020 population was 662 individuals, and the DCCED estimated the 2022 population to be 673 (Table 3-16). For the remainder of the vulnerability assessment, the larger population estimate will be used (DCCED: 673 individuals).

Table 3-16 Estimated Population and Building Inventory

Population		Residential Buildings	
2020 Census	DCCED 2022 Data	Total Housing Units (2020 Census data)	Total Value of Buildings*
662	**673** (used for analysis)	441	US Census: $74,132,100 HUD: **$271,555,011** (used for analysis)

Sources: US Census 2021- City and Borough of Yakutat population data, DCRA 2023, HUD 2022.
*The 2021 US Census estimates median house value at $168,100. However, the United States Department of Housing and Urban Development (HUD) determined that the average structural replacement value of a 3-bedroom residential building in Yakutat is $615,771 per structure.

Estimated replacement values for residential building structures were obtained from the 2021 US Census, which estimated the median home value per structure was $168,100. Replacement costs in Alaska typically exceed US Census structure estimates due to material purchasing, barge or airplane delivery, and construction in Alaska, therefore, residential replacement values are generally understated.

The United States Department of Housing and Urban Development (HUD) completed a new study in 2022 for Tribal communities throughout Alaska and estimates an average 3-bedroom residential structure in Yakutat has a replacement value of $615,771 (HUD 2022). The more conservative HUD approximation for replacement value was used for this analysis. A total of 441 housing units were considered in this analysis.

3.4.4 VULNERABILITY ASSESSMENT METHODOLOGY

An analysis was conducted to assess the risks of each identified hazard. This analysis looked at the potential effects of each hazard on values of critical facilities at risk without considering the probability or level of damage. The analysis also represents the number of people at risk from each hazard but does not estimate the number of potential injuries or deaths.

Fairweather Science used the critical facilities identified in the 2019 HMP as the foundation to complete this analysis. The Planning Team provided information on newly constructed facilities and these critical facilities were then mapped using GIS. Publicly available GIS layers regarding Yakutat's risk to natural hazards (tsunami inundation, earthquake probability, etc.) were then overlayed on the critical facilities layer to complete the risk assessment.

Hazard	Methodology
Earthquake Severe Weather Wildland and Community Fire	It is assumed that all identified critical facilities are threatened by earthquakes, severe weather, and wildland/community fire.
Tsunami	DGGS tsunami inundation mapping was used to determine the critical facilities in the inundation zone.
Ground Failure/Landslide	This Risk Assessment analyses landslides in terms of both subaerial and submarine and their potential to create a tsunami and resultant damages. Therefore, critical facilities that are located in the tsunami inundation zone were also labeled as being threatened by landslides, as both submarine and subaerial landslides have the potential to produce a tsunami in Yakutat. This method may overestimate landslide damages in Yakutat, as subaerial landslides themselves do not pose a threat to critical facilities in Yakutat.
Flood	At the time of this Risk Assessment, Yakutat does not have completed 100-year flood mapping. Critical facilities threatened by flooding, independent of tsunamis, were determined by the Planning Team, historically flooded locations/facilities, and agency reports.
Erosion	Critical facilities threatened by erosion were determined by the Planning Team, agency reports, and other scientific studies.
Changes in the Cryosphere	It was determined that changes in the Cryosphere threaten areas of the Planning Area, but do not threaten critical facilities. Therefore, no loss estimations were made for this hazard.

3.4.5 DATA LIMITATIONS

The provided vulnerability estimates use the best data currently available, and the methodologies used result in a risk approximation. These estimates may be used to understand relative risk from hazards and potential losses. However, uncertainties are inevitable in any loss estimation. This is due in part from incomplete scientific knowledge or data concerning hazards and their effects on the built environment. As well as the use of approximations and simplifications, when necessary, for a comprehensive analysis.

It should be noted that the results from the quantitative vulnerability assessment are limited to the exposure of people, buildings, and critical facilities and infrastructure to the identified hazards. It was beyond the scope of this MJHMP Update to develop a more detailed or comprehensive assessment of risk. A more comprehensive assessment may include loss of facility/system function, annualized losses, people injured or killed, shelter requirements, and/or economic losses. Such impacts may be addressed with future updates of this MJHMP Update or other planning documents.

3.4.6 CRITICAL FACILITIES INVENTORY

A critical facility is defined as a facility that provides essential products and services to the public. Critical facilities assist in preserving the quality of life in Yakutat and fulfilling important public safety, emergency response, and disaster recovery functions.

The critical facilities profiled in this plan include the following:

- Government facilities
- Emergency response services
- Medical facilities
- Educational facilities
- Transportation facilities
- Roads and bridges
- Utilities
- Community facilities
- Vulnerable populations

Yakutat's critical facilities and infrastructure are listed in Table 3-17. The CBY and Tribe utilize the same facilities and have shared assets.

Table 3-17 Yakutat's Critical Facilities and Infrastructure

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
Government	6	City Hall	434 Max Italio Dr	$324,065	CBY	CBY	X	X	X					
	20	Elementary School-Yakutat Tlingit Tribal Offices	564 Forest Hwy No. 10	$1,000,000	CBY	State of Alaska	X	X	X					
	20	Jacobson Bldg-Yakutat Tlingit Tribal Offices	187 Mallott Ave	$637,300	YTT	YTT	X	X	X					
	9	Courthouse Bldg-City & Borough of Yakutat Planning & Public Works Offices/State of Alaska Courthouse/YTT Radio Station	390 Max Italio Dr	$623,837	CBY	CBY	X	X	X					
	3	Quonset - City & Borough of Yakutat Public Works Shop	424 Max Italio Dr	$1,103,827	CBY	CBY	X	X	X					
	5	Federal Transportation Security Administration	935 Endicott Way	$125,900	Marc Lenart	State of Alaska	X	X	X					
	1	FAA Office/Warehouse	473 Hill St	$141,500	FAA	FAA	X	X	X					
	0	USCG Tower	657 Ridge Rd	$250,000	USCG	CBY	X	X	X					
	0	FAA Communication Tower 1	445 N Range St	$292,100	FAA	State of Alaska	X	X	X					
	0	FAA Communication Tower 2	1391 Lost River Rd	$750,000	FAA	State of Alaska	X	X	X					
	1	NOAA Offices	875 Forest Service Rd	$500,000	NOAA	USFS	X	X	X					
	0	USFS Shop	936 Forest Service Compound Rd	$367,900	USFS	USFS	X	X	X					

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
	6	USFS Ranger Office	421 Ocean Cape Rd	$1,059,300	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc.	X	X	X					
Emergency Response	0	Tsunami Siren (existing)	59.5529071, -139.7423575	$30,000	CBY	CBY	X	X	X					
	0	Tsunami Siren (new)	59.5402841, -139.754816	$30,000	CBY	TBD	X	X	X					
	5	Fire and Police Station	609 Forest Hwy No. 10	$1,798,545	CBY	CBY	X	X	X					
Medical	25	Yakutat Community Health Center	115 Airport Rd	$12,000,000	YTT	YTT	X	X	X					
Educational	65	Yakutat School (K-12)	620 Forest Hwy No. 10	$10,000,000	CBY	State of Alaska	X	X	X					
	10	Yakutat School-Vocational Shop	596 Forest Hwy No. 10	included with the school	CBY	State of Alaska	X	X	X					
	15	Tlingit & Haida Headstart	540 Forest Hwy No. 10	$533,031	CBY	CBY	X	X	X					
Transportation	0	Airport Runways	1 Airport Rd	$50,000,000	State of Alaska	State of Alaska	X	X	X	X				
	10	Airport Terminal	1044 Airport Rd	$2,000,000	Alaska Airlines	State of Alaska	X	X	X	X				
	1	Harbor Building	1041 Mallott Dr	$423,900	CBY	CBY	X	X	X					
	0	Harbor Public Restroom	1039 Mallott Dr	$750,000	CBY	CBY	X	X	X					
	0	Boat Harbor	59.563237, -139.741414	$12,000,000	CBY	CBY	X	X	X	X		X	X	
	6	DOTPF Shop	1015 Airport Rd	$6,000,000	State of Alaska DOT	State of Alaska	X	X	X					
	2	DOTPF Administrative	941 Airport Rd	$827,800	State of Alaska DOT	State of Alaska	X	X	X					
	0	Ocean Cape Dock (Fish Processing & Ferry Load/Unload)	224 Sandy Beach Rd	$10,000,000	CBY	CBY	X	X	X	X		X	X	
	0	Multi Purpose Dock (Fuel & AML Freight)	180 Sandy Beach Rd	$6,356,500	CBY	CBY	X	X	X	X		X	X	
Roads and Traditional Subsistence Trails	0	Ankau Road (Ocean Cape Road)	6.20 miles	$12,400,000	N/A		X	X	X					
		Ankau Road Extension	8.90	$17,800,000			X	X	X					
		City Dock	0.10	$200,000			X	X	X	X		X	X	
		City Dock Access Road	0.10	$200,000			X	X	X	X		X	X	
		Council Avenue (ASHA)	0.15	$300,000			X	X	X					
		Crusher Road	0.10	$200,000			X	X	X					
		Dangerous River Road (Forest Hwy 10)	29.0	$58,000,000			X	X	X	X	X			
		Dock	0.20	$400,000			X	X	X	X		X	X	
		Dock Access Road	0.40	$800,000			X	X	X	X		X	X	
		Dry Bay Road	19.20	$38,400,000			X	X	X					
		Dry Bay Trail	8.50	$17,000,000			X	X	X					
		First Street	0.05	$100,000			X	X	X	X		X	X	
		FS 9981	2.30	$4,600,000			X	X	X					

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
		GaGaanDeiyi (Thunderland)	0.27	$540,000			X	X	X					
		Glacier Bear Road	0.60	$1,200,000			X	X	X					
		Haida Street	0.29	$580,000			X	X	X					
		Hemlock Street (Village)	0.17	$340,000			X	X	X					
		High Avenue	0.12	$240,000			X	X	X					
		Highland Avenue (Monti Bay Heights)	0.20	$400,000			X	X	X					
		Highland Place	0.02	$40,000			X	X	X					
		Hill Street	0.25	$500,000			X	X	X					
		Lake Street	0.23	$460,000			X	X	X					
		Leonard's Landing Road	0.45	$900,000			X	X	X					
		Lodge Lane	0.16	$320,000			X	X	X					
		Lost River Road	4.30	$8,600,000			X	X	X					
		Lower Situk River Boat Launch	0.10	$200,000			X	X	X	X				
		Lower Situk Road	2.50	$5,000,000			X	X	X	X				
		Max Italio Drive	1.35	$2,700,000			X	X	X	X	X	X	X	
		Monti Bay Loop Road	0.40	$800,000			X	X	X					
		Multi Use Dock	0.10	$200,000			X	X	X	X		X	X	
		N. Range Street	0.09	$180,000			X	X	X					
		N. Second Street	0.07	$140,000			X	X	X					
		Ocean Cape Road (Airport Rd to MBL Rd)	1.33	$2,660,000			X	X	X					
		Ophir Creek Road (South Addition)	0.28	$560,000			X	X	X					
		Orca Avenue	0.17	$340,000			X	X	X					
		Post Office Street	0.15	$300,000			X	X	X					
		Public Safety Office Parking Facility	0.10	$200,000			X	X	X					
		Rainy Avenue	0.17	$340,000			X	X	X					
		Redfield Cove Road	4.20	$8,400,000			X	X	X					
		Resort Road	0.26	$520,000			X	X	X					
		Ridge Road	0.64	$1,280,000			X	X	X					
		Riley Lane	0.04	$80,000			X	X	X					
		Rough Way	0.14	$280,000			X	X	X					
		Russell Fiord Road	1.70	$3,400,000			X	X	X					
		S. Range Street	0.05	$100,000			X	X	X					
		Sandy Beach Road	0.52	$1,040,000			X	X	X	X		X	X	
		Sawmill Cove Road	0.30	$600,000			X	X	X					
		Small Boat Harbor	0.10	$200,000			X	X	X	X		X	X	
		Small Boat Harbor Access Road	0.10	$200,000			X	X	X	X				

