All Hazards

Mitigation Plan Update

Anchorage, Alaska

Municipality of Anchorage
Project Management & Engineering
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EXECUTIVE SUMMARY

The Municipality of Anchorage (MOA) is vulnerable to a wide range of natural, technological, and human/societal hazards including earthquakes, avalanches, and hazardous material accidents. These hazards can affect the safety of residents, damage or destroy public and private property, disrupt the local economy, and negatively impact the quality of life.

Typically, we cannot eliminate these hazards altogether but we can lessen their impact by undertaking hazard mitigation activities. Hazard mitigation activities are those that reduce or eliminate the long-term risk to property and human life from hazards. Examples of hazard mitigation activities include elevating a structure out of a floodplain, bolting a structure to its foundation and developing a hazard mitigation plan.

The Disaster Mitigation Act of 2000 (DMA 2000) requires that local governments have a local mitigation plan approved by the Federal Emergency Management Agency (FEMA) as a condition for receiving future FEMA mitigation funds. This hazard mitigation plan was developed to fulfill federal and state hazard mitigation planning requirements.

Development and implementation of this plan has been directed by the Anchorage Hazard Mitigation Planning Team consisting of representatives from a variety of municipal departments including the Office of Emergency Management, Project Management & Engineering, Maintenance & Operations, Anchorage School District, Anchorage Water & Wastewater Utility, the Port of Anchorage, Anchorage Police Department and Anchorage Fire Department.

Upon approval by FEMA, this plan will be formally adopted by the MOA Assembly.

FEMA REQUIREMENTS

According to the FEMA regulations, a mitigation plan must identify the hazards that occur in Anchorage, contain a strategy to mitigate those hazards and a method of monitoring and updating the plan.

HAZARDS IN ANCHORAGE

The hazards that may occur in Anchorage include:

Natural	**Technological**
Earthquake	Dam Failure
Wildfire	Energy Emergency
Extreme Weather	Urban Fire
Flooding	Hazardous Materials Release
Avalanche	Dock Failure
Ground Failure/Landslide	Transportation Accident
Severe Erosion	Communications Failure

For each hazard, there is a description of the hazard's characteristics, the location where the hazard can occur, previous occurrences of the hazard, and what is vulnerable to the hazard. Where possible, the location of the hazard area has been mapped.

MITIGATION STRATEGY

Goal 1: Implement and maintain the MOA All Hazards Mitigation Plan.

Objective 1.1 Insure municipal involvement by appointed personnel in this plan.
Objective 1.2 Require periodic meetings with municipal personnel and the public.
Objective 1.3 Insure funding for plan maintenance and 5 year updates.

Goal 2: Inform the community on the local hazards and ways to be prepared if a hazard event occurs.

Objective 2.1 Educate individuals and businesses about hazards, disaster preparedness, and mitigation.
Objective 2.2 Increase coordination between hazard mitigation goals and existing and future plans, including the incorporation of effective hazard mitigation strategies into the Capital Improvement Program.
Objective 2.3 Educate public officials, developers, realtors, contractors, building owners, and the general public about hazard risks and building requirements.
Objective 2.4 Partner with Municipal Departments and other agencies serving vulnerable populations to minimize harm in the event of an emergency.
Objective 2.5 Ensure hazard information/maps are easy to access and up to date in the municipal GIS database.
Objective 2.6 Partner with private sector to promote employee education about disaster preparedness while on the job and at home.

Goal 3: Increase the survivability and resiliency of municipal structures and functions for local hazards.

Objective 3.1 Conduct surveys of essential municipal building and infrastructure to determine if seismic and life safety retrofits are required.
Objective 3.2 As surveys are completed prioritize the municipal facilities to receive upgrades.
Objective 3.3 Implement the facility upgrades as funding becomes available.
Objective 3.4 Incorporate non-structural mitigation into existing buildings.
Objective 3.5 Create redundancies for critical networks such as water, sewer, digital data, power, and communications.

Goal 4: Improve the resiliency of essential private sector functions

Objective 4.1 Create a planning document to determine which private sector facilities should be prioritized for MOA assistance in disaster recovery
Objective 4.2 Develop a recovery plan for essential private sector functions such as health

care or food distribution facilities

Objective 4.3 Determine if essential private sector functions should be required to implement seismic upgrades.

Objective 4.4 Minimize economic loss.

Goal 5: Land Use Planning: Develop land use regulations to reduce the hazard risk to the general population and property.

Objective 5.1 Conduct studies to determine hazard areas within the MOA

Objective 5.2 Adopt and enforce public policies to minimize impacts of development and enhance safe construction in high hazard areas.

Goal 6: Reduce the flood risk to the community

Objective 6.1 Continue to participate in the National Flood Insurance Program.

Objective 6.2 Revise and update flood hazard information whenever possible.

Objective 6.3 Implement flood reductions measures and improve local drainage.

Goal 7: Emergency Management: Create and maintain a community where people and property are safe.

Objective 7.1 Develop mechanisms in advance of a major emergency to cope with subsequent rebuilding and recovery phases.

Objective 7.2 Plan for and respond to the secondary effects of disasters, such as hazardous waste and hazardous materials spills, when planning and developing mitigation projects.

Objective 7.3 Promote disaster contingency planning and facility safety among institutions that provide essential services such as food, clothing, shelter, and health care.

Objective 7.4 Improve disaster warning systems.

Goal 8: Reduce the Urban and rural Wildfire Risk

Objective 8.1 Support the AFD Wildfire Strategic Plan.

Objective 8.2 Promote Firewise homes through the concepts in Firewise Alaska; landscaping and vegetation management; structure protection through preparedness; building design, siting, and construction material; and homeowner awareness.

Objective 8.3 Promote vegetation management in greenbelts and parks to limit fire spread.

Objective 8.4 Maintain the wildfire risk model.

Objective 8.5 Maintain and develop additional water resources.

Objective 8.6 Improve road connectivity for evacuation purposes.

ACTION ITEMS

Action 1. The MOA shall establish a Mitigation Advisory Committee for the All Hazards Mitigation Plan and establish a semi-annual meeting schedule.

Action 2. Review and update prioritization strategy (in Appendix F). Upon completion, prioritize action items.

Action 3. Insure funding is provide for plan maintenance and revision. In year 3 of the plan the MOA should apply for State or Federal Grants for plan revision.

Action 4. The MOA will continue to review and advise the community on the various methods of making structures and their contents more disaster-resistant, which would include workshops, literature, and public safety announcements. Bilingual outreach will also be used.

Action 5. Acquire updated air photos or LiDAR information for the entire MOA.

Action 6. Make the All Hazards Mitigation Plan available for incorporation into other municipal long range plans, e.g., MOA Comprehensive Plan. To the best of our ability insure mitigation strategies are integrated into MOA long range plans and capital improvement budgets.

Action 7. Retrofit and enhance MOA-owned facilities that will be needed during and after a hazard.

Action 8. Identify critical infrastructure and other facilities that need to be seismically retrofitted or rebuilt to current seismic standards. AFD Fire Stations 8, 10, 11, & 12 are the only stations that have not been upgraded to meet current seismic requirements.

Action 9. Retrofit or enhance to improve the resiliency of police stations as listed in the APD's Strategic Plan and CIB/CIP plan.

Action 10. Complete the Port of Anchorage modernization.

Action 11. Continue to strengthen the existing Port of Anchorage pilings until they can be replaced.

Action 12. Install gas shut-off valves in MOA-owned public facilities used in response/recovery efforts.

Action 13. Perform seismic and structural analysis of all ASD owned facilities.

Action 14. Construct necessary seismic and structural upgrades of all ASD owned facilities .

Action 15. Develop a recovery plan for essential private sector functions.

Action 16. Continue to implement the policies and strategies in Anchorage 2020-Anchorage Bowl Comprehensive Plan that address crime prevention and public safety, natural and manmade hazards, and emergency response.

Action 17. Incorporate the action items identified in the Downtown Seismic Risk Assessment into local ordinances.

Action 18. Update snow avalanche mapping for Chugiak/Eagle River, Anchorage Bowl, and Turnagain Arm/Girdwood.

Action 19. The MOA shall continue to apply floodplain management regulations for development in the flood plain and floodway.

Action 20. The MOA shall continue to utilize the FEMA Flood Insurance Rate Map to define the special flood hazard area, the floodway, and the floodplain.

Action 21. Annually review and amend, as appropriate, a list of potential flood mitigation projects such as culvert replacement, channel rehabilitation and property acquisition.

Action 22. Annually identify and prioritize Flood Insurance Rate Maps that need to be updated.

Action 23. Update the Flood Insurance Study.

Action 24. Convert the local vertical datum to a national standard vertical datum.

Action 25. Annually review the list of drainage studies that need updating.

Action 26. Map estimated dam inundation areas within the Municipality and evaluate alternative methods to mitigate the potential risk of a dam failure in these areas.
Action 27. Identify ways to improve local public information and warning capabilities.
Action 28. Update the MOA Continuity of Operations Plan (COOP).
Action 29. Review existing zoning ordinances to determine if additional wildfire mitigation measures could be incorporated to address wildfire mitigation which has been proposed for inclusion in updates to Title 21. Consider adoption of the International Code Council Wildland Urban Interface Code (current edition).
Action 30. Conduct fire-wise home assessments.
Action 31. Update the wildfire risk model.
Action 32. Continue and maintain vegetation management
Action 33. Develop additional water resources for wildfire response purposes.

Plan Maintenance

This plan will be maintained through a series of annual evaluations, evaluations after major hazard events, and a formal re-adoption every five years. On an annual basis, the plan will be evaluated to:

- Semi-annually monitor progress made on plan recommendations during the previous 12 months.
- Identify mitigation accomplishments in projects, programs and policies.
- Update the status of mitigation projects included on the city's Capital Improvement Program list, and elsewhere.
- Ensure new mitigation needs are identified.
- Identify new mitigation projects.
- Review project prioritization to ensure it reflects current conditions.
- Modify or remove existing initiatives, and the justification for doing so.
- Incorporate changes in membership to the MOA Hazard Mitigation Planning Committee.
- Continue to provide public outreach and receive public input to the plan.

Table of Contents

List of Tables **On or Following Page**

List of Figures **On or Following Page**

Appendices

CHAPTER 1 - INTRODUCTION

1.1 BACKGROUND

The Municipality of Anchorage (MOA) is vulnerable to a wide range of natural, technological, and human/societal hazards including earthquakes, avalanches, and hazardous material accidents. These hazards can affect the safety of residents, damage or destroy public and private property, disrupt the local economy, and negatively impact the quality of life.

> **Benefits of hazard mitigation include…**
> - Reduced loss of life, property, essential services, critical facilities, and economic hardship
> - Reduced short-term and long-term recovery and reconstruction costs
> - Increased cooperation and communication within the community through the planning process
> - Expedited pre-disaster and post-disaster grant funding
> - Increased disaster resilience
> - Improved environmental quality
> - Improved economic vitality
> - Improved quality of life

Typically, we cannot eliminate these hazards altogether, but we can lessen their impact by participating in hazard mitigation. Hazard mitigation is any action taken to reduce or eliminate the long-term risk to property and human life from hazards.

There is a wide variety of hazard mitigation activities available. They can be structural in nature, such as reinforcing a building's foundation or constructing a levee, or they can be non-structural, such as rezoning a flood-prone area or securing a water heater to a wall. Mitigation activities can focus on preventing the damage from occurring in the first place (by limiting development in hazard-prone areas), or by protecting against damage (strengthening existing or future development so that it is not damaged by a hazard event). More information about hazard mitigation activities can be found in Chapter 6.

One of the most effective tools to reduce vulnerability to hazards is a local hazard mitigation plan. A hazard mitigation plan identifies what hazards exist in the community and establishes goals and specific mitigation activities to be undertaken.

To encourage communities to develop hazard mitigation plans, the United States Congress passed the Disaster Mitigation Act of 2000 (DMA 2000). This Act requires local governments to have a Federal Emergency Management Agency (FEMA)-approved mitigation plan by November 2004 to remain eligible for FEMA Hazard Mitigation Grant Program (HMGP) funding and Pre-Disaster Mitigation (PDM) grants.

This plan for the MOA has been prepared in coordination with the State of Alaska (SOA) Division of Homeland Security and Emergency Management (DHS&EM) to ensure it meets all applicable DMA 2000 requirements. FEMA's Local Mitigation Plan Crosswalk, found in Appendix A, provides a summary of federal and state minimum standards and documents where each requirement is met within the plan.

1.2 PURPOSE

The purpose of this plan is to:

- Identify hazards[1], mitigation goals and objectives, and potential mitigation projects within the MOA.
- Fulfill the DMA 2000 Local Hazard Mitigation Plan requirements.
- Serve as a qualifying document for hazard mitigation programs coordinated through the DHS&EM.

1.3 HOW THIS PLAN WILL BE USED

A hazard mitigation plan is not intended to be developed and forgotten, because it is the implementation of the plan that is essential. To be effective, the goals of the plan need to be incorporated into the everyday activities of the Municipality. As a result, this plan should be used to modify existing MOA plans and policies so that they support the Municipality's hazard mitigation goals. Issues related to emergency response are not included in this plan; these issues should be addressed in the MOA's Emergency Operations Plan (EOP).

1.4 SUMMARY OF HAZARDS IN THE MUNICIPALITY OF ANCHORAGE

According to the MOA's 2015 EOP, Anchorage is vulnerable to three main types of hazards: natural, technological, and human/societal hazards. Table 1.1 shows the types of potential hazards in the MOA. More information about natural and technological hazards can be found in Chapter 4.

A. Table 1.1 Hazards in Anchorage

Natural	Technological
Earthquake	Dam Failure
Wildfire	Energy Emergency
Extreme Weather	Urban Fire
Flooding	Hazardous Materials Release
Avalanche	Radiation Accident
Ground Failure/Landslide	Transportation Accident
Volcanic Ash Fall	Air Pollution
Severe Erosion	Communications Failure

Source: 2015 MOA Comprehensive Emergency Operations Plan

Hazards can be measured in terms of their frequency and severity. Frequency is the number of times the hazard has occurred. Severity measures how bad the situation can be and is

[1] Hazard information is from various federal, state, public, and private sources and is for planning purposes only. The information should not be used for purposes it was not intended for including permit applications or for construction.

based on several factors, including the number of deaths/injuries; how long critical facilities are shut down; extent of property damage; effect on economy; and the effect on response systems. Table 1.2 shows the frequency and severity of Anchorage's potential hazards.

B. Table 1.2 Hazard Rating Matrix

Frequency

	Has not occurred yet	**Low (11-100 years)**	**Medium (5-10 years)**	**High (1-4 years)**
Catastrophic (Deaths or Injuries: 50 or more)		Severe Earthquake		
Critical			Wildfire	Communications Failure
Limited	Energy Emergency	Civil Disturbance	Ground Failure/Landslide	Avalanche Extreme Weather Urban Fire Transportation Accident
Negligible	Dam Failure Severe Erosion		Volcano Ash Fall	Minor Earthquake Flooding

Catastrophic: More than 50 deaths/injuries; complete shutdown of critical facilities for 20 days or more; more than 50% property damage; severe long-term effects on economy; severely affects state/local/private sectors' capabilities to begin or sustain recovery activities; overwhelms local and state response resources.

Critical: 10-50 deaths/injuries; shutdown of critical facilities for 8-30 days; 25-50% property damage; short-term effect on economy; temporarily (24-48 hours) overwhelms response resources.

Limited: Fewer than 10 deaths/injuries; shutdown of critical facilities for 3-7 days; 10-25% property damage; temporary effect on economy; no effect on response system.

Negligible: Minor injuries; no deaths; shutdown of critical facilities for fewer than 3 days; less than 10% property damage; no effect on economy; no effect on response system.

Source: 2015 EOP

After the hazards are identified, the potential consequences of the hazard are considered. One potential consequence is property damage. Potential property damage was estimated using Geographical Information System (GIS) analysis. Table 1.3 summarizes the number of parcels and the taxable value (land and structure) that are vulnerable to each hazard. These values represent the parcels that could be vulnerable to a hazard event, the actual number and location of parcels impacted will vary depending on the size and location of the event.

C. Table 1.3 Vulnerability Summary

Hazard	Number of Parcels	Taxable Value
Earthquake	84,219	$39,974,839,600
Wildfire	84,219	$39,974,839,600
Extreme Weather	84,219	$39,974,839,600
Flooding	4,652	$3,355,324,850
Avalanche	969	$30,4008,700
Ground Failure/Landslide	5,120	$4,016,899,000
Volcanic Ash Fall	84,219	$39,974,839,600
Severe Erosion	N/A	N/A
Dam Failure	N/A	N/A
Energy Emergency	84,219	$39,974,839,600
Urban Fire	66,945	$132,357,638,300
Hazardous Materials Release	84,219	$39,974,839,600
Power Failure	84,219	$39,974,839,600
Communications Failure	84,219	$39,974,839,600

Source: MOA 2016

Additional information about the property, infrastructure, and populations vulnerable to each hazard can be found in Chapter 4.

1.5 SCOPE

This plan is an update of the 2011 Anchorage All Hazard Mitigation Plan. Chapter 2 (Community Profile) and Chapter 3 (Asset Inventory) were updated to reflect the current conditions. Other changes to Chapter 4 involved updating the natural hazards information, including the vulnerability tables. In Chapter 5 significant updates to the plan's goals and objectives were required. The Action Items were also review by the Planning Team. All action items were updated to reflect their current status, and additional action items were identified. In addition, modifications to the plan were made to improve readability and ease of use whenever possible. A more detailed summary of changes can be found in Appendix A.

1.6 ORGANIZATION OF THE PLAN

The plan is organized as follows:

Chapter 1

Chapter 1 is an introduction to the plan and includes the purpose, scope, and organization of the plan, as well as a description of the planning process.

Chapter 2

Chapter 2 is a community profile providing an overview of the MOA's:

- Location,
- Natural Setting,
- History,
- Demographics, and
- Economy.

Chapter 3

Chapter 3 is an asset inventory identifying what development could be vulnerable to a hazard event.

Chapter 4

Chapter 4 provides details about the hazards that can occur in Anchorage. For each hazard, there is a description of the hazard's characteristics, the location where the hazard can occur, previous occurrences of the hazard, and what is vulnerable to the hazard. Where possible, the location of the hazard area has been mapped.

Chapter 5

Chapter 5 contains the MOA's mitigation strategy, including mitigation goals, objectives, and action items. This chapter also contains information about how the mitigation measures will be implemented.

Chapter 6

This chapter is devoted to the maintenance, evaluation, and updating of the plan.

Chapter 7

This chapter lists the references used in the development of the plan.

Appendices

The appendices contain the plan's supporting documentation.

1.7 PLANNING PROCESS

The planning process was led by the MOA's Project Management and Engineering (PM&E) department.

The planning process began with two lines of focus; public feedback and an multi-department input. Notice was sent to the community about the MOA Hazard Mitigation Plan update. Invitations to MOA Departments to participate as part of the MOA Hazard Mitigation Planning Committee were also sent. As work on the plan developed, additional departments were added to the committee. The following departments were involved in the development of the updated all-hazards mitigation plan:

- PM&E
    - Watershed Manager, Kristi Bischofberger
    - Flood Hazard Administrator, Steven Ellis
- Anchorage Fire Department (AFD)
    - Deputy Chief, Jodie Hettrick
- Anchorage Police Department (APD)
    - Chief, Chris Tolley
- Office of Emergency Management (OEM)
    - Director, Kevin Spillers
- Planning & Development Services (P&DS)
    - Director, Hal Hart
    - Geotechnical Advisory Committee Liaison, Jon Cecil
- Anchorage School District (ASD)
    - Superintendent, Ed Graff
- Building Safety
    - Plan Review Engineer, Ron Wilde
- Department of Health and Human Services (DHHS)
    - Director, Melinda Freeman
    - PHIP Manager, Steven Ashman
- Port of Anchorage
    - Director, Steve Ribuffo
    - Deputy Director, Sharen Walsh

The all-hazards mitigation plan update process began with a MOA planning committee meeting to introduce the process, to inform representatives about the process, and to identify what would be expected from them. This meeting was held on November 16, 2015.

The next step was to review the asset inventory to determine if there were any changes to be made to the list of critical facilities. Each department was responsible for reviewing the list of facilities and identifying the hazards to which the facility was exposed.

Simultaneously, the hazard section was updated. The natural hazard section was updated and the technological hazard section was drafted based on a review of existing literature, consultation with state and federal agencies and MOA departments, and interviews with MOA staff.

The next step was to review the existing goals, objectives, and action items to identify any changes that might be necessary. First, the existing goals and objectives were reviewed by the planning committee and changes were identified. Each department was also asked to review the list of action items to identify the current status of each action item and to identify new action items for their department. Based on input from the planning committee, additional goals and objectives were then added and a list of action items was developed.

The next task was to develop a draft of the updated all-hazards mitigation plan, authorized by the Municipal Manager, Mike Abbott. The draft was circulated internally within the MOA for review. The plan was made available for review by the public and other interested parties. Based on the comments provided on the public review draft, the plan was revised and submitted to DHS&EM and FEMA for approval. After FEMA approves the plan, it will go to the MOA Assembly for adoption. This process is summarized in Figure 1.1.

A. Figure 1.1 The Planning Process

1.8 PUBLIC INVOLVEMENT

The plan update announcement was placed on the home page of MOA's website (www.muni.org). The Municipality of Anchorage held two public meeting to advise and inform the public of updates to the AHMP. The meetings were announced two to three weeks prior to the meeting date. The meeting dates were January 14th and August 2nd 2016. No one from the community attended the meetings. The first meeting was to notify the community of the AHMP update and request input. The second meeting was to go over the Draft AHMP and again allow for public input. A notice that the AHMP was being updated was posted on the Municipal webpage from July 5th to August 10th 2016. This notice provided links to the 2011 and the 2016 Draft AHMP, points of contact with phone numbers and an e-mail address to provide written comments or ask questions. The 2011 version and the most recent 2016 version of the AHMP are still posted on the Project Management and Engineering webpage. You can go to the municipal home page (www.muni.org), search for "all hazard mitigation plan" and it will direct you to the Project Management and Engineering webpage for the AHMP updates. The notices and webpages are provided in Appendix B, Public Involvement. The AHMP will still have one more public involvement phase. This will happen during the two week notice for adoption of the AHMP by the Municipal Assembly. The MOA will continue to monitor its e-mail for public comments.

CHAPTER 2 COMMUNITY PROFILE

This chapter is a brief community profile for Anchorage. It contains information about Anchorage's location, history, demographics, economy, and natural setting. This information provides an overview of the MOA's physical and socioeconomic characteristics. A community profile is important because it provides an overview of the community and can be used in conjunction with the asset inventory as a reference when identifying the potential impacts of a hazard event.

2.1 LOCATION

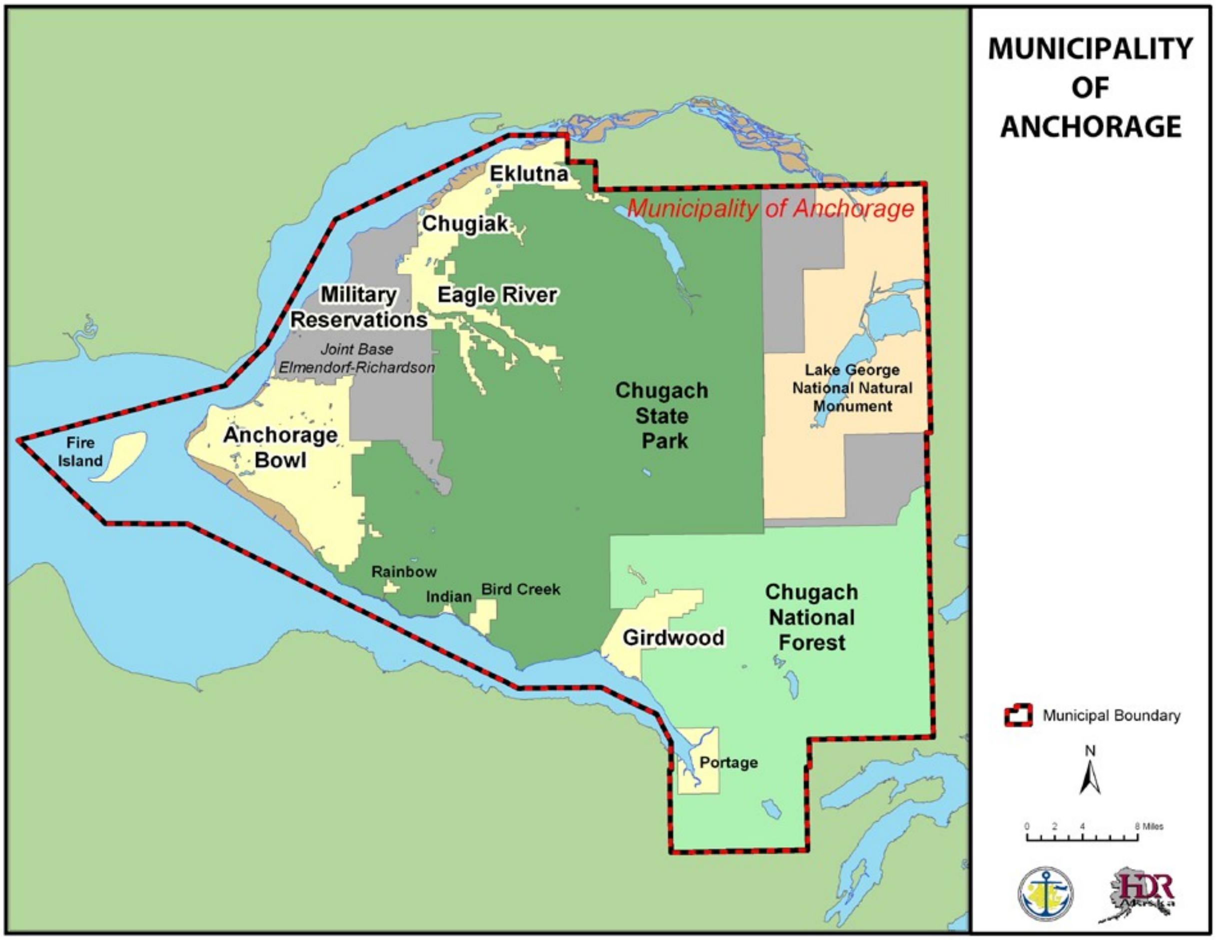
The MOA is located in Southcentral Alaska at the head of Cook Inlet. It is a 1,955-square-mile area between northern Prince William Sound and upper Cook Inlet. The area consists of mostly rugged mountainous terrain, 84 percent of which is taken up by national forest or state parklands and tidelands. Six percent is occupied by military reservations. Only the remaining 10 percent of the entire MOA is inhabited.

The Anchorage Bowl is the most urbanized area of the MOA. It occupies approximately 100 square miles, bounded by Chugach State Park, Turnagain and Knik Arms, and Joint Base Elmendorf - Richardson (JBER) (see Figure 2.1). Settlements north of the Fort Richardson Military Reservation include Eagle River, Chugiak, Birchwood, Peters Creek, and Eklutna. Most of this lowland area is between the Chugach Mountains and Knik Arm. South of the Anchorage Bowl are the Turnagain Arm communities of Girdwood, Indian, Rainbow, Bird, and Portage.

2.2 NATURAL SETTING

Anchorage has a unique natural setting, as it is an urban area surrounded by wilderness and water. Several thousand acres of municipal greenbelts and parklands link developed areas with surrounding natural open space and wildlife habitat in Chugach State Park (the second largest state park in the country), the Chugach National Forest, and the 50-square-mile Anchorage Coastal Wildlife Refuge. Anchorage has five salmon species and 52 mammal species, including wolf, bear, lynx, and moose.

B. Figure 2.1 Municipality of Anchorage



2.3 HISTORY [2]

The Anchorage area was originally inhabited by the Dena'ina Athabascan Indians. The Native Village of Eklutna was one of eight winter settlements and is the last occupied Dena'ina village in the MOA.

2.3.1 ANCHORAGE BOWL

Anchorage was founded in 1914 when the government established the field headquarters for the construction of the Alaska Railroad at Ship Creek. Soon after, in 1920, Anchorage was incorporated as a city.

Between 1940 and 1990, Anchorage grew in spurts. Military build-ups, post-1964 earthquake reconstruction, the Trans Alaska Pipeline construction in the mid-1970s, and the early 1980s petroleum boom each pumped up the economy and spurred rapid community growth. Often, the aftermath was recession. By the 1990s, Anchorage had a much more diverse and stable economy, resulting in modest and steady community growth.

[2] Information was taken with permission from *Anchorage 2020: Anchorage Bowl Comprehensive Plan*, the *Girdwood Area Plan*, and the *Chugiak-Eagle River Comprehensive Plan Update*.

2.3.2 CHUGIAK/EAGLE RIVER

The area north of the Anchorage Bowl saw additional development after 1900 when traders and prospectors began to arrive in the area looking for minerals and routes to the gold fields. As a result of federal involvement (home for Native Children and the Eklutna hydroelectric project), Eklutna was the dominant settlement in the area in the 1920s. However, growth occurred closer to Anchorage, with the creation of Fort Richardson Army Reservation and Elmendorf Air Force Base. Many military personnel and civilians associated with military construction jobs moved into the area. The Chugiak/Eagle River area continued to grow as people looked for a more rural lifestyle than that offered in the Anchorage Bowl. Commercial enterprises subsequently followed the population to the area.

2.3.3 GIRDWOOD

Girdwood was founded just before the turn of the century as a supply and transport center for the area's placer and lode gold mines. The mining claims operated through the 1930s, when they stopped due either to the exhaustion of lode deposits or to lawsuits and presidential orders to stop environmentally destructive hydro-mining. In the 1920s, the construction of the Alaska Railroad benefited Girdwood, because the town was a source of timber for rail ties.

Development in the Girdwood area was revived in 1949 because of the construction of the Seward Highway. Much of the growth and development in Girdwood since the 1950s has been associated with skiing and other recreational opportunities.

2.4 DEMOGRAPHICS

For most of its history, Anchorage grew as a community of immigrants and newcomers from outside the state, and Alaska Natives from rural areas within the state. For decades, a seasonal boom-bust economy and military personnel rotations made Anchorage a fast-growing town of transient residents without a strong stake in the community. Those who stayed as permanent residents lived in Anchorage by personal choice, not by chance of birth. They were rooted by their liking for the place and for the distinctive lifestyle it offered. At the time of the 1990 census, barely a quarter of Anchorage residents were born in Alaska.

In the 1990s, economic stability and military cutbacks dramatically slowed immigration and reduced annual population turnover by half. As a result, Anchorage's population has become much less transient and more committed to long-term community betterment.

The majority of the MOA's population lives in the Anchorage Bowl (see Table 2.1), although the number preferring the lifestyle offered by the smaller outlying communities is increasing. The population residing on the military bases is declining.

D. Table 2.1 Historic Population of the Municipality of Anchorage

Year	Anchorage Bowl	Chugiak/Eagle River	Turnagain Arm	Military Bases	Total
1980	143,351	12,858	876	17,346	174,431
1990	184,557	25,324	1,360	15,097	226,338
1998	213,919	31,654	2,108	11,117	258,798
*2006	233,844	34,139	2,243	12,587	282,813
**2015	268,915	38,066	2,760	10,226	319,967

*Source: Anchorage 2020. *Source: MOA, 2007. **Source: 2015 LUPM Technical Forecast Report*

Today, Anchorage's population is diverse. Racial and ethnic minorities are the fastest-growing segment of the population and account for about 28 percent of the total population. Alaska Natives make up about seven percent of the total population and are the largest minority group. There are also substantial African American, Asian/Pacific Islander, and Hispanic communities, each making up about six percent of the total population. Table 2.2 is a profile of the general demographic characteristics for the MOA.

E. Table 2.2 Profile of General Demographic Characteristics for the Municipality of Anchorage (July 2014 Estimate)

	Number	Male	Female
Total population	300,549	152,124	148,425
AGE			
0 to 4 years	21,629	11,161	10,468
5 to 9 years	21,321	11,020	10,301
10 to 14 years	20,331	10,482	9,849
15 to 19 years	19,461	9,913	9,548
20 to 24 years	24,708	13,324	11,474
25 to 29 years	25,735	13,310	14,425
30 to 34 years	24,249	12,194	12,055
35 to 39 years	19,445	9,734	9,711
40 to 44 years	18,879	9,517	9,362
45 to 49 years	18,770	9,282	9,488
50 to 54 years	21,746	10,932	10,814
55 to 59 years	20,548	10,175	10,373
60 to 64 years	16,462	8,330	8,132
65 to 69 years	11,277	5,702	5,575
70 to 74 years	6,566	3,213	3,353
75 to 79 years	4,196	1,885	2,311
80 to 84 years	2,763	1,180	1,583
85 to 89 years	1,519	561	958
90+	944	299	645
Median age (years)	33.5	32.8	34.2

Source: 2014 American Community Survey/Alaska Dept. of Labor

2.4.1 FUTURE POPULATION

Population increases are expected throughout the MOA. A June 2014 report on the Alaska Department of Labor web site projects, in 2017 the MOA will have a population of 313,348. By 2037 this number is expected to increase to 356,584. Much of the population growth is expected to occur in the Anchorage Bowl.

Table 2.3 shows employment, population, and housing demand in Chugiak/Eagle River. Table 2.4 shows employment, population, and housing demand in Girdwood.