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
		Small Boat Harbor Boat Launch	0.10	$200,000			X	X	X	X		X	X	
		Small Boat Harbor Boat Launch Access Road	0.10	$200,000			X	X	X	X				
		Small Boat Harbor Parking Facility	0.10	$200,000			X	X	X	X				
		Small Boat Harbor Ramp	0.10	$200,000			X	X	X	X		X	X	
		Small Boat Harbor Seaplane Float	0.10	$200,000			X	X	X	X				
		Small Boat Harbor Trestle	0.10	$200,000			X	X	X	X		X	X	
		Spruce Loop Road	0.32	$640,000			X	X	X					
		Spruce Street	0.09	$180,000			X	X	X	X		X	X	
		Strawberry Point Road (Cannon Beach Road)	1.40	$2,800,000			X	X	X					
		Third Street	0.07	$140,000			X	X	X					
		Thomas Lane	0.05	$100,000			X	X	X					
		Tlingit Street	0.27	$540,000			X	X	X					
		Tongass Street	0.17	$340,000			X	X	X					
		Totem Avenue	0.09	$180,000			X	X	X					
		Upper Situk River Boat Launch	0.10	$200,000			X	X	X					
		Upper Situk River Boat Launch Access Road	0.10	$200,000			X	X	X					
		Upper Situk River Boat Launch Parking Facility	0.10	$200,000			X	X	X					
		Upper Situk Road	2.70	$5,400,000			X	X	X	X	X			
		Water Tank Road	0.18	$360,000			X	X	X					
		West Gate Road	6.20	$12,400,000			X	X	X					
		Yakutat Avenue	0.17	$340,000			X	X	X					
		Yakutat Elementary School Parking Facility	0.10	$200,000			X	X	X					
		Yakutat High School Parking Facility	0.10	$200,000			X	X	X					
		Yakutat School Access	0.10	$200,000			X	X	X					
		Yakutat Senior Center Parking Facility	0.10	$200,000			X	X	X					
		YCHC Parking Facility	0.10	$200,000			X	X	X					
		YTT Drive	0.11	$220,000			X	X	X					
		YTT Office Parking Facility	0.10	$200,000			X	X	X					
		Total:	**110.44 miles**	**$220,880,000**										
Bridges	0	Ankau Bridge	59.5461206, -139.8201914	$11,000,000	CBY	State of Alaska: Over water CBY-Kwaan: Road Surface	X	X	X	X	X	X	X	

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
Utilities	0	Fuel Storage Tanks (school) 1,000 gallon gas 1,000 gallon diesel	620 Forest Hwy No. 10	$100,000	Yakutat Schools/CBY	CBY	X	X	X					
	0	Landfill Class III Muni	1501 Forest Hwy No. 10	$772,453	CBY	CBY	X	X	X					
	0	Satellite, ATT	135 E. Ocean Cape Rd	$50,000	ATT	CBY	X	X	X					
	0	Satellite, GCI	111 E. Ocean Cape Rd	$50,000	GCI	CBY	X	X	X					
	0	Tower, GTP	59.5396643, -139.7374382	$250,000	Aircell, LLC	CBY	X	X	X					
	0	Satellite/Data, CTC	59.5401018, -139.7371466	$50,000	CTC	CBY	X	X	X					
	8	Power Plant Generation Facility	48 Airport Rd	$8,000,000	AVEC	AVEC	X	X	X					
	2	Power Maintenance Shop	549 Forest Hwy No. 10	$800,000	AVEC	AVEC	X	X	X					
	2	Facility Manager’s House	26 Airport Rd	$250,000	AVEC	AVEC	X	X	X					
	0	Power Plant Fuel Storage Tanks 10,000 gallon	48 Airport Rd	$250,000	AVEC	AVEC	X	X	X					
	0	Redwood Water Tank (scheduled for demo 2024, no replace, new pump system alternative)	381 Water Tank Rd	$250,000	CBY	CBY	X	X	X					
	0	Water Tank 1,000,000 gallon	657 Ridge Rd	$1,800,000	CBY	CBY	X	X	X					
	0	CTC Internet Towers	59.5443597, -139.7332006	$235,000	CTC	CBY	X	X	X					
	0	CTC Microwave Tower- Icy Bay	59.9769518, -141.5526262	$3,500,000	CTC	CBY	X	X	X					
	0	CTC Microwave Tower- Icy Bay Airport	59.9659595, -141.6403768	$3,500,000	CTC	CBY	X	X	X					
	0	CTC Microwave Tower- Yakataga	60.0629882, -142.3511178	$3,500,000	CTC	CBY	X	X	X					
	0	CTC Microwave Tower- Suckling	60.0124373, -143.8031781	$3,500,000	CTC	CBY	X	X	X					
	1	Waste Water Treatment Plant	506 Max Italio Dr	$700,000	CBY	CBY	X	X	X	X	X	X	X	
	0	Waste Water Lift Stations x 7	1. Max Italio (lagoon)	$1,200,000	CBY	CBY	X	X	X	X		X	X	
			2. First St (village)	$1,200,000			X	X	X	X		X	X	
			3. Forest Hwy (school)	$1,200,000			X	X	X					
			4. Sandy Beach Rd	$1,200,000			X	X	X					
			5. Max Italio (cannery)	$1,200,000			X	X	X					
			6. YTT Dr (Sunrise Apts)	$1,200,000			X	X	X					
			7. Monti Ave (Jensen)	$1,200,000			X	X	X					
	0	Airport Waste Water Lagoon	59.5106603, -139.6701637	$250,000	CBY	State of Alaska	X	X	X					
	0	Delta Western 3 large storage tanks 10,000-20,000	352 E Ocean Cape Rd	$2,090,900	Delta Western	Delta Western	X	X	X					
Community	0	Cemetery 1	59.5482753, -139.8128573	$110,000	CBY	CBY	X	X	X					

	# of Occupants	Facility	Location	Estimated Value	Facility Owner	Land Owner	Earthquake	Severe Weather	Wildland and Community Fire	Flood	Erosion	Tsunami	Landslide	Changes in the Cryosphere
	0	Cemetery 2	59.5547278, -139.7456766	$30,900	CBY	CBY	X	X	X	X		X	X	
	0	Cemetery 3	59.5587118, -139.746919	$20,000	CBY	CBY	X	X	X	X		X	X	
	150	ANB Hall	342 Max Italio Dr	$1,000,000	Alaska Native Brotherhood	Alaska Native Brotherhood	X	X	X					
	2	US Post Office	477 Mallott Ave	$500,000	L&C Rentals	L&C Rentals	X	X	X					
	25	St Ann's Catholic Church	678 Forest Hwy No. 10	$500,000	Church of Diocese	Church of Diocese	X	X	X					
	20	Church of Latter Day Saints	213 Mallott Ave	$300,000	Church of Latter Day Saints	Church of Latter Day Saints	X	X	X					
	30	Lakeside Chapel Assembly of God	453 Mallott Ave	$300,000	Assemblies of God	Assemblies of God	X	X	X					
	2	Manse -Assembly of God	389 Ridge Rd	$282,500	Assemblies of God	Assemblies of God	X	X	X					
	30	Presbyterian Church	308 Mallott Ave	$569,800	Presbyterian Church	Presbyterian Church	X	X	X					
	2	Manse-Presbyterian Church	310 Mallott Ave	$350,000	Presbyterian Church	Presbyterian Church	X	X	X					
	60	Yakutat Seafoods- Cannery, Bunkhouse, Shop	254 Max Italio Dr	$8,127,564	CBY	CBY	X	X	X	X		X	X	
	15	YKI Facility- Cannery Equipment Storage, Ice House, Bunkhouse	174 Sandy Beach Rd	$750,000	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc./CBY	X	X	X	X		X	X	
	0	Community Garden	59.546944, -139.723611	$50,000	CBY	AKDNR/ AKDOT	X	X	X					
	0	Community Food Waste Recycling Center	733 Glacier Bear Rd	$750,000	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc./CBY	X	X	X					
Vulnerable Populati	15	Senior Center	426 Ocean Cape Rd	$3,200,000	YTT	YTT	X	X	X					
	20	YTT Childcare and Essential Personnel Housing	281 Ridge Rd	$1,000,000	Yak-Tat Kwaan, Inc.	Yak-Tat Kwaan, Inc.	X	X	X					
Total Occ.	594		**Total Potential Losses**	$411,209,622										

Source: City and Borough of Yakutat 2023, Yakutat Tlingit Tribe 2023, 2018 YTT LRTP (road inventory)

The City and Borough of Yakutat is responsible for maintaining most of the roads in Yakutat, with an exception to the main corridors which are owned and maintained by the State of Alaska Department of Transportation and Public Facilities (ADOT&PF). There are also several routes that are owned and maintained by the U.S. Forest Service and some routes that are owned and maintained by Yak-Tat Kwaan Incorporated. The Yakutat Tlingit Tribal Council is considered a public road authority of the Tribe and has the authority to maintain public access for routes constructed on tribal lands or facilities which are owned by the Tribe (2018 YTT LRTP).

Tribes can use a portion of Tribal Transportation Program (TTP) funding for annual maintenance activities of public transportation facilities in accordance with 23 U.S.C. § 202(a). Yakutat Tlingit Tribe Council operates a maintenance program for eligible and approved maintenance activities typically associated with transportation projects. The Tribe understands the importance of maintaining the transportation system to ensure the facility is functional for the full duration of its design life. Grading, resurfacing, pothole repair, applying dust control treatment, cleaning, and thawing out drainage structures and annual upkeep to trails are a few examples of the annual maintenance required after construction, that not only keeps the roadways safe, but also extends the roadway's usable life span (2018 YTT LRTP).