F. Table 2.3 Employment, Population, and Housing Demand in Chugiak/Eagle River

	2015	2025	2035
Total Employment	5,082	5,974	6,227
Total Population	38,066	44,748	51,042
Total New Housing Demand	13,178	15,698	18,130

Source: 2015 LUPM Technical Forecast Report

G. Table 2.4 Employment, Population, and Housing Demand in Girdwood

	2015	2025	2035
Total Employment	1,220	1,323	1,400
Total Population	2,760	2,965	3,107
Total New Housing Demand	1,289	1,384	1,451

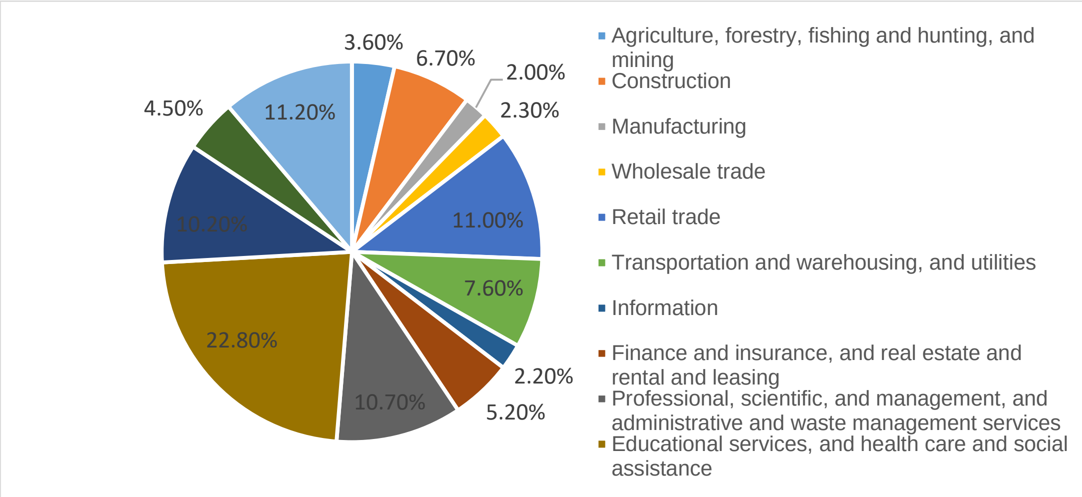
Source: 2015 LUMP Technical Forecast Report

The Planning Department, in a 2006 growth forecasting analysis, updated the Girdwood population estimate, forecasting approximately 5,900 residents in the year 2030. This number represents a slower growth rate for Girdwood than was predicted in 1995. The population of Girdwood is expected to remain at less than 1 percent of the total Municipality population.

2.5 ECONOMY

At first glance, Anchorage appears off the beaten path, lying as far north as Helsinki, Finland, and almost as far west as Honolulu, Hawaii. However, its location, together with air, road, port, and rail transportation facilities, is the city’s prime economic asset. Anchorage has capitalized on its location and versatile transportation assets to build a solid economic base. The community is firmly established as the statewide trade, finance, service, transportation, and administrative center and is the distribution gateway for central, western, and northern Alaska. Federal Express and the United Postal Service have made Anchorage a major hub and other firms have expanded their air cargo operations. With over 17 billion pounds of landed cargo, Ted Stevens Anchorage International Airport (TSAIA) is the nation’s second busiest air cargo airport in the U.S. and forth busiest in the world (Wikipedia 2015). Figure 2.2 shows employment by industry in the MOA.

C. **Figure 2.2 Employment by Industry: Municipality of Anchorage**



Source: 2014 American Community Survey

The educational services, and health care services, and social assistance industry are the largest in the MOA. The growth in the health care sector is due largely to the expansion of hospitals and more local provision of services. Residents from outside Anchorage often receive treatment in Anchorage, and Anchorage residents can stay in Anchorage for more of their medical care instead of having to go to the "Lower 48."

Tourism is a growing part of the economy (Anchorage Visitor and Convention Bureau, undated). Anchorage has received an increasing number of visitors due to the increase in conventions being held in Anchorage and visits associated with the cruise ship facilities in Seward.

In the Chugiak/Eagle River area, local retail growth in response to the increasing population has made retail trade the area's largest employment sector. Services are second, and the third-largest employment sector is government. Many government jobs are associated with education, although some are with the U.S. Postal Service and the Alaska Department of Corrections. Many residents commute to the Anchorage Bowl for employment (MOA, 2006). Approximately 85% of all workers in the Chugiak/Eagle River area work in the Anchorage Bowl (Department of Transportation and Public Facilities, 2009).

Girdwood's biggest economic sector is services, and the largest employer is the Alyeska Resort. The service industry has more than triple the amount of employment than the next closest category—construction. The third-largest employment sector is trade, mostly associated with tourism. There is seasonality to employment in Girdwood, as many of the jobs are associated with skiing in the winter or with the summer tourists. Many Girdwood residents who are not employed in the tourism sector commute into the Anchorage Bowl.

Approximately 12,000 people commute daily from the Eagle River to Eklutna area of the MOA. Another 16,000 commute from the Matsu Borough (ADOT Annual Average Daily Trips 2014).

CHAPTER 3 ASSET INVENTORY

Before a community can develop its mitigation strategy, it needs to know what should be protected. The purpose of this chapter is to identify what needs to be protected, including Anchorage's critical facilities. Anchorage has many other assets that should be protected, including its infrastructure and existing development. This information will be used in Chapter 4 to describe Anchorage's vulnerability to each hazard.

3.1 INFRASTRUCTURE

Infrastructure is the basic facilities and services needed for a community. Anchorage's infrastructure includes roads, water supplies, wastewater treatment plants, water and wastewater pipes, power plants, electrical lines, bridges, ports, airports, railroads, telecommunications equipment, schools, etc. The critical facilities matrix in Appendix D lists the hazards to which each facility is exposed.

3.1.1 SCHOOLS

The following is a list of public schools in Anchorage. In addition to those listed below, there are several private schools. Schools identified with an asterisk (*) after their name may be used as a shelter. School locations are shown in Figure 3.1.

Charter

- Alaska Native Cultural
- Aquarian
- Eagle Academy
- Family Partnership
- Frontier Charter School
- Highland Tech High School
- Rilke Schule
- Winterberry

Elementary

- Abbott Loop Elementary
- Airport Heights Elementary
- Alpenglow Elementary*
- Aurora Elementary
- Baxter Elementary
- Bayshore Elementary
- Bear Valley Elementary*
- Birchwood ABC
- Bowman Willard Elementary*
- Campbell Elementary*
- Chester Valley Elementary
- Chinook Elementary
- Chugach Optional Elementary
- Chugiak Elementary
- Lake Otis Elementary
- Mountain View Elementary*
- Mt. Iliamna Elementary
- Mt. Spurr Elementary
- Muldoon Elementary
- North Star Elementary
- Northern Lights ABC
- Northwood Elementary
- Nunaka Valley Elementary
- O'Malley Elementary
- Ocean View Elementary*
- Orion Elementary
- Ptarmigan Elementary
- Rabbit Creek Elementary

- College Gate Elementary
- Creekside Park Elementary
- Denali Montessori Elementary
- Eagle River Elementary
- Fairview Elementary
- Fire Lake Elementary*
- Girdwood Elementary*
- Gladys Wood Elementary
- Government Hill Elementary
- Homestead Elementary
- Huffman Elementary
- Inlet View Elementary
- Kasuun Elementary*
- Kincaid Elementary*
- Klatt Elementary*
- Lake Hood Elementary*
- Ravenwood Elementary*
- Rogers Park Elementary
- Russian Jack Elementary*
- Sand Lake Elementary
- Scenic Park Elementary*
- Spring Hill Elementary*
- Susitna Elementary
- Taku Elementary*
- Trailside Elementary*
- Tudor Elementary
- Turnagain Elementary
- Tyson Elementary*
- Ursa Major Elementary
- Ursa Minor Elementary
- Williwaw Elementary*
- Willow Crest Elementary*
- Wonder Park Elementary

Middle

- Begich Middle School*
- Central Middle School of Science
- Clark Middle School*
- Goldenview Middle School*
- Gruening Middle School*
- Hanshew Middle School*
- Mears Middle School*
- Mirror Lake Middle School*
- Romig Middle School*
- Wendler Middle School*

High

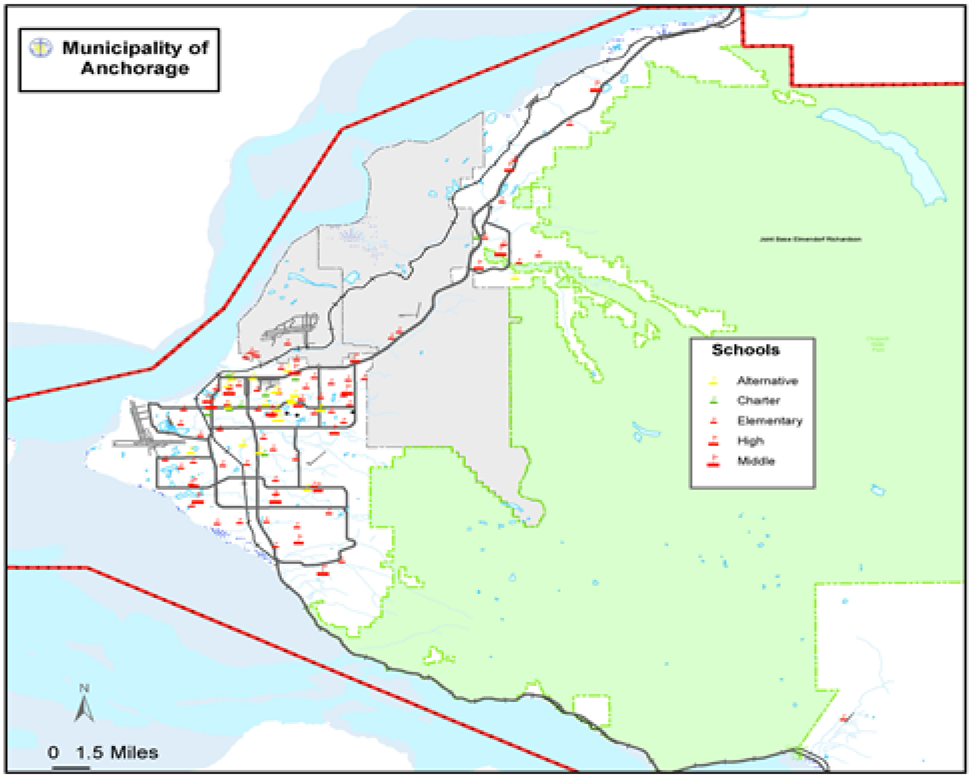
- Bartlett High School*
- Chugiak High School*
- Dimond High School*
- Eagle River High School*
- East High School
- Service High School
- South Anchorage High School
- West High School

Other

- ACE/ACT Program
- Alaska State School for the Deaf and Hard of Hearing
- AVAIL Program
- Benson Secondary/SEARCH
- Bragaw Heights
- Crossroads
- Debarr Residential
- Humphrey Heights
- McKinley Heights
- McLaughlin
- New Path
- PAIDEIA Cooperative
- Polaris K-12
- Providence Heights
- SAVE High
- Steller Secondary
- STrEam Academy

- Jesse Lee
- King Career Center
- Maplewood
- Turning Point Heights
- Whaley School

D. Figure 3.1 Schools



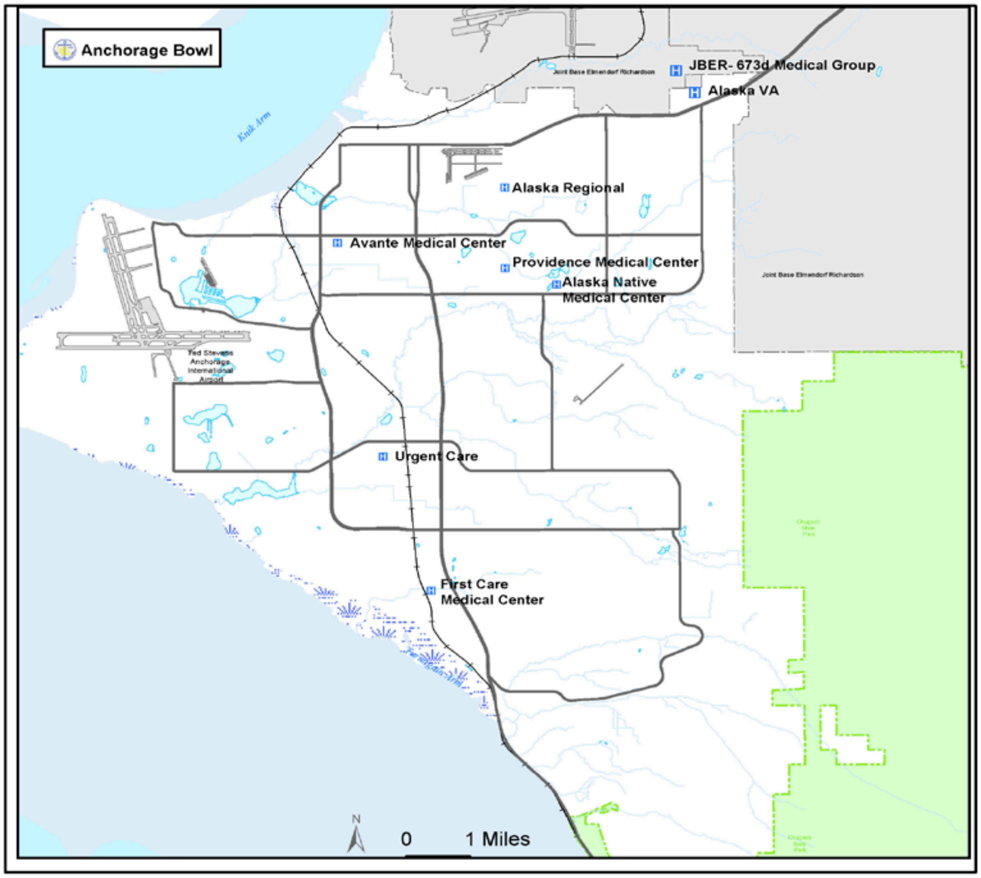
3.1.2 HOSPITALS AND MEDICAL FACILITIES

The main hospitals in Anchorage are:

- Joint Base Elmendorf/Richardson Hospital
- Alaska VA Health Care System
- Alaska Regional Hospital
- North Star Behavioral Health System
- First Care Medical Center
- Providence Alaska Medical Center
- Alaska Psychiatric Institute
- Alaska Native Medical Center
- Providence Extended Care Facility
- Medical Park Family Care
- St. Elias Specialty Hospital
- Anchorage Neighborhood Health Center

The locations of these facilities are shown in Figure 3.2.

E. Figure 3.2 Hospitals and Major Medical Facilities



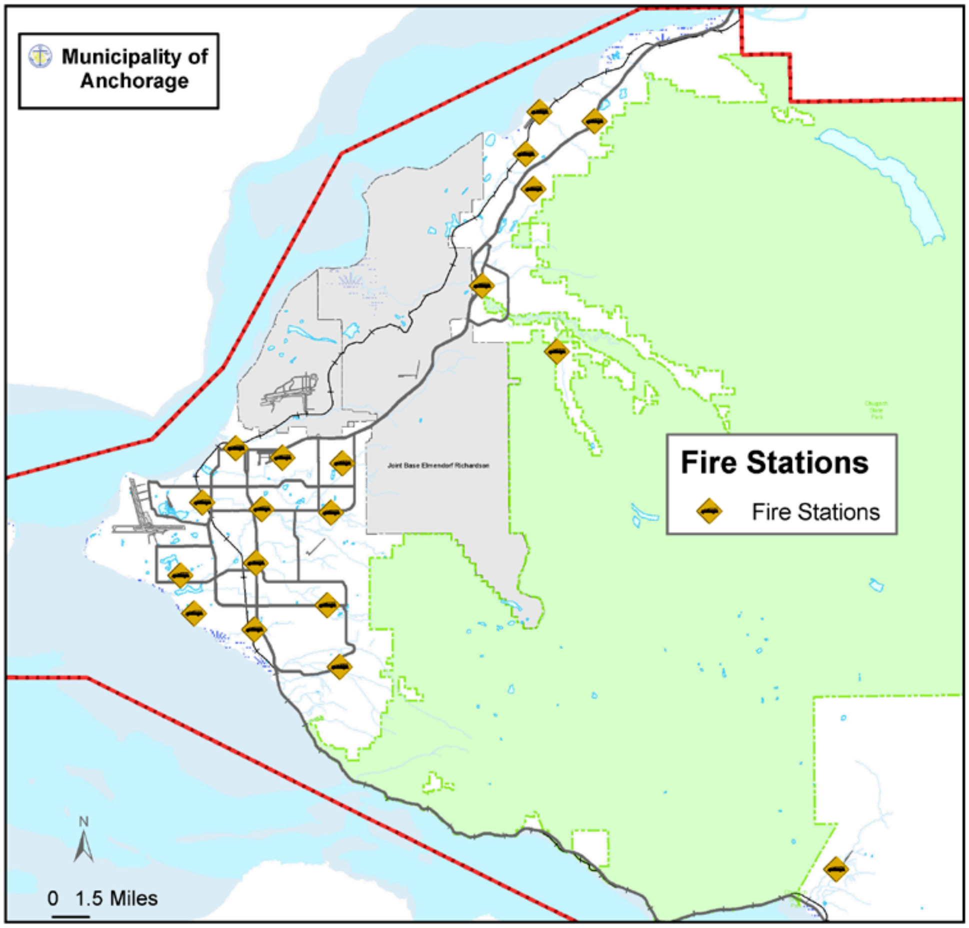
3.1.3 FIRE DEPARTMENTS

Fire protection in MOA is provided by several sources. The AFD covers most of the Anchorage Bowl. Outside the Bowl, communities rely on volunteer fire departments. The fire stations in MOA are:

- AFD Communications Center
- AFD Fire Station #1
- AFD Fire Station #3
- AFD Fire Station #4
- AFD Fire Station #5
- AFD Fire Station #6
- AFD Fire Station #7
- AFD Fire Station #8
- AFD Fire Station #9
- AFD Fire Station #10
- AFD Fire Station #11
- AFD Fire Station #12
- AFD Fire Station #14
- AFD Fire Station #15
- Ted Stevens Int'l Airport Aircraft/Rescue/Fire
- Joint Base Elmendorf/Richardson
- State of Alaska, Division of Forestry
- Bureau of Land Management
- Chugiak VFD Station #31
- Chugiak VFD Station #32
- Chugiak VFD Station #33
- Chugiak VFD Station #34
- Chugiak VFD Station #35
- Station 41 Girdwood VFD
- Municipal Emergency Preparedness Office

The locations of these stations are shown in Figure 3.3.

F. Figure 3.3 Fire Stations



3.1.4 LAW ENFORCEMENT

Police protection is provided by the APD and the Alaska State Troopers (AST). The Federal Bureau of Investigation (FBI) has an office in Anchorage. The law enforcement facilities in Anchorage include:

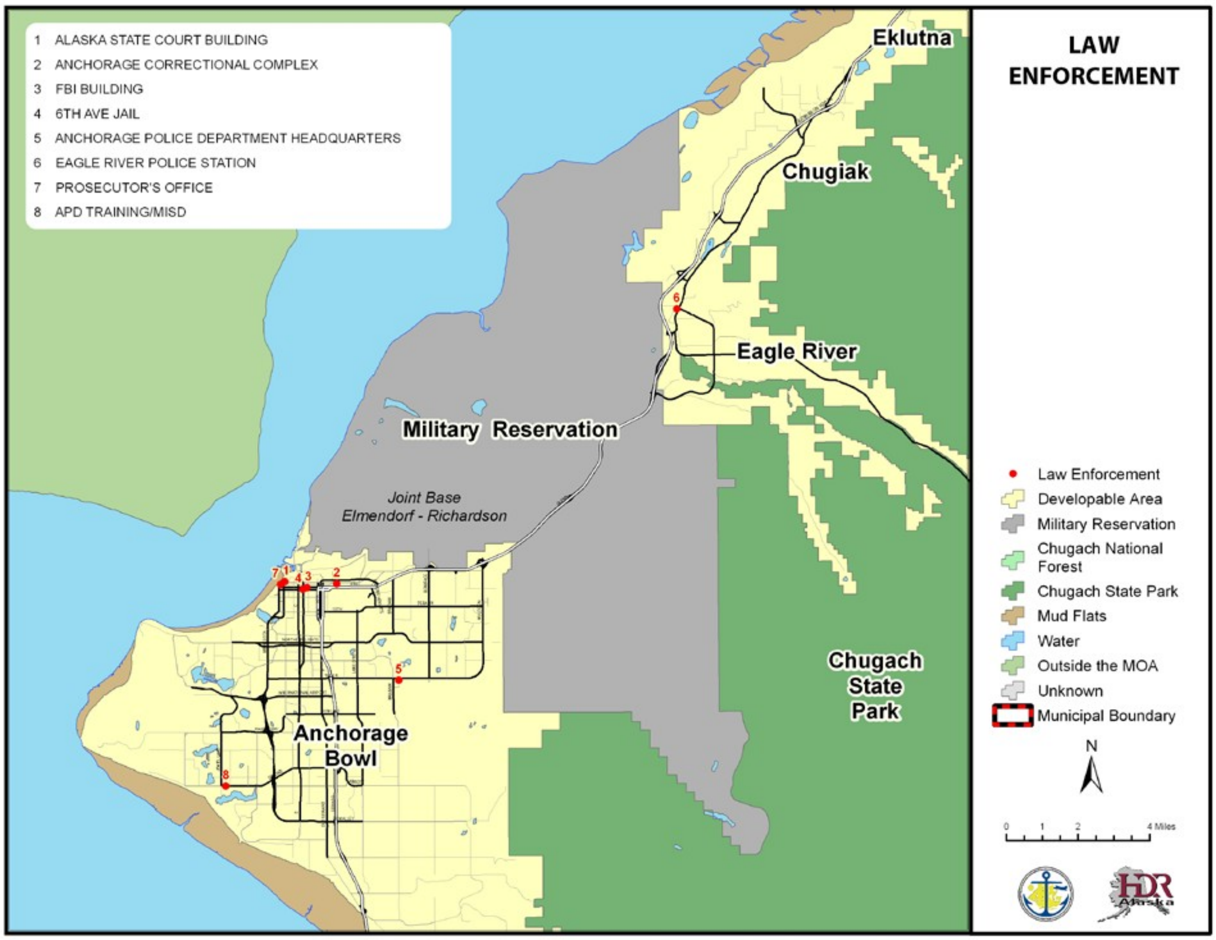
- Airport Police and Fire
- Alaska State Troopers Headquarters
- Anchorage Police Department Headquarters
- Anchorage Safety Center (Public Inebriate Title 47 Protective Custody Facility
- Eagle River Police Substation[3]
- APD Training/Miscellaneous
- Alaska State Court Building
- Anchorage Correctional Complex
- Department of Homeland Security Immigration & Customs Enforcement
- Department of Justice

[3] There are other APD substations in the MOA. They are not listed here because they are not staffed facilities.

- Federal Emergency Management Agency
- FBI Building
- Prosecutor's Office
- U.S. Coast Guard Marine Safety
- U.S. Department of Homeland Security, U.S. Customs and Border Protection
- U.S. Drug Enforcement Administration

The locations of these facilities are shown in Figure 3.4.

G. Figure 3.4 Law Enforcement Facilities

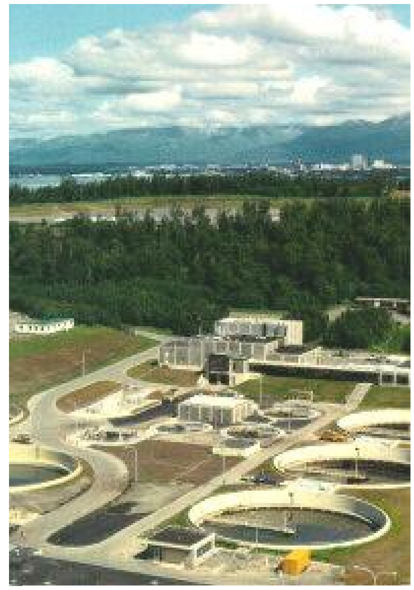


3.1.5 WATER SOURCES

The MOA gets its potable water from three sources:

- Eklutna Water Treatment Plant (Eklutna Lake)
- Ship Creek Water Treatment Plant
- Wells

The Eagle River/Chugiak area relies on the Eklutna Water Treatment Plant; the Anchorage Bowl is supplied by the Eklutna Water Treatment Plant and the Ship Creek Water Treatment Plant, while Girdwood relies on wells.



John M. Asplund Wastewater Treatment

3.1.6 WASTE WATER TREATMENT FACILITIES

The MOA has three wastewater treatment facilities:

- John M. Asplund Wastewater Treatment Facility
- Eagle River Wastewater Treatment Facility
- Girdwood Wastewater Treatment Facility

3.1.7 ELECTRICITY

Within MOA, electricity is provided by three utilities:

- Municipal Light & Power (MOA-owned)
- Chugach Electric Association
- Matanuska Electric Association

These utilities operate several power plants within MOA, including:

- George M. Sullivan Plant 2
- Generation Plant One (also known as Hank Nikkels Plant 1)
- Eklutna Hydroelectric Power Plant

In addition to the power plants, each utility operates substations and electrical (transmission and distribution) lines.

3.1.8 AIRPORTS

The largest airport in MOA is TSAIA. It serves passenger and cargo travel. Merrill Field is one of the largest general aviation (limited to aircraft that weigh 12,500 pounds or less) airports in the United States. Lake Hood, Anchorage's only seaplane base, is considered to be the largest and most active seaplane base in the world (Alaska Department of Transportation & Public Facilities, 2016). However, many local lakes are used for floatplanes in the summer months. Other airports in the MOA are located in Birchwood and Girdwood.

3.1.9 RAIL

The Alaska Railroad (ARRC) is headquartered in Anchorage, near Ship Creek. The main ARRC depot is near the headquarters, and the Bill Sheffield Depot is located at the Ted Stevens

Anchorage International Airport. Within MOA, the ARRC has more than 100 miles of track.

3.1.10 ROAD

Within the MOA, there are more than 1,000 lane miles[4] of road, with numerous bridges, overpasses, etc. Most of the roads in the Anchorage Bowl are in the Anchorage Roads and Drainage Service Area (ARDSA). Other parts of Anchorage are in Limited Road Service Areas. One of the largest is the Chugiak, Birchwood, Eagle River Rural Road Service Area (CBERRRSA), which has more than 350 lane miles of roadway. Some roadways, including the Seward and Glenn Highways, are owned and maintained by the State.

3.1.1 PORT OF ANCHORAGE

The Port of Anchorage is located at the mouth of Ship Creek. Port facilities include three general cargo terminals, two petroleum terminals, a dry barge landing, bulk cement-handling, gantry cranes and roll-on/roll-off capability. Docks are maintained at a full seaway depth of 35 ft. Most products used in Alaska are transported into our state on container ships and barges. The Port of Anchorage handles three-quarters of all Southcentral Alaska/Railbelt-bound, waterborne, non-fuel freight.

3.1.12 OTHER UTILITIES

Natural Gas Utilities

- ENSTAR

Telephone/Communication Utilities

- GCI
- Alaska Communications Systems (ACS)
- Spark Wireless
- AT&T
- Alaska Telecom
- Matanuska Telephone Association (MTA) Wireless
- TelAlaska
- ASTAC
- Hughesnet
- Verizon
- Borealis Broadband
- ASTAC
- Alaska Fiber Star
- TelAlaska Long Distance, Inc.
- Level 3 Communications, LLC
- EarthLink Business, LLC
- France Telecom Corporate Solutions, LLC
- Comtec Business Systems, Inc.

[4] Lane miles refer to a way of measuring a roadway based on its length and the number of lanes it has. A two lane street that is one mile long has two lane miles

- Mobilitie, LLC
- Mitel NetSolutions, Inc.
- Metropolitan Telecommunications of Alaska, Inc.
- QuantumShift Communications, Inc.
- Bowhead Communication Services, LLC
- Wide Voice, LLC

3.1.2 HISTORICAL SITES

According to the National Register Information System, the MOA has the following sites listed on the National Register of Historic Places. The State Historic Preservation Office's (SHPO) Alaska Heritage Resources Survey (AHRS) has many more sites considered historically significant within MOA. Because the AHRS has numerous entries and is not available to the general public, information about these sites is not listed here. For more information about these resources, please contact the SHPO. Several historic properties listed on the National Register of Historic Places were also adopted into the Four Original Neighborhoods Historic Preservation Plan as "Landmarks to Save". This includes the Government Hill Wireless Station, Block 13-Army Housing Association Historic District, and the Government Hill Water Tower. Contact the Anchorage Historic Preservation Program Officer for additional information.

H**. Table 3.1 National Register of Historic Places**

Resource Name	**Address**	**City**	**Listed**
A. E. C. Cottage No. 23	618 Christensen Dr.	Anchorage	1990-06-11
Alaska Engineering Commission Cottage No. 25	645 W. 3rd Ave.	Anchorage	1996-02-16
Alex, Mike, Cabin	Off AK 1	Eklutna	1982-09-08
Anchorage Cemetery	535 E. 9th Ave.	Anchorage	1993-04-26
Anchorage City Hall	524 W. 4th Ave.	Anchorage	1980-12-02
Anchorage Depot	411 W. 1st Ave.	Anchorage	1999-08-27
Anchorage Hotel Annex	330 E St.	Anchorage	1999-04-15
Anderson, Oscar, House	4th Ave. extended	Anchorage	1978-06-13
Atwood Campus Center	University Drive	Anchorage	1979-06-22
Beluga Point Site	Address Restricted	Anchorage	1978-03-30
Block 13-Army Housing Association Historic District	Between A and Cordova Streets and 10th and 11th Avenues	Anchorage	Pending, locally eligible
Civil Works Residential Dwellings	786 and 800 Delaney St.	Anchorage	2004-07-21
Crow Creek Consolidated Gold Mining Company	NE of Girdwood	Girdwood	1978-09-13
David, Leopold, House	605 W. 2nd Ave.	Anchorage	1986-07-24
Eklutna Power Plant	NE of Anchorage	Anchorage	1980-06-20
Federal Building-U.S. Courthouse	601 W. 4th Ave.	Anchorage	1978-06-23

Fourth Avenue Theatre (AHRS Site No. ANC-284)	630 W. 4th Ave.	Anchorage	1982-10-05
Gill, Oscar, House	1344 W. 10th Ave.	Anchorage	2001-02-02
Government Hill Federal Housing Historic District		Anchorage	2015-14-01
Government Hill Water Tower	West Harvard Avenue	Anchorage	Pending, locally eligible
Government Hill Wireless Station	123 West Manor	Anchorage	Pending, locally eligible
Historic Pioneer School House	3rd Ave. and Eagle St.	Anchorage	1980-12-03
Indian Valley Mine	Address Restricted	Indian	1989-10-25
KENI Radio Building	1777 Forest Park Dr.	Anchorage	1988-04-18
Kimball's Store	500 and 504 W. 5th Ave.	Anchorage	1986-07-24
Loussac-Sogn Building	425 D St.	Anchorage	1998-05-20
McKinley Tower Apartments	337 E. 4th Ave.	Anchorage	2008-09-12
Mt. Alyeska Roundhouse	Approx. 2 mi. W of Alyeska	Girdwood	2003-11-05
Nike Site Summit	Off Arctic Valley Rd., 12.5 mi. E of Anchorage	Anchorage	1996-07-11
Old St. Nicholas Russian Orthodox Church	Eklutna Village Rd.	Eklutna	1972-03-24
Pilgram 100B Aircraft	Anchorage Aviation Heritage Museum	Anchorage	1986-07-08
Potter Section House	Off AK 1	Anchorage	1985-12-06
Spring Creek Lodge	18939 Old Glenn Hwy.	Chugiak	2001-09-09
Wendler Building[5]	400 D St.	Anchorage	1988-06-24

Source: National Register of Historic Places

3.2 EXISTING DEVELOPMENT IN MOA

Anchorage's history has shaped its development patterns, making the Anchorage Bowl the dominant area locale in terms of developed areas in the region. Table 3.2 shows the number of parcels (by land use) in the Anchorage Bowl, the Turnagain Arm area (including Girdwood), and the Chugiak/Eagle River area. Table 3.3 shows the taxable value of the land and buildings in the MOA by land use. The number of parcels was used as a substitute for the number of structures, as it is assumed that the non-vacant parcels include existing structures (which determine the land use). Development data from 2009 and 2016 has been provided to show potential growth trends. Some of the changes are due to better available data or changes in data collection. Overall, the biggest increase is in residential development.

[5] The Wendler Building does not appear on the National Park Service's National Register of Historic Places Database. However, the weekly register listing for 1988 states this property was entered in the National Register (National Park Service, 1998).

I. Table 3.2 Number of Parcels by Land Use

Type of Parcels	In Turnagain Communities	In Chugiak/Eagle River	In Anchorage Bowl
Residential	1,485	12,935	60,603
Commercial	225	465	3,375
Industrial	20	86	2,491
Institutional	25	205	805
Parks, Open Space, and	2	194	40
Recreation			
Transportation-Related	91	110	493
Other Land Uses	0	145	213
Vacant Land	621	2,608	7,891
Unidentified	7	80	141
Total	**1,855**	**14,220**	**68,131**

Source: MOA GIS, 2016

2011 Table 3.2 Number of Parcels by Land Use

Type of Parcels	In Turnagain Communities	In Chugiak/Eagle River	In Anchorage Bowl
Residential		10,137	53,600
Commercial		195	3,370
Industrial		109	1,642
Institutional		129	594
Parks, Open Space, and		354	1,204
Recreation			
Transportation-Related		137	584
Other Land Uses		97	95
Vacant Land		2,093	4,750
Unidentified	1,965	695	1,825
Total	**1,965**	**13,946**	**67,664**

Source: MOA GIS, 2009

J. Table 3.3 Total Parcels and Taxable Value for MOA

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA-GIS 2016

2011 Table 3.3 Total Parcels and Taxable Value for MOA

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	63,711	$5,766,405,700	$13,213,579,200	$18,979,984,900
Commercial	3,546	$1,690,127,200	$2,862,701,850	$4,552,829,050
Industrial	1,674	$502,003,600	$573,493,400	$1,075,497,000
Institutional	717	$175,304,800	$433,943,800	$609,248,600
Parks	1,174	$17,570,700	$11,216,800	$28,787,500
Transportation	430	$21,429,600	$229,500	$21,659,100
Other	869	$13,316,500	$300,200	$13,616,700
Vacant	6,843	$818,046,700	$434,800,700	$1,252,847,400
Unidentified	4,493	$721,943,328	$1,116,386,372	$1,838,329,700
Total	83,457	$9,726,148,128	$18,646,651,822	$28,372,799,950

Source: MOA GIS, 2009

3.3 FUTURE DEVELOPMENT

Since 2011, the development in Anchorage was slower than in preceding years but did not suffer the serious downturn as the rest of the United States. Recently oil prices have fallen significantly and this trend is having a downward impact on development. There are indications that the population of Alaska is no longer growing and may decline. This will likely slow the demand for new single family dwellings. New development should not increase the probability of a hazard event, but it does increase the amount of property and infrastructure at risk.

Anchorage 2020, the Chugiak Eagle River Comprehensive Plan Update, the Girdwood Area Plan, and numerous other plans all describe future development in the MOA. A few items are highlighted below because they could have a strong influence in the MOA's future vulnerability. It is important to know and track where and what will be developed in the future to plan for its protection and to mitigate hazards during development.

3.3.1 HOUSING

According to the March 2012 *Anchorage Housing Market Analysis*, by McDowell Group and ECO Northwest, there is not enough buildable land to accommodate future housing demand under historical development patterns, current land use policies, and development options. The study forecasts a demand for about 18,200 new dwellings in the Anchorage Bowl and 3,300 new dwellings in Chugiak-Eagle River over the next 20 years. However, the study predicts that without increasing the current level of housing density and increasing the rate of redevelopment, the Anchorage Bowl will lack land for about half of the expected demand. While Chugiak-Eagle River has enough land to meet its own projected demand for all housing types, the study finds it cannot accommodate all of the Bowl's projected demand as well.

3.3.2 INFRASTRUCTURE

It is expected that MOA will experience more utility development, including:

- Electrical infrastructure improvements and a new electrical substation to serve southeast Anchorage. The location for the substation has yet to be identified. For more information on potential improvements, please contact Chugach Electric or Municipal Light & Power.
- New water and sewer lines (locations to be determined during the Water Master Plan and the Wastewater Master Plan updates). For more details about this process, please visit http://www.awwu.biz

3.3.3 TRANSPORTATION

Population forecasts of more than 500,000 residents in the Mat-Su Borough and the Municipality of Anchorage by 2035 drive a multi-faceted approach toward meeting area transportation needs. The expectation is that there will be greater total vehicle miles traveled throughout the region as greater shares of the population move to more suburban locations, and employment grows predominantly in the Anchorage Bowl. Increased population densities in the Downtown, Midtown, and U-Med District will provide demand and opportunities for increased access by public transportation and non-motorized transportation. Specific recommendations are contained in the *2035 Metropolitan Transportation Plan* and the *Interim 2035 Metropolitan Transportation Plan* (June 26, 2015 public review draft).

3.3.4 OTHER PLANS

Table 3.4 lists several plans that help guide where future development in the MOA will occur.

Below are most of the comp plan elements in code. Only a few were listed in the *All Hazards Mitigation Plan*, but here are the ones not included on the list. Note that *Anchorage 2020* is not on the list but is mentioned throughout their plan. *Girdwood Area Plan* and *Chugiak-Eagle River Comp Plan* are noted elsewhere in plan also but not specifically listed either.

K. Table 3.4 MOA Publications, Studies, and Adopted Plans

Name of Plan	Year of Adoption or Publication
Anchorage 2020 – Anchorage Bowl Comprehensive Plan	2001
Anchorage Wetlands Management Plan	2014
Chugiak-Eagle River Comprehensive Plan	
Crow Creek Neighborhood Land Use Plan	2006
East Anchorage District Plan	2014
Eagle River Greenbelt Plan	1985
Fairview Neighborhood Plan	2014
Girdwood Commercial Area and Transportation Master Plan	2001
Girdwood Area Plan	1995
Girdwood-Iditarod Trail Route Study	1997
Glacier-Winner Creek Access Corridor Study	1997
Government Hill Neighborhood Plan	2013
Historic Preservation Plan for Anchorage's Four Original Neighborhoods	2013
Potter Valley Land Use Analysis	1999
Section 36 Land Use Study	1992
Ship Creek/Waterfront Land Use Plan	1991
Ship Creek Framework Plan	2014
Spenard Community District Development Plan	1986
3500 Tudor Road Master Plan	2007
Tudor Road Public Lands and Institutions Plan	1986
Utility Corridor Plan	1990
Downtown Anchorage Seismic Risk Assessment and Land Use Regulations to Mitigate Seismic Risk	2010
Geotechnical Hazards Assessment Study (Harding-Lawson Associates)	1979
Snow Avalanche and Mass-wasting Hazard Analysis – Glacier/Winner Creek Areas, Alaska	1993
Anchorage Commercial Land Assessment	2012
Anchorage Housing Market Study	2012
Anchorage Police Department Strategic Plan	2009 - 2013
Anchorage Wildfire strategic Plan	2003

CHAPTER 4 – HAZARDS IN THE MUNICIPALITY OF ANCHORAGE

One of the requirements of a hazard mitigation plan is that it describes the hazards that affect a jurisdiction. This chapter profiles the hazards that occur in the MOA by identifying each hazard's location, extent, previous occurrences, and the likelihood of future events.

Hazard mitigation plans are also required to summarize the vulnerability to the hazards. The vulnerability information was calculated by identifying the parcels that intersect each of the hazard zones. Some notes about this method are:

- Not all the hazard GIS layers used to perform this analysis cover the entire MOA. Most include only a portion of the Municipality. (Parcels could be at risk but the risk area has not been mapped and included in the GIS yet.)
- The taxable value is based on 2016 MOA tax assessor data.
- Using the taxable value underestimates the vulnerability because:
    - Some parcels, such as schools, religious facilities, and military land, are not taxed and therefore do not have a taxable value.
    - Some parcels are treated as economic units (separate parcels that are treated as one for tax purposes) and do not have taxable values listed.
    - Taxable value does not consider the value of the contents.
    - The taxable value is the sum of the land and building taxable values. This is different from the total taxable value listed in the tax assessor's file because tax exemptions have been applied to those totals.
    - If a parcel was in multiple risk areas, the entire parcel was considered to be in the highest risk area (i.e., no partial parcels). However, depending on how much of the parcel is in the hazard zone and site specific factors, existing or future structures may not be at risk.
    - The number of unidentified parcels could be wrong due to data issues (i.e., extra polygons in the GIS file, not all tax records associated with a parcel, etc.).

It is important to remember that the information listed in this chapter is meant to provide an overview of each hazard. While based on the best available information, the information is for planning purposes and should not be used for purposes which it was not intended such as securing permits, or for construction.

As part of this update, MOA departments, along with several state and federal agencies, were contacted to find out if new information was available. When available, the additional information was incorporated into the plan. The tables showing the number of parcels vulnerable to each hazard have been updated. The section on volcanoes was revised to focus more on volcanic ash as this is the biggest threat to the MOA compared to other aspects of a volcanic event. Tsunami section was removed. Throughout this chapter, text boxes highlighting completed or on-going mitigation success stories have also been included.

After consultation with the National Weather Service (NWS), winter storms were removed from the extreme weather section because it is too generic. The types of extreme weather events experienced in the MOA are better reflected by the other types of events in this section.

Future plan updates should continue to make the hazard descriptions and vulnerabilities more MOA-specific.

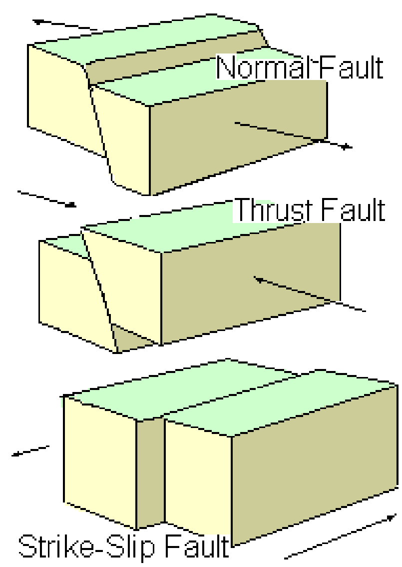
4.1 NATURAL HAZARDS

Natural hazards are unexpected or uncontrollable events caused by nature, such as earthquakes, floods, or volcanic eruptions. In some cases, although rare, they can be human-triggered, such as a human-triggered avalanche. The impacts of a natural hazard can also be worse based on human development and changes to the landscape.

The majority of the following information describing these hazards is from the October 2013 State Hazard Mitigation Plan and is used by permission from the DHS&EM.

4.1.1 EARTHQUAKES

An earthquake is the shaking of the earth's surface. Most large earthquakes are caused by the sudden release of accumulated stresses as the Earth's crustal plates move against each other. Other earthquakes occur along faults that lie within these plates. The dangers associated with earthquakes include ground shaking, ground failure, and surface faulting as well as secondary hazards, such as avalanches or landslides.



Three types of faults. Image courtesy of USGS

Ground shaking is responsible for most of the damage. Ground shaking is the result of the three classes of seismic waves generated by an earthquake. Primary waves (P waves) are the first waves, often felt as a sharp jolt. Secondary, or shear, waves (S waves) are slower and usually have a side-to-side movement. They can be very damaging because structures are more vulnerable to horizontal than vertical motion. Surface waves are the slowest waves, but they can carry the bulk of the energy in a large earthquake.

The intensity of the shaking is dependent on many factors, including the magnitude of the quake, the geology of the area, distance from the epicenter, building design, and local construction practices. The amount of damage to buildings depends on how the specific characteristics of each incoming wave interact with the buildings' height, shape, and construction materials.

Surface faulting is the differential movement of the two sides of a fault. There are three general types of faulting: strike-slip, normal, and thrust (reverse). Strike-slip faults are where each side of the fault moves horizontally. Normal faults have one side dropping down relative to the other side. Thrust (or reverse) faults have one side moving up and over the fault relative to the other side.

Secondary Hazards

Secondary effects from an earthquake include seismically induced ground failure, snow avalanches, tsunamis, landslides, and infrastructure failure. These will be discussed in greater detail in other sections of the plan.

> **Richter Scale**
> On the Richter scale, magnitude is expressed in whole numbers and decimals. A 5.0 earthquake is a moderate event; a 6.0 characterizes a strong event; a 7.0 is a major earthquake; and a great earthquake exceeds 8.0. The scale is logarithmic and open-ended.

Magnitude and Intensity

Earthquakes are usually measured in terms of their magnitude and intensity. Magnitude is related to the amount of energy released during an event, while intensity refers to the effects on people and structures at a particular place. Each earthquake will have only one magnitude but may have many intensities. Earthquake magnitude is usually reported according to the standard Richter scale (M_L) for small to moderate earthquakes. Large earthquakes are reported according to the moment-magnitude scale (M_W) because the standard Richter scale does not adequately represent the energy released by these large events.

> **Peak Ground Acceleration**
> Peak ground acceleration (PGA) in percent of g with 10% probability of exceedance in 50 years represents the ground motions that can be reasonably expected in a 50-year period.
> The acceleration values are the *peak* or maximum values expected during the earthquake. The "10% probability of exceedance in 50 years" refers to the fact that earthquakes are somewhat random in occurrence. One cannot predict exactly whether an earthquake of a given size will or will not occur in the next 50 years.

Intensity is usually reported using the Modified Mercalli Intensity Scale (MMI). This scale has 12 categories ranging from not felt to total destruction. Different MMI values can be recorded at different locations for the same event, depending on local circumstances such as distance from the epicenter or building construction practices. Soil conditions in Anchorage are a major factor in determining an earthquake's intensity, as areas with unconsolidated fill, liquefiable soils, or that are susceptible to lateral spread will sustain more damage than areas with shallow bedrock. Seismic landslide hazard is a key local issue and is discussed in more detail in see section 4.1.6 Landslide/Ground Failure.

Location

The entire MOA faces a significant threat from earthquakes. Earthquakes that result from the Pacific Plate subducting beneath the North American Plate are most likely to impact the MOA (Haeussler, 2010).

Likelihood of Occurrence

While it is impossible to know when the next earthquake will affect MOA, given the MOA's seismic history, earthquakes will continue to occur. An event similar to the 1964 earthquake usually occurs every 300 to 900 years so the MOA is less likely to experience one in the near future. (Haeussler, 2010). However, given Anchorage's geologic situation, a dangerous damaging earthquake with a lower magnitude of 7 or 8 could occur at any time in the MOA. See Hazard Rating Matrix, Table 1.2.

Peak ground acceleration with a 10% probability of exceedance in 50 years represents events that are reasonably expected to occur. Peak ground acceleration (PGA) is one method to measure the strength of ground movements. The MOA has a peak ground acceleration of 40%g (Wesson et al, 2007). This can be considered a high seismic hazard.

Historic Events

1964 Good Friday Earthquake

The best known earthquake in Anchorage's history is the March 27, 1964 Good Friday earthquake. This 9.2 M_W earthquake is the largest ever recorded in North America and the second largest in the world. The shaking lasted between four and five minutes and was felt over an area of approximately seven million square miles.

The Government Hill School after the 1964 Good Friday earthquake.

This earthquake occurred at approximately 5:36 pm. The timing of the event may have saved many lives, as several structures with the most damage, such as the Government Hill School, were unoccupied at this time. In 1973, the National Research Council observed that this event could have had 50 times the number of deaths and 60 times as much property damage if it had affected a more densely populated area during work/school hours. The ground shaking caused a significant amount of ground deformation as well as triggering landslides and tsunamis. The Turnagain Heights landslide was the most damaging, with more than 100 homes destroyed.

Vulnerability

An earthquake could affect the entire Municipality. The exact number and location of impacted structures will depend on the size, location and frequency of the earthquake. The type of building also plays a role. For example, unreinforced masonry buildings tend to be more vulnerable to earthquake damage than wood framed buildings. Many of the MOA's taller buildings are located in Downtown and Midtown. In addition, infrastructure, including roads and utilities, and other development is vulnerable to an earthquake. The disruptions to the transportation infrastructure including bridges can have an impact on emergency response activities.

L. Table 4.1 Earthquake Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Earthquakes have a higher potential for injuries and fatalities than many of the other hazards in the MOA. While everyone in the MOA could be impacted by an earthquake, some populations, such as those living in poorly constructed housing may be more vulnerable than other populations. People could be impacted by the loss of utilities and business closures. The MOA is also likely to experience a decrease in tourism.

4.1 2 WILDFIRE

The MOA's location in the boreal forest makes wildfires (sometimes called a wildland urban interface fire) a concern. For the purposes of this plan, a wildfire is a fire that burns within the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

The creation and maintenance of the fire requires the interaction of heat, fuel, and oxygen. This is often referred to as the fire triangle.

Fire Behavior

Fuel, weather, and topography influence wildland fire behavior. Wildland fire behavior can be erratic and extreme, causing fire whirls and firestorms that can endanger the lives of firefighters trying to suppress the blaze. The danger increases when the fire involves developed areas with structures, property and populations. The additional fuel load, high value property, life safety risk, and the need for simultaneous evacuation and suppression add significant wildfires firefighting challenges.

H. Figure 3.5 The Fire Triangle. Image from Northern & Intermountain Regions of the U.S.

Fuel [6]

Fuel determines how much energy the fire releases, how quickly the fire spreads, and how much effort is needed to contain the fire. The primary fuels in wildland fires are living and dead vegetation. Fuels differ in how readily they ignite and how hot or long they burn. This depends on the following characteristics:

- Moisture content
- Size and shape
- Fuel loading
- Horizontal continuity of fuels
- Vertical arrangement of fuels

Weather

Weather is the most variable and uncontrollable factor in wildland fire fighting. Weather includes temperature, relative humidity, wind, and precipitation. High temperatures and low humidity encourage fire activity, while low temperatures and high humidity help retard fire behavior. Wind dramatically effects fire behavior and is a critical factor in fire spread and control.

Topography

Topography directs the movement of air, which can also affect fire behavior. When the terrain funnels air, as in a canyon, it can lead to faster spreading. Fire can also travel up-slope quicker than it goes down.
Burning material can roll down the slope and ignite fires below. Certain areas in the MOA with glaciers, including the Eagle River and Eklutna Valleys, may experience local glacial wind effects dramatically influencing fire behavior.

Slope orientation also influences fire behavior. Forests on southern or southwestern slopes (those exposed to the sun) generally have lower humidity and higher temperatures than those on northern or northeast slopes.
Consequently, fire hazard is often higher on south- and southwest-facing hills.

According to the AFD, the factors contributing to Anchorage's wildfire risk include:

- Mixed hardwood and conifer forests that burn readily in high fire danger conditions. White spruce trees have persistent branches that contribute to ladder fuels. Black spruce trees have a very low moisture content that allows them to burn easily when ambient weather conditions provide for low relative humidity, high temperatures, and dry duff layers in the soil.
- Residential and rural neighborhoods exist throughout forested stands that have been affected by the spruce bark beetle. In the MOA, this area extends over 85,000 acres. Dead trees resulting from beetle attacks contribute to forest fuel accumulations that create high risk for wildfire.
- Mutual aid resources to help the AFD may take an hour or more to arrive on site. Suppression resources from the SOA Division of Forestry must travel to Anchorage from Palmer and other locations outside the MOA.
- On the south Anchorage Hillside, Eagle River Valley, South Fork, and other sites around the MOA, there are limited water resources to help fight a wildland fire.
- Many neighborhoods in the MOA have limited ingress and egress routes for suppression apparatus to enter and for residents to evacuate.
- The hilly topography throughout the area contributes to increased rate of fire spread. Where the Miller's Reach Fire of 1996 spread across mostly flat terrain and still burned more than 400 structures, a wildfire in South Anchorage would spread even faster because fire spread rates increase with slope.
- The spring fire season is a dry time in Southcentral Alaska. Dry foliage on trees and dead bluejoint grass burn readily soon after snow melts

[6] Adapted from Eli, 2003 and wildlandfire.com

Location

The entire MOA has the potential for wildfires. The AFD has identified a 345,309- acre study area for wildfire exposure.
Approximately 17,088 acres of this study area are exposed to hazardous wildfire conditions (MOA, 2010b). The exact location of the wildfire hazard changes because it depends on a combination of factors, including availability of fuels, availability of ignition sources, and weather. Because of the changing conditions, the AFD has developed an Anchorage Fire Exposure Model to calculate wildfire exposure. For current information on wildfire exposure, please contact the Wildfire Mitigation Division of the AFD.

The AFD Wildfire Home Assessment
The AFD provides home assessments to provide homeowners with specific recommendations for vegetation management and home maintenance activities to reduce a home's potential to ignite during a wildfire. The AFD is also able to provide financial assistance to remove dead, beetle killed spruce trees and densely growing coniferous trees.

In addition, AFD has been conducting neighborhood wildfire assessments. These assessments are considered works in progress and are re-evaluated throughout the fire season. The assessments contain an evaluation of the hazard; potential hazards/complications, such as power lines; potential staging areas for equipment; water sources, potential safety zones (to wait out passing fire); and potential evacuation sites. They exist for the following areas:

- Tudor Road to Abbott Road, including Far North Bicentennial Park
- Eagle River
- Hiland Road, South Fork
- DeArmoun Road to Potter Creek Heights
- Chugiak

Individual neighborhood assessments are available through the AFD.

Likelihood of Occurrence

The high fire danger months are typically May through August in the MOA; however, wildfires can occur in other months. Wildfires are more likely to occur during drought or low-precipitation times and are less likely to occur during high-precipitation times and when snow is on the ground. See Hazard Rating Matrix, Table 1.2.

Wildfires in the MOA are more likely to be caused by humans than by other sources. As development increases in areas with high wildfire potential, the chances of wildfire also increase. The AFD is taking measures to reduce the risk of fires by controlling the amount of fuel available. The AFD does this through controlled burns, homeowner education, and the development of firebreaks.

Historic Events

No declared wildfire disasters have been identified to date in the MOA. However, the potential exists. Every year, the AFD puts out dozens of fires that could be disastrous if not contained early. Between 2010 and 2015, the number of wild fires per year in the MOA ranged from 58 fires in 2012 to 102 fires in 2011. Between 2007 and 2015, the MOA had 773 wildfire calls that burned approximately 152 acres (Table 4.2).

M**. Table 4.2 Wildfires in the MOA, 2010-2015**

Cause	Number	Percent	Acres
Undetermined	354	45.80%	72.11
Misuse of Fire/Unintentional	98	12.68%	15.96
Intentional/Incendiary	86	11.13%	14.31
Open/Outdoor Fire	77	9.96%	23.61
Smoking	73	9.44%	7.93
Debris/Vegetation Fire	24	3.10%	3.85
Other	21	2.72%	4.81
Act of Nature/Natural	20	2.59%	2.64
Equipment	19	2.46%	6.53
Structure/Exposure	1	0.13%	.1
Totals	**773**	**100%**	**151.85**

Other Wildfire Events

O'Malley/Hillside Fire, 1973

In May 1973, a small brush fire at a private home, fanned by 40 mile per hour (mph) winds, burned out of control in the foothills of the Chugach range. The fire threatened 25 homes and forced several families to evacuate. By the time firefighters contained the blaze, 300 acres of brush and timber were destroyed.

Dowling Road Fire, 2003

A wildfire near the east end of Dowling Road was ignited by a homeless person's fire. This fire burned approximately 2.5 acres.

Otter Lake Fire, 2006

The Otter Lake Fire began in an approximately five-mile area near the ARRC tracks on Fort Richardson. The fire quickly expanded to approximately 50 acres before it was extinguished.

Piper Fire, 2008

On July 2, 2008, a wildfire burned 10 acres of Municipal park land. This fire was ignited by a homeless person. The AFD was able to extinguish the fire before it reached nearby subdivisions.

Eklutna Lake fires 1999, 2010

There have been two wildfires over 100 acres in the MOA's Eklutna Lake Valley in the last twenty years. In 1999 a landowner ignited a fire to clear brush on a windy day and the fire escaped control and burned over 200 acres. The fire threatened homes and potentially the

MOA's Eklutna Lake water treatment facility. In May of 2010 there was a wildfire that burned over 1000 acres at the far end of the lake that threatened Eklutna State Park developments and homes near the lake.

McHugh Creek Fire. In July 2016 this fire burned approximately 800 acres of steep and remote terrain in the MOA. The fire affected travel on the Seward Highway. It was reported the fire was started by an unextinguished campfire.

Vulnerability

In 2001, Anchorage was declared a community-at-risk for wildfire by the U.S. Department of Agriculture (USDA) Forest Service (USFS). According to the AFD, a wildfire could occur anywhere in the MOA, so the entire MOA is represented in Table 4.3. Only a portion of these properties are likely to be affected by a given event. The number and location of the impacted parcels depend on the size and location of the wildfire event.

Wildfires have the potential to destroy property and vegetation. Without vegetation, these areas may experience soil erosion which can have an impact on water quality. Wildfires may reduce the amount of animal habitat. Wildfires may also cause injuries or loss of life. Fire response systems are well prepared to deal with wildfires so large numbers of injuries or fatalities are not expected. Additional research would be required to identify the number of people who could be injured or killed as the result of a wildfire.

N. Table 4.3 Wildfire Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

More detailed information has not been calculated because the information will change depending on current conditions. For the latest vulnerability information, please contact the Wildfire Mitigation division of the AFD.

4.1.3 EXTREME WEATHER

Extreme weather is a broad category that includes heavy snow, extreme cold, ice storms (freezing rain), high wind, thunder & lightning, hail, coastal storms, and storm surge. High winds, ice storms, and heavy snow are the most likely types of extreme weather in the MOA.

Heavy Snow

Heavy snow is generally considered to be more than six inches of accumulation in less than 12 hours. (Albanese, 2010b). Heavy snow can have a significant impact on an area.

Until the snow can be removed, airports and roadways experience delay, or are closed completely, stopping the flow of traffic, supplies and disrupting emergency and medical services. Heavy snow loads can damage light aircraft and sink small boats. It can also cause roofs to collapse and knock down trees and power lines.

Heavy snowfalls can cause secondary hazards. In the mountains, heavy snow can lead to avalanches. A quick thaw can cause flooding, especially along small streams and in urban areas. The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts.

Snow Terminology

A heavy snow is considered to be 6 or more inches of snow in 12 hours. The NWS criteria for a heavy snow advisory is 6 to 11 inches in 12 hours or 12 to 23 inches in 24 hours. A heavy snow warning may be issues for 12 or more inches of snow in 12 hours or 24 or more inches of snow in 24 hours.

Snow Squalls are periods of moderate to heavy snowfall, intense, but of limited duration, accompanied by strong, gusty surface winds, and possibly lightning.

A Snow Shower is a short duration of moderate snowfall.

Snow Flurries are an intermittent light snowfall of short duration with no measurable accumulation.

Blowing Snow is wind-driven snow that reduces surface visibility. Blowing snow can be falling snow or snow that already has accumulated but is picked up and blown by strong winds.

Drifting Snow is an uneven distribution of snowfall and snow depth caused by strong surface winds. Drifting snow may occur during or after a snowfall.

Location

The entire Municipality can get heavy snow but Girdwood tends to receive more snow than other areas.

In general, the location of heavy snowfall depends on the weather system involved. The typical storm is a low pressure system originating in Prince William Sound that moves in from the East. This results in heavier snow on the hillside, and less as you get further from the mountains. When the storm is out of the south, the snowfall is heavier in West Anchorage (Vonderheide, 2003). Occasionally, air comes up Cook Inlet and hits the mountains. This may lead to heavy snow on the upper hillside and less in the bowl area (Vonderheide, 2003). Blizzards are rare events in the MOA but could occur along the Turnagain Arm. See Figure 4.1 for the average annual snowfall pattern in MOA.

Snowfall Records

Normal snowfall – 74.5'

Top 5 Highest Winter Snowfalls

134.5..........2011-2012
132.6..........1954-1955
128.8..........1955-1956
121.5..........1994-1995
113.9..........2003-2004

Top 5 Lowest Winter Snowfall

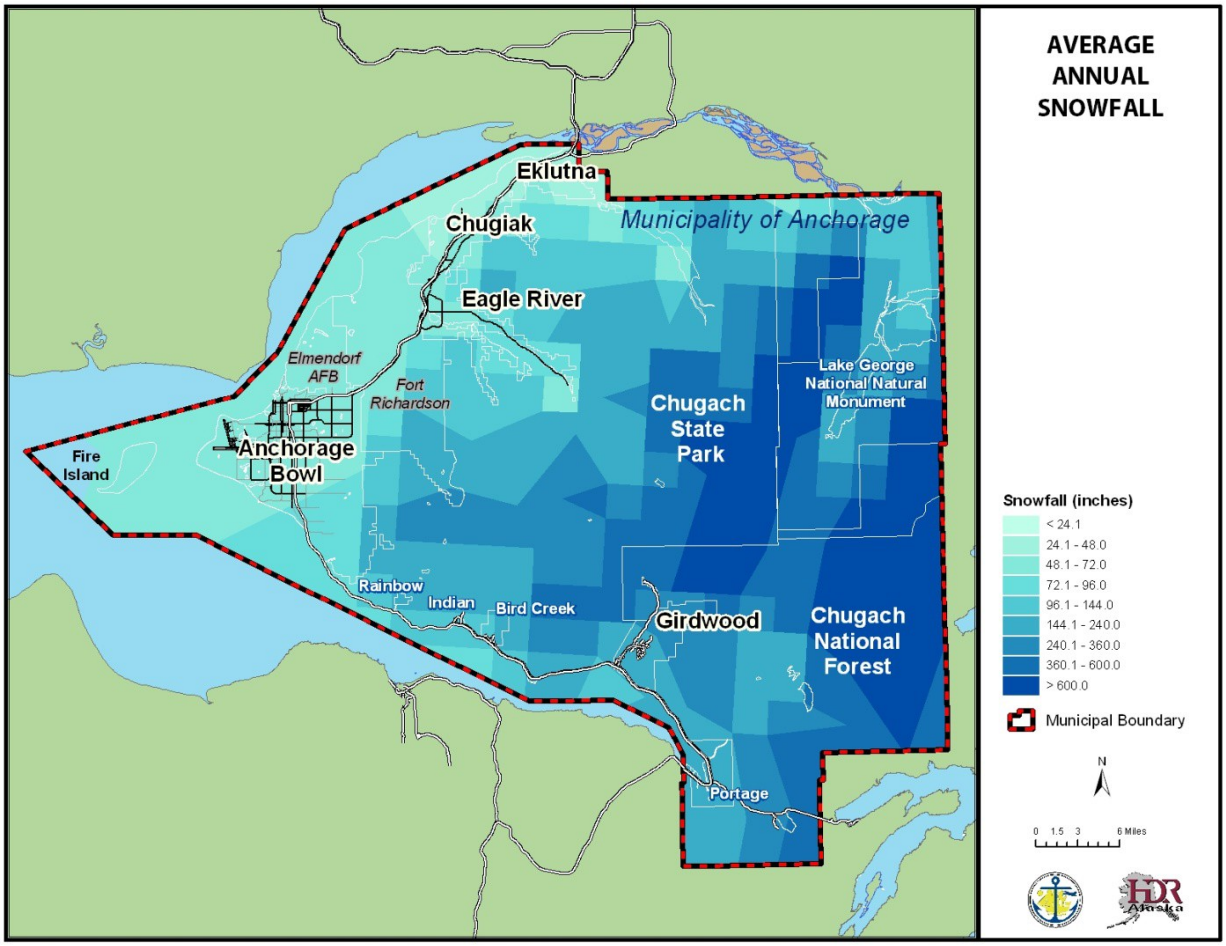
25.1..........2014-2015
30.4..........1957-1958
32.9..........1980-1981
36.8..........2002-2003
38.5..........1960-1961

Source: National Weather Service Anchorage Forecast Office's Climate Records List, (1917 – current) Available at http://pafc.arh.noaa.gov/misc.php?p

Likelihood of Occurrence

While snow falls frequently in Anchorage during the winter, most snowfalls are not usually heavy. Anchorage tends to experience one or two heavy snowfalls each winter (Albanese, 2010). However, these tend not to result in disaster declarations. The occurrence of heavy snowfall events depends on the weather conditions.

l. Figure 4.1 Average Annual Snowfall



Historic Events

2002 Heavy Snow Fall

Record heavy snow occurred in MOA on March 17, 2002 when two to three feet of snow fell in less than 24 hours. TSAIA recorded a total of 28.7 inches while an observer near Lake Hood measured over 33 inches. The Municipality was essentially shut down because of the accumulating snow. Fortunately, the storm occurred on a Sunday morning when fewer businesses are open. The following day, both military bases, both universities, and many businesses remained closed, while Anchorage schools remained closed for two days. It took four days for snowplows to reach all areas of the city.

Other Snow Events

On March 20, 2001, 8-12 inches of snow fell in the Anchorage Bowl-Eagle River area.

Vulnerability

As a heavy snowfall could affect the entire Municipality, the entire MOA is represented in Table 4.4. Heavy snowfall can also damage infrastructure and critical facilities. Heavy snowfalls make transportation difficult, especially by road, and result in more money spent on snow plow services. Transportation may be distributed more in steeper areas such as the Hillside and parts of Eagle River. High numbers of injuries and fatalities are not expected with a heavy snow event. Heavy snow can have a greater impact on people who need access to medical services, emergency services, pedestrians, and people who rely on public transportation. The cost of fuel to heat homes during times of heavy snow can be a financial burden on populations with low or fixed incomes. According to the 2010-2014 American Community Survey 5-Year Estimates, the MOA had approximately 12,530 households with a household income less than $25,000. Homeless populations are also vulnerable. According to the January 2016 single-night homeless count, there were 1,105 homeless people in Anchorage (Anchorage Coalition Data). Heavy snows may also result in school and business closures which may result in some individuals having a loss of income. Heavy snows may also result in school and business closures, which may result in some individuals having a loss of income.

O. Table 4.4 Heavy Snow Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
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Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Heavy Rain

There is no universal definition of heavy rain. Generally, when rainfall is sufficient to cause localized or widespread flooding, it is considered heavy. The NWS is most concerned about potential flooding with 10% of an area's annual rainfall occurs in one day (Albanese, 2010b).

Heavy rains are sometimes associated with a weather system called the "Pineapple Express". This weather system originates in Hawaii and usually brings heavy rain with it. This rain can lead to flooding. The "Pineapple Express" may also melt snow contributing to flooding.