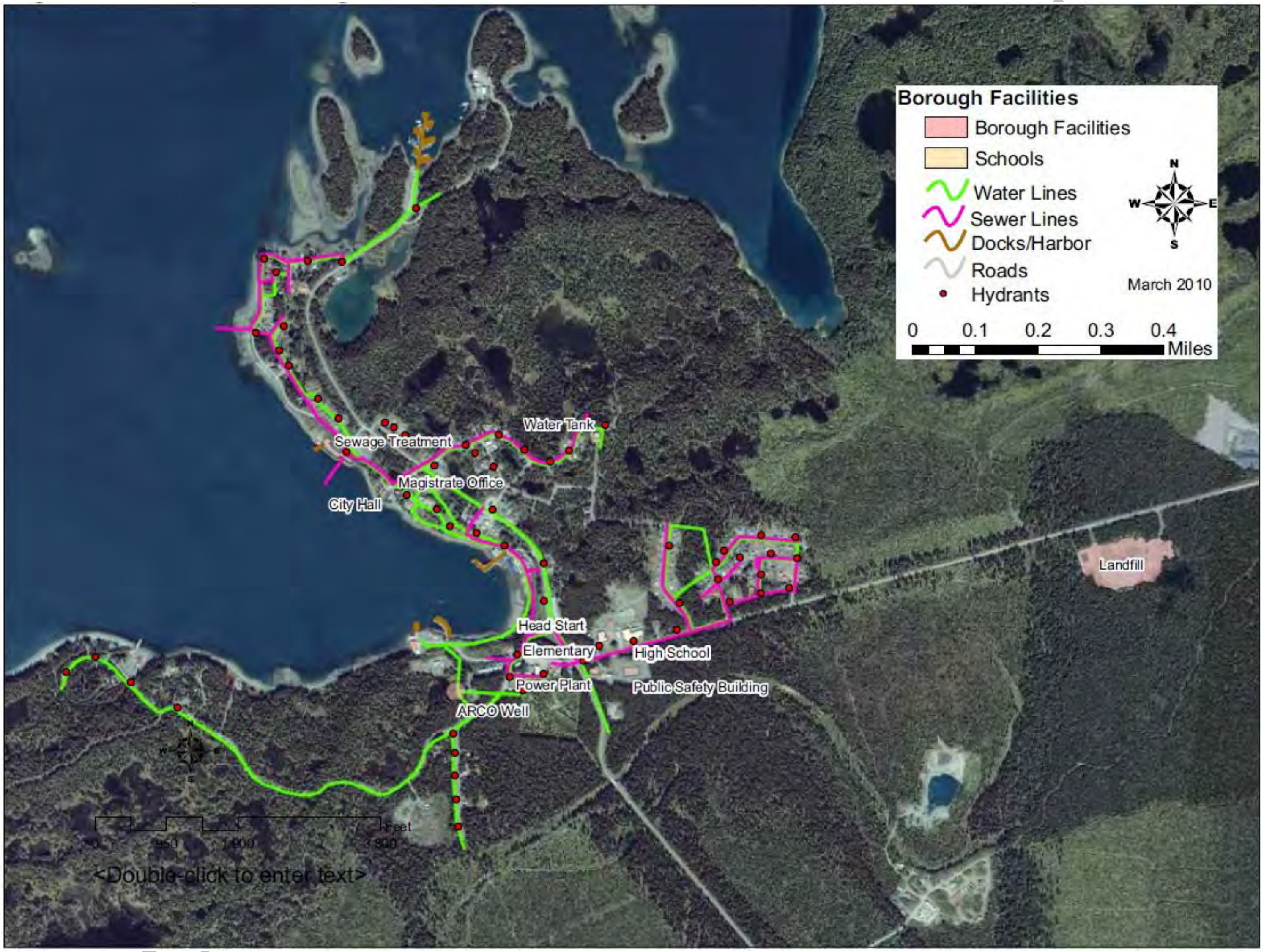
Figure 3-102 Map of Yakutat's Critical Facilities

Figure 3-103 shows an aerial image of the Ankau Bridge.

Source: CoastView 2021

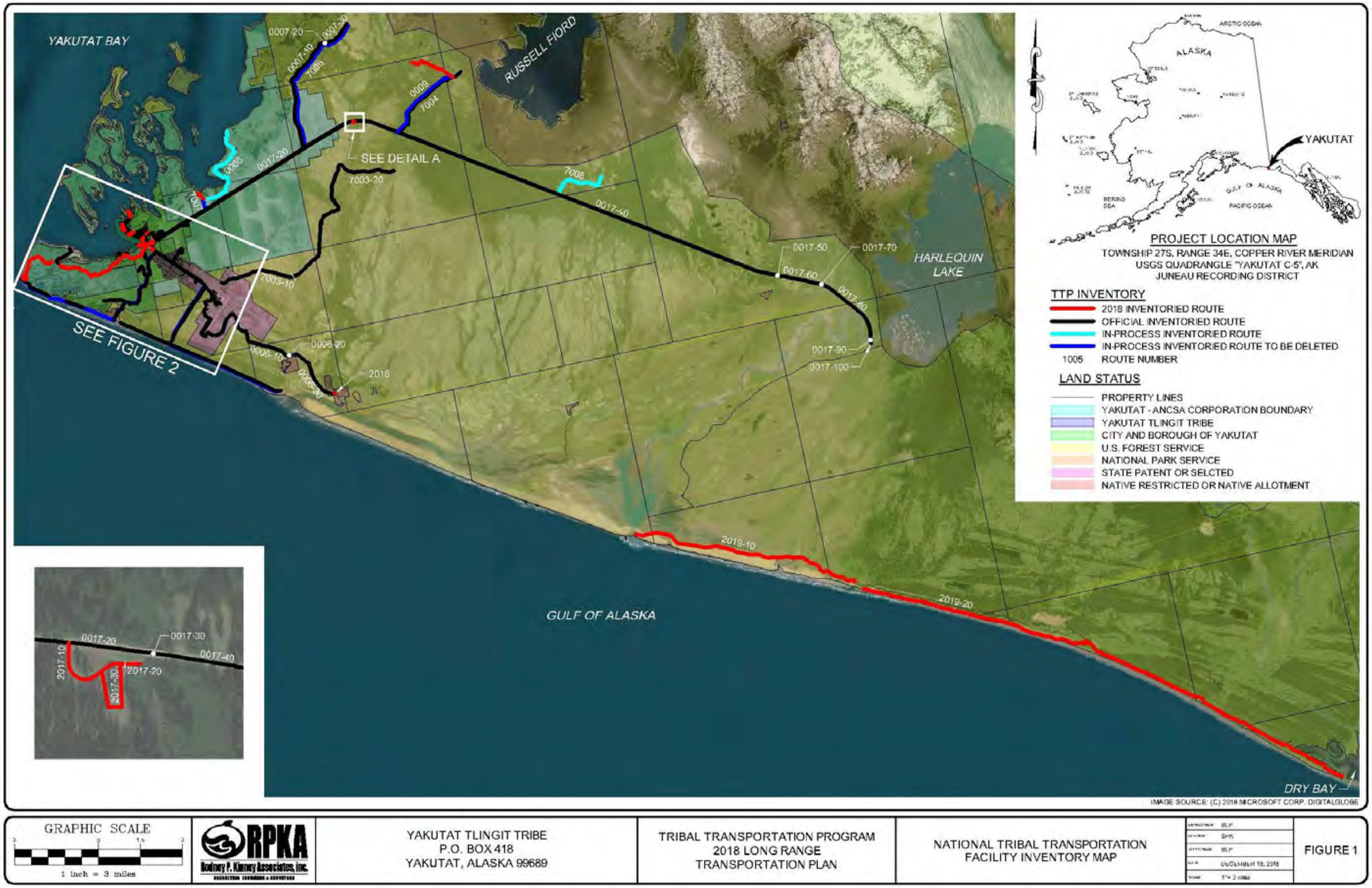
Figure 3-103 Ankau Saltchucks and Ankau Bridge

Figure 3-104 shows the location of Yakutat's utility systems.



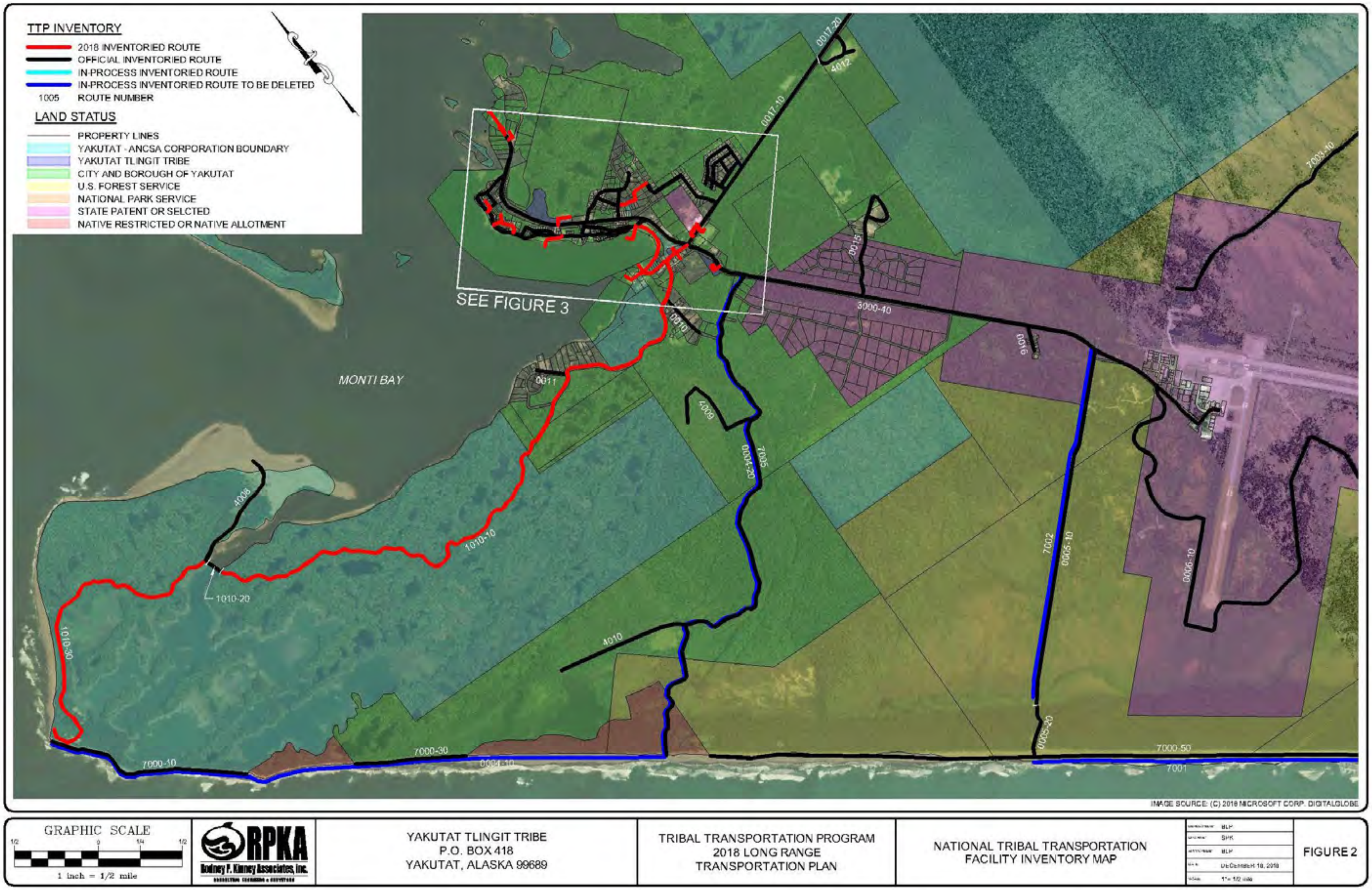
Source: 2010 Yakutat Comprehensive Plan

Figure 3-104 Map of Yakutat's Utility Systems (2010)