Precipitation **Records**

Normal Precipitation: 16.08 inches

Highest Annual Precipitation: 27.75 inches (1989)

Lowest Annual Precipitation: 8.08 inches (1969)

Longest Consecutive Days with Measurable Precipitation: 17 days (September 12 – 28, 1979)

Consecutive Days Without Precipitation:

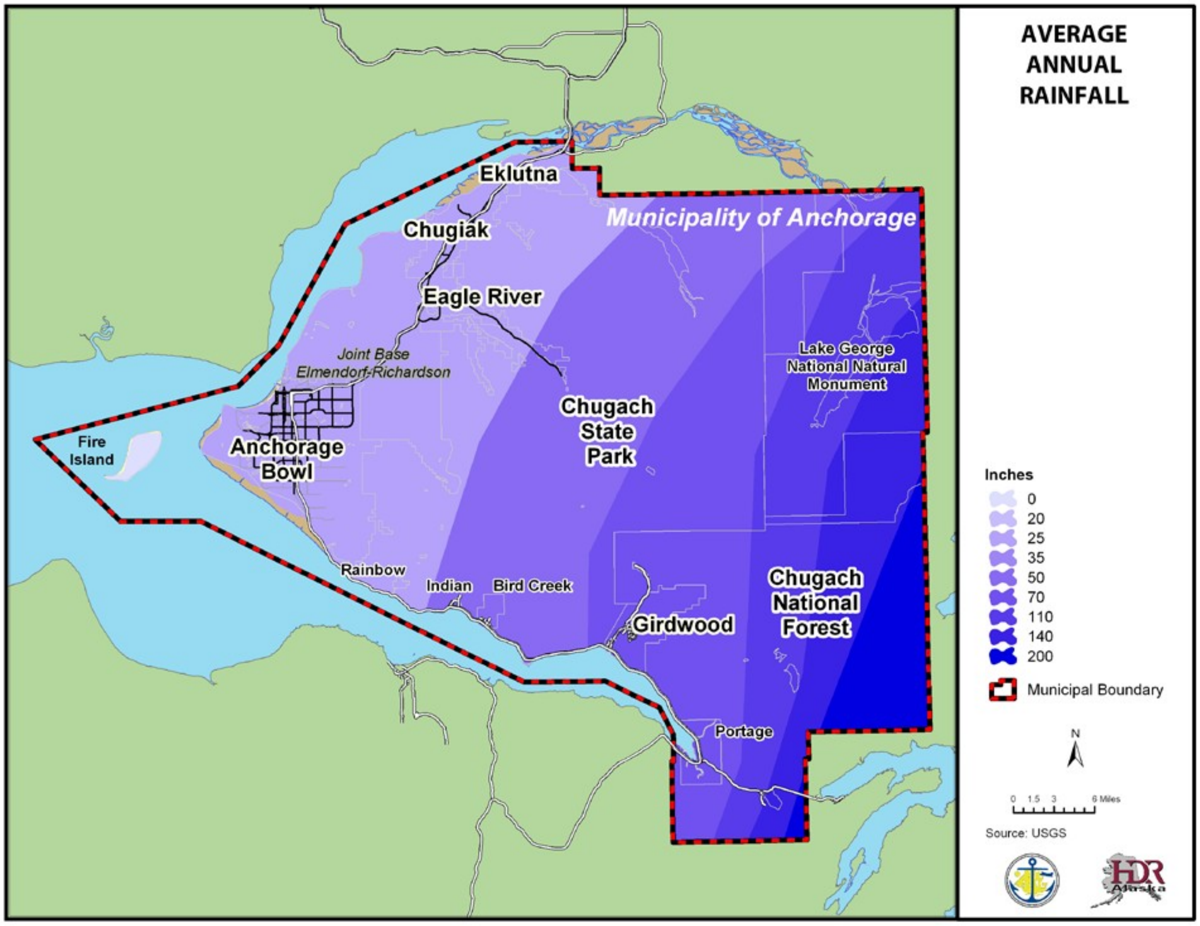
47 (January 6 – February 21, 1939)

Source: National Weather Service Anchorage Forecast Office's Climate Records List, (1917 – current)

Location

The Girdwood area receives the most rainfall in the MOA. See Figure 4.4 for the average annual rainfall pattern. Rainfall also varies with time of year with most precipitation occurring in late summer and fall. Table 4.5 summarizes precipitation in the MOA.

J. **Figure 4.2 Average Annual Rainfall**



P. Table 4.5 Precipitation in the MOA

	(a)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION (in.)													
Water Equivalent													
-Normal		0.79	0.7	0.69	0.67	0.73	1.14	1.71	2.44	2.70	2.03	1.11	1.12
-Maximum Monthly	42	2.71	3.07	2.76	1.91	1.93	3.40	4.44	9.77	6.64	4.11	2.84	2.67
-Year		1987	1955	1979	1977	1989	1962	1958	1989	1990	1986	1976	1955
-Minimum Monthly	42	0.02	0.07	T	T	0.02	0.17	0.42	0.33	0.76	0.35	0.08	0.09
-Year		1982	1958	1983	1969	1957	1993	1.72	1969	1973	1960	1985	1995
-Maximum in 24 hrs	42	1.19	1.16	1.25	0.78	1.18	1.84	2.06	4.12	1.92	1.60	1.66	1.62
-Year		1961	1956	1986	1989	1980	1962	1956	1989	1961	1986	1964	1955
Snow, Ice Pellets, Hail													
-Maximum Monthly	42	27.5	48.5	31.0	27.6	3.9	0.0	0.0	0.0	4.6	27.1	38.8	41.6
-Year		1990	1955	1979	1963	1963				1965	1982	1994	1955
-Maximum in 24 hrs	42	10.5	12.4	14.5	9.1	3.9	0.0	0.0	0.0	3.5	11.2	16.4	17.7
-Year		1955	1956	1959	1955	1963				1965	1991	1964	1955

Likelihood of Occurrence

The occurrence of heavy rain depends on various weather conditions. Low pressure over the Bearing Sea, El Nino or La Nina conditions or the direction the storm is coming from. Storms moving up Cook Inlet can cause significant precipitation in the Anchorage bowl and the Hillside area but usually have little precipitation in Girdwood. While storms coming from the Prince William Sound can cause significant precipitation from Girdwood to Portage areas but may not produce much rain in Anchorage. A warm weather rain event during the winter can cause flooding due to the snow melt, the inability of the water to infiltrate into the ground and decreased ability of the stream channels and storm drains to pass the runoff. See Hazard Rating Matrix, Table 1.2.

Historic Events

No significant historic heavy rainfalls that have resulted in a declared disaster have been identified. However, heavy rainfalls have resulted in flood events. For more information, please see the flood section, 4.1.4.

Vulnerability

As a heavy rain could affect the entire Municipality, the entire MOA is represented in Table 4.6. The flooding associated with a heavy rain is typically the greatest concern. For more information, please see the flood section. High numbers of injuries and fatalities are not anticipated with a heavy rain event.

Q. Table 4.6 Heavy Rain Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0

Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Extreme Cold

What is considered an excessively cold temperature varies according to the normal climate of a region. In areas unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." In Alaska, extreme cold usually involves temperatures below –40º Fahrenheit (F). Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity.

Extreme cold can also bring transportation to a halt for days or weeks at a time. Aircraft may be grounded due to extreme cold and ice fog conditions. Long cold spells can cause rivers to freeze which increases the likelihood of ice jams and ice jam related flooding. If extreme cold conditions are combined with low or no snow cover, the ground's frost depth can increase, and disturb buried utility pipes.

The greatest danger from extreme cold is to people. Prolonged exposure to the cold can cause frostbite or hypothermia and become life threatening, especially for infants and the elderly. Carbon monoxide (CO) poisonings also increase as people use supplemental heating devices.

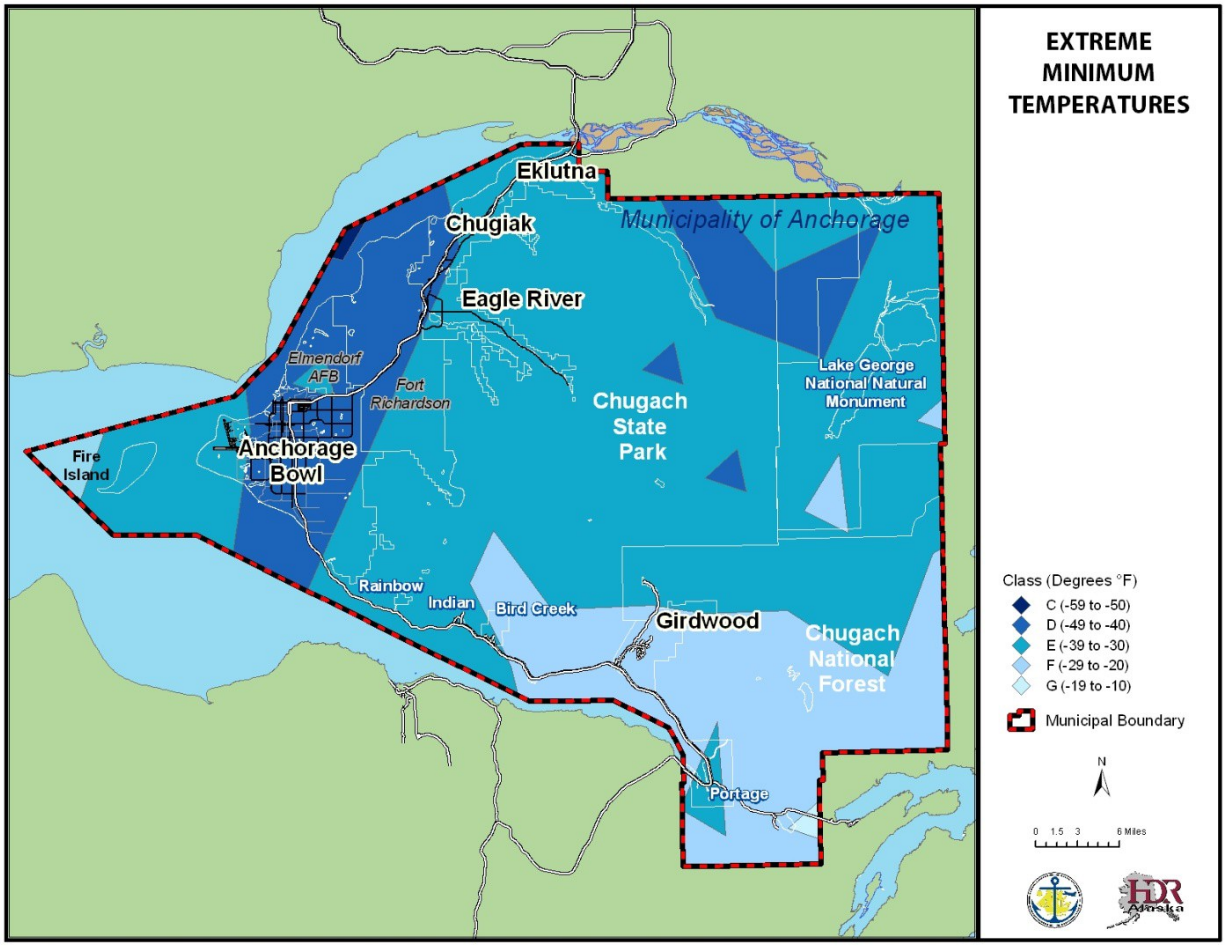
Frostbite is damage to body tissue caused by that tissue being frozen. Frostbite causes a loss of feeling and a white or pale appearance in the extremities.

Hypothermia is low body temperature. Normal body temperature is 98.6ºF. When body temperature drops to 95ºF, however, immediate medical help is needed. Hypothermia also can occur with prolonged exposure to temperatures above freezing.

Location

In MOA, the official temperature is recorded at TSAIA. Due to its close proximity to open water, the airport tends to be warmer than the rest of Anchorage. For example, east Anchorage is generally 10 to 15 degrees cooler than at the airport (Vonderheide, 2003). The Chugiak/Eagle River area tends to get the coolest temperatures in the winter. See Figure 4.3 for the extreme minimum temperatures.

K. Figure 4.3 Extreme Minimum Temperatures



The coldest months in Anchorage are generally December, January, and February. The temperature tends to decrease, the further inland you are. Table 4.7 summarizes the temperature in the MOA.

R. **Table 4.7 Anchorage Climate Records**

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE (Deg. F)													
Normals													
-Daily Maximum	23.1	26.6	33.9	44.5	56.0	62.8	65.4	63.5	55.1	40.5	27.8	24.8	43.7
-Daily Minimum	11.1	13.8	19.2	29.1	39.6	47.7	52.2	50.0	42.0	29.1	16.6	13.2	30.3
-Monthly	17.1	20.2	26.6	36.8	47.8	55.2	58.8	56.7	48.6	34.8	22.2	19.0	37.0
Extremes													
-Record Highest	50	48	5.1	69	77	85	84	82	73	64	54	48	85
-Year	1961	1991	1984	2005	1969	1969	2003	1968	1957	2006	2002	1992	JUN 1969
-Record Lowest	-34	-28	-24	-4	17	33	36	31	19	-5	-21	-30	-34
-Year	1975	1999	1971	1985	1964	1961	1964	1984	1992	1956	1956	1964	JAN 1975
NORMAL DEGREE DAYS													
Heating (base 65 Deg. F)	1485	1254	1192	846	533	293	194	256	494	936	1284	1426	10193
Cooling (base 65 Deg. F)	0	0	0	0	0	0	2	0	0	0	0	0	0
PRECIPITATION (Inches)													
Normals													
-Mean Precipitation	0.73	0.72	0.60	0.47	0.72	0.97	1.83	3.25	2.99	2.03	1.16	1.11	
-Snowfall	11.3	10.9	9.9	4.0	0.3	0.0	0.0	0.0	0.4	7.9	13.1	16.7	
Extremes													
-1 Day Maximum Total	1.1	1.16	1.25	1.32	0.97	1.62	2.00	2.76	1.41	1.68	1.16	1.39	2.76
-Year	1987	1956	1986	2008	1980	1962	1956	1997	2012	1952	1964	1955	1997
-Highest Total Precipitation	2.71	3.07	2.76	2.32	1.93	3.40	4.49	9.77	7.35	4.28	2.87	2.67	27.55
-Year	1987	1955	1979	2008	1989	1962	2001	1989	2004	2002	2010	1955	1989
-Lowest Total Precipitation	0.02	0.07	0.01	0.01	0.02	0.02	0.42	0.33	0.72	0.35	0.04	0.09	8.08
-Year	1974	1958	1997	1957	1955	1952	1972	1969	1998	1960	2006	1995	1969
-1-Day Maximum Snow	11.2	13.0	22.0	15.5	5.0	0.0	0.0	0.0	6.0	12.6	10.9	15.6	
-Year	2007	1996	2002	2008	2001	---	---	---	2004	1996	1964	1955	
-Highest Total Snow	29.3	52.1	31.0	30.8	6.10	0.00	0.0	0.0	6.3	28.1	38.8	41.6	133.6
-Year	2007	1996	1979	2008	2001	---	---	---	2004	1996	1994	1955	2011-2012
-Lowest Total Snow	0.5	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.4	25.1
-Year	1974	2003	1984	1993	---	---	---	---	---	2003	1995	1980	2014-2015

Source: Alaska Climate Research Center/National Weather Service, 2016

Likelihood of Occurrence

Extreme cold temperatures could happen every winter, depending on weather conditions. However, it is rare for temperatures in the MOA to be colder than -50°F (Albanese, 2010). See Hazard Rating Matrix, Table 1.2.

Historic Events

Extreme cold temperatures can be especially problematic if they are associated with low snow levels as happened in the winter of 1995-1996. The combination of these two factors resulted in the ground freezing to a greater depth than usual (more than 10 feet compared to the usual three of four feet). As utility pipes, including water and wastewater, are buried to a depth of 10 feet, some pipes froze and subsequently broke. Repairing the broken pipes was a massive undertaking as the ground had to be thawed before work could commence (Vonderheide, 2003).

Vulnerability

As extreme cold could affect the entire Municipality, the entire MOA is represented in Table 4.8. An extreme cold event is likely to result less property damage than other hazards such as an earthquake. In the MOA, typically buried pipes are most vulnerable to an extreme cold event. Homeless populations and people who have difficultly heating their homes (due to poor insulation, unable to afford heating costs, etc.) also tend to be more vulnerable. According to the 2010-2014 American Community Survey 5-Year Estimates, the MOA had approximately 12,530 households with a household income less than $25,000. Homeless populations are also vulnerable. According to the January 2016 single-night homeless count, there were 1,105 homeless people in Anchorage (Anchorage Coalition Data). Heavy snows may also result in school and business closures which may result in some individuals having a loss of income.

S. Table 4.8 Extreme Cold Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Ice Storms

Ice storm is the term used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storms result from the accumulation of freezing rain (rain that becomes super cooled and freezes upon impact with cold surfaces). Freezing rain most commonly occurs in a narrow band within a winter storm that is also producing heavy amounts of snow and sleet in other locations. Ice storms can be devastating and are often the cause of automobile accidents, power outages and personal injuries.

Glace ice, also known as black ice, which occurs when rains hits the cold ground and turns into ice, is possible in the MOA. It is responsible for multiple traffic accidents every winter.

Location

Ice storms can occur anywhere but the atmospheric conditions that can lead to ice storms occur most frequently around Cook Inlet. Freezing rains often approach from the west as storms from the Bering Sea move westward and mix with the pre-existing cold air in the MOA area.

Likelihood of Occurrence

The future occurrence of ice storms in the MOA depends on the weather conditions. Typically,

there are a few episodes of light freezing rain each winter. The NWS will issue a freezing rain advisory which is for freezing rain up to 0.24 inches accumulation of ice. In the MOA, most events have an accumulation less than a tenth of an inch (Albanese, 2010b).
More commonly, rain will fall on ice or snow pack covered roads which result in difficult driving conditions. This can occur when there is a storm in the Bering Sea/Bristol Bay area that has ample warm air advecting over the region and is accompanied by a strong southeast Chinook wind. See Hazard Rating Matrix, Table 1.2.

Historic Events

No significant historic ice storms have been identified. In November 2010, there were several days of freezing rain that made the roads slick and resulted in school closures. There was also an ice event in the mid-1990s (Albanese, 2010).

Vulnerability

As an ice storm could affect the entire Municipality, the entire MOA is represented in Table 4.9. An ice storm is likely to result in less building and property damage than other hazards. An ice storm has the potential to damage power lines. Infrastructure, especially above ground power lines are also vulnerable to ice. Ice storms can also increase the number of traffic accidents. Large numbers of injuries and fatalities are not anticipated with an ice storm. Ice storm related power outages can affect people who rely on electricity for life-safety items such as respirators, monitoring equipment or medication that needs to be kept refrigerated.

T. Table 4.9 Ice Storm Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

High Winds

High winds are generally considered to be winds in excess of 73 mph (Albanese, 2010b). A strong wind can be considered to be between 45 and 72 mph (Albenese, 2010b). They can lead to dangerous wind chill temperatures or combine with loose snow to produce blinding blizzard conditions. High winds have the potential to cause serious damage to a community's infrastructure, especially above ground utility lines. With early season high wind events, like the events in September 2010 and September 2012, high winds can cause trees to be blow over and uprooted. Later in the year, when trees are free of leaves and the ground is frozen, trees are more likely to break or have limbs broken off than being uprooted (Albanese, 2010b).

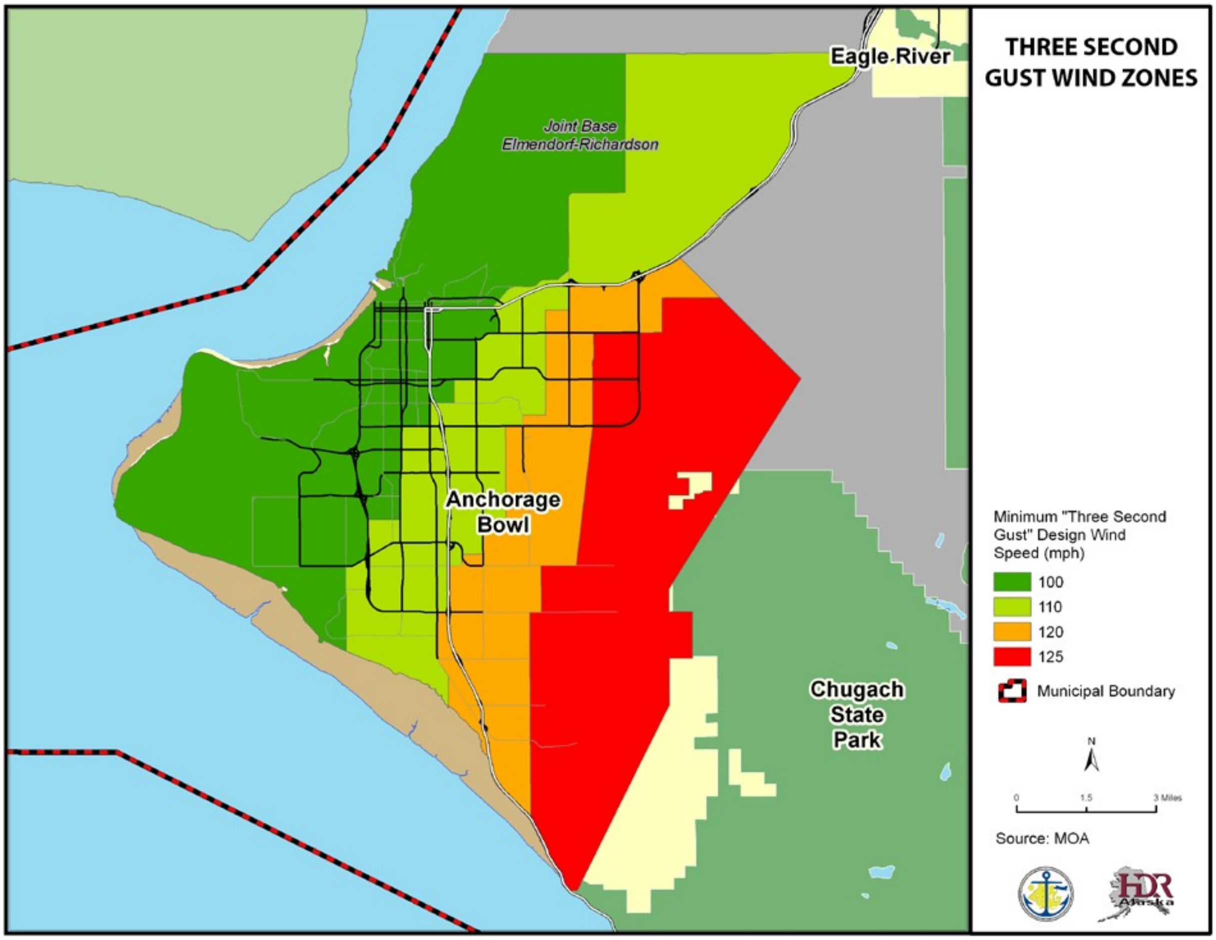
In mountainous areas, down slope windstorms created by temperature and pressure differences across the terrain can produce winds in excess of 100 mph. These windstorms can be particularly damaging as they are gusty in character and may seem to come from several directions.

Location

Typically, high wind warnings are for the Hillside and along Turnagain Arm. These areas common get high winds but the impacts is not that great until the winds are above 85 mph (Albanese, 2010b). When winds exceed 85 mph, it is not unusual for there to be damage. The damage is more widespread (especially along the Hillside and in East Anchorage), when the winds exceed 100 mph. Weaker winds (in the 50 to 60 mph range) will have more of an impact in the downtown area (Albanese, 2010b). The Port of Anchorage gantry crane operations stop at wind speeds greater than 50 miles per hour.

In the MOA, the basic wind speed, for the determination of the wind loads is determined in accordance with the Anchorage “Three Second Gust” wind zone map. This Anchorage Area-Wide Wind Speed Study noted that Anchorage gets strong winds from the southerly direction in the summer and northerly directions during the winter (RWDI, 1998).

L. Figure 4.4 50-Year Wind Speed



Localized high winds can also occur (see Table 4.10). The most well-known local wind is the Chugach wind which blows off the Chugach Mountains. These Chugach winds are really Chinook winds (a strong warm wind) and mostly affect the eastern side of the Anchorage Bowl. There can be winds just in the Turnagain Arm area, which affects traffic on the New Seward Highway (Vonderheide, 2003). Winds near McHugh Creek can get in the 80-90 mph range (Vonderheide, 2003). There is a Knik Valley wind, which brings warm air from Prince William Sound. The hillside area can experience a Chinook/Chugach wind. Eagle River can get winds from the Southeast. Localized winds in Bear Valley can reach 125 mph.

U. **Table 4.10 Wind Speeds**

	(a)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
WIND														
Mean Speed (mph)	42	6.4	6.9	7.0	73	8.4	8.4	7.3	6.9	6.7	6.7	6.5	6.3	7.1
Prevailing Direction		NNE	N	N	N	S	S	S	S	NNE	N	NNE	NNE	N
through 1964	38	03	04	03	15	35	17	16	02	22	03	04	05	03
Fastest Mile		61	52	51	35	33	30	29	31	35	40	41	41	61
-Direction(!!)		1971	1979	1989	1964	1964	1971	1957	1987	1993	1966	1978	1964	JAN
-Speed(mph)														1971
-Year	16	E	NE	NE	SE	S	SE	SE	N	S	S	NE	SE	
Peak Gust	16	64	61	75	43	43	46	40	44	48	55	55	55	NE
-Direction(!!)		1986	1994	1989	1987	1988	1985	1980	1987	1985	1987	1990	1992	75
-Speed(mph)														MAR
-Date														1989

Likelihood of Occurrence

High wind advisories, watches, and warnings are frequently issued by the National Weather Service (NWS) for different parts of Anchorage. See Hazard Rating Matrix, Table 1.2.

Historic Events

<u>September 2012</u>

A cooperative station weather observer in Glen Alps, in the Chugach Mountain foothills east of Anchorage, reported a peak gust to 131 mph on the night of September 4 to 5. Countless large trees were blown down, and there was other wind damage to structures. The damage from this storm was augmented by two factors. First, the ground was still wet and soft from rains in August. Second, the summer's growth of leaves remained on the trees as the wind increased. Combined, these factors strengthened the wind's grip on the forest canopy and weakened the ground that held the trees. At least 50,000 homes and businesses lost power as the storm hit. The Anchorage airport was closed until mid-day September 5.

<u>2003 Winter Storm – Federal Disaster 1461</u>

In March 2003, a winter storm brought high winds and freezing temperatures to Anchorage and surrounding communities for several days. This event involved a Bora wind, which is a very cold northerly wind (sometimes called the Matanuska wind). Bora winds are rare in Anchorage, and usually only occur every 10 to 15 years (Vonderheide, 2003). Prior to this event, the last one occurred in 1989.

Within the Municipality, the worst effects occurred in the west Anchorage area. Ted Stevens Anchorage International Airport had record high winds, sustained winds around 92-94 mph and a peak gust of 109 mph (Scott, Baines, and Papineau, 2004). Damage for the event in MOA alone exceeded $3.5 Million. MOA conducted a voluntary on-line survey about the damage caused by storm. The survey results are displayed in Figure 4.5.

2000 Central Gulf Coast Storm - Federal Disaster 1316
In December 1999 and January 2000, there was series of severe winter storms (involving high winds and avalanches) that caused damage throughout Southcentral Alaska. Anchorage was one of many jurisdictions included in a Federal Disaster Declaration. In Anchorage, damage from this event included one fatality, property damage, disruption of electrical service, and interruption of rail and road access south of the Potter Weigh Station.

April 1980 Windstorm
On April 1, 1980, a Chinook wind with maximum gust speeds estimated at 134 mph caused approximately $25 million in damages.

Other Wind Events (From RWDI 1998a and b)
- December 3, 1994 - southeasterly downslope wind storm
- February 20, 1994 – northeasterly wind storm
- November 22, 1993 - southeasterly downslope wind storm
- February 3, 1993 – northeasterly wind storm
- December 1, 1992 windstorm - southeasterly downslope wind storm
- Had maximum gust speeds estimated at 112mph
- December 26, 1991 - southeasterly downslope wind storm
- March 4, 1989 – northeasterly wind storm
- November 9, 1986 – southeasterly downslope wind storm
- February 14, 1979 – northeasterly windstorm

Vulnerability

The entire MOA was not included in the Anchorage Area-Wide Wind Speed Study. The area included in the study is shown on Figure 4.4. The size of each wind speed zone is shown in Table 4.11. The vulnerability tables for each wind speed zone (Tables 4.12 – 4.15) only reflect the area included in the study.

V. Table 4.11 Area of Wind Speed Zones

Minimum "Three Second Gust" Design Wind Speed (mph)	Fastest Mile	Acres
100	85	31,489
110	95	21,545
120	104	12,120
125	109	22,372

W. Table 4.12 100 mph "Three Second Gust" Vulnerability in the Anchorage Building Service Area

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	21338	2597575600	5253931000	7851506600
Commercial	2442	1520269900	3143414100	4663684000
Industrial	1004	488792600	744528000	1233320600
Institutional	240	455801100	316954300	772755400
Open Space	34	20163000	476700	20639700
Transportation	104	2392100	227800	2619900
Other	127	117746600	13342700	131089300
Vacant	397	0	0	0
Total	25686	5202740900	9472874600	14675615500

Source: MOA GIS, 2016

X. Table 4.13 110 mph "Three Second Gust" Vulnerability in the Anchorage Building Service Area

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	12705	1345616400	2849712300	4195328700
Commercial	673	579464500	881644400	1461108900
Industrial	1415	906007900	1044356700	1950364600
Institutional	122	269195800	813039000	1082234800
Open Space	1	254600	0	254600
Transportation	20	0	0	0
Other	13	19226800	11192100	30418900
Vacant	15	0	0	0
Total	14964	3119766000	5599944500	8719710500

Source: MOA GIS, 2016

Y. Table 4.14 120 mph "Three Second Gust" Vulnerability in the Anchorage Building Service Area

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	14606	1521998100	3460575500	4982573600
Commercial	220	183366800	298402000	481768800
Industrial	71	57714000	83264100	140978100
Institutional	241	259074200	187242200	446316400
Open Space	1	254600	0	254600
Transportation	4	0	0	0
Other	4	6955400	11452000	18407400
Vacant	42	0	0	0
Total	15189	2029363100	4040935800	6070298900

Source: MOA GIS, 2016

Z. Table 4.15 125 mph "Three Second Gust" Vulnerability in the Anchorage Building Service Area

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	11242	1448168400	3085166200	4533334600
Commercial	39	34156200	39603400	73759600
Industrial	1	0	0	0
Institutional	146	169233900	117153000	286386900
Open Space	4	1503900	0	1503900
Transportation	5	0	0	0
Other	0	0	0	0
Vacant	16	0	0	0
Total	11453	1653062400	3241922600	4894985000

Source: MOA GIS, 2016

In general, a windstorm is more likely to cause property damage than injuries and fatalities. High winds can cause falling trees and branches which can bring down utility lines and cause property damage. Windstorms can lead to power failures which can affect people who rely on electricity for life-safety items such as respirators, monitoring equipment or medication that needs to be kept refrigerated. Power failures can also cause school and business closures. Fallen trees and branches can block roads making it difficult to travel around town. Areas that are near forested areas such as the Hillside may be more vulnerable.

Fog

Fog is basically a cloud on the ground. When the air is saturated with water vapor, a drop in temperature will cause the excess water vapor to condense into water droplets. These droplets, if thick enough, will turn into fog.

When it is foggy, ice can be deposited on the roadways, causing black ice conditions (Vonderheide, 2003).

Location

Fog is more frequent in West Anchorage. In the fall and early winter, a northerly wind comes from the north and reduces visibility. In East Anchorage, the drainage winds from the mountains mix the air to help keep the area relatively fog free.

Fog can also occur in the lower parts of Eagle River, but it is rare in the higher elevations.

Likelihood of Occurrence

Fog is likely to occur when the climatic conditions are right. Fog events are usually short-term with no lasting effects. See Hazard Rating Matrix, Table 1.2.

Historic Events

No significant historic fog events have been identified to date.

Vulnerability

As fog could affect the entire Municipality, the entire MOA is represented in Table 4.16. Property damage does not typically occur during a dense fog event. Dense fog can reduce visibility leading to an increase in traffic accidents. Traffic accidents have the potential to result in injuries and fatalities. Large numbers of injuries and fatalities due to dense fog is not anticipated. Dense fog may result in closures at local airports.

AA. Table 4.16 Fog Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Other Weather Events

Other extreme weather events that are possible, but rare, in the MOA include:

- Tornados
- Coastal Storms
- Storm Surges
- Thunder and Lightning
- Hail

4.1.4 FLOODING

Flooding occurs when weather, geology, and hydrology combine to create conditions where river and stream waters flow outside of their usual course and "spill" beyond their banks. In the MOA, these natural factors can be exacerbated by development and result in an increase in the frequency of flood events. The MOA spans a wide range of climatic and geologic regions, resulting in considerable variation in precipitation. Primary factors in the amount of precipitation and area will receive are elevation and slope aspect, or direction. Within the MOA, annual precipitation varies from less than 15 inches at TSAIA to over 70 inches in Girdwood and along Turnagain Arm. Snowmelt from the Chugach Mountains provides a continuous water source throughout the year, and can contribute significantly to the development of flooding.

Types of Flooding

Riverine, icing, and urban flooding are the three types[7] of flooding that primarily affect the MOA. Riverine flooding is the overbank flooding of rivers and streams. The natural processes

[7] Flooding types are not exclusive categories and a flood event could have elements of multiple types of floods.

of flooding add sediment and nutrients to fertile floodplain areas. Riverine flooding can be the result of rainfall runoff or snowmelt and can occur on any of the rivers and streams within the MOA. Riverine flooding occurred on many rivers and creeks during the falls of 1995, 1997, 2002, and 2005.

Icing, also called aufeis, occurs when the growth of large bodies of ice on the streambed during freeze-up or breakup creates an obstruction to normal streamflow, causing river and streams to leave their banks. This can occur on many streams within the MOA. During the winters of 2003 and 2006, aufeis lead to overbank flooding on many creeks including Peters Creek and Rabbit Creek.

Urban flooding results from the conversion of land from wetlands or woodlands to parking lots and roads, through which the land loses its ability to absorb rainfall, causing runoff to overwhelm natural and manmade drainages.

Within the MOA, other types of flooding that may occur infrequently include:

Ice Jam Floods – the MOA tends not to have the typical ice jam flood like other parts of Alaska. In the MOA, when an ice jam flood occurs, it tends to be the result of ice collecting in a channel constriction such as a culvert. During a rain event or a sudden thaw, runoff enters a stream before the stream ice can melt, resulting in a flood. This type of flooding is more likely on larger creeks such as Campbell Creek.

Flash Floods - These floods are characterized by a rapid rise in water level and are often caused by heavy rain on small stream basins, ice jam formation, or by dam failure. Flash floods are usually swift moving and debris filled, which cause them to be very powerful and destructive. Steep coastal areas in general are subject to flash floods. A flash flood could occur downstream of a Lake o' the Hills Dam. For more information, please see section 4.2.1, Dam Failure.

Fluctuating Lake Level Floods - Generally, lakes buffer downstream flooding due to the storage capacity of the lake. But when lake inflow is excessive, flooding of the lake shore area can occur.

Alluvial Fan Floods - Alluvial fans are areas of eroded rock and soil deposited by rivers. When various forms of debris fill the existing river channels on the alluvial fan, the water overflows and is forced to cut a new channel. Fast, debris-filled water causes erosion and flooding problems over large areas. The Girdwood area is prone to this type of flooding.

Glacial Outburst Floods - A glacial outburst flood, also known as a jökulhlaup, is a sudden release of water from a glacier or a glacier-dammed lake. They can fail by overtopping, earthquake activity, melting from volcanic activity, or draining through conduits in the glacier dam.

Subglacial releases occur when enough hydrostatic pressure occurs from accumulated water to "float" the glacial ice. Water then drains rapidly from the bottom of the lake.
This type of flooding can occur on Lake George.

Other problems related to flooding are deposition and stream bank erosion. Deposition is the accumulation of soil, silt, and other particles on a river bottom or delta. Deposition leads to the destruction of fish habitat and presents a challenge for navigational purposes. Deposition also reduces channel capacity, resulting in increased flooding or bank erosion. Stream bank erosion involves the removal of material from the stream bank. When bank erosion is excessive, it becomes a concern because it results in loss of streamside vegetation, fish habitat, and land and property.

A flood can injure or kill people as well as damage property. A flood may disrupt public utilities including water supplies and water treatment facilities. It can impact the transportation system by washing out roads or damaging bridges and culverts. This can make it difficult for emergency responders to get where they are needed.

Overflowing wastewater treatment systems can expose people to raw sewage which may make them ill. If a flooded building has not been treated properly, mold and mildew may develop which can become a health hazard especially for people with respiratory issues. The contents of a building such as household furnishing can be lost if they are washed away. Important papers, photographs, and similar items may be damaged. Standing pools of water may become breeding grounds for mosquitoes.

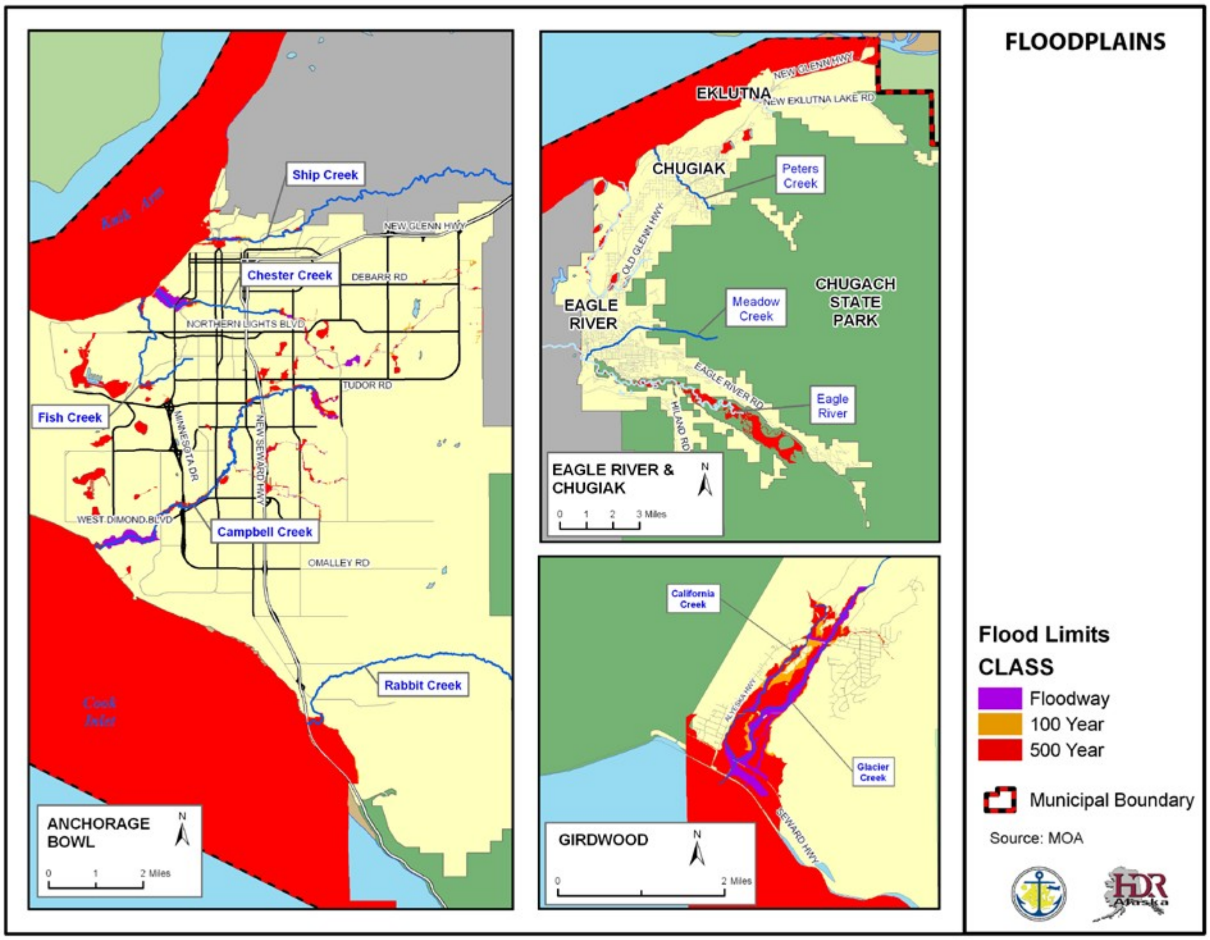
Location

The MOA has many small streams and larger rivers that are susceptible to annual flooding events. Large rivers include the Glacier Creek, Twentymile River, Portage Creek, Placer River, Ship Creek, and Eagle River. Smaller streams include California Creek, Virgin Creek, Alyeska Creek, Fire Creek, Chester Creek, Campbell Creek, Little Campbell Creek, Fish Creek, Furrow Creek, Rabbit Creek, Meadow Creek, Fire Creek, and Peters Creek. Additionally, the shorelines of many of the small lakes in Anchorage are subject to periodic flooding. Coastal areas may experience flooding associated with extreme high tides.

The flood hazard varies by location and type of flooding. The FEMA Flood Insurance Study from 2009 identifies potential areas of flooding. The study excluded Fire Island, Elmendorf Air Force Base, Fort Richardson Military Reservation, and Kincaid Park (referred to in the study as the Point Campbell Military Reservation). According to this report, most of the development land in MOA is “low, swampy, and subject to inundate from flooding” (FEMA, 2009). There are no flood studies being updated at this time. FEMA would like the MOA to change vertical datum prior to initiating or adopting any new flood studies.

Figure 4.6 shows flood-prone areas in the MOA. This map is for illustrative purposes, as not all the floodplains identified on MOA’s Flood Insurance Rate Maps (FIRM) are on this map. The main flood-prone areas are near Glacier and California Creeks in Girdwood, near Eagle River Road in Eagle River, Potter’s Marsh, and along Campbell and Chester Creeks in Anchorage. Please see the appropriate FIRM for more detailed flood information.

M. Figure 4.5 Flood-Prone Areas in the MOA



Much of Girdwood is subject to flooding because Girdwood valley occupies a fluvial valley drained by Glacier and California Creeks. The mouth of the valley is at sea level and gains elevation inland of the Seward Highway (MOA, 1995). The entire mouth of the Girdwood valley and the area adjacent to Glacier Creek to the airport is essentially within the 100-year floodplain. Other areas susceptible to flooding are California, Alyeska, and Virgin Creeks. The primary cause of flooding is runoff during heavy rainfall or during rapid snowmelt during the spring (MOA, 1995).

Property Owner Outreach
On an annual basis, the MOA sends an informational letter to people who own property located in a floodplain. The letter provides an overview of flooding sources within the MOA, the causes of flooding, recent flooding events, flood insurance, floodplain regulation, flood safety tips and a list of contacts where home owners can obtain additional information.

Likelihood of Occurrence

Coastal areas are more likely to flood when there is a storm that causes storm surge, high waves, or intense rainfall. Riverine flooding is more likely to occur in the spring when the snowpack is melting. There is also more chance of flooding in heavy snow seasons. Riverine flooding can also occur in response to heavy rainfall in upstream areas. Glacier outburst floods are not very predictable. See

Hazard Rating Matrix, Table 1.2.

Historic Events

July 2015

A 50 year rainfall event, 2 inches of rain in less than 12 hours, recorded by the National Weather Service. Approximately 30 people were evacuated from an apartment building at 12th and Cordova that partly flooded. A storm drain had failed and caused localized flooding.

Summer 2008

During the summer of 2008, an intense localized "cloudburst" caused flooding on the east side of the Anchorage Bowl. Stormwater runoff exceeded the capacity of the constructed and natural drainage system. Floodwaters flowed into the crawlspaces and lower floors of some local residences.

Winter of 2003 and 2006

During the winters of 2003 and 2006, colder than normal temperatures, combined with later than normal snowfall, caused the formation of aufeis in local streams, leading to overbank flooding, particularly on Peters Creek.

Fall of 1995, 1997, 2002, and 2005

The "Pineapple Express" brought warm weather to Anchorage in the fall of 1995, 1997, 2002, and 2005. The warmer than average temperatures, combined with prolonged precipitation, resulted in flooding throughout Southcentral Alaska, including the MOA. The 1995 event resulted in a federal disaster and is discussed below.

Peters Creek Flooding
In 2006, Peters Creek has some of the worst flooding local residents have seen in 50 years. The Anchorage Soil and Water Conservation District (ASWCD) had to blast a series of ice dams on Peters Creek to reopen the creek channel and stop the flooding. Since then, the ASWCD has been working on the Peters Creek Flooding and Erosion Control Project address the flooding issue.

In September 1995, there was a federal disaster declaration (AK-1072-DR) due to flooding caused by heavy rainfall. Most of the damages were outside the MOA, but Girdwood was negatively impacted. Officials in Girdwood had to shut down the wastewater treatment plant when it was overwhelmed by large volumes of mud and water. This resulted in raw sewage being washed into local creeks.

Other Flood Events

August 30, 1989

In August 1989, more than 5 inches of rain fell in the Anchorage area, causing heavy flooding along drainage systems in the MOA. The flooding was concentrated at homes and businesses along Campbell, Chester, and Ship creeks. The flooding resulted in a State Disaster Declaration.

February 10, 1978

During February 1978, the south fork of Campbell Creek experienced flooding and glaciation. Glaciation is when a stream freezes to the bottom or a culvert freezes full. The water flowing on top of the ice also freezes, so more ice develops and spreads into the overbank areas.

The flooding affected an area bounded by East 80th Avenue, Spruce Avenue, Lake Otis Parkway, and Abbott Loop Road. Many residential structures were threatened with water, ice, and contamination of surface and subsurface water. The flooding resulted in a State Disaster Declaration.

June 1966

Glacial outburst flooding last occurred on Lake George in June 1966. Between 1914 and 1966, the lake flooded almost every June or July. Prior to 1914, however, flooding occurred irregularly. These flood events were caused by the Knik Glacier blocking the valley of Lake George, trapping glacier and snow meltwater. The lake enlarges and the water erodes the glacier until it breaks out. The released water can be flowing as fast as 150 million gallons per minute. The flooding threatened structures on the Knik River floodplain (Davis, 1980).

Other flooding events are listed in Table 4.17.

BB. Table 4.17 Historic Flooding

Flooding Source and Location	Maximum Discharge (cfs)	Date	Estimated Recurrence Interval (Years)
Ship Creek Near Anchorage	1,860	June 1949	50.0
South Fork Campbell Creek at mouth	891	June 1949	100.0
Chester Creek	N/A	April 1963	5.0
Rabbit Creek	N/A	June 1964	100.0
Eagle River	6,240	September 1967	N/A
Glacier Creek at Girdwood	7,710	September 1967	20.0
Ship Creek Below Power Plant at Elmendorf Air Force Base	1,600	August 1971	20.0
Campbell Creek Near Dimond Boulevard	421	August 1971	1.7
Chester Creek At Arctic Boulevard At Anchorage	95	August 1971	1.1
Peters Creek	N/A	August 1971	50.0
Meadow Creek	N/A	August 1971	5.0

From: Flood Insurance Study, 2002

Vulnerability

The MOA has almost 10,000 acres of floodplain and more than 3,500 parcels that are partially or wholly located within the regulatory floodplain. Ongoing development increases the developed area that is vulnerable to flooding as natural areas that have historically functioned as flood storage are displaced.

Parcels adjacent to waterbodies are the most vulnerable to flooding. The vulnerability shown in Tables 4.18 and 4.19 are based on the Municipality's flood limit GIS file shown in Figure 4.7. The number and location of parcels impacted may be different during different events. Flood waters may cause road closures leading to a disruption of the transportation infrastructure. While the exact number of people living in the 2,827 residential parcels in a known floodplain, based on the MOA average household size of 2.65, the number of people who could be affected by a flood event is approximately 7,492. Large numbers of injuries and fatalities are not anticipated with a flood event however people could be impacted by the need to evacuate their home, water damaged belongings, and the cost of clean-up activities. Proper clean-up after a flood event is important to prevent mold from developing.

CC. Table 4.18 100-YearFloodplain Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	2233	442489300	496510900	939000200
Commercial	283	96818500	84792200	181610700
Industrial	211	9717250	73592500	83309750
Institutional	258	288382700	839591000	1127973700
Open Space	315	146199700	58629200	204828900
Transportation	29	0	0	0
Other	241	250204600	12481500	262686100
Vacant	17	71214500	0	71214500
Watershed	6	612200	0	612200
Total	3593	1305638750	1565597300	2871236050

Source: MOA GIS, 2016

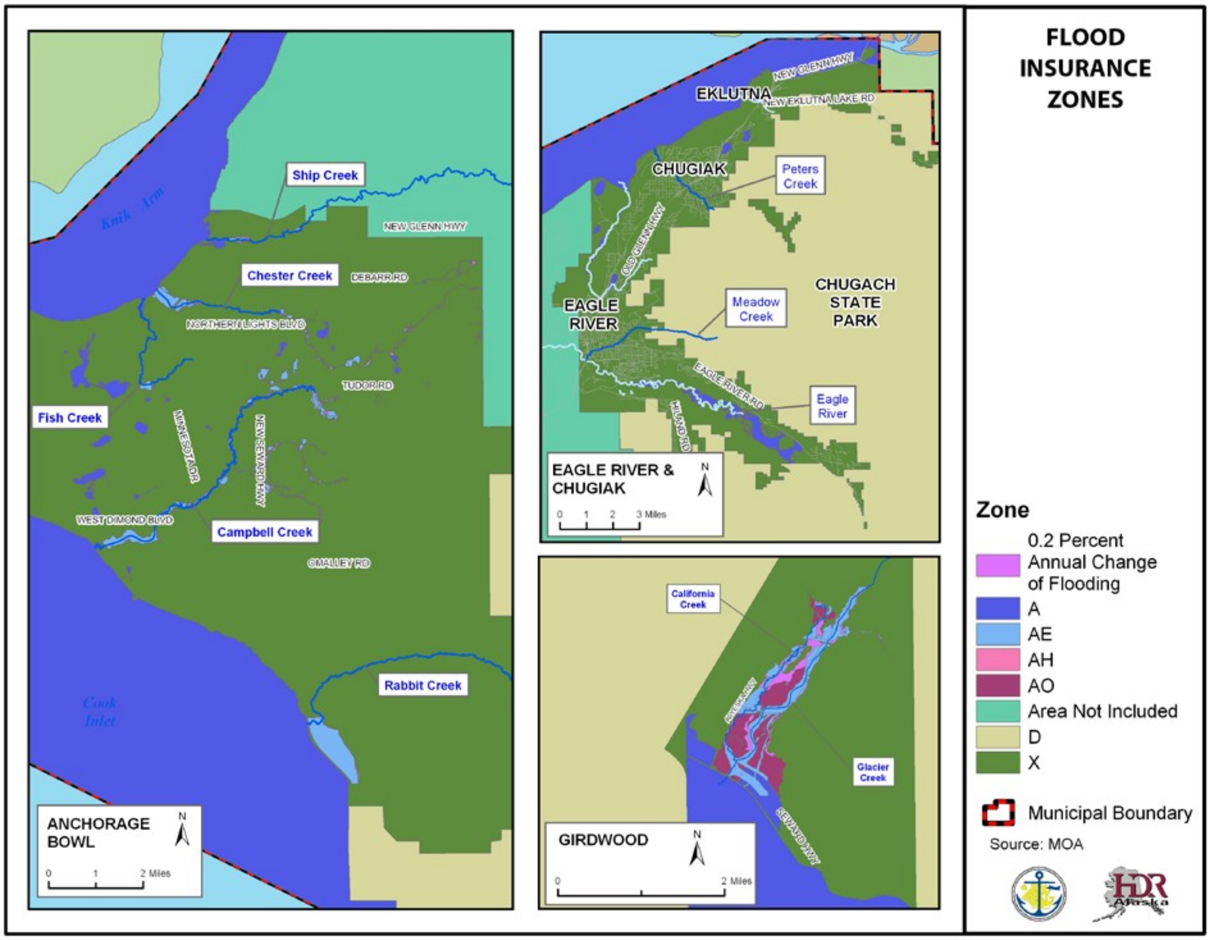
DD. Table 4.19 500-Year Floodplain Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	802	98676700	190217500	288894200
Commercial	60	11823300	5437300	17260600
Industrial	71	13311600	15087700	28399300
Institutional	35	10904000	111697800	122601800
Open Space	66	22899500	4033400	26932900
Transportation	2	0	0	0
Other	22	0	0	0
Vacant	1	0	0	0
Watershed	0	0	0	0
Total	1059	157615100	326473700	484088800

Source: MOA GIS, 2016

For more information about potential vulnerabilities, please see the 2009 Flood Insurance Study.

N**. Figure 4.6 Flood Insurance Zones**



None of the above properties have been identified as a repetitive loss property. A repetitive loss property is defined in the Flood Insurance Manual as a National Flood Insurance Program (NFIP) "insured structure that has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978."

Flood Insurance

The Municipality of Anchorage participates in the NFIP, which makes federally backed flood insurance available for all structures, whether or not they are located within the floodplain. Membership within NFIP —and the availability of flood insurance to municipal residents — requires the MOA to manage its floodplain in ways that meet or exceed standards set by FEMA. Federal financial assistance requires the purchase of flood insurance for buildings located within the Special Flood Hazard Area, a requirement that affects nearly all mortgages financed through commercial lending institutions. While the mandatory flood insurance purchase requirement has been in effect in the MOA since 1970, this requirement was often overlooked by lending institutions. Today, however, all institutions are complying with the applicable flood insurance purchase requirements, and are reviewing all mortgage loans to determine whether flood insurance is required and should have been required in the past. Currently, the MOA has 474 NFIP policies, for a total premium of $320,234. There have been 22 closed paid losses.

There are no known repetitive claims for flooding within the MOA. The MOA requires permits for activity within the FEMA mapped Special Flood Hazard Areas (SFHA) (see appendix D for a copy of the permit application). The MOA complies with the NFIP and FEMA regulations for work in the floodplain. Copies of the FIRMs, elevation certificates, Letters of Map Changes and other documents are maintained by the MOA. All building permits are reviewed for FEMA/NFIP requirements. The floodplain manager also reviews MOA and ADOT projects that will work in the mapped FEMA SFHA. As a participant in the NFIP, the MOA has adopted code to comply with 44 CFR, Part 60.3(d).

The MOA has participated in the NFIP since 1979. The first FIRM became effective in 1979 and the current effective map date is September 25, 2009. The MOA makes PDF versions of the FIRM maps available through their Web site. The web site also has interactive flood maps that can be searched by address. Digital FIRMs are available through FEMA's Map Service Center. The MOA's floodplain ordinance exceeds the FEMA and state minimum requirements by having a 1-foot freeboard requirement, prohibiting critical facilities from being located in a floodplain, and prohibiting most types of floodway development. The floodplain permitting process is described in Appendix D.

The MOA has a dedicated floodplain manager, whose primary duty is floodplain management. Currently, the MOA has three Certified Floodplain Managers on staff. The MOA also currently provides the following administrative services: map and records depository, permit review, cooperative technical partners mapping, assistance with letters of map changes preparation, technical and design assistance, and agency coordination. The only change that would improve the effectiveness of the NFIP program would be the addition of more support from the development community and some sectors of the MOA.

The MOA is in good standing with the NFIP and there are no outstanding compliance issues. The most recent Community Assistance Visit or Community Assistance Contact was in 2015 and there are none scheduled or needed at this time. In 2009 FEMA and the MOA updated all of the FIRMs to digital FIRMs or DFIRMS. There are no new mapping projects pending. Only one Letter of Map Revision (LOMR) is pending for Chester Creek at Muldoon Rd.

The flood hazard program is not involved with the current risk map process that is ongoing with the MOA. The MOA is not at risk for tsunamis and has access to DFIRMs on its Graphic Information System. The Risk Map model would not be able to use new USGS storm data in determining local flooding potential in excess of the current DFIRMs. With GIS the MOA is able to determine by watershed the flood risk to the number of and types of structures (ie residential, commercial, institutional). In discussion with Amanda Siok, we concluded participation in the proposed risk map, would not provide any benefit to the flood hazard program.

Community Rating System

The MOA participated in the Community Rating System (CRS); the current CRS class ranking is 6. Flood hazard policy holders within the Municipality receive a 20 percent discount on their premiums, due to MOA's Flood Hazard Program rating.

4.1.5 AVALANCHE

A snow avalanche is a swift, downhill-moving snow mass. The amount of damage is related to the type of avalanche, the composition and consistency of the avalanche material, the force and velocity of the flow, and the avalanche path.

Avalanche Types

There are two main types of snow avalanches: loose snow and slab. Other types of avalanches include cornice collapse, ice, and slush.

Loose Snow Avalanches

Loose snow avalanches, sometimes called point releases, generally occur when a small amount of uncohesive snow slips and causes additional uncohesive snow to travel downhill. They occur frequently as small, local cold dry "sluffs" that remove excess snow (involving just the upper layers of snow) and keep the slopes relatively safe. Loose avalanches are often small. Most dry loose snow avalanche do not have enough size to cause damage (American Avalanche Association, 2002). Wet loose snow avalanches, most commonly occurring in the spring, also tend to be small but are more likely to cause damage (American Avalanche Association, 2002). Loose snow avalanches can also trigger slab avalanches.

Loose snow avalanches typically occur on slopes above 35 degrees, and leave behind an inverted V-shaped scar. They are often caused by snow overloading (common during or just after a snowstorm), vibration, or warming (triggered by rain, rising temperatures or solar radiation).

Slab Avalanches

Slab avalanches are the most dangerous types of avalanches. They happen when a mass of cohesive snow breaks away and travels down the mountainside. As it moves, the slab breaks up into smaller cohesive blocks.

Slab avalanches usually require the presence of structural weaknesses within interfacing layers of the snowpack. The weakness exists when a relatively strong, cohesive snow layer overlies weaker snow or is not well bonded to the underlying layer. Weaknesses are caused by changes in the thickness and type of snow cover due to changes in temperature or multiple snowfalls. The interface fails for several reasons. It can fail naturally due to earthquakes, blizzards, temperature changes, or other seismic and climatic causes, or artificially by human activity. When a slab is released, it accelerates, gaining speed and mass as it travels downhill.

The slab is defined by fractures. The uppermost fracture delineating the top line of the slab is termed the "crown surface;" the area above that is called the crown. The slab sides are called the flanks. The lower fracture indicating the base of the slab is called the "stauchwall." The surface over which the slab slides is called the "bed surface." Slabs can range in thickness from less than an inch to 35 feet or greater.

Cornice Collapse

A cornice is an overhanging snow mass formed by wind blowing snow over a ridge crest or the sides of a gulley. The cornice can break off and trigger bigger snow avalanches when it hits the wind-loaded snow pillow.

Ice Fall Avalanche

Ice fall avalanches result from the sudden fall of broken glacier ice down a steep slope. They can be unpredictable. They are unrelated to temperature, time of day, or other typical avalanche factors.

Slush Avalanches

Slush avalanches occur mostly in high latitudes. One reason they are more common in high latitudes is because of the rapid onset of snowmelt in the spring. Slush avalanches can start on slopes from 5 to 40 degrees, but usually not above 25 to 30 degrees. The snowpack is totally or partially water-saturated. The release is associated with a bed surface that is nearly impermeable to water. It is also commonly associated with heavy rainfall or sudden intense snowmelt. Additionally, depth hoar is usually present at the base of the snow cover.

Slush avalanches can travel slowly or reach speeds up to more than 40 mph. Their depth is variable as well, ranging from 1 foot to more than 50 feet.

Avalanche Terrain Factors

There are several factors that influence avalanche conditions. The main factors are slope angle, slope aspect, and terrain roughness. Other factors include slope shape, vegetation cover, elevation, and path history. Avalanches usually occur on slopes above 25 degrees. Below 25 degrees, there usually is not enough stress on the snowpack to cause it to slide. Above 60 degrees, the snow tends to "sluff" off and does not accumulate. It is uncommon for avalanches to occur outside this slope angle range.

Slope aspect, also called orientation, describes the direction a slope faces with respect to the wind and sun. Leeward slopes loaded by wind-transported snow are problematic because the wind-deposited snow increases the stress and enhances slab formation. Intense direct sunlight, primarily during the spring months, can weaken and lubricate bonds between snow grains, weakening snowpack. Shaded slopes are potentially more unstable because weak layers are held for a longer time in an unstable state.

Terrain influences snow avalanches because trees, rocks, and general roughness act as anchors, holding snow in place. However, once an anchor is buried by snow, it loses its effectiveness. Anchors make avalanches less likely but do not prevent them unless the anchors are so close together that a person could not travel between them.

Avalanche Path

The local terrain features determine an avalanche's path. The path has three parts: the starting zone, the track, and the run-out zone.

The starting zone is where the snow breaks loose and starts sliding. It is generally near the top of a canyon, bowl, ridge, etc., with steep slopes between 25 and 50 degrees. Snowfall is usually significant in this area.

Avalanche Impact Pressures Related to Damage

ImpactPressures		**Potential Damage**
Kilopascals (kPa)	Pounds per square foot (Lbs/ft^2)	
2-4	40-80	Break windows
3-6	60-100	Push in doors, damage walls, roofs
10	200	Severely damage wood frame structures
20-30	400-600	Destroy wood frame structures, break trees
50-100	1000-2000	Destroy mature forests
>300	>6000	Move large boulders

Source Mears 1992.

The track is the actual path followed by an avalanche. The track has milder slopes, between 15 and 30 degrees. This is where the avalanche will reach maximum velocity and mass. Tracks can branch, creating successive runs that increase the threat, especially when multiple releases share a run-out zone.

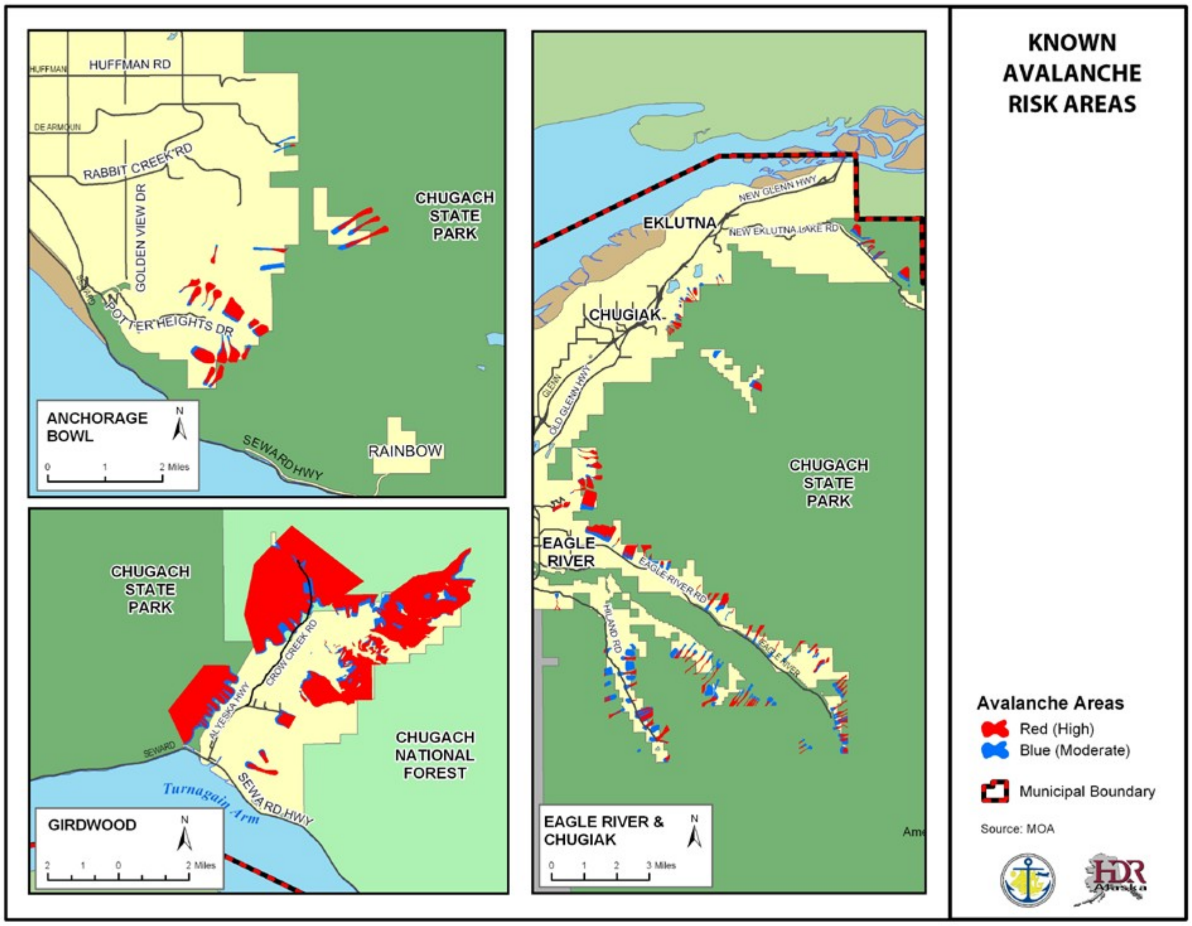
The run-out zone is a flatter area—around 5 to 15 degrees. It is located at the path base where the avalanche slows down, resulting in snow and debris deposition.

The impact pressure determines the amount of damage caused by an avalanche. The impact pressure is related to the density, volume (mass), and velocity of the avalanche.

Location

Avalanches can occur anywhere, but gullies, steep snow-covered slopes, and areas below steep ridges are particularly susceptible. To identify avalanche-prone areas in Anchorage, the Anchorage Snow Avalanche Zoning Analysis was conducted in 1982 by Arthur Mears. This report identified moderate (blue) and high (red) hazard areas, as shown in Figure 4.8.

O. Figure 4.7 Known Avalanche Risk Areas



The report describes the red zone as subject to avalanches with a 10-year average return period and the blue zone as prone to avalanches with a 100-year average return period. This means that a 10-year avalanche has a 10% annual probability, while a 100-year event has a 1% probability. Because an average return period is used, a 10-year avalanche has a return period of 3 to 30 years, while a 100-year avalanche has a return period of approximately 30 to 300 years. Events greater than a 100-year avalanche will affect parcels outside the blue zone.

The area with the potential for the largest avalanches is the Girdwood/Crow Creek area. Evidence of snow avalanches is prominent along the mountainsides above the Girdwood valley. The western mountainside has high and moderate avalanche danger from Turnagain Arm to California Creek. Avalanche hazard is moderate to high on the eastern mountainside at the head of the valley, near the day lodge and resort area, and southeast of Virgin Creek. Alyeska's daylodge and day parking are located partially in both the moderate and high avalanche hazard areas. Part of the original base area hotel and condos are in a moderate hazard area.