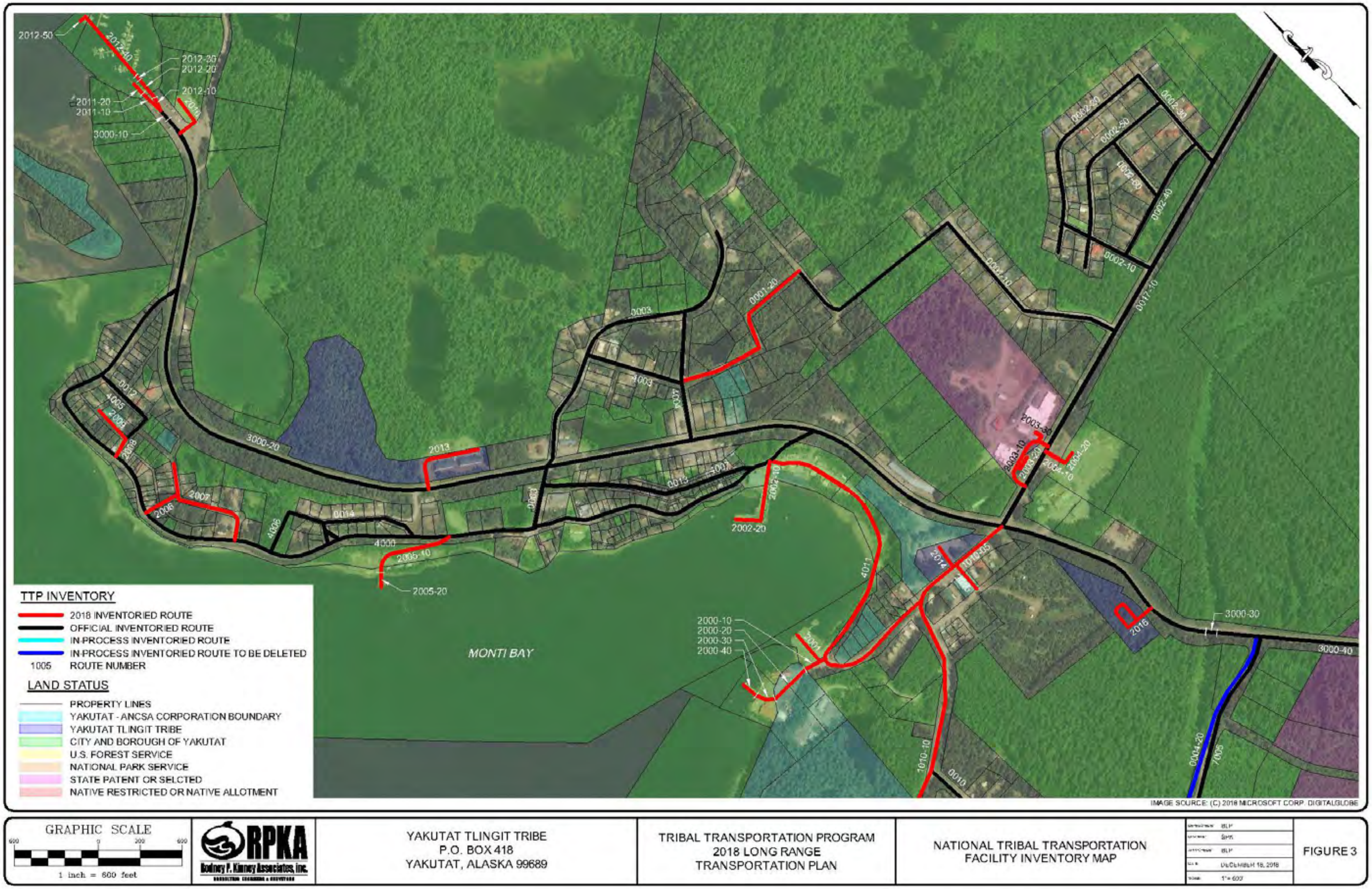
Source: 2018 YTT LRTP

Figure 3-105 2018 Yakutat Road Inventory (1 of 3)



Source: 2018 YTT LRTP

Figure 3-106 2018 Yakutat Road Inventory (2 of 3)



Source: 2018 YTT LRTP

Figure 3-107 2018 Yakutat Road Inventory (3 of 3)

3.4.7 Vulnerability Exposure Analysis

Table 3-18 summarizes the results of the vulnerability exposure analysis for loss estimations in the City and Borough of Yakutat and Yakutat Tlingit Tribe.

Table 3-18 Vulnerability Exposure Analysis

	Earthquake	Severe Weather	Wildland and Community Fire	Ground Failure (Landslide)	Tsunami	Flood	Erosion*	Changes in the Cryosphere
Government Facilities	Bldgs: 13 Occ: 71 Value: $7,175,729	Bldgs: 13 Occ: 71 Value: $7,175,729	Bldgs: 13 Occ: 71 Value: $7,175,729	-	-	-	-	-
Emergency Response	Bldgs: 3 Occ: 5 Value: $1,858,545	Bldgs: 3 Occ: 5 Value: $1,858,545	Bldgs: 3 Occ: 5 Value: $1,858,545	-	-	-	-	-
Medical Facilities	Bldgs: 1 Occ: 25 Value: $12,000,000	Bldgs: 1 Occ: 25 Value: $12,000,000	Bldgs: 1 Occ: 25 Value: $12,000,000	-	-	-	-	-
Educational Facilities	Bldgs: 3 Occ: 90 Value: $10,533,031	Bldgs: 3 Occ: 90 Value: $10,533,031	Bldgs: 3 Occ: 90 Value: $10,533,031	-	-	-	-	-
Transportation Facilities	Bldgs: 9 Occ: 19 Value: $88,358,200	Bldgs: 9 Occ: 19 Value: $88,358,200	Bldgs: 9 Occ: 19 Value: $88,358,200	Bldgs: 3 Occ: 0 Value: $28,356,500	Bldgs: 3 Occ: 0 Value: $28,356,500	Bldgs: 5 Occ: 10 Value: $80,356,500	-	-
Roads	# of Roads: 77 Miles: 110.44 Value: $220,880,000	# of Roads: 77 Miles: 110.44 Value: $220,880,000	# of Roads: 77 Miles: 110.44 Value: $220,880,000	# of Roads: 13 Miles: 3.31 Value: $6,620,000	# of Roads: 13 Miles: 3.31 Value: $6,620,000	# of Roads: 21 Miles: 38.01 Value: $76,020,000	# of Roads: 3 Miles: 11.35 Value: $22,700,000	-
Bridges	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	# of Bridges: 1 Value: $11,000,000	-

	Earthquake	Severe Weather	Wildland and Community Fire	Ground Failure (Landslide)	Tsunami	Flood	Erosion*	Changes in the Cryosphere
Utilities & Communication	Bldgs: 27 Occ: 13 Value: $41,563,353	Bldgs: 27 Occ: 13 Value: $41,563,353	Bldgs: 27 Occ: 13 Value: $41,563,353	Bldgs: 3 Occ: 1 Value: $3,100,000	Bldgs: 3 Occ: 1 Value: $3,100,000	Bldgs: 3 Occ: 1 Value: $3,100,000	Bldgs: 1 Occ: 1 Value: $700,000	-
Community Facilities	Bldgs: 15 Occ: 336 Value: $13,640,764	Bldgs: 15 Occ: 336 Value: $13,640,764	Bldgs: 15 Occ: 336 Value: $13,640,764	Bldgs: 4 Occ: 75 Value: $8,928,464	Bldgs: 4 Occ: 75 Value: $8,928,464	Bldgs: 4 Occ: 75 Value: $8,928,464	-	-
Vulnerable Populations	Bldgs: 2 Occ: 35 Value: $4,200,000	Bldgs: 2 Occ: 35 Value: $4,200,000	Bldgs: 2 Occ: 35 Value: $4,200,000	-	-	-	-	-
Total:	# of CF: 151 Occ: 594 Value: $411,209,622	# of CF: 151 Occ: 594 Value: $411,209,622	# of CF: 151 Occ: 594 Value: $411,209,622	# of CF: 24 Occ: 76 Value: $58,004,964	# of CF: 24 Occ: 76 Value: $58,004,964	# of CF: 34 Occ: 86 Value: $179,404,964	# of CF: 5 Occ: 1 Value: $34,400,000	# of CF: 0 Occ: 0 Value: $0

*Note: Estimated losses due to logging erosion were not included in this assessment as YTT did not have estimated values for areas that are impacted (Figure 3-76).