Other areas south of the Anchorage Bowl that may experience avalanches are Bird Creek, Indian, and Rainbow. North of the Anchorage Bowl, the areas near the South Fork of Eagle River, Eagle River, Peters Creek (especially near what is locally known as 4-mile), and Mirror

Lake/N.W. Spur of Mt. Eklutna have avalanche potential. For more details, please refer to the Anchorage Snow Avalanche Zoning Analysis.

Another avalanche-prone area is the Seward Highway between the flats near Bird Point and the entrance to the Girdwood Valley (CSAC, 2004). This may be one of the most dangerous stretches of highway for avalanches due to traffic volume. In this area, avalanches have caused numerous accidents, killed at least five people, and caused other deaths from drowning by sweeping people into Turnagain Arm (CSAC, 2004).

Likelihood of Occurrence

Multiple avalanches occur every year, but they usually occur in more remote areas. The number and location depends on the conditions —the formation of weak layers in the snow, wind loading, terrain, etc. On a large scale, avalanches are hard to predict because winter conditions change and can vary from hour to hour. See Hazard Rating Matrix, Table 1.2.

Historic Events

The most remembered avalanches in recent history are those associated with the 2002 winter storms. Those avalanches resulted in road and rail access to Girdwood being blocked, disruption of electrical service, property damage, and the death of a heavy equipment operator who was clearing debris from an earlier avalanche off the Seward Highway.

<u>2000 Central Gulf Coast Storm - Federal Disaster 1316</u>

In December 1999 and January 2000, a series of severe winter storms triggered avalanches and flooding throughout Southcentral Alaska. Anchorage was one of many jurisdictions included in a Federal Disaster Declaration. In Anchorage, damage from this event included one fatality, property damage, disruption of electrical service, and interruption of rail and road access south of the Potter Weigh Station.

The section of New Seward Highway from Bird Point to Girdwood is very avalanche-prone. Between 1951 (when the Seward Highway opened, and 1998) avalanches have blocked the road at least 485 times and have been a factor in more than 60 accidents (CSAC, 2004). In 1998, a six-mile stretch of highway was relocated (from mountainside to a new sea-level route) and was expected to reduce avalanche danger by approximately 70 percent. See Table 4.20 for additional historic avalanche events.

EE. Table 4.20 Known Historic Avalanche Events

Date	Description
February 13, 2010	An avalanche near Mile 7.3 of Hiland Road in Eagle River resulted in a cross-country skier being fatally injured.
March 25, 2009	An avalanche hit an ARRC freight train approximately 5-20 miles south of Portage. Several of the rail cars were buried by the avalanche but there were no fatalities.
January 3, 2006	An avalanche on Ragged Top Mountain near Girdwood, Resulted in fatal injuries to a skier.
February 9, 2006	A snowshoer was fatally injured on Flat Top Mountain.
February 28, 2004	A cornice gave way on Bryon Glacier Peak, near Portage, and triggered an avalanche resulting in the death of a mountain climber.
January 22, 2004	A block of ice slide off the roof of a Forest Service warehouse near Portage and killed a Forest Service employee.
November 11, 2003	A self-triggered slab avalanche occurred in the Chugach State Park on Triangle Peak near the head of the South Fork of the Eagle River Valley. One man was partially buried but his two companions were able to dig him out.
April 1, 2002	An avalanche occurred on the south side of Mount Magnificent, killing two snowshoers. A third man was caught in the avalanche but was able to free himself. The avalanche triggered other slides in the area.
March 28, 2002	Two backcountry skiers and two dogs triggered an avalanche in the south bowl of Three Bowl Path near Mile 6.6 of Hiland Road in Eagle River. One skier was buried under 4 feet of debris and was rescued by the other skier. The following day, while searching for the dogs, a rescuer triggered another slide that hit a house. The slide damaged the fence but not the house; however, there were several feet of debris against the back wall.
November 11, 2000	On the North Gully of Flat Top Mountain, in Chugach State Park, one person was severely injured when he was caught by a small slab avalanche.
February 1, 2000	Avalanche near Bird Flats on the Seward Highway. An Alaska Railroad employee who was helping clear previous slides from the highway was killed when the avalanche struck the bulldozer he was operating. Three avalanches occurred that day. This specific avalanche occurred at the Five Fingers chute, and was estimated to have crossed the highway at between 100 and 125 miles per hour. Slides also occurred at Mile 5.7 on the Eklutna Lake Road, Mile 7.5 of the Old Glenn Highway, and the Glenn Highway at Mile 95.
	Late 1999 and early 2000 saw avalanches in Cordova, Valdez, Anchorage, Whittier, Cooper Landing, Moose Pass, Summit, Matanuska-Susitna Valley, and Eklutna from the Central Gulf Coast Storm.
January 25, 2000	An avalanche occurred in the High Traverse area of Alyeska Resort. All skiers in the area were accounted for.

March 1999	An avalanche at Alyeska Resort partially buried two skiers. This was the first time in 25 years that an avalanche hit skiers at the resort.
December 7,1997	One woman was killed in a self-triggered soft slab avalanche while hiking on the Crow Pass Trail. Her companion was not caught by the avalanche but was unable to locate her.
April 1997	There was a series of avalanches between April 5th and 11th that involved skiers, climbers, and snowmachiners. A snowmachiner was killed in one of those accidents. http://www.sarinfo.bc.ca/Library/Rescues/girwood.AK
1987-88	Several (34) avalanches reached the Seward Highway. Some of the avalanches resulted in temporary highway closures and downed power poles. One avalanche, near Super Scooper (MP 94), struck a vehicle on the highway.
January 1980	Near MP 94, in a chute called Super Scooper, an avalanche hit a vehicle and derailed 4 locomotives and 13 cars of a freight train. Later that winter, avalanches blocked the road again, closing it for 4 days.
March 1979	A series of storms near Bird Hill caused 24 avalanches over several weeks. One slide, with 33 separate tongues, buried 2 miles of highway, closing it for 3 days.
1978	Seward Highway was blocked at least 17 times. One series of slides trapped 20 cars on Bird Hill. Another slide, near MP 99, hit one car and took high voltage lines off 13 poles.
1959-60	The Seward Highway was blocked by avalanches at least 81 times because of frequent blizzards in the Bird Hill area.
1952	On the Girdwood Flats near MP 91.8, an avalanche hit several cars on the highway. One person got out of their vehicle and was hit by a second slide and subsequently died.
1920	Near MP 91, an avalanche buried an Alaska Railroad train. As the train's occupants started to dig themselves out, the train was struck by a second slide. This slide buried 25 people and 4 killed others. It has been reported that several people were swept into Turnagain Arm and drowned.
1918	An avalanche near the present Seward Highway MP 92 killed several draft horses and knocked a telegraph pole over.

Additional avalanche events are listed in Mears, 1993 and Mears, 1982.

Vulnerability

Avalanche vulnerability is calculated using the areas in the MOA's avalanche GIS file (shown in Figure 4.10). The number of parcels in a high-risk avalanche area is shown in Table 4.21, while those in a moderate-risk area are shown in Table 4.22. Only a portion of these parcels are likely to be impacted by a given avalanche event. Other development including above ground utility lines can also be vulnerable to avalanches.

Avalanches have the ability to cause injury and death to people in the impacted area. With the average household size in the MOA being 2.65, the 24 residential parcels there is approximately 64 people living in an area with a known avalanche risk. Most avalanche related fatalities involve outdoor recreationalists such as back country skiers, snowboarders and snowmachiners but not exclusively. Many times, the victim triggers the avalanche. Other people such as passing motorists can also be at risk. Avalanches have the ability to destroy buildings, cover buildings and roads with snow and debris. They can also take down utility lines.

Historically, avalanches have caused the closure of the Seward Highway isolating Girdwood from the rest of the MOA. The avalanche hazard may increase road maintenance costs. Depending on the conditions, more avalanche mitigation measures may be needed.

FF. Table 4.21 High Avalanche Hazard Area Vulnerability

Land Use: Anchorage	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	1	48600	285600	334200
Commercial	0	0	0	0
Industrial	0	0	0	0
Institutional	0	0	0	0
Parks	0	0	0	0
Transportation	0	0	0	0
Other	0	0	0	0
Vacant	25	4641600		4641600
Watershed	10	0	0	0
Total	36	4690200	285600	4975800
Land Use: Chugiak/Eagle River	**# of Parcels**	**Taxable Value (Land)**	**Taxable Value (Buildings)**	**Total**
Residential	97	11521400	25484800	37006200
Commercial	0	0	0	0
Industrial	0	0	0	0
Institutional	4	0	0	0
Parks	0	0	0	0
Transportation	0	0	0	0
Other	10	0	0	0
Vacant	74	8475900		8475900
Watershed	67	0	0	0
Total	252	19997300	25484800	45482100
Total	252			
Land Use: Girdwood	**# of Parcels**	**Taxable Value (Land)**	**Taxable Value (Buildings)**	**Total**
Residential	31	1339400	3202500	4541900
Commercial	12	5402700	1133400	6536100
Industrial	1	459900	185000	644900
Institutional	0	0	0	0

Parks	0	0	0	0
Transportation	0	0	0	0
Other	11	0	0	0
Vacant	15	861800	0	861800
Watershed	2	0	0	0
Total	72	8063800	4520900	12584700

Source: MOA GIS, 2016

GG. **Table 4.22 Moderate Avalanche Hazard Area Vulnerability**

Land Use: Anchorage	**# of Parcels**	**Taxable Value (Land)**	**Taxable Value (Buildings)**	**Total**
Residential	9	712,400	3,001,900	3,714,300
Commercial	0	0	0	0
Industrial	0	0	0	0
Institutional	2	1981900	0	1981900
Parks	0	0	0	0
Transportation	0	0	0	0
Other	0	0	0	0
Vacant (residential)	34	5,500,500	0	5,500,500
Watershed	8	3415700	0	3415700
Total		11610500	3001900	14,612,400
Land Use: Chugiak/Eagle River	**# of Parcels**	**Taxable Value (Land)**	**Taxable Value (Buildings)**	**Total**
Residential	270	30,820,800	73,422,300	104,243,100
Commercial	0	0	0	
Industrial	0	0	0	0
Institutional	4	2901100		2901100
Parks	3	7108500	0	7108500
Transportation	0	0	0	0
Other	19	38477300		38477300
Vacant	137	20,188,100		20,188,100
Watershed	74	26480200	2938500	29418700
Total	507	125,976,000	76,360,800	202,336,800
Land Use: Girdwood	**# of Parcels**	**Taxable Value (Land)**	**Taxable Value (Buildings)**	**Total**
Residential	15	4461700	6363400	10825100
Commercial	12	5781400	1458000	7239400
Industrial	0	0	0	0
Institutional	0	0	0	0
Parks	0	0	0	0
Transportation	0	0	0	0
Other	3	0	0	0

Vacant	18	1745000		1745000
Watershed	1	0	0	0
Total	49	11988100	7821400	19809500

Source: MOA GIS, 2016

4.1.6 LANDSLIDE/GROUND FAILURE

Ground failure is a general term used to describe hazards that affect the stability of the ground. It can occur in many different ways, including landslides, land subsidence, and failures related to seasonally frozen ground and permafrost. Frequently, ground failure occurs as the result of another hazard such as an earthquake or volcanic eruption. Seismically-induced ground failure is a major concern in the MOA.

Ground failure tends to cause more property damage than injuries or fatalities. Property damage can occur to buildings and infrastructure such as buried pipes. Ground failure can cause damage to the transportation system including roads, bridges, and railroads. Areas threatened by ground failure may have lower real estate values which can result in lower property tax revenue.

Landslides

Landslide is a generic term for a variety of downslope movements of earth material under the influence of gravity. Some landslides occur rapidly, in mere seconds, while others might take weeks or longer to develop.

It is hard to identify high and moderate zones of hazard intensity for different types of landslides. For example, hazard zones for rock falls can't be identified because the risk depends on the size of the rocks involved. It is known that the bluff near Points Campbell and Woronzof is a "narrow zone of very unstable material with a strong risk of landslide" (Mason, 1997: 198-199). The area near Campbell Lake has a high risk of landslides (Mason, 1997). "Debris flows occur in small, steep drainage basins throughout the" Glacier/Winner Creek area (Mears, 1993:13).

Landslides can occur naturally or be triggered by human activities. They occur naturally when inherent weaknesses in the rock or soil combine with one or more triggering events such as heavy rain, snowmelt, changes in groundwater level, and seismic or volcanic activity. Landslides can be caused by long-term climate change that results in increased precipitation, ground saturation, and a rise in groundwater level, which reduces shear strength and increases the weight of the soil. Erosion that removes material from the base of a slope can also trigger landslides.

Human activities that trigger landslides are usually associated with construction, such as grading that removes material from the base, loads material at the top, or otherwise alters a slope. Changing drainage patterns, groundwater level, slope, and surface water (for example, the addition of water to a slope from agricultural or landscape irrigation, roof downspouts, septic-tank effluent, or broken water or sewer lines) can also cause landslides.

Three main factors that influence landslides are topography, geology, and precipitation. Topography and geology are associated with each other; the steeper the slope, the greater the gravitational influence. Rock strength is important, as certain bedrock formations or rock types appear to be more prone than others to landsliding. Precipitation may erode and undermine slope surfaces. When precipitation is absorbed into the ground, it increases the pore water pressure and lubricates weak zones of rock or soil.

Secondary Effects

Landslides are often associated with other hazards. For example, a landslide may occur during floods because both involve precipitation, runoff, and ground saturation. Landslides are often associated with seismic and volcanic events. It has been estimated that ground failure, not shaking, caused most of the damage in the Good Friday Earthquake in Alaska.

The secondary effects of landslides can extend the damage past the limits of the actual landslide. For example, a landslide that dams a river or creek can cause damage upstream due to flooding and downstream due to flooding that may result from a sudden break in the dammed river. Landslides can also trigger tsunamis and seiches.

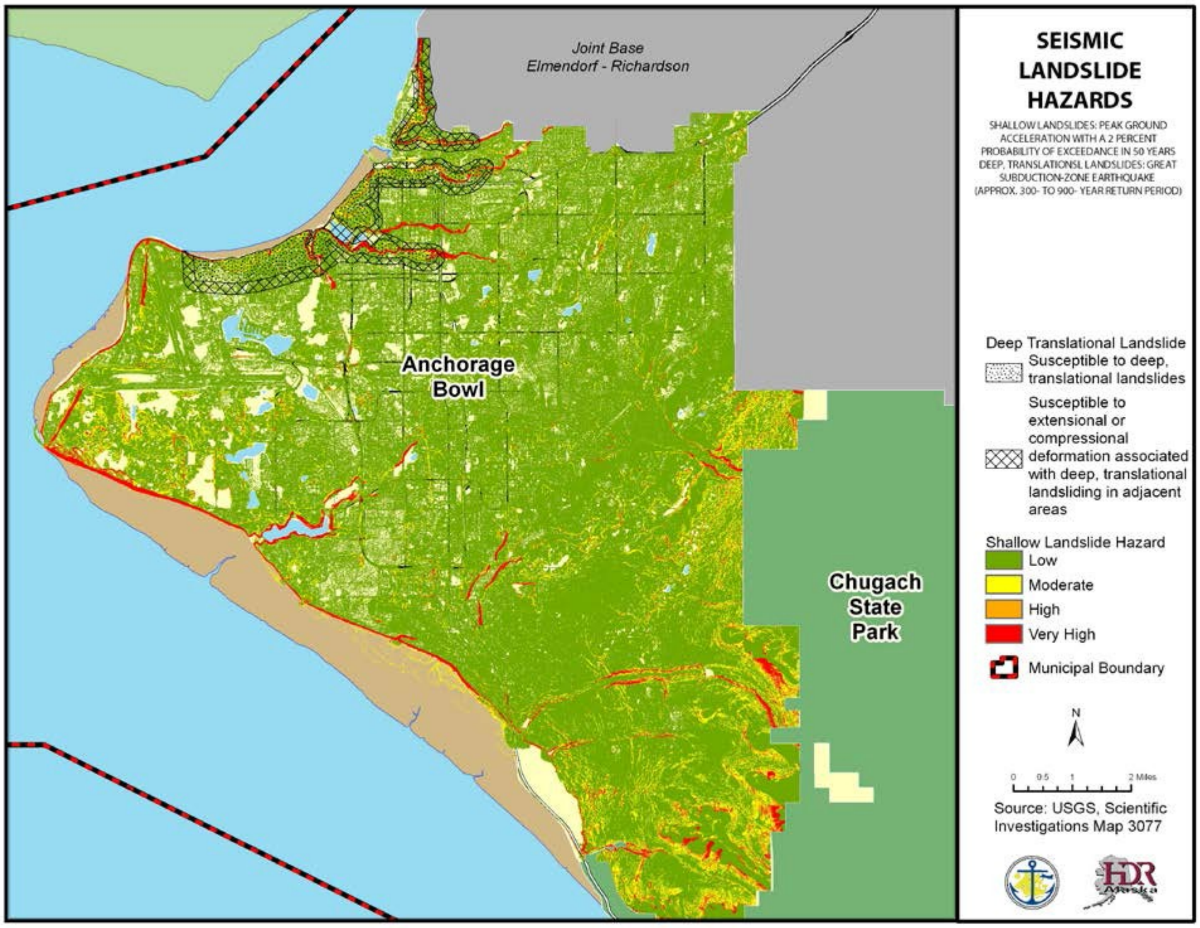
Seismically Induced Ground Failure

In 1979, a Geotechnical Hazards Assessment Study was developed to "inventory all significant geotechnical data with respect to geologic hazards, to analyze the data to provide an indication of the degree of hazard, and to designate those areas of potential hazards upon a series of maps" (Harding-Lawson, 1979:3).

Most landslides caused by the 1964 earthquake fall into two categories: "(1) deep, translational block-type landslides on sub-horizontal shear surfaces, and (2) shallower, more disrupted slides and slumps, on more steeply dipping shear surfaces, along coastal and stream bluffs and other steep slopes" (USGS, 2009). The translational block slides occurred mostly in the downtown and Turnagain Heights areas. These areas tend to have thick (over 30 feet) layers of Bootlegger Cove Formation clay. The shallower slides generally occurred in coastal areas and stream bluffs. The following figures show the seismic landslide hazard for deep translational landslides associated with great subduction zone earthquakes with return periods between approximately 300 and 900 years, shallow landslides with a 2 percent probability of exceedance in 50 years, and shallow landslides with a 10 percent probability of exceedance in 50 years.

The United States Geologic Survey (USGS) recently completed a report on seismic landslide hazards in the Anchorage Bowl (Jobson and Michael, 2009). According to this report, a large portion of the Anchorage Bowl has a low hazard but areas with moderate, high, and very high potential exist.

P. Figure 4.8 Seismic Landslide Hazards



As Figure 4.9 shows, the areas most likely for a deep translational landslide are Turnagain Heights, Downtown, Government Hill, and along the western portion of Chester Creek and Ship Creek. The areas most likely for shallow landslides are "steeper slopes, principally along coastal and stream bluffs and steep slopes bounding some glacial hills" (Wesson and others, 2007). Areas that have high and very high shallow landslide hazard include the Government Hill, along Chester Creek, along the Turnagain and Knik Arms, and Campbell Lake.

The Chugiak/Eagle River and Turnagain Arm areas were not included in this report. While landslides are possible in these areas, additional research is needed

Land Subsidence

Land subsidence is any sinking or downward settling of the Earth's surface. Common causes of land subsidence in Alaska are sediment compaction and seismic or volcanic activity.

Based on previous experience, the Portage and Girdwood areas are susceptible to subsidence.

Seasonally Frozen Ground

Frost action is the seasonal freezing and thawing of water in the ground and its effect on the ground and development. Frost heave is when ice formation causes an upward displacement of the ground. When the ground ice thaws, the ground loses bearing strength and its ability to support structures is weakened. This is a widespread problem in Alaska.

Likelihood of Occurrence

Ground failure events are difficult to predict, as many of them are triggered by other events such as earthquakes. See Hazard Rating Matrix, Table 1.2.

Historic Events

The 1964 Good Friday earthquake triggered a wide variety of falls, slides, and flows through Southcentral Alaska. The Anchorage area was heavily impacted because of Bootlegger Cove clay failures. Some of the more significant events occurred at 4th Avenue, L Street, Government Hill, and Turnagain Heights. Several less-devastating slides occurred throughout town, including slides at Point Woronzof and Potter Hill.

The Government Hill slide was a complex movement. Government Hill Elementary School was severely damaged by the translational slide. The south wing of the school dropped about 30 feet, while the east wing split lengthwise and collapsed. Part of this slide became an earth flow that spread 150 feet across the flats into the Alaska Railroad yards. Anchorage All-Hazards Mitigation Plan Update

The Turnagain Heights landslide is also considered a complex movement. In fact, it was probably the most complex of all the Anchorage landslides associated with the Good Friday earthquake. The landslide likely began as a block slide, but evolved to include lateral spreading, slumping, and possibly other types of movement. This landslide caused serious damage to a housing development, in which three people died.

The earthquake caused at least one rock avalanche as a slab of rock became detached from the mountain peak overlooking Sherman Glacier. The rock slab disintegrated as it moved downhill, enabling it to reach high velocity and extend a great distance over the glacier. Rockslides were also triggered, including “one relatively significant event in the Winner Creek drainage” (Mears, 1993:12).

Extensive subsidence also occurred as a result of the 1964 Good Friday earthquake. The zone of subsidence covered about 110,039 square miles, including the north and west parts of Prince William Sound, the west part of the Chugach Mountains, most of Kenai Peninsula, and almost all the Kodiak Island group. Some areas experienced subsidence that exceeded seven feet, but most areas subsided less. For example, part of the Seward area is about 3.5 feet lower than before the earthquake and portions of Whittier subsided more than five feet. The village of Portage, at the head of Turnagain Arm of Cook Inlet, experienced six feet of tectonic subsidence during the earthquake.

Vulnerability

An earthquake could cause seismically induced landslide. For information about earthquakes, please see Section 4.1. The susceptibility for seismically induced ground failure has been determined only for the part of the Municipality shown in Figure 4.9. Table 4.23 shows the parcels that are susceptible to a deep, translational landslide while Table 4.24 shows the parcels that are susceptible to deformation associated with deep, translational landslides in adjacent areas. A similar calculation could not be conducted to identify the vulnerability to the shallow landslide hazard as the file format did not permit this analysis. Based on an average MOA household size of 2.65, there is approximately 5,955 people living areas that are vulnerability to deep, translational landslides and an additional 3,729 living in the adjacent areas. Infrastructure, including buried pipes, are vulnerable to ground failure.

HH. Table 4.23 Deep, Translational Landslide Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	2339	433511900	637984400	1071496300
Commercial	419	223303600	451056700	674360300
Industrial	48	49107700	44055800	93163500
Institutional	43	74470000	77213700	151683700
Open Space	12	3164300	271500	3435800
Transportation	0	0	0	0
Other	3	0	0	0
Vacant	22	0	0	0
Total	2886	783557500	1210582100	1994139600

Source: MOA GIS, 2016

II. Table 4.24 Deformation in Adjacent Areas Vulnerability

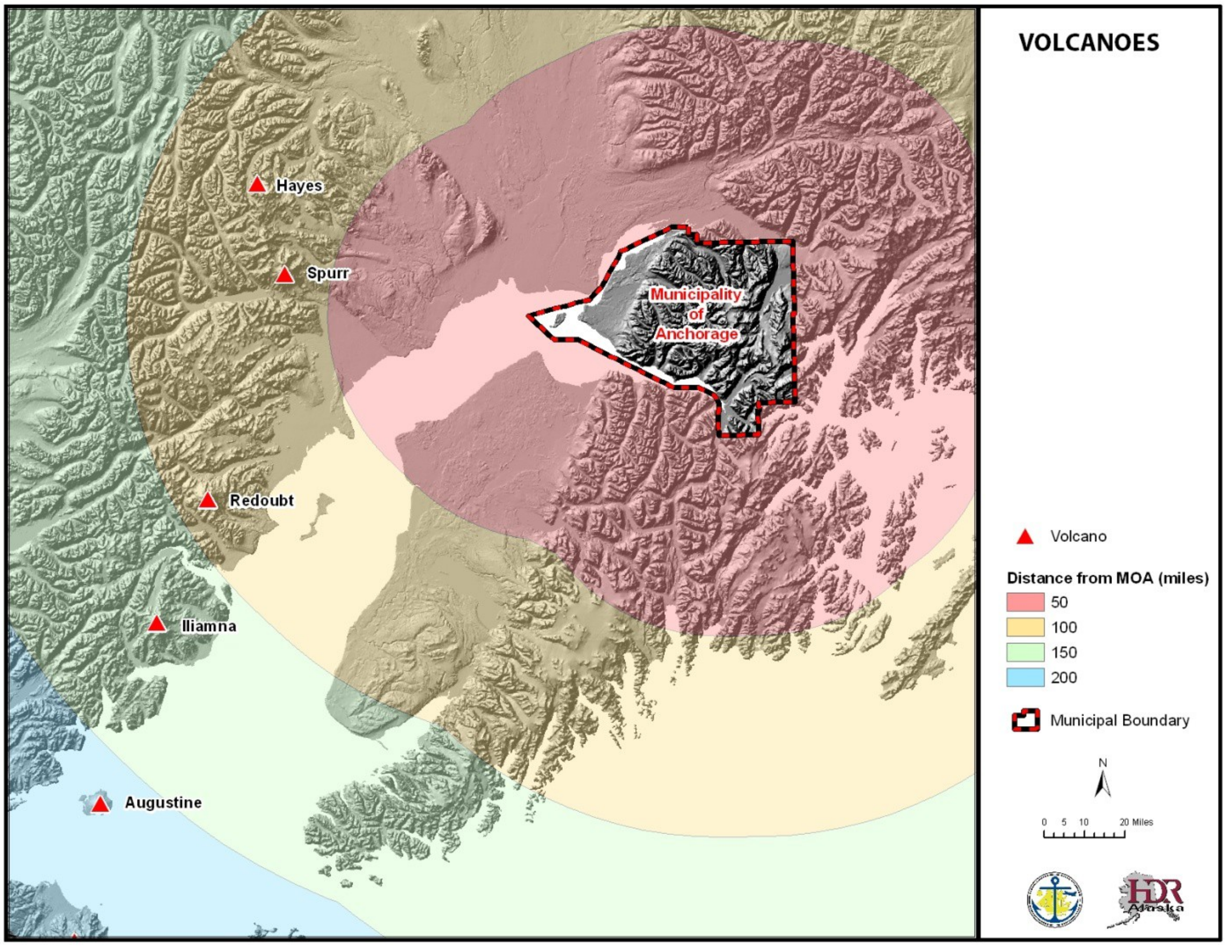
Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	1350	189932800	320803700	510736500
Commercial	700	362166700	879711300	1241878000
Industrial	80	72405800	123638800	196044600
Institutional	59	39055100	32231200	71286300
Open Space	9	2814000	0	2814000
Transportation	0	0	0	0
Other	4	0	0	0
Vacant	32	0	0	0
Total	2234	666374400	1356385000	2022759400

Source: MOA GIS, 2016

4.1.7 VOLCANIC ASHFALL

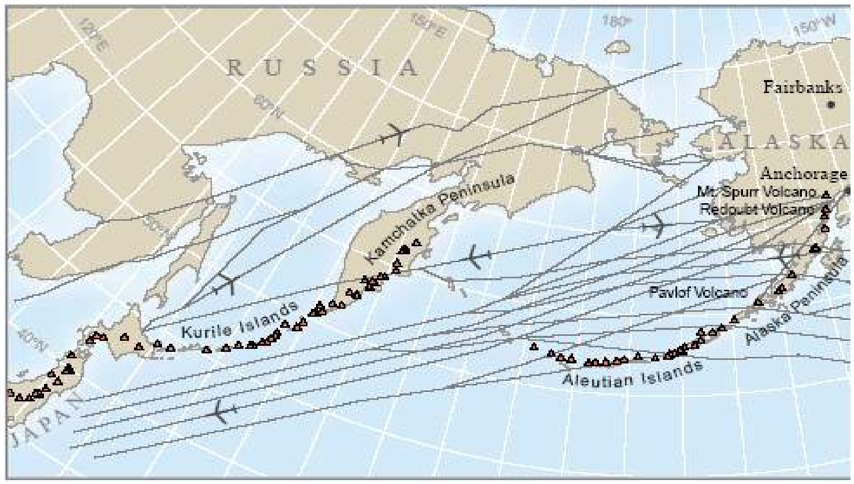
According to the Alaska Volcano Observatory (AVO), a volcano is “a vent in the surface of the Earth through which magma and associated gases and ash erupt; also, the form or structure (usually conical) that is produced by the ejected material” (AVO www.avo.alaska.edu, undated). Alaska is home to over 130 volcanoes with 90 of them being active in the last 10,000 years and over 50 have been active since approximately 1760. None of these volcanoes are located within the MOA (see Figure 4.10). Because of the distance between any volcano and the MOA, the MOA will not be likely be directly affected by most elements of a volcanic eruption that occurs in Alaska; with the exception of ash fall.

Q. Figure 4.9 Volcanoes



There are a variety of hazards associated with a volcanic eruption, but the primary hazard to the MOA is volcanic ash fall. Volcanic ash consists of small jagged pieces (less than 1/12 inch in diameter) of rocks, minerals, and volcanic glass sent into the air by a volcano (Kenedi and others, 2000). Volcanic ash is created during an explosive volcanic eruption. Alaska's volcanic activity is dominated by explosive volcanism.

Volcanic ash can accumulate on roof tops, power lines or other structures causing them to collapse. Wet ash can conduct electricity and may cause short circuits or the failure of electrical components. Ash fall may interfere with telephone and radio communications. Ash can also interfere with the operation of mechanical equipment, including aircraft. In Alaska, this is a major problem, as many major flight routes are near historically active volcanoes; the main airport for the MOA and all of Alaska, the TSAIA along with Merrill Field, and JBER



Alaska's volcanoes and a schematic depiction of selected major North Pacific and Russian Far East air routes. SOURCE: AVO

Elmendorf AFB air facilities, are all at risk from volcanic ash fall. Ash falling or resuspended can also reduce visibility and make roads and runways slippery making transportation difficult. Ash may be a health risk especially to people with cardiac or respiratory conditions, children and the elderly. Ash is abrasive and can injure eyes (Kenedi and others, 2000).

Based on proximity, the volcanoes that are most likely to result in ash fall in the MOA are the five Cook Inlet Volcanoes, Hayes, Spurr, Redoubt, Iliamna and Augustine (figure 4.11). Of these, Augustine is considered the most historically active volcano in the Cook Inlet region (Wallace and others, 2010). For more information about these volcanoes, please see the respective volcano hazard report available on the AVO website at http://www.avo.alaska.edu/downloads/classresults.php?pregen=haz

Location

The entire MOA could be impacted by a volcanic ash event. Different areas of the MOA may be impacted by any given event depending on which volcano erupts, wind direction, and duration of the eruption. Due to the prevailing winds, the MOA could receive ash fall from any Cook Inlet volcano depending on wind conditions at the time of the eruption (Waythomas and others, 1997; Waythomas and Waitt, 1998). Recent lake-core studies in the Anchorage area indicate that Mount Spurr volcano is the most prolific source of ash fall in the MOA over the last 12,000 years (Wallace and others, 2010). It is also possible that ash could reach the MOA from a large eruption outside of the Cook Inlet region.

Likelihood of Occurrence

Volcanic activity that poses a risk to aircraft or local populations in Alaska is infrequent. The AVO actively monitors Alaska's volcanoes for signs of unrest. AVO is also responsible for issuing warnings of eruptions or activity that may lead to an eruption. See Hazard Rating Matrix, Table 1.2.

The MOA is more likely to experience ash fall from Spurr, Redoubt, and Augustine volcanoes because of the proximity of the MOA to these sources upwind. Based on geologic studies of the Cook Inlet volcanoes, Spurr, Redoubt, and Augustine are considered more frequently active than Hayes or Iliamna volcanoes, According to the USGS, “large-volume, explosive, ash-forming eruptions of Iliamna are probably unlikely in the future but significant disruptive small eruptions could occur (Waythomas and Miller, 1999). Hayes Volcano appears to be largely inactive in the past few thousand years and historical eruptions are unknown (USGS, 2002). However, the largest ash fall event in the MOA in the late Holocene occurred from Hayes Volcano (3,700–4,200 years ago).

Historic Events

In its nearly 100 years of existence, Anchorage has dealt with ash from historical eruptions of Spurr, Redoubt, and Augustine volcanoes. Additional information about these eruptions can be found in the respective Volcano-Hazard Assessments.

Spurr Volcano

In 1992, a series of three ash-producing eruptions occurred from Crater Peak, the active vent on Spurr Volcano. Ash fall from one of the three events occurred in the MOA (August 18) and triggered a disaster declaration. Approximately 0.12 inches (3 mm) of sand-sized ash fell in the MOA. The eruption caused health problems and property damage. Economic losses resulted from businesses, schools, and industrial facility closures. Cars, computers, and other electronic devices were damaged. TSAIA was closed for 20 hours. Two people had heart attacks while shoveling ash (Waythomas and Nye, 2002). Numerous air-quality alerts were issued for days following the ash-fall event due to resuspension of the ash deposit and air-quality was a concern until the first snow in the fall (Waythomas and Nye, 2002).

The only other historical eruption of Mount Spurr, was in July 1953. Ash from this eruption reached the MOA and deposited about twice as much ash as in 1992 (Waythomas and Nye, 2002).

Redoubt Volcano

The most recent eruption of Redoubt occurred in 2009 and produced at least 19 ash-producing explosions between March 22 and April 4 (Wallace and Schaefer, 2009). Only one such explosion on March 28 resulted in trace (< 0.8 mm or 0.031 in) ash fall in the MOA. Ash-fall impacts to the MOA were relatively minor due to the short duration (<1 hour) of ash fall and occurrence during winter months where the ash quickly mixed with snow on the ground preventing significant resuspension. Economic losses due to disruptions to airline travel were however, significant and the TSAIA was closed for 22 hours (March 28) and numerous flights were cancelled or rerouted throughout the eruption (Wallace and Schaefer, 2009).

Redoubt Volcano also erupted in 1989–1990 during which some 20 ash-producing explosions occurred (Scott and McGimsey, 1994). Ash fall in the MOA occurred on 3 occasions depositing trace amounts of ash (<0.8 mm or 0.031 in). The most serious impacts were economic losses due to disruptions to airline travel and the KLM Boeing 747-400 jet aircraft that temporarily lost power when it encounter the a diffuse volcanic ash plume causing millions of dollars in damage . The volcanic ash cloud affected flights from TSAIA, Merrill Field, and Elmendorf Air Force Base. As a result of eruption, the lost revenue to TSAIA is estimated at $2.6 million

(Waythomas and others, 1997). The volcanic ash resulted in some school and business closures. Some people experienced respiratory problems from inhaling fine ash particles.

Augustine Volcano

The most recent eruption of Augustine occurred in 2006 when 13 major ash-producing explosions occurred between January 11 and mid-March. This was the fifth major eruption in 75 years (Power and others, 2010). Impacts from this event were considered minor with the biggest economic losses associated with cancelled, diverted, and rescheduled flights to avoid possible exposure to ash (Neal and others, 2010). The level of respirable particulate matter in the air within the MOA was reportedly elevated on several days during the eruption but did not exceed Environmental Protection Agency (EPA) standards (Wallace and others, 2010). There is no known significant property damage or adverse health effects associated with this eruption (Neal and others, 2010).

The 1986 eruption of Augustine (March-April) deposited trace (<0.8 mm or 0.031 in) amounts of ash in the MOA and caused significant disruptions to air traffic. A dome formed in the crater and caused some to fear it would subsequently collapse and trigger a tsunami along the east shore of Cook Inlet, as occurred in 1883. This eruption caused flights to and from TSAIA to be cancelled and military aircraft were evacuated from Elmendorf Air Force Base. The level of respirable particulate matter in the air within the MOA was elevated for several days in late March but remained just below the health emergency threshold (EPA national standard), although some sensitive people experienced respiratory problems. Many schools and businesses were temporarily closed (Swanson and Kinele, 1988).

A significant eruption also occurred in 1976 and produced ash plumes during January, February, and April. Minor ash fall (0.6 in or 1.5 mm) occurred in the MOA on January 24–25 (Shackelford, 1978). Advisories to remain indoors were issued and many schools and businesses were closed in the MOA. Some people experienced respiratory problems and visibility in some locations was reduced to about 300 feet (100 meters or less) (Waythomas and Waitt, 1998). Ash was ingested by the equipment at the Beluga power plant, the primary power supply for Anchorage (Swanson and Kinele, 1988).

Vulnerability

Because the ash from a volcanic eruption could affect the entire Municipality, the entire MOA is represented in Table 4.32. In general, weather patterns and wind direction during an eruption will influence where ash fall occurs. Air transportation is particularly vulnerable to volcanic ash clouds as these clouds can travel great distances and cover broad areas. Ash may lead to increased traffic accidents as it reduces visibility and can make roadways slippery (IVHHN, unknown). Disruptions to the transportation system may cause delayed shipments of goods into the area.

Ashfall can disrupt power service. Power generation facilities may close to prevent equipment damage. As wet ash is conductive, equipment may need to be shut down to be properly cleaned or serviced (USGS, 2009a). Ash can contaminate water supplies making them unsafe to drink (IVHHN, unknown). Volcanic ash can cause changes in water quality (turbidity, acidity, and chemistry), increased wear on water delivery and treatment systems and high demand for water during cleanup activities (USGS 2009). Building roofs may collapse under the weight of the ash (IVHHN, unknown). In addition, volcanic ash also poses a health risk to people especially those cardiac or respiratory conditions such as asthma and emphysema (IVHHN, unknown). Volcanic ash can also cause eye irritation and skin irritation (IVHHN, unknown).

JJ. Table 4.25 Volcanic Ash Vulnerability

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

4.1.8 EROSION

Erosion is a process that involves the wearing away, transportation, and movement of land. Erosion rates can vary significantly because erosion can occur quite quickly as the result of a flash flood, coastal storm, or other event. It can also occur slowly, as the result of long-term environmental changes. Erosion is a natural process, but its effects can be exacerbated by human activity.

Erosion rarely causes death or injury. However, erosion causes the destruction of property, development, and infrastructure. In Alaska, coastal erosion is the most destructive, riverine erosion a close second, and wind erosion a distant third.

Bluff erosion occurs when water runs off the land, forming gullies. It is also caused by wave action at the toe of the bluff or when a bluff collapses under the weight of a heavy snow or rainfall.

Beach erosion occurs when wave action removes the light sand.

Classifying erosion can be difficult, as there are multiple terms used to refer to the same type of erosion. For example, riverine erosion may be called stream erosion, stream bank erosion, or riverbank erosion, among other terms. Coastal erosion is sometimes referred to as tidal erosion. Sometimes bluff erosion is included in coastal erosion; other times they are considered two separate processes. The same goes for beach erosion. For this plan, coastal erosion encompasses bluff and beach erosion, while riverine erosion will be considered synonymous with stream erosion, stream bank erosion, and riverbank erosion.

Coastal Erosion

Coastal erosion is the wearing away of land, through natural activity or human influences, that results in loss of beach, shoreline, or dune material. Coastal erosion occurs over the area roughly from the top of the bluff out into the near-shore region, to about the 30-foot water depth. It is measured as the rate of change in position or the horizontal displacement of a shoreline over a period of time. Bluff recession is the most visible aspect of coastal erosion because it causes dramatic in the landscape. As a result, this aspect of coastal erosion usually receives the most attention.

On the coast, the forces of erosion are embodied in waves, currents, and wind. Surface and ground water flow, and freeze-thaw cycles may also play a role. Not all of these forces may be present at any particular location.

Coastal erosion can occur from rapid, short-term daily, seasonal, or annual natural events such as waves, storm surge, wind, coastal storms, and flooding, or from human activities including boat wakes and dredging. The most dramatic erosion often occurs during storms, particularly because the highest-energy waves are generated under storm conditions. Coastal erosion also may be from multi-year impacts and long-term climatic change such as sea-level rise, lack of sediment supply, subsidence, or long-term human factors such as the construction of shore protection structures and dams or aquifer depletion. Studies are underway to determine the effects generated from global warming.

Ironically, attempts to control erosion through shoreline protective measures such as groins, jetties, seawalls, or revetments can actually lead to increased erosion activity. This is because shoreline structures eliminate the natural wave run-up and sand deposition processes and can increase reflected wave action and currents at the waterline. The increased wave action can cause localized scour both in front of and behind structures and prevent the settlement of suspended sediment.

Fortunately, in Alaska, erosion is hindered by bottomfast ice, which is present on much of the Arctic coastline during the winter. These areas are fairly vulnerable while the ice is forming. The winds from a fall storm can push sea ice into the shorefast ice, driving it onto the beach. The ice will then gouge the beach and cause other damage.

Definitions

Groin - A narrow, elongated coastal-engineering structure built on the beach perpendicular to the trend of the beach. Its purpose is to trap longshore drift to build up a section of beach.

Jetty - A narrow, elongated coastal-engineering structure built perpendicular to the shoreline at inlets to stabilize the position of a navigation channel, to shield vessels from wave forces, and to control the movement of sand along adjacent beaches to minimize the movement of sand into a channel.

Seawall - A vertical, wall-like coastal-engineering structure built parallel to the beach or duneline and usually located at the back of the beach or the seaward edge of the dune. It is designed to halt shoreline erosion by absorbing the impact of waves.

Revetment - An apron-like, sloped, coastal-engineering structure built on a dune face or fronting a seawall. It is designed to dissipate the force of storm waves and prevent undermining of a seawall, dune or placed fill.

Factors Influencing the Erosion Process

There are a variety of natural and human-induced factors that influence the erosion process. For example, shoreline orientation and exposure to prevailing winds, open ocean swells, and waves influence erosion rates. Beach composition influences erosion rates as well. For example, a beach composed of sand and silt, such as those near Shishmaref, is easily eroded, whereas beaches consisting primarily of boulders or large rocks are more resistant to erosion. Other factors may include:

- Shoreline type
- Geomorphology of the coast
- Structure types along the shoreline
- Density of development
- Amount of encroachment into the high hazard zone
- Proximity to erosion inducing coastal structures
- Nature of the coastal topography
- Elevation of coastal dunes and bluffs
- Shoreline exposure to wind and waves.

Riverine Erosion

Rivers constantly alter their course, changing shape and depth, trying to find a balance between the sediment transport capacity of the water and the sediment supply. This process, called riverine erosion, is usually seen as the wearing away of riverbanks and riverbeds over a long period of time.

Riverine erosion is often initiated by failure of a riverbank, causing high sediment loads, or by heavy rainfall. This generates high volume and velocity run-off that will concentrate in the lower drainages within the river’s catchment area. When the stress applied by these river flows exceeds the resistance of the riverbank material, erosion will occur.

As the sediment load increases, fast-flowing rivers will erode their banks downstream. Eventually, the river becomes overloaded or velocity is reduced, leading to the deposition of sediment further downstream or in dams and reservoirs. The deposition may eventually lead to the river developing a new channel.

While all rivers change in the long-term, short-term rates of change vary significantly. In less-stable braided channel reaches, erosion and deposition of material are a constant issue. In more stable meandering channels, episodes of erosion may only occur occasionally. The erosion rate depends on the sediment supply and amount of run-off reaching the river. These variables are affected by many things including earthquakes, floods, climatic changes, loss of bank vegetation, urbanization, and the construction of civil works in the waterway.

Riverine erosion has many consequences, including the loss of land and development on that land. It can cause increased sedimentation of harbors and river deltas, hinder channel navigation, and affect marine transportation.

Other problems include reduction in water quality due to high sediment loads, loss of native aquatic habitats, damage to public utilities (roads, bridges and dams) and maintenance costs from trying to prevent erosion sites.

Location

Most of the MOA is not impacted by riverine erosion, although it may occur in some localized areas. For example, "Peters, Meadow, and Rabbit Creeks experience high-velocity flows that can lead to extensive erosion of banks and washouts at inadequate stream crossings" (FEMA, 2002:11).

Likelihood of Occurrence

Riverine erosion will always occur in Anchorage because rivers and other flowing water bodies are constantly altering their course. See Hazard Rating Matrix, Table 1.2.

Historic Events

No significant riverine erosion events have been identified.

Vulnerability

A recent GIS file showing the location of riverine erosion is not available. Only property adjacent to a river may be affected by riverine erosion. Property is considered more vulnerable to riverine erosion that people.

Wind Erosion

Wind erosion is when wind is responsible for the removal, movement, and redeposition of land. It occurs when soils are exposed to high-velocity wind, which picks up the soil and carries it away. The wind moves soil particles 0.0039 -0.0197 inch in size in a hopping or bouncing fashion (known as saltation) and those larger than 0.0197 inch by rolling (known as soil creep). The finest particles (less than 0.0039 inches) are carried in suspension. Wind erosion can increase during periods of drought.

Wind erosion can cause a loss of topsoil, which can hinder agricultural production. The dust can reduce visibility, which can cause automobile accidents, hinder machinery, and have a negative effect on air and water quality, creating animal and human health concerns. Wind erosion can also cause damage to public utilities and infrastructure.

Location

Every parcel in MOA could be affected by wind erosion. Those in higher wind areas are more likely to experience wind erosion.

Likelihood of Occurrence

In Anchorage, wind erosion is not a significant problem, but it can occur during a weather event with strong winds. See Hazard Rating Matrix, Table 1.2.

Historic Events

No significant wind erosion events have been identified.

Vulnerability

Every parcel in MOA could be vulnerable to wind erosion, but this is not a significant threat. Property is considered more vulnerable to wind erosion than people.

Coastal Erosion

Coastal erosion is the long-term landward movement of the shoreline. It is generally associated with high-energy events such as coastal storms, flooding, etc. Coastal erosion can result from a series of short-term events such as storms. Alternatively, it can result from long-term processes such as changes in sea level or subsidence.

Coastal erosion is a natural process, but can be influenced by human activity such as dredging and boat wakes. Coastal erosion rarely causes death or injuries, but it can destroy buildings and infrastructure.

According to NHIRA, the degree of exposure to coastal erosion may be related to:

- Shoreline type
- Geomorphology of the coast
- Structure type along the shoreline
- Development density
- Amount of encroachment into the high-hazard zone
- Shoreline exposure to waves and wind
- Proximity to erosion-inducing coastal structures
- Nature of the coastal topography
- Elevation of coastal dunes and bluffs

Location

Coastal erosion is occurring west of TSAIA, as:

> …several hundred yards of bluff have eroded in this century, much of it since 1949. The bluffs erode when high-energy storms enter Cook Inlet and generate large waves at their bases. Storms arriving in the fall are the most dangerous because the bluffs are not yet frozen and their sediment can be easily eroded (Mason, 1997: 193).

Coastal erosion is also occurring near the Tony Knowles Coastal Trail because “piles of construction or earthquake rubble plus a rock revetment built by the state to protect the bike path are increasing local rates of shoreline erosion by blocking lateral beach sand transport” (Mason, 1997:198).

Point Woronzof has a lack of vegetation, lack of a talus pile at the base, and lack of a protective mudflat, which indicate erosion about two feet per year (Mason, 1997). Point Campbell is also eroding but at a slightly slower rate (Mason, 1997).

Likelihood of Occurrence

Coastal erosion is a natural process that continually occurs. Unlike other parts of Alaska, it would be rare to have a single event in the MOA associated with a significant amount of coastal erosion.

Historic Events

No significant coastal erosion events have been identified.

Vulnerability

Only coastal areas are vulnerable to coastal erosion. Property is considered more vulnerable to coastal erosion than people.

4.2 TECHNOLOGICAL HAZARDS

Technological hazards are hazards originating from technological or industrial accidents, dangerous procedures, infrastructure failures, or human error or omission.

4.2.1 DAM FAILURE

Alaska Statute 46.17.900(3) defines a dam as an, "artificial barrier and its appurtenant works, which may impound or divert water." Dam safety is regulated by Alaska Statute 46.17 and 11 Alaska Administrative Code 93 Article 3, Dam Safety, which became effective in May 1987.

Dam failures involve the unintended release of impounded water. A dam failure can destroy property and cause injury and death downstream. A dam failure does not always involve a total collapse of the dam. Dams may fail due to structural deficiencies, poor initial design or construction, lack of maintenance or repair, weakening of the dam through aging, debris blocking the spillway, other disasters such as earthquakes, improper operation, or vandalism.

The failure of a dam can be result in a major catastrophe with substantial economic impacts and loss of life. There are varying degrees of failure that can contribute to the uncontrolled release of water from the reservoir, ranging from improper gated spillway operation to the partial or full breach of the main structural component of the dam. Lesser degrees of failure often occur in advance of a catastrophic failure and are generally amenable to mitigation if detected and properly addressed. According to the State Hazard Mitigation Plan, there are several general causes of dam failure, including:

In Alaska, dams exist for many purposes, some of which include:

- Hydroelectric
- Water supply
- Flood control and storm water management
- Recreation
- Fish and wildlife habitat
- Fire protection
- Mine tailings

- Inadequate spillway capacity, which results in dam overtopping during extreme rainfall events.

- Internal erosion or piping caused by seepage through the embankment or foundation or along conduits.
- Improper or insufficient maintenance, leading to decay and deterioration.
- Inadequate design, improper construction materials, and poor workmanship.
- Operation issues.
- Failure of upstream dams on the same river system.
- Landslides into a dam's reservoir, creating a wave that overtops the dam.
- Seismic instability.

Location

According to DNR, there are 10 dams in the MOA (Table 4.26 and Figure 4.15).

KK. Table 4.26 Dams Located Within the MOA

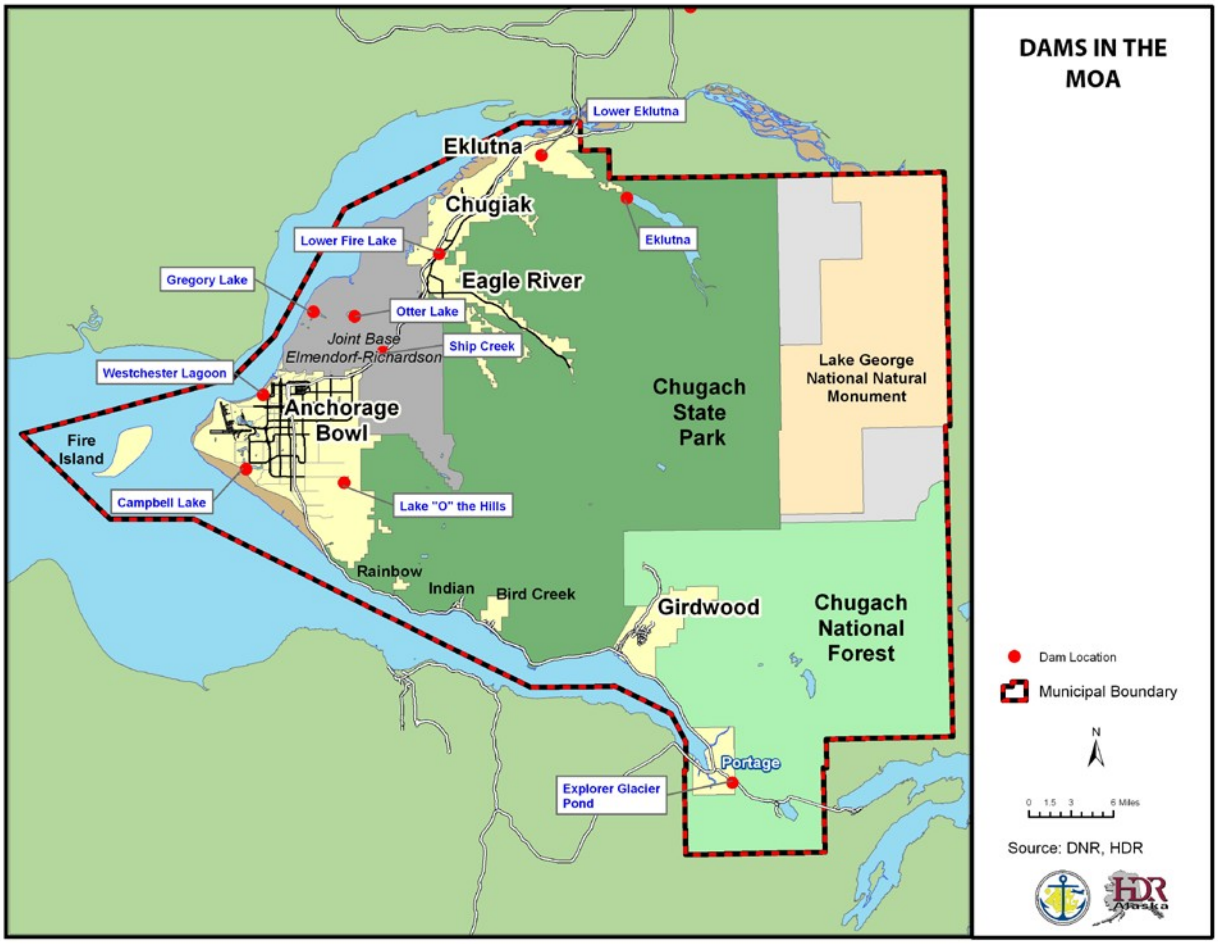
DAM ID	Name	Nearby Development	Hazard Potential Classification	Emergency Action Plan	Regulatory Jurisdiction
AK00033	Eklutna	Eklutna Village	High	Yes	State
AK00034	Lake "O" The Hills	Anchorage	High	Yes	State
AK00189	Lower Fire Lake Dam	Eagle River	High	Yes	State
AK00028	Campbell Lake Dam	Anchorage	Low	Not Required	State
AK00029	Westchester Lagoon Dam	Anchorage	Significant	No	State
AK00093	Lower Eklutna	Eklutna Village	Significant	No	State
AK00035	Ship Creek Dam	Anchorage	Low	Not Required	Federal
AK00036	Gregory Lake Dam	Elmendorf Air Force Base	Low	Not Required	Federal
AK00076	Otter Lake Dam	Ft. Richardson Army Base	Low	Not Required	Federal
AK82401	Explorer Glacier Pond Dam	Portage	Low	No	Federal

Source: State Hazard Mitigation Plan, 2013

Likelihood of Occurrence

Dam failures can occur wherever there is a dam. The risk increases as dams age and deteriorate from deferred maintenance and decay. Eighty percent of older dams designed and constructed before Alaska adopted dam safety regulations (1989) may have a higher risk due to design inadequacy. The State is especially concerned about those dams with known or suspected deficiencies because they pose a greater failure risk than properly designed and structurally sound dams. See Hazard Rating Matrix, Table 1.2.

S. Figure 4.11 Map of Dams in the MOA



Historic Events

Only one dam failure in Alaska has resulted in a fatality. Anchorage's Lake O' the Hills dam failed in 1972, resulting in the downstream death of a child swept into a culvert by the floodwaters. The inundation map for this dam includes the grounds adjacent to O'Malley Elementary School, homes, and O'Malley Road. Table 4.27 lists the known dam failures in Anchorage since 1962.

LL. Table 4.27 Dam Failures in Anchorage Since 1962

Name	NID No.	Description	Class	Height	Date of Failure	Type of Failure	Consequences	Suspected Cause
Campbell Lake Dam	AK00028	Earth embankment	Low	11	1964	Full breach	Repair costs	Foundation liquefaction, slope stability
Lake O' the Hills	AK00034	Earth embankment	High	13	1964	Unknown	Unknown	Seismic
Old Eklutna Dam	None	Earth and sheet pile	Low	NA	1964	Structural damage	Replacement costs	Seismic racking
Lake O' the Hills	AK00034	Earth embankment	High	13	1972	Full breach	One life lost	Inadequate low level outlet design, and construction, classic piping
Campbell Lake Dam	AK00028	Earth embankment	Low	11	1989	Full breach	Repair costs	Insufficient spillway capacity

Source: State Hazard Mitigation Plan, 2013

Vulnerability

Areas located within the inundation area of a dam are vulnerable to dam failure. However, most dams within the MOA have not had their inundation areas mapped. The exceptions are the Lake O' the Hills dam and the Eklutna dam. The inundation mapping for these areas is several years old. The actual dam inundations areas may be different due to increased development in the area, changes in the amount of water being impounded, or other reasons. Maps are in Appendix F.

4.2.2 ENERGY MANAGEMENT

An energy emergency refers to the inability to produce and transmit sufficient quantities of energy to the public, businesses and industry. It can involve one or more energy resources such as heating oil, natural gas, gasoline, coal, or electricity.

An energy emergency can develop quickly. For example, a storm could cause a power line to break. It could also develop over days or weeks. For example, during the 1973 OPEC (Oil Producing and Exporting Countries) embargo, gasoline, fuel oil, and other petroleum derivatives were in short supply. An energy emergency could even develop over years or decades. For example, increased development puts pressure on the amount of energy needed; if a utility company expands to meet that need but the revenue is not sufficient, the utility company could potentially close.

The 2011 plan identified potential winter natural gas shortages due to the Cook Inlet Gas Fields and infrastructure to supply peak demands. The Cook Inlet Natural Gas Storage Alaska facility was constructed. This is a ground injection facility able to store natural gas for peak demands. The facility was ready for operation November 2013. The MOA and some utilities still maintain the energy watch campaign on their web-sites but it appears there has not been any practice of the system for the past few years. Long duration energy disruption, 24 hours or greater, during extreme cold weather can cause significant damage to buildings in Anchorage if the structures remain unheated.

"Energy Watch" Campaign. The MOA and regional utility organizations have worked together to create a public awareness campaign designed to ask residents to conserve energy use in the event of an energy emergency.

Location

All areas of the MOA are susceptible to energy emergencies.

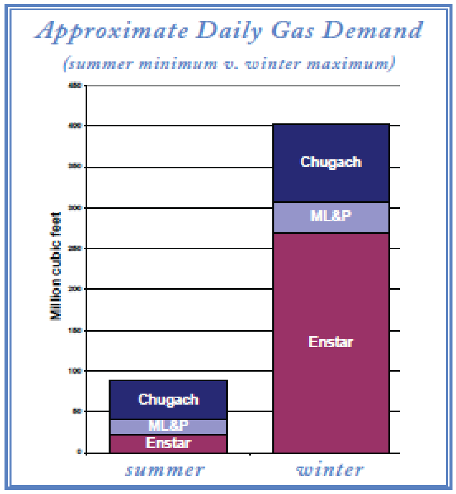
Likelihood of Occurrence

Typically, several small localized power outages occur every year. However, a large- scale, extended-duration power outage is not considered likely. See Hazard Rating Matrix, Table 1.2.

Historic Events

While power outages are not rare, they typically occur for a short duration and are limited to a small geographic area. There have been no known prolonged citywide power outages or other type of energy emergency recorded in Anchorage.

T. Figure 4.12 Approximate Daily Gas Demand



Source: MOA, 2009

Vulnerability

The MOA is vulnerable to localized short-term energy emergencies. Because an energy emergency could affect the entire Municipality, the entire MOA is represented in Table 4.28. Power failures are more likely to affect people than the built environment though. As the MOA continues to grow, the amount of energy demanded will increase. This has the potential of increasing the city's vulnerability unless the energy supply also increases. Facilities that rely on electricity for life safety needs such as hospitals and nursing homes tend to be more vulnerable to an energy emergency. While these facilities tend to have back-up generators, they may not be able to meet the needs of the facility for an extended period of time. Extended power outages will also have negative impact on the local economy as many businesses will be unable to functions. Businesses with perishable inventories, such as grocery stores and restaurants may suffer permanent losses.

MM. Table 4.28 Parcels Vulnerable to Energy Emergencies

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

4.2.3 URBAN FIRE (CONFLAGRATION)

An urban fire is one involving a structure or property within an urban or developed area. For the purposes of this plan, urban fires are defined as major fires affecting (or with the potential to affect) multiple properties. These types of fires are rare in modern, developed cities but could happen if associated with another disaster such as an earthquake, secondary to an aircraft crash, during civil unrest, where multiple ignitions could occur simultaneously, overwhelming the fire department's ability to respond.

Location

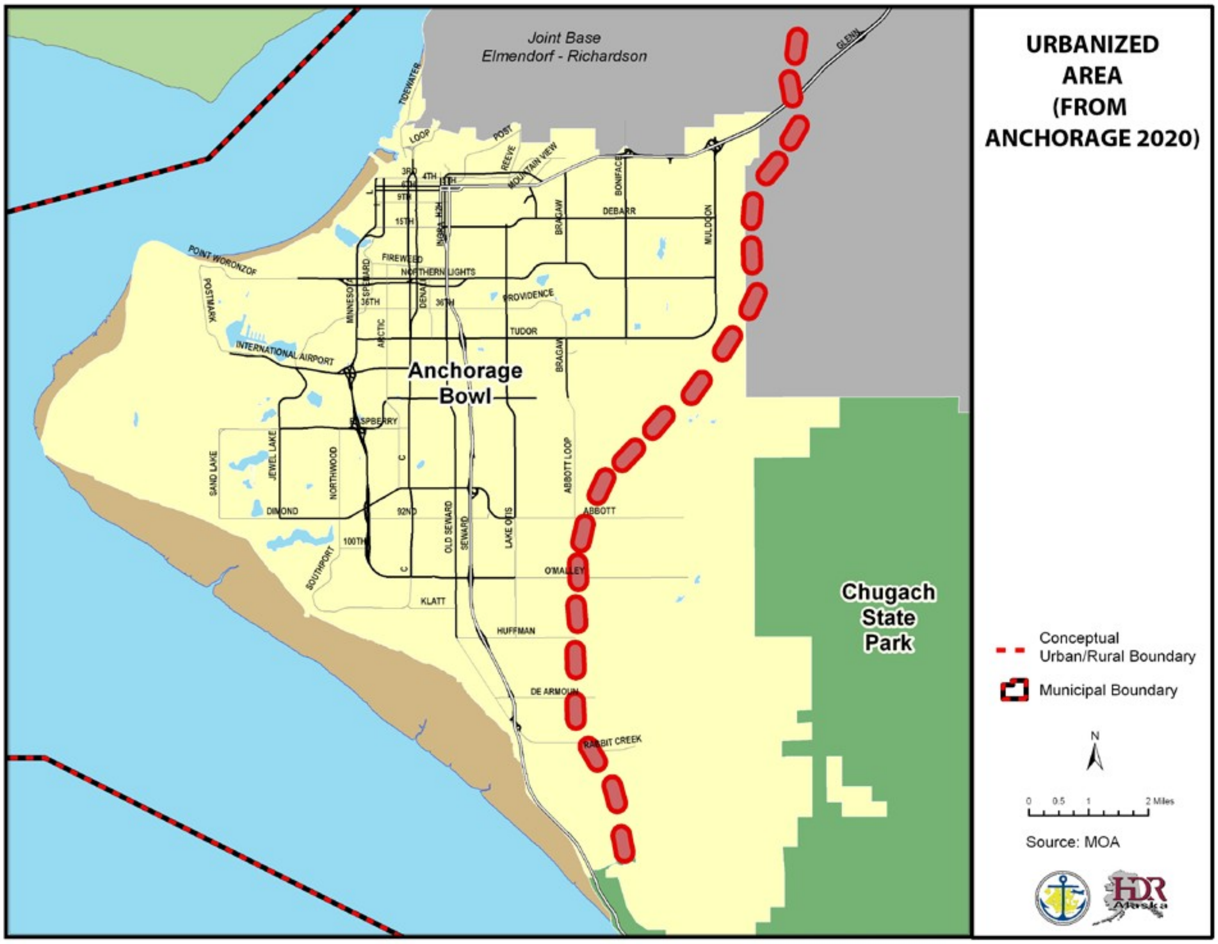
Every parcel in the urbanized portion of the MOA, as identified in Anchorage 2020 (see Figure 4.15) has the potential for a major urban fire. In general, the potential for a conflagration is higher in high-density areas that have structures located close to each other.

Parts of the Chugiak/Eagle River area also have the potential for a conflagration but a specific geographic area has not been identified. The downtown area, which tends to have higher densities, is more likely than areas with lower densities.

Likelihood of Occurrence

In the MOA, there is not a significant likelihood of a major urban fire but the potential exists. Modern building codes, construction techniques, building materials have been developed to reduce the possibility of a major urban fire. A major urban fire is more likely to occur as the secondary effect of another hazard such as an earthquake as fire department resources may have to respond to multiple incidences simultaneously, water for firefighting purposes may be unavailable, etc. See Hazard Rating Matrix, Table 1.2.

U. Figure 4.13 Map of Urbanized Area from Anchorage 2020



Historic Events

There have been no major urban fires in the MOA in recent years that have resulted in a disaster declaration. Fires within the urbanized portion of the MOA are usually quickly contained and are typically limited to one or two buildings.

One of the most significant urban fires in recent history occurred on June 5, 2007 at the Park Place Condominiums. This fire was accidentally started during plumbing maintenance. Damages from the fire were estimated at $19 million: $14 million in property loss and $5 million in personal content loss.

Vulnerability

Every parcel in the urbanized portion of the Anchorage Bowl could be vulnerable to a major urban fire and is represented in Table 4.29. This is not considered a significant threat. Hotels, nursing homes, theaters, daycares, assisted living facilities, nightclubs and other places where large groups of people tend to gather tend to have a higher potential for injuries and fatalities.

NN. Table 4.29 Parcels Vulnerable to Urban Fire in the Anchorage Bowl

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	55,130	6,165,655,300	13,159,778,900	19,325,434,200
Commercial	3,375	2383528500	4349166300	6732694800
Industrial	2491	1452514500	1872148800	3324663300
Institutional	368	650247000	1348498700	1998745700
Parks	259	287975300	9803500	297778800
Transportation	129	89869000	49512800	139381800
Other	0	0	0	0
Vacant (residential)	5,193	538,939,700	0	538,939,700
Watershed	0	0	0	0
Total	66945	11487847200	19575309000	31063156200

Source: MOA GIS, 2016

A geographic boundary has not been established for the Eagle River area so the number of parcels and their value that could be impacted has not been calculated as part of this update.