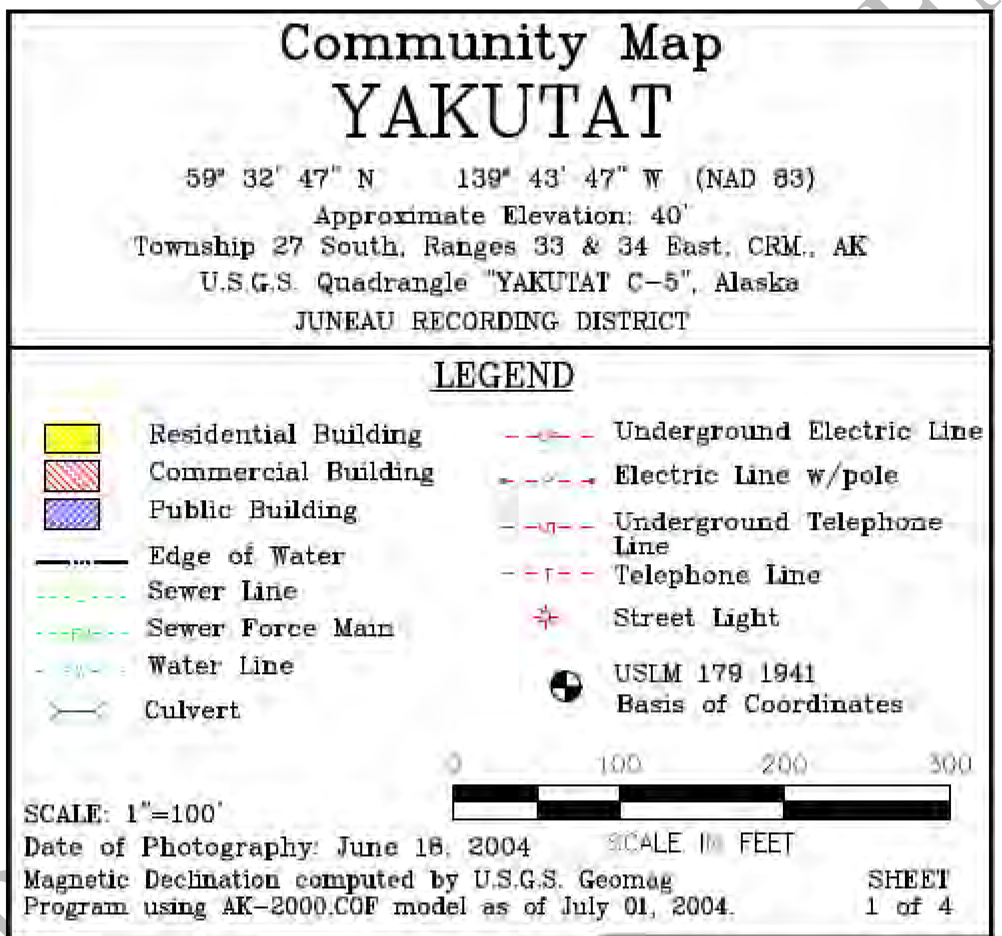
*Additionally, estimated losses for roads were only for the length of road currently impacted by erosion (the entirety of the value of the road was not included in the erosion loss estimation). Max Italio Dr: 1.35 miles, Upper Situk Road: 2.70 miles, Forest Hwy 10: 7.30 miles are threatened by erosion.

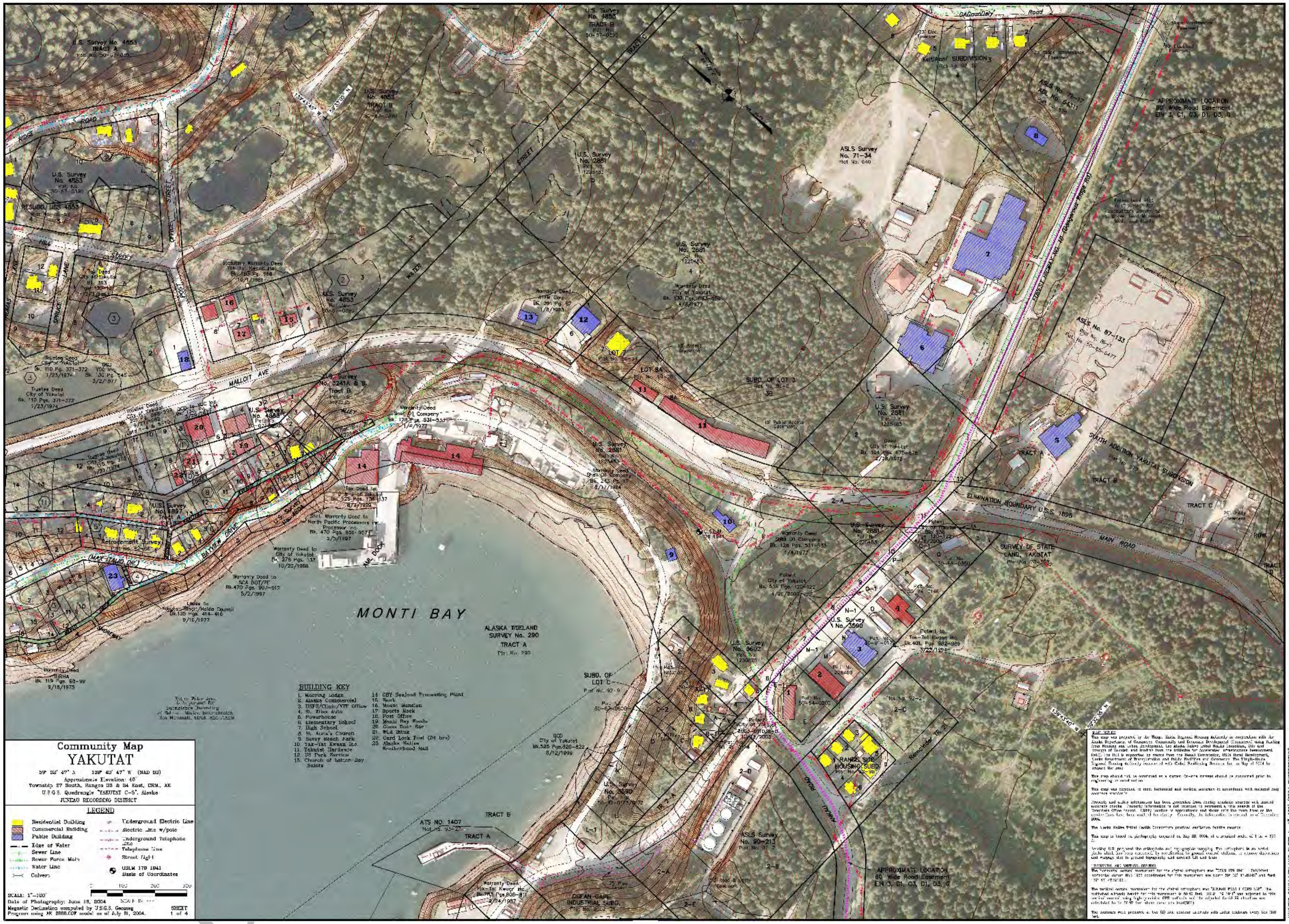
3.4.8 LAND USE IN YAKUTAT

The CBY is roughly the size of Vermont and encompasses approximately 7,650 sq. miles of land and 1,809 sq. miles of water.

There are many land owners in the Planning Area- such as the City and Borough of Yakutat, the state (State of Alaska, Alaska Mental Health Trust, FAA), the Federal government (USFS, NPS, BLM), and private ownership (Yak-Tat Kwaan Native Corporation, Chugach Alaska Corporation, Native Allotments, and private landowners) (Figure 3-110 to Figure 3-113).

Figure 3-108 and Figure 3-109 shows the 2004 DCRA community profile of Yakutat. The legend for these maps is below.





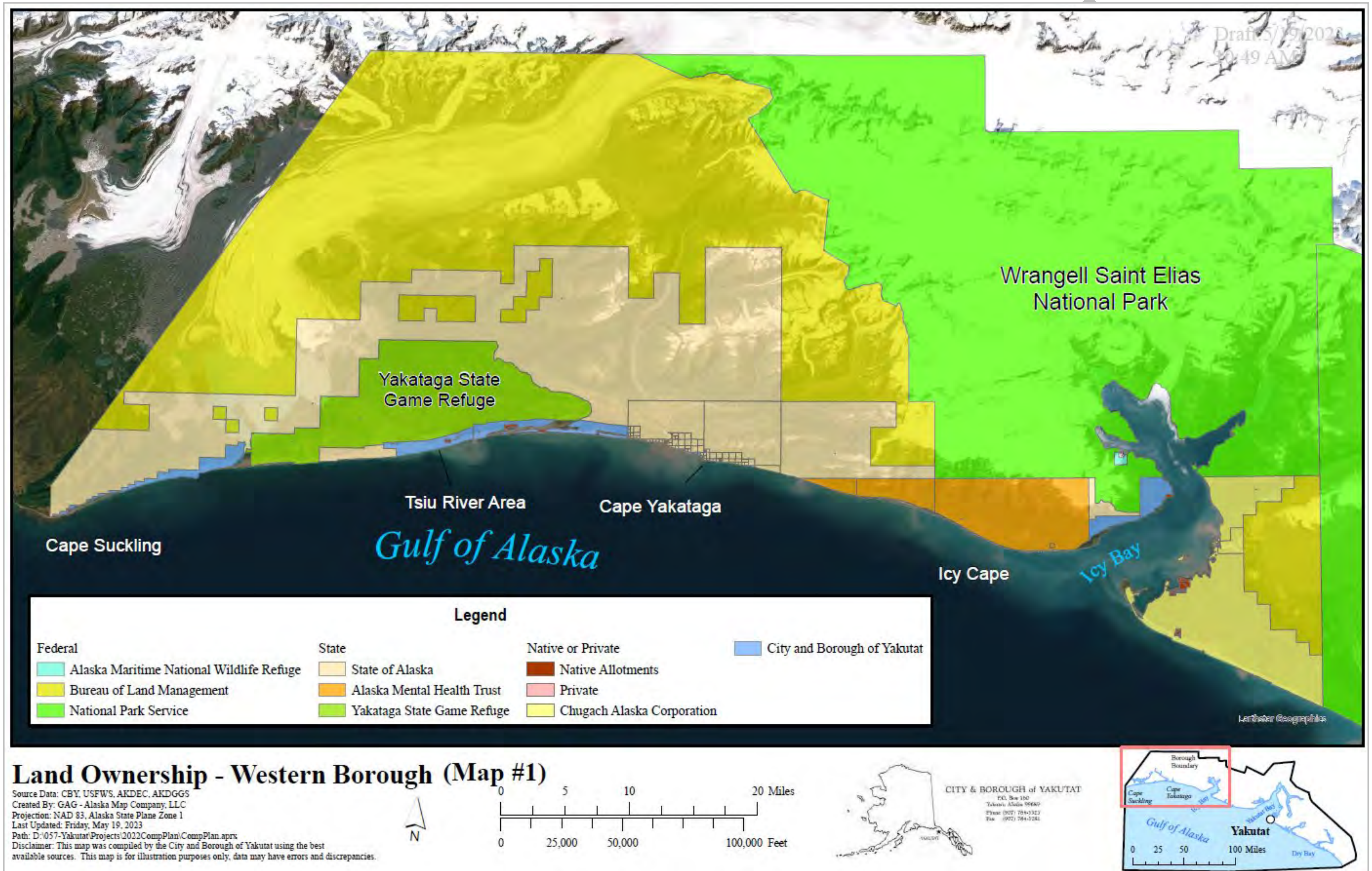
Source: DCRA 2004

Figure 3-108 Yakutat Community Map (2004) (1 of 2)

Source: DCRA 2004

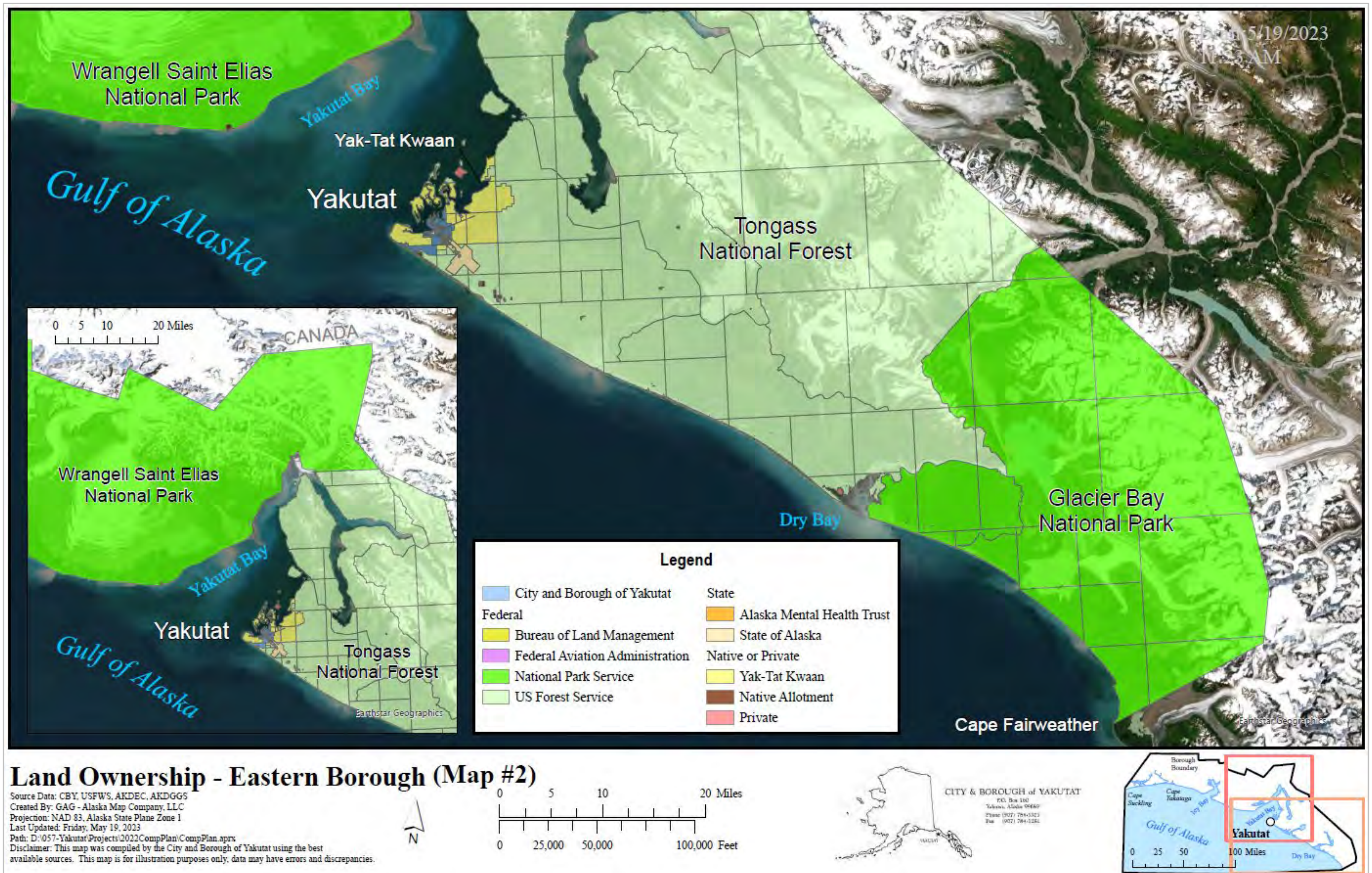
Figure 3-109 Yakutat Community Map (2004) (2 of 2)

Yakutat's 2023 Comprehensive Plan provides maps of land ownership in the Planning Area.



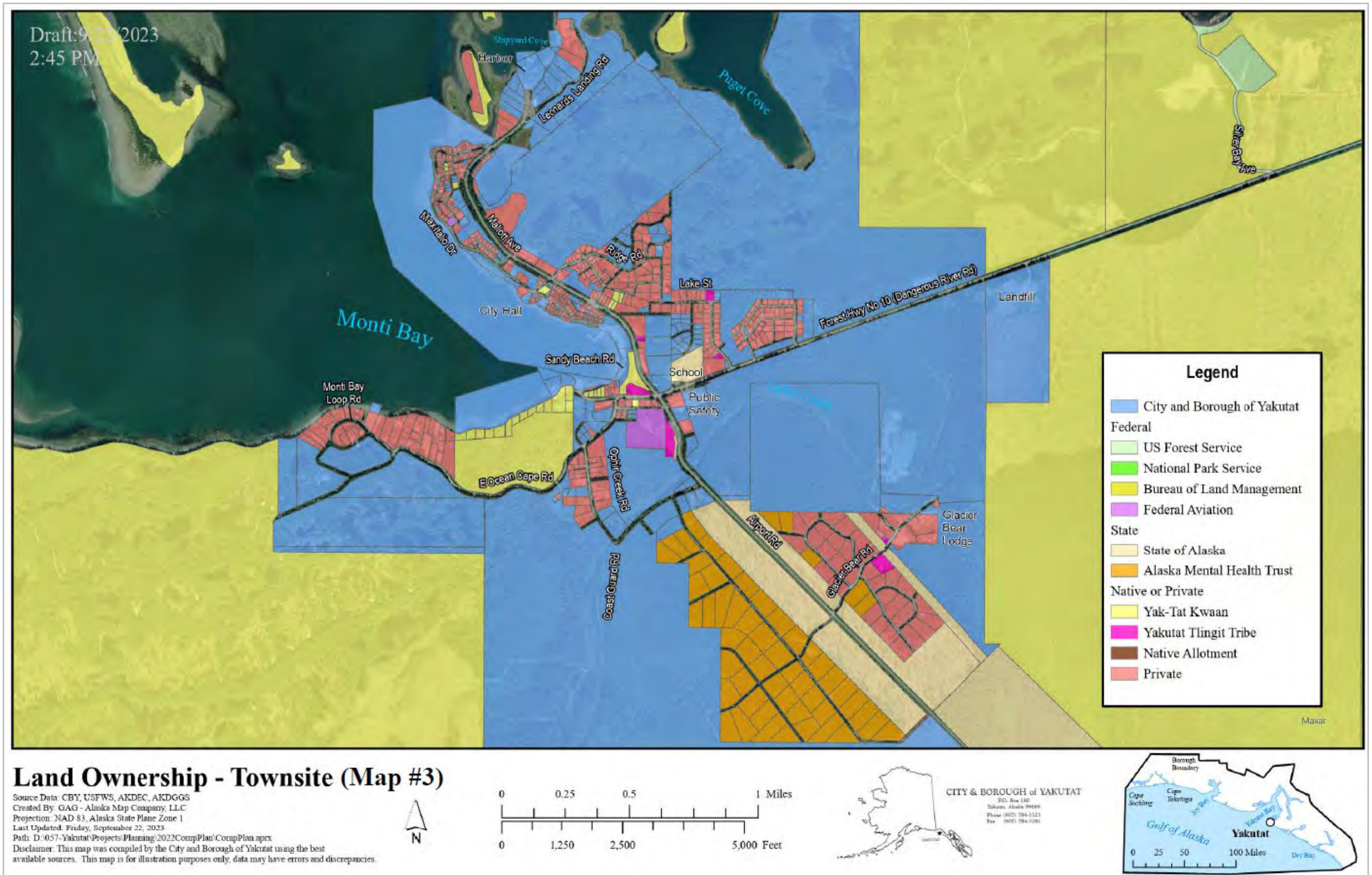
Source: 2023 Yakutat Comprehensive Plan

Figure 3-110 Land Ownership- Western Borough



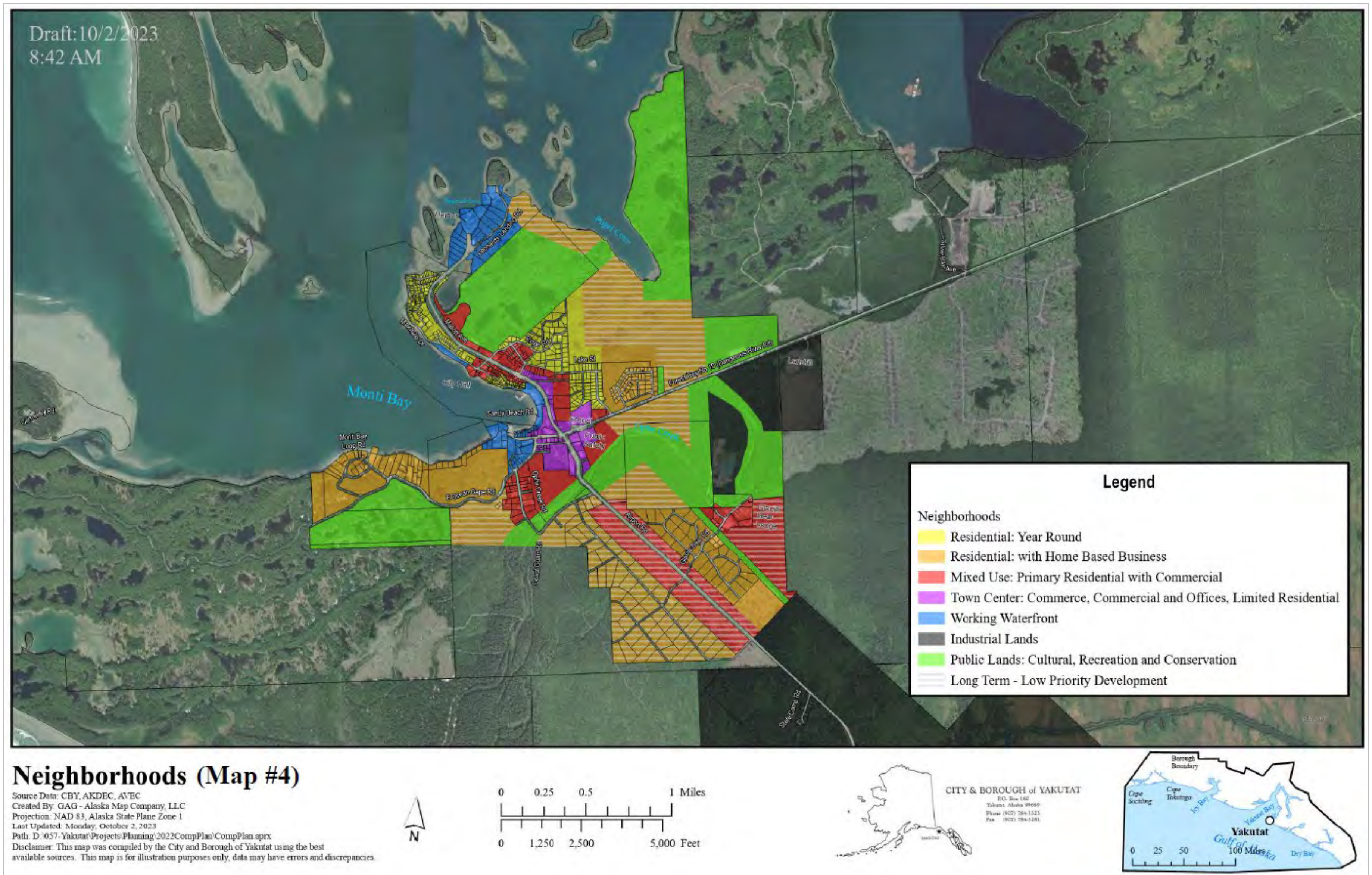
Source: 2023 Yakutat Comprehensive Plan

Figure 3-111 Land Ownership- Eastern Borough



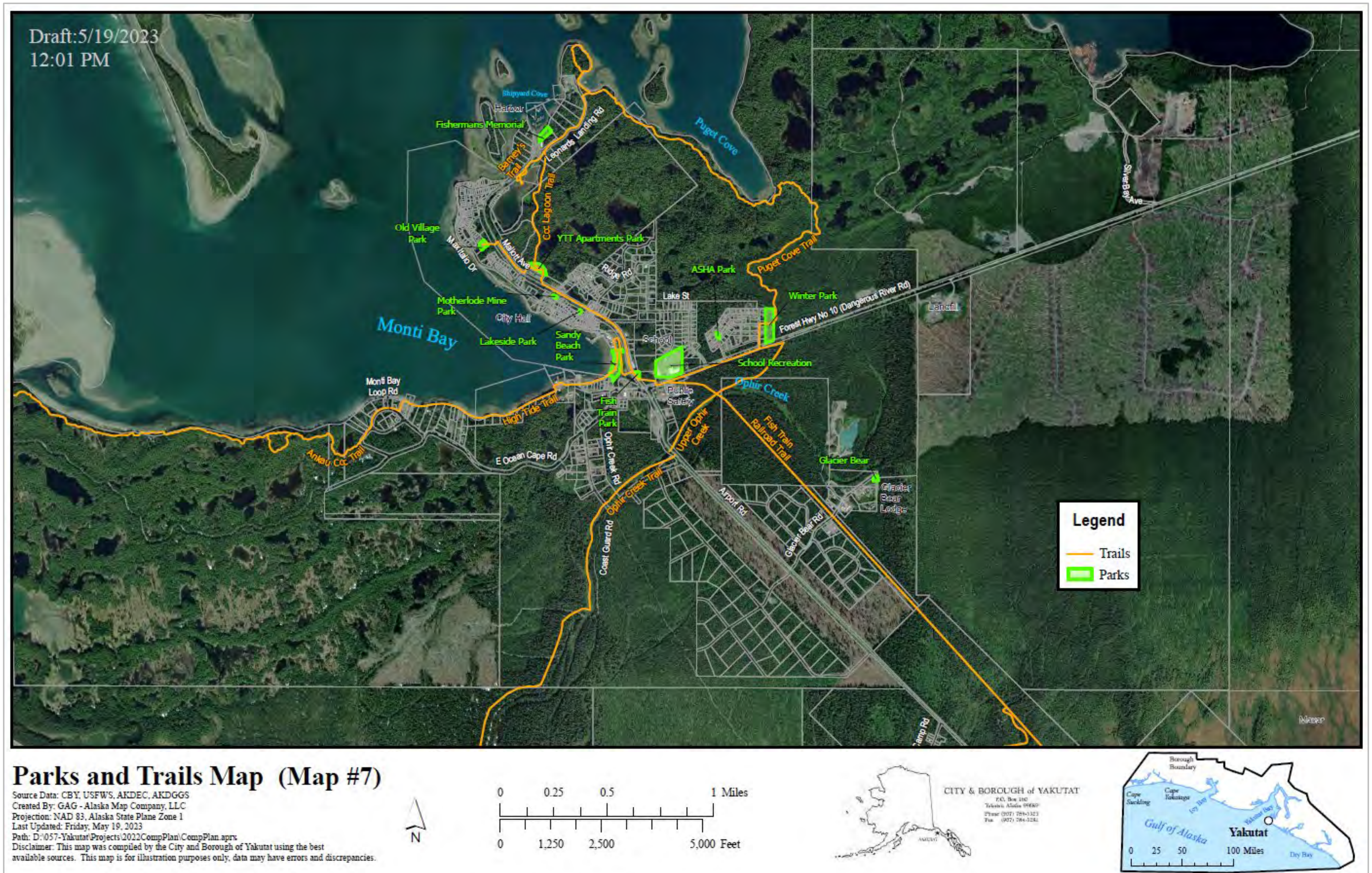
Source: 2023 Yakutat Comprehensive Plan

Figure 3-112 Land Ownership- Yakutat Townsite



Source: 2023 Yakutat Comprehensive Plan

Figure 3-113 Neighborhoods in Yakutat



Source: 2023 Yakutat Comprehensive Plan

Figure 3-114 Parks and Trails Map

3.4.9 Future Development

The CBY established the following development goals in its 2023 Comprehensive Plan.

Community Wellbeing and Connectedness

Goal: Yakutat residents enjoy healthy lifestyles, quality education and healthcare, and a safe, resilient, and thriving community

- Objective 1: Support a place-based culture of health through healthcare, mental health, and social services, programs, and facilities
- Objective 2: Prioritize services and projects centered on cultural heritage and Indigenous values
- Objective 3: Support the school system's capacity to deliver excellent, culturally-rooted education
- Objective 4: Encourage safety through holistic, collaborative, and effective policies and services
- Objective 5: Connect with residents through accessible channels of communication

Stewardship and Environment

Goal: Yakutat residents are empowered to protect and manage their resources and lands for current and future generations with a priority on stewardship, lifestyle, and creating a safe and resilient community.

- Objective 1: Steward the environment and natural resources
- Objective 2: Defend subsistence and build food security
- Objective 3: Protect cultural resources
- Objective 4: Build resiliency of hazard lands and areas prone to natural disasters
- Objective 5: Manage environmental impacts on the community

Economic Stability and Opportunity

Goal: Yakutat's economy is diverse, stable, and balances economic prosperity and required infrastructure with community values and a healthy environment.

- Objective 1: Diversify the economy based on Yakutat's competitive advantages and assets
- Objective 2: Ensure balance by considering the "quadruple bottom line" when making decisions, taking actions, or making investments
- Objective 3: Invest in sustainable infrastructure and technology to meet the needs of economic activities and business ventures
- Objective 4: Grow a visitor industry in alignment with community values

Neighborhoods and Land Use

Goal: Yakutat's land is managed in an orderly, responsible, and efficient manner that enhances the wellbeing of present and future generations, increases housing types and affordability, maximizes use of existing infrastructure before building new, fosters economic opportunity, and creates a mix of neighborhoods that have distinct purposes and character.

- Objective 1: Prioritize infill development of vacant or underused parcels that already have or are close to existing water, sewer, and power
- Objective 2: Sustain a mix of neighborhoods with distinct purposes and character, which together satisfy a diversity of current and future residential, commercial, and industrial needs
- Objective 3: Provide consistent zoning compliance reviews and zoning code enforcement
- Objective 4: Regularly update and consistently implement and enforce plans

Housing

Goal: Yakutat has housing that meets community needs, matches the range of residents' incomes, is energy efficient and environmentally sustainable, and located in safe and connected neighborhoods.

- Objective 1: Prioritize and build quality and more affordable housing
- Objective 2: Develop policies and partnerships to develop new housing and protect existing housing
- Objective 3: Mitigate the impacts of seasonal rentals and short-term housing

Infrastructure and Amenities

Goal: Yakutat has infrastructure and amenities that increase housing opportunities, generate economic growth, mitigate climate change and impacts to natural and cultural resources, and create a safe, resilient, and thriving community.

- Objective 1: Improve and logically expand public utilities
- Objective 2: Protect water quality
- Objective 3: Improve local transportation between neighborhoods and community destinations
- Objective 4: Improve regional transportation connections
- Objective 5: Provide access to public lands
- Objective 6: Manage facilities responsibly and at an appropriate level

Future transportation projects identified in Yakutat's 2022 Transportation Improvement Plan include:

1. Multi-Purpose Dock extension
2. Ocean Cape Dock repair
3. Max Italio Dr. road repair
4. Small Boat Harbor replacement
5. Ankau Bridge and Road upgrade
6. Denali and Ridge Road Extension
7. ASHHA Subdivision road pavement
8. Leonard's Landing Road improvement/paving

Future transportation projects identified in YTT's 2018 Long Range Transportation Plan include:

Transportation Priorities

1. Existing Community Streets Improvements
2. Proposed Route Construction
3. Community Street Paving
4. Senior Center Parking Lot Improvements
5. Pedestrian Facility Improvements
6. Community Street Lighting
7. Interpretive Signage at Recreation Sites
8. Proposed Yakutat Community Health Center Parking Facility
9. YTT Drive Road Improvements
10. Dry Bay Trail Improvements

Maintenance Priorities

1. Community Streets Road Maintenance
2. Maintenance Equipment and Facility
3. Snow Disposal Area

Waterway Transportation Priorities

1. Barge Landing Site Upgrades
2. Multi-Purpose Dock Improvements
3. Upper and Lower Situk River Boat Launches
4. Commercial Boat Storage Area

Transportation Safety Priorities

1. Develop Transportation Safety Plan
2. Safety Plan Implementation

Bridge Priorities

1. Ankau Bridge Rehabilitation
2. Rehabilitation and/or Replacement of Off-System Bridges
3. Proposed Bridge Construction

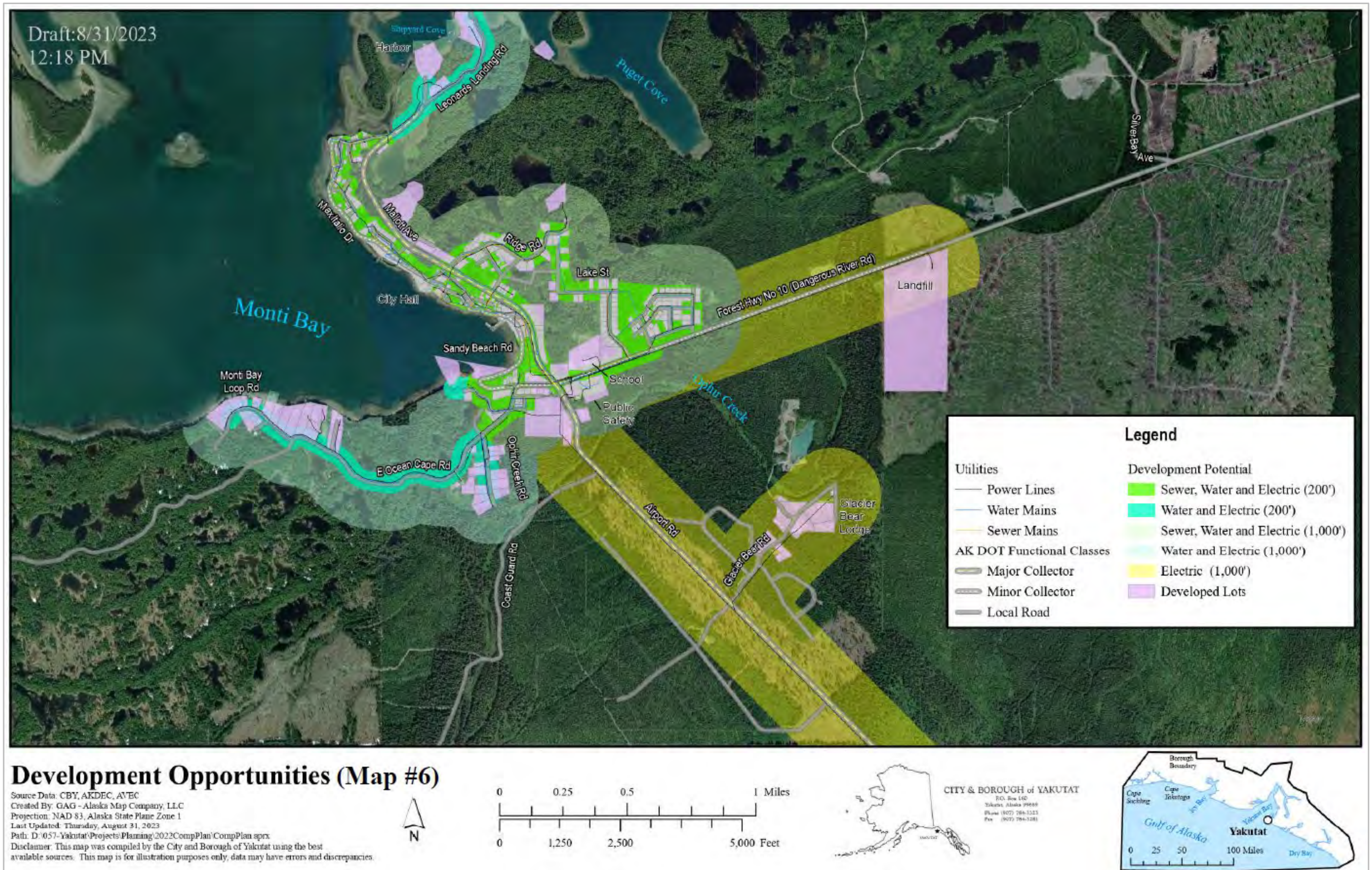
Other Corporation, Borough, and State Priorities

1. Continue Existing Road Maintenance (ADOT&PF Owned Routes)
2. Expand Transit System Program
3. Yakutat Cultural Center
4. Small Boat Harbor Improvements
5. Fuel Dock Facility Improvements
6. Community Street Improvements
7. Trail Improvements
8. Street Lighting
9. Dust Control Application
10. Float Plane Base
11. Erosion Protection

The YTT's 2018 Long Range Transportation Plan describes right-of-way and ownership regarding road improvements in Yakutat:

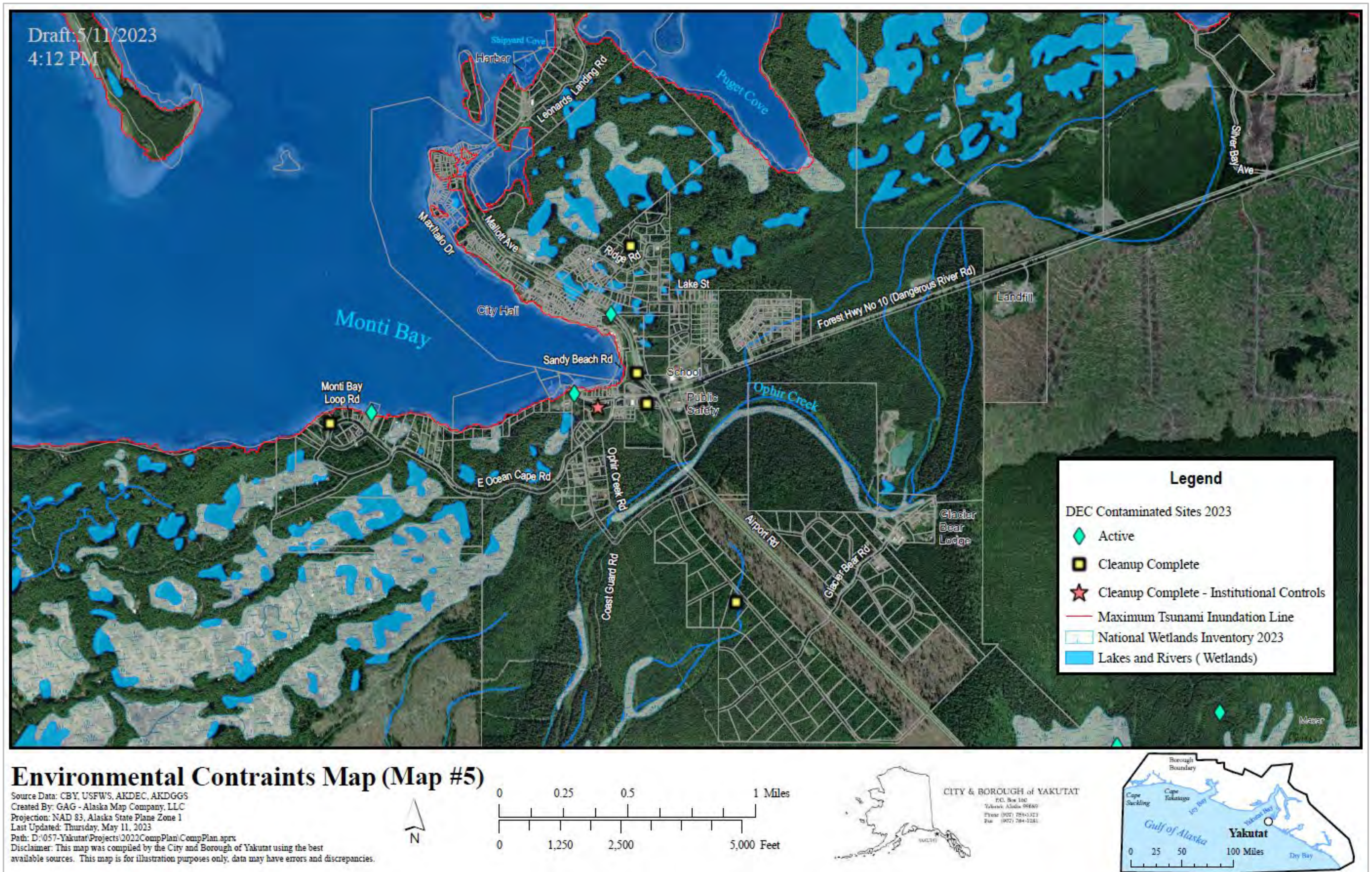
> *The City and Borough of Yakutat and the State of Alaska own most of the roads within right-of-way. There are several Native Allotments in Yakutat; any needed right-of-way through Native Allotments must be acquired in accordance with 25 CFR Part 169. Yak-tat Kwan Incorporated owns the surface rights within the corporation boundary, while Sealaska Corporation owns the subsurface rights. Land use requirements for specific projects may vary depending on the project location; as applicable, improvements are subject to 25 CFR Parts 169 and 170; Alaska Statute 40.15; Yakutat Tlingit Tribe Council requirements; and private landowner approvals.*

Yakutat's 2023 Comprehensive Plan identified the future land growth opportunities in Yakutat, along with environmental constraints that may prohibit future development.



Source: 2010 Yakutat Comprehensive Plan

Figure 3-115 Development Opportunities



Source: 2023 Yakutat Comprehensive Plan

Figure 3-116 Environmental Constraints Map

3.4.10 Subsistence and Food Security in Rural Alaska

Food security and climate change are two of Alaska's most daunting challenges. Alaska is warming twice as fast as the global average, which affects the ability to access traditional hunting, fishing, and gathering areas. Between 2000 and 2010, over 30% of Alaska Natives were consistently food insecure and were twice as likely to be food insecure when compared to white populations (Alaska Food Systems 2023).

Alaskans import 95% of their store-bought food, which is shipped through long supply chains. In rural Alaska, once supplies enter the state, they are flown into the villages and deliveries are weather-dependant. Extreme weather events and seasonality make rural communities, far beyond the end of the road, susceptible to weeks without food delivery, and the food that arrives often has a high spoilage rate due to long travel time and poor storage conditions (UAF AFPC 2023).

Alaska's supply chain is vulnerable and in turn, food supply is unstable- this was most recently highlighted by the 2018 earthquake in Southcentral Alaska that disrupted air traffic and the COVID-19 global pandemic with its associated supply chain breakdowns. The Port of Alaska in Anchorage is the state's primary inbound cargo-handling facility and nearly 80% of the goods entering the states comes through the Port of Alaska.

On February 9, 2022, Alaska Governor Mike Dunleavy issued Administrative Order 3311 establishing the Alaska Food Security and Independence Task Force. The task force was charged with being "responsible for recommendations on how to increase all types of food production and harvesting in Alaska, and to identify any statutory or regulatory barriers preventing our state from achieving greater food security (UAF AFPC 2023). A subsequent report was drafted over three months by the University of Alaska Fairbanks and the Alaska Food Policy Council (AFPC) on behalf of the Alaska Food Security and Independence Task Force and was released in March 2023. The report discussed the food insecurity issues in Alaska and provided recommendations for improving Alaska's food security and independence which draw a roadmap for the State administration, legislators, and Alaska's food producers to make Alaska more food secure the next time the supply chain is disrupted (UAF AFPC 2023). Some of their recommendations include

- Identify barriers that farmers, stock growers, fishermen, mariculture professionals, and others engaged in the growing, harvesting, or raising of food face when starting a business or getting their products into the Alaska market. Provide recommendations on how the State can address those obstacles, including through administrative or statutory changes.
- Assess the levels of wild game and fish harvests in Alaska. Suggest measures that would increase the abundance and harvest of wild game, fish, and food by Alaskans.
- Recommend a program to assist communities and households impacted by fishery shortfalls and disasters.
- Assess the need for disaster food caches within the State; and how the caches can be developed utilizing Alaskan-sourced foods.
- Identify research needed to support and encourage increased consumption and production of Alaskan foods sourced within the State.

In Yakutat, the Environmental Department of the YTT is protecting Yakutat's traditional food's security by monitoring waters and shellfish for harmful algal blooms (HABs), collecting baseline water quality of rivers, coordinating marine debris and community cleanups, and monitoring outdoor air quality (YTT 2023).

In 2021, a community garden opened near the school that includes 44 raised beds, two greenhouses, and a compost house. Additionally, there is a facility for recycling food waste. The YTT and Yakutat school have provided education to the community on how to preserve harvested food for long-term food storage.

Source: Juneau Empire 2021

Figure 3-117 Yakutat Community Garden

In 2023, the Yakutat Tlingit Tribe was awarded $559,548 from the EPA to develop a community-wide composting program, create and share outreach and education materials with the community to help the program succeed in diverting food waste from the community landfill, and support the tribal greenhouse and community garden (EPA 2023).