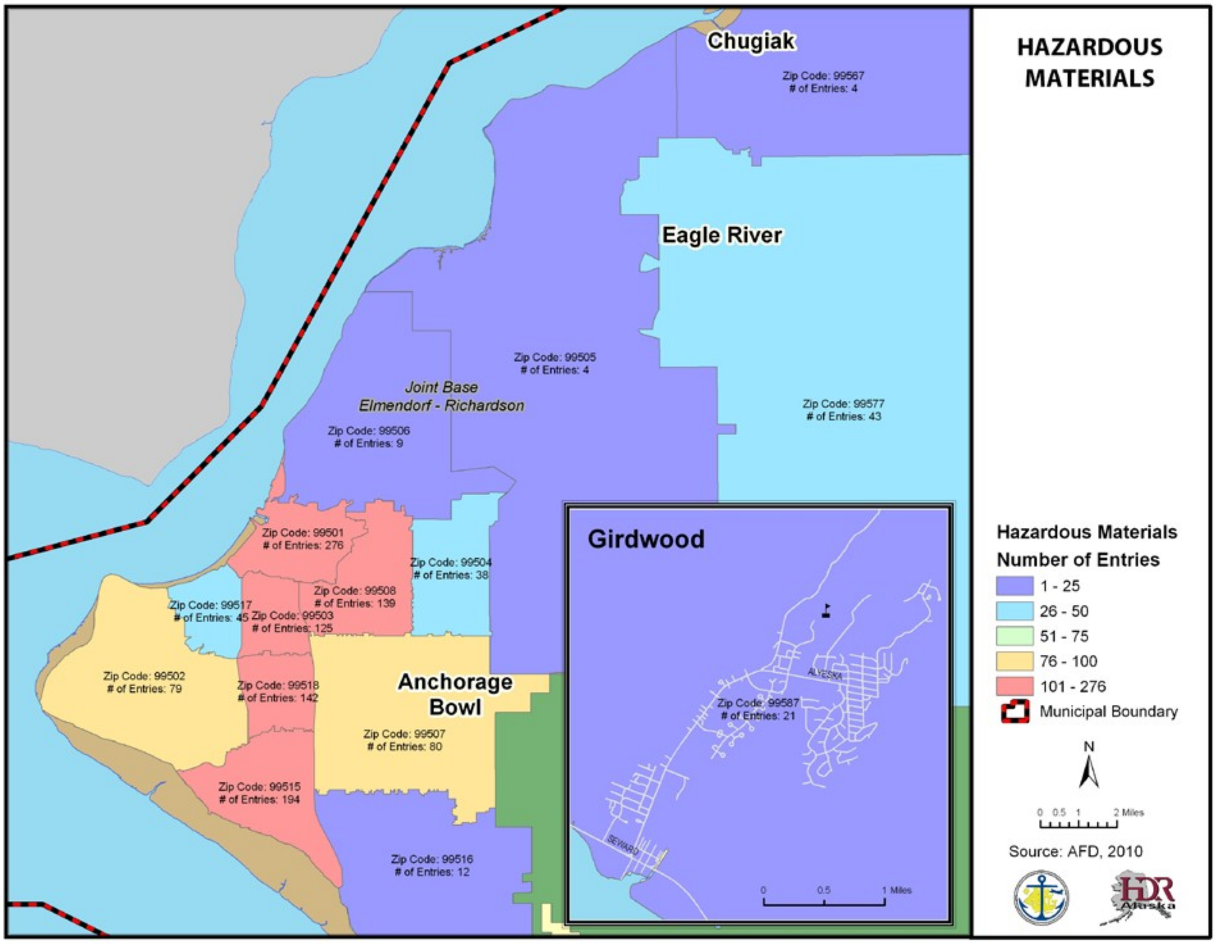
4.2.4. HAZARDOUS MATERIALS (HAZMAT) RELEASE

In general, a hazardous material is any substance or a material that has the potential to harm humans, animals, or the environment. A hazardous materials incident is the intentional or accidental release of toxic, combustible, illegal, or dangerous nuclear, biological, or chemical agents into the environment. The types of material that can cause a hazardous materials incident are wide ranging. Examples include materials such as chlorine, sulfuric acid, gasoline, medical/biological waste, etc. Many accidents happen at fixed sites (where hazardous materials are stored or handled), but incidents may also occur during transportation (by road, rail, pipeline or waterway). Terrorist incidents are not covered in this chapter.

Location

Hazardous materials incidents are more likely to occur where hazardous materials are located. Facilities that meet certain requirements are required to report information regarding the type and volume of hazardous materials to the State of Alaska and the AFD. According to the AFD records (as of July, 2016), zip code 99506 has the highest number of reportable hazardous materials. This zip code includes the Ship Creek area which has a higher percentage of industrial land uses (see Figure 4.15).

V. **Figure 4.14 Map of the Distribution of Hazardous Materials**



The MOA Solid Waste Services Division has two sites to collect hazardous wastes. The first Hazardous Waste Collector Center is located at the Anchorage Regional Landfill (near the intersection of the Glenn Highway and Hiland Road). The second Household Hazardous Waste Collection Facility is located at the Central Transfer Station near E. 54th and Juneau (east of the Old Seward Highway). These sites are for household use only.

Transportation related incidents are more likely on the main transportation routes such as the Seward and Glenn Highways and the Alaska Railroad. Materials enter the Port of Anchorage and are dispersed around the State. However, they can also occur on local roads or by air or marine vessel traffic.

Pipelines, such as the pipeline used to transport fuel from the Port of Anchorage to TSAIA, are another potential source of a hazardous materials incident.

Likelihood of Occurrence

Small-scale hazardous materials incidents occur every year although the exact number is unavailable. As the MOA continues to grow, it is likely that the number of facilities using hazardous materials will increase and so will the likelihood of a hazardous materials incident. Additionally, as the State of Alaska itself grows, so too will the demand for Hazardous Materials needed statewide, more of which are brought through the Port of Anchorage. In the year 2015 there were a total of 417 HazMat calls requiring AFD response. 289 of these were fuel/chemicals. 137 were a release of CO and 144 pertained to a gas leak in nature. See Hazard Rating Matrix, Table 1.2.

Historic Events

There have been no events that resulted in a declared disaster. However, small scale hazardous materials incidents have occurred. For example, on June 9, 2009, there was a chemical spill at TSAIA that resulted in a cargo hanger being evacuated for an hour.

Vulnerability

As a hazardous material incident could occur at a facility or during transportation, the entire MOA is considered vulnerable to a hazardous materials incident (see Table 4.30).

OO. Table 4.30 Parcels Vulnerable to a Hazardous Material Incident

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

Areas with higher concentrations of hazardous material usage, such as industrial areas, are more vulnerable. Zip code 99501 has the highest number of hazardous materials. People living in close proximity to a hazardous material incident are more vulnerable. The number of people vulnerable to a hazardous material incident will depend on the location of the event, the amount of material involved and the specific material involved.

Discharges/Releases, nuclear facilities (such as power plants, waste storage sites, and processing plants) in eastern Russia could impact Alaska because weather patterns have the potential to bring radioactive fallout to the state. Most Russian facilities are considered to have substandard construction and have had a history of reported and unreported releases (Alaska Department of Environmental Conservation, 2010).

4.2.6 TRANSPORTATION ACCIDENT

The transportation system in the MOA consists of air, road, rail, and marine systems. All of these modes have the potential for accidents that could lead to a disaster. For this plan, a transportation accident is any large-scale aircraft, vehicular, railroad, or marine accident, i.e., one that is not handled on a day-to-day basis by emergency responders.

Anchorage is home to many public airports, the largest of which is TSAIA. TSAIA is the major passenger and cargo facility and is located on the western edge of the city. Merrill Field, one of the busiest general aviation[8] airports in the country, is located just east of downtown. Several of the flight paths of both airports pass over developed parts of the Municipality. Other airports located within the MOA include Birchwood Airport and Girdwood Airport. There are also two military air fields on JBER. In addition, the MOA has one seaplane base (Lake Hood), although several lakes are used by seaplanes, including Sand Lake, Campbell Lake, and Lower Fire Lake.

The MOA is vulnerable to two major types of air transportation accidents; a crash involving a large passenger aircraft or a crash causing casualties on the ground. Mid-air collisions between two aircrafts are also possible.

As a coastal community, the MOA has the potential for marine accidents. The type of accident of greatest concern involves barges transporting materials, fuels, or other hazardous materials. Most goods designated for Alaska come through the Port of Anchorage. The Port also provides all of the jet fuel to JBER and between 66 to 80 percent of the fuel to TSAIA (MOA, 2016). The Port also exports petroleum products.

There are several major transportation routes in the MOA, including the Seward and Glenn Highways, which connect the MOA to adjacent boroughs (see Figure 4.19). There are approximately 1,800 miles of roadway in the MOA.

There are approximately 140 miles of railroad track in the MOA. The ARRC operates passenger and freight trains on this track.

Location

The majority of airplane crashes occur immediately before landing or after takeoff. The areas most likely to be impacted by a plane crash are under or close to the flight path, especially if they are within 5 miles of an airport (see Figure 4.16).

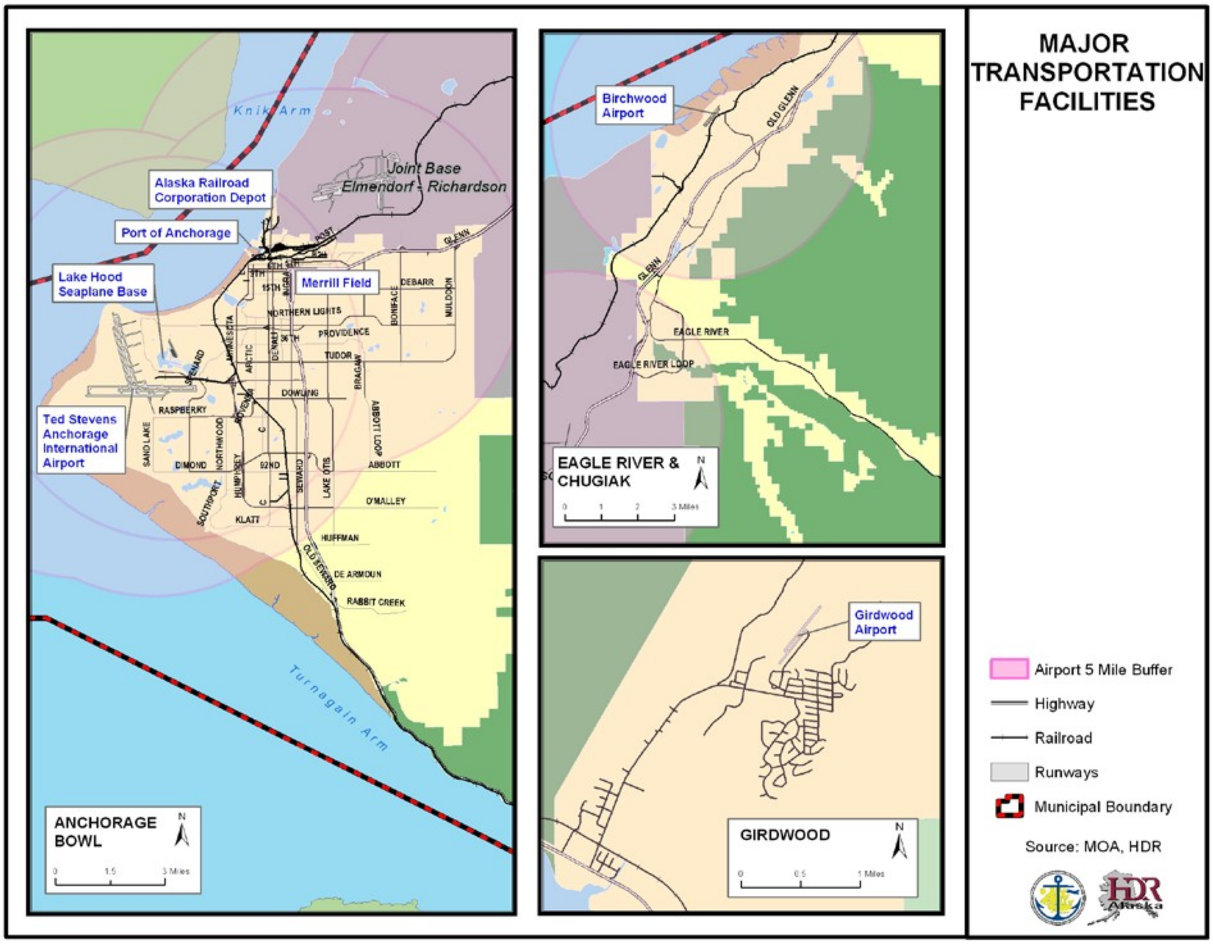
A marine accident is more likely in the Port of Anchorage area and in shipping lanes but with the high tides in Anchorage and strong currents could rapidly affect the entire coastline.

A motor vehicle accident could occur on any roadway in the MOA, but is more likely on roads with higher traffic volumes.

A rail accident would occur along the railroad tracks.

[8] General aviation refers to non-military flying except scheduled passenger airlines (Department of Transportation & Public Facilities, 2006).

W. Figure 4.15 Map of Major Transportation Facilities



Historic Events

From January 1, 2004 to December 14, 2009, there were 70 reported aircraft accidents/incidents within the MOA (National Transportation Safety Board, 2010). Most of the accidents/incidents were minor; only 3 of the 70 accidents involved fatalities.

On May 27, 2011, a small plane crashed shortly after takeoff from the Birchwood airport. The crash killed the five people on board. The crashed caused the closure of the ARRC tracks for several hours.

On June 29, 2010, a cargo plane crashed shortly after takeoff on Elmendorf Air Force Base. The crash killed all four crew members on board. The crash also damaged the ARRC's main rail line and a parallel siding, forcing train traffic to be suspended until repairs could be made.

On June 2, 2010, a plane crashed just after taking off from Merrill Field resulting in one fatality and four people seriously injured. The plane crash occurred during rush hour near a busy intersection (7^{th} Avenue and Ingra Street). Traffic in the downtown area was disrupted for several hours due to road closures.

On September 22, 1995, an E-3B Airborne Warning and Control Systems (AWACS) jet carrying a crew of 24 crashed just after takeoff from Elmendorf Air Force Base. The cause of the crash was due to bird strikes.

On August 24, 2013, an airplane was coming in to land at Merrill Field and was told to wait due to another plane on the runway. The plane continued over the runway at approximately 100 feet when it suddenly pitched to the left and crashed. It was determined that the plane had been starved for fuel due to the nose-high altitude during the go-around and the engines failed. Two people were killed in this accident.

On May 28, 2014, a Robinson R44 II helicopter collided with the ground and caught fire while conducting practice flights for an external load project that was coming up at the Birchwood Airport. The pilot was killed in the crash.

On July 2, 2014, a plane crashed at Merrill Field killing the pilot after undergoing maintenance and modifications over the course of several years. The elevator controls had been misrigged and were in the opposite locations resulting in the reversal of control inputs. Witnesses stated that the airplane climbed steeply in an extreme nose-high attitude until it pivoted and descended straight to the ground.

On August 6, 2015, two people were missing after a Piper PA-18-150 plane crashed into the Knik Arm off the Birchwood Airport. The airplane was located and recovered, with extensive damage. The two occupants were never recovered and are presumed deceased.

On December 21, 2015, a small airplane lost engine power after taking off from Girdwood and landed on a highway bridge. No one was injured or killed.

On December 29, 2015, a Cessna 172 was destroyed and the pilot lost his life when the plane collided with an office building in downtown Anchorage.

The worst crash in Anchorage occurred on November 27, 1970. A DC-8-63F plane went off the end of the runway at TSAIA and was destroyed in a post-crash fire. The National Transportation Safety Board determined that the probable cause was that the plane was not traveling fast enough during takeoff. Of the 229 people on board, there were 47 fatalities (Embry-Riddle Aeronautical University, 1972).

Other aircraft accidents include:

- An in-flight engine separation on March 31, 1993
- A collision between two aircrafts at TSAIA on December 23, 1983
- A crash during landing on December 4, 1978; five of the seven people on board were fatally injured.

According to the Minerals Management Service's Alaskan Shipwreck online database, there have been approximately 19 marine accidents since 1900. The actual number of accidents is likely to be different because not all accidents are reported and because the location description may not be detailed enough to determine if the accident with within the MOA limits. Reported accidents include:

- A ship ran into the dock at the Port of Anchorage and damaged a 30-ton section of dock on February 10, 1972
- A ship ran into the Port of Anchorage dock on July 22, 1974 and damaged the pier
- A strong wind pushed a ship onto the mudflats on April 19, 1982
- A ship ran into the dock on March 17, 1985 and damaged part of the dock

Motor vehicles accidents are typically small-magnitude events, some with fatalities, but of no impact to the entire community. According to the 2013 MOA Annual Traffic Report, in 2013 there were 4,283 accidents, including 13 that involved fatalities. In the past, there have numerous accidents that resulted in roadway closures for several hours, but there have been no accidents that resulted in a disaster declaration.

According to the Federal Rail Administration database, there were 4 train accidents in the MOA from 2000 to 2009, with no fatalities.

Likelihood of Occurrence

Most airplane accidents are likely to involve general aviation aircraft. However, it is unlikely that a general aviation aircraft could cause a citywide emergency. However, the presence of large planes over the developed portion of the city makes a large crash a possibility.

Marine, road, and rail accidents that result in a citywide emergency are also possible; however, the likelihood is considered low.

Vulnerability

The entire MOA is vulnerable to a transportation accident and is shown in Table 4.32. In general, the areas closer to a transportation route are more vulnerable than areas further away. A major transportation accident could have an impact on the local economic if it results in a long-term shut down of that transportation mode.

PP. Table 4.32 Parcels Vulnerable to Transportation Accidents

Land Use	# of Parcels	Taxable Value (Land)	Taxable Value (Buildings)	Total
Residential	75024	8526159300	17756156200	26282315500
Commercial	4065	2568664400	4512337400	7081001800
Industrial	2597	1494944600	1907337000	3402281600
Institutional	1035	1215398400	1554183700	2769582100
Open Space	44	24995700	503000	25498700
Transportation	664	0	0	0
Other	562	377462100	36697800	414159900
Vacant	228	0	0	0
Total	84219	14207624500	25767215100	39974839600

Source: MOA GIS, 2016

In subsequent updates of the plan, additional research should be conducted to identify the areas vulnerable to each mode of transportation. For example, areas underneath the flight path for one of the airports would be more vulnerable to an airplane crash than other parts of the MOA.

4.2.7 COMMUNICATIONS FAILURE

A communications failure is the interruption or loss of communications systems including transmission lines, communications satellites, and associated hardware and software necessary for the communications system to function. A communications failure may be the result of an equipment failure, human acts (deliberate or accidental) or the result of another hazard event.

When a communications failure occurs, it can have a wide range of affects. A failure that results in a small delay in response times by emergency service providers might have a minimal impact on the community in general even though it may be problematic to individuals who require those services. A failure of the 911 system or an emergency warning system has the potential to impact the entire community.

Location

All parts of the MOA have the potential to be impacted by a communications failure.

Likelihood of Occurrence

The likelihood of a large-scale extended communications failure is low. However, small scale failures with a short duration are frequent.

Historic Events

Communication failures in the MOA have been limited to small scale outages associated with equipment failures or natural events such as severe weather storms and mainly affecting landline and cellular telecommunication capabilities.

There have been no failures of the 911 system in the MOA since the late 1990s. Backup systems are in place so when the APD dispatch is unable to answer 911 calls, the calls are directed to the AFD. In the past 5 years, there have been 3 instances where the back-up system has been activated. Two of these events were caused by human error which the third event was caused by a computer failure (Kurtz, 2010).

On May 19, 2002, the APD dispatch and the 911 center was evacuated due to a fire/air conditioning overheating which resulted in Halon being discharged (Roberts, 2010).

Vulnerability

Anyone who relies on technology such as telephones, are somewhat vulnerable to experiencing some type of communications failure. Interruptions in day to day communications would create problems for businesses, public agencies, citizens, and emergency services. The most common problems would range from minor inconveniences of our citizens to loss of production and revenues for businesses. Emergency services could face more serious consequences, as nonexistent communications failure could escalate what would have been a minor emergency into a disaster situation.

CHAPTER 5 MITIGATION STRATEGY

The purpose of this chapter is to document the MOA's mitigation strategy, which is based on the findings presented in the preceding chapters. This chapter is divided into the following sections:

- Hazard Mitigation Goals and Objectives
- Hazard Mitigation Strategies
- Action Plan

The goals, objectives, and action items in this chapter are intended to guide everyday activities and provide a long-term hazard mitigation approach for the MOA to follow. The intent is that these goals, objectives, and action items will be incorporated into future MOA plans, policies, and projects. The goals are broad statements about what the MOA wants to achieve in terms of hazard mitigation. Objectives identify how the MOA will achieve those goals. The Action Plan items are specific actions that will be taken or projects that will be built to implement this mitigation plan.

A review of the goals, objectives and action items was conducted as part of this plan update. The planning group has met twice to discuss the goals, objectives and action items and has provided written and verbal input. This has resulted in extensive changes in the goal and objectives with corresponding updates to our action items.

5.1 GOALS AND OBJECTIVES

Goal 1: **Implement and maintain the MOA All Hazards Mitigation Plan.**
Objective 1.1 Insure municipal involvement by appointed personnel in this plan.
Objective 1.2 Require periodic meetings with municipal personnel and the public.
Objective 1.3 Insure funding for plan maintenance and 5 year updates.

Goal 2: **Inform the community on the local hazards and ways to be prepared if a hazard event occurs.**
Objective 2.1 Educate individuals and businesses about hazards, disaster preparedness, and mitigation.
Objective 2.2 Increase coordination between hazard mitigation goals and existing and future plans, including the incorporation of effective hazard mitigation strategies into the Capital Improvement Program.
Objective 2.3 Educate public officials, developers, realtors, contractors, building owners, and the general public about hazard risks and building requirements.
Objective 2.4 Partner with Municipal Departments and other agencies serving vulnerable populations to minimize harm in the event of an emergency.
Objective 2.5 Ensure hazard information/maps are easy to access and up to date in the municipal GIS database.
Objective 2.6 Partner with private sector to promote employee education about disaster preparedness while on the job and at home.

Goal 3: Increase the survivability and resiliency of municipal structures and functions for local hazards.

Objective 3.1 Conduct surveys of essential municipal building and infrastructure to determine if seismic and life safety retrofits are required.

Objective 3.2 As surveys are completed prioritize the municipal facilities to receive upgrades.

Objective 3.3 Implement the facility upgrades as funding becomes available.

Objective 3.4 Incorporate non-structural mitigation into existing buildings.

Objective 3.5 Create redundancies for critical networks such as water, sewer, digital data, power, and communications.

Goal 4: Improve the resiliency of essential private sector functions

Objective 4.1 Create a planning document to determine which private sector facilities should be prioritized for MOA assistance in disaster recovery

Objective 4.2 Develop a recovery plan for essential private sector functions such as health care or food distribution facilities

Objective 4.3 Determine if essential private sector functions should be required to implement seismic upgrades.

Objective 4.4 Minimize economic loss.

Goal 5: Land Use Planning: Develop land use regulations to reduce the hazard risk to the general population and property.

Objective 5.1 Conduct studies to determine hazard areas within the MOA

Objective 5.2 Adopt and enforce public policies to minimize impacts of development and enhance safe construction in high hazard areas.

Goal 6: Reduce the flood risk to the community

Objective 6.1 Continue to participate in the National Flood Insurance Program.

Objective 6.2 Revise and update flood hazard information whenever possible.

Objective 6.3 Implement flood reductions measures and improve local drainage.

Goal 7: Emergency Management: Create and maintain a community where people and property are safe.

(From Anchorage 2020, LRTP, Housing & Community Development Consolidated Plan, Work Force & Economic Development Plan)

Objective 7.1 Develop mechanisms in advance of a major emergency to cope with subsequent rebuilding and recovery phases.

Objective 7.2 Plan for and respond to the secondary effects of disasters, such as hazardous waste and hazardous materials spills, when planning and developing mitigation projects.

Objective 7.3 Promote disaster contingency planning and facility safety among institutions that provide essential services such as food, clothing, shelter, and health care.

Objective 7.4 Improve disaster warning systems.

Goal 8: Reduce the Urban and rural Wildfire Risk

Objective 8.1 Support the AFD Wildfire Strategic Plan.

Objective 8.2 Promote Firewise homes through the concepts in Firewise Alaska; landscaping and vegetation management; structure protection through preparedness; building design, siting, and construction material; and homeowner awareness.

Objective 8.3 Promote vegetation management in greenbelts and parks to limit fire spread.

Objective 8.4 Maintain the wildfire risk model.

Objective 8.5 Maintain and develop additional water resources.

Objective 8.6 Improve road connectivity for evacuation purposes.

5.2 IMPLEMENTATION

5.2.1 STRATEGIES

The MOA will implement the mitigation measures identified in this plan by using the comprehensive plan, Capital Improvement Plan, and other hazard mitigation tools they have at their disposal.

While there are many different ways to mitigate hazards, not all are appropriate for all situations. Each situation must be evaluated in order to decide what activities are the most appropriate. General strategies that can be used to mitigate hazards include:

Structural Features

Structural features are designed to control the hazard and restrict the exposed area. The construction of a structure such as a dam, levee, or avalanche deflection wall can lessen the impact of a hazard event. Structures can be incorporated into new development, but this should be discouraged in hazard-prone areas. The following departments can implement this strategy:

- PM&E
- Port of Anchorage
- Maintenance and Operations

Land Use Planning

Land use planning can guide development away from hazard-prone areas. Planning is more effective at protecting future development. The responsibility for land use planning is with the Planning and Development Services Department.

Zoning

Zoning ordinances regulate development by dividing a community into areas and by establishing development criteria for each area. They may restrict certain uses in hazard-prone areas or add restrictions such as minimum elevations. Zoning is more effective with future development. Zoning can:

- Prevent new development in hazard-prone areas
- Preserve or establish low densities in hazard-prone areas
- Control changes in use and occupancy of structures in hazard-prone areas
- Establish performance standards
- Require special use permits

The Planning Department and the Planning and Zoning Commission have the primary responsibility for zoning in the MOA.

Subdivision Regulations
Subdivision regulations govern how a parcel of land can be subdivided into two or more smaller parcels. It is better to incorporate mitigation measures into subdivision regulations before a parcel of land is developed. These regulations are better at protecting future development than existing development. The Planning Department, Development Services and the Platting Board administer the MOA's subdivision regulations.

Capital Improvement Plan
A Capital Improvement Plan (CIP) is used to guide major public expenditures for physical improvements over a given period of time. These expenditures can be used to mitigate existing and future development. For example, funds could be used to retrofit an existing structure, build a new levee, or purchase property. The lack of investment in infrastructure in hazard-prone areas may also act to restrict development, as it is too costly for a private developer to build the necessary improvements. All municipal departments have input into the CIP, but the Office of Management & Budget is the coordinating department.

Open Space Preservation
Open space preservation is a tool to keep existing open spaces in hazard-prone areas from being developed. This prevents putting more people and facilities at risk. Typically, a municipal government will acquire the property from a private property owner. The property then becomes zoned as open space, which limits the future development of the property. Property that is already government-owned can also be preserved as open space. Open space is usually managed by the Parks & Recreation Department.

Acquisition
Acquisition involves purchasing property in high-risk areas and demolishing any structures on it to prevent the structure from being damaged during a hazard event. The structure is demolished to ensure that it is not re-used in the future. This technique is appropriate for mitigation of existing structures. It can also be used to buy vacant land in high-risk areas to prevent development from occurring. Many departments would be involved in the acquisition of property and structures.

Relocation
Relocation is similar to acquisition, except that any structures on the property are relocated out of a hazard-prone area. The structure may be relocated to a different parcel or within the same parcel. This technique is also more appropriate for existing structures. Many departments would be involved in the relocation of structures.

Building Codes
Building codes are a compilation of laws, regulations, ordinances, or other statutory requirements adopted by a government legislative authority relating to the physical structure of buildings. They establish minimum requirements regarding the construction of a structure to protect public health, safety, and welfare. They apply to new buildings as well as those undergoing significant renovations, which makes building codes helpful in protecting new and existing development. Enforcement is essential in order for building codes to be an effective hazard mitigation tool. It is also less expensive and easier to incorporate mitigation

measures into new structures than it is to retrofit existing ones. Development Services is responsible for administering the building code in Anchorage.

Insurance
Insurance provides funding to rebuild a structure and replace its contents after a hazard event. Insurance is appropriate for mitigating existing structures. The problem with insurance is that it can make it easier to rebuild in a hazard-prone area, thus creating a repetitive loss situation. Because municipal governments such as the MOA are typically self-insured, this strategy is used more by private property owners. The Risk Management Department is responsible for ensuring the MOA's insurance needs are met.

Education
Education involves teaching the public about potential natural hazards, the importance of mitigation, and how to prepare for emergency situations. It is used to inform residents, business owners, visitors, etc. about the hazards in the area and what they can do to protect themselves and their property. Examples include real estate disclosure, homeowner wildfire reduction publications, and training. Many departments within the MOA can undertake education activities, including OEM, the Mayor's Office, AFD, Planning Department and Development Services.

5.3 ACTION PLAN

The action plan consists of specific activities or projects that will be used to implement the goals and objectives of this hazard mitigation plan. The action items are categorized by the hazard being addressed with action items addressing more than one hazard being grouped in a multi-hazard category. The action plan contains many items that have no funding sources identified. The timelines are dependent upon obtaining funding. If and when funding becomes available, more specific timelines will be established. This list is in the early stages of development and will be updated as needed. For each item, several characteristics are listed, including:

- Purpose: Why this item is included in the action plan
- How Identified: How the action item was identified
- Coordination Organization : The primary organization to implement the action item
- Objective: The objectives being implemented
- Status/Timeline: What stage the project is at or the target start date
- Priority: The priority of the project as determined by the process established in Appendix G (Departments have not begun to use this tool and priorities will be included in the next version of the mitigation plan.)
- Cost: The estimated cost of the project (if known)
- Potential Funding Sources: Possible sources of funding (if known)
- Hazard: The hazard being addressed (for multi-hazard action items only)
- Benefit Cost: Determines the benefit to the community for the resources expended.

Goal 1: Implement and maintain the MOA All Hazards Mitigation Plan.

Action 1. The MOA shall establish a Mitigation Advisory Committee for the All Hazards

Mitigation Plan and establish a semi-annual meeting schedule.

- Purpose: As department staffing levels, resources, and responsibilities change over time, the MOA should review which department is responsible for the hazard mitigation plan.
- How Identified: Planning Team
- Coordinating Organization: Municipal Manager
- Objective: 1.1
- Hazard: All
- Status/Timeline: 6 months from plan adoption
- Priority: High
- Cost: Staff time
- Potential Funding Sources: MOA Budget
- Benefit Cost: Little to no cost to appoint committee members and will greatly aid the implementation of this plan.

Action 2. Review and update prioritization strategy (in Appendix F). Upon completion, prioritize action items.

- Purpose: Prioritizing the projects will help the MOA make decisions regarding how to allocate the resources available for hazard mitigation activities.
- How Identified: Planning Team
- Coordinating Organization: Mitigation Advisory Committee
- Objective: 1.2
- Priority: High
- Cost: Staff time
- Potential Funding Sources: MOA Budget
- Benefit Cost: Little to no cost and once a Mitigation Advisory Committee is appointed this action item can easily be accomplished

Action 3. Insure funding is provide for plan maintenance and revision. In year 3 of the plan the MOA should apply for State or Federal Grants for plan revision.

- Purpose: To insure complete plan maintenance and revision with maximum agency and public involvement.
- How Identified: Planning Team
- Coordinating Organization: Mitigation Advisory Committee
- Objective: 1.3
- Priority: Medium
- Cost; Staff time and potential consultant contract.
- Potential Funding Sources: MOA Budget, State and Federal Grants
- Benefit Cost: This action will have little cost to the MOA with significant potential for benefit to the community to implement a plan update.

Goal 2. Inform the community on the local hazards and ways to be prepared if a hazard event occurs.

Action 4. The MOA will continue to review and advise the community on the various methods of making structures and their contents more disaster-resistant, which would include workshops, literature, and public safety announcements. Bilingual outreach will also be used

- Purpose: To educate people about hazard mitigation
- How Identified: by Planning Team
- Coordinating Organization: All departments
- Objective: 2.1
- Hazard: All
- Status/Timeline: The staff of some departments currently perform this function.
- Priority: Medium
- Cost: unknown, varies by department
- Potential Funding Sources: MOA Budget, State and Federal Grants
- Benefit Cost: This action item is currently ongoing with minimal cost and has a benefit to community outreach of pre-disaster preparation.

Action 5. Acquire updated air photos or LiDAR information for the entire MOA

- Purpose: To allow the MOA to provide more accurate information to the public.
- How Identified: PM&E
- Coordinating Organization: PM&E/GIS
- Objective: 2.5
- Hazard: All
- Status/Timeline: Continuous, 2-3 years for air photos and 5 years for LIDAR
- Priority: Medium
- Cost: will be determined at the time of procurement
- Potential Funding Source: Municipal Budget, State and Federal Grants
- Benefit Cost: This process is ongoing and its cost is not budget breaking but it is not insignificant. Obtaining periodic updates to LIDAR and aerial imagery is important to maintaining hazard maps.

Action 6. Make the All Hazards Mitigation Plan available for incorporation into other municipal long-range plans, e.g. MOA Comprehensive Plan. To the best of our ability, ensure mitigation strategies are integrated into MOA long-range plans and capital improvement budgets.

- Purpose: To ensure hazard concerns, mitigation strategies and goals are incorporated into public planning documents.
- How Identified: Planning Team
- Coordinating Organization: Municipal Manager, Planning Director
- Objective: 2.2
- Status/Timeline: Will be implemented as MOA plans are updated.
- Priority: Medium
- Cost: Staff time
- Potential Funding Sources: MOA Budget

- Benefit Cost: This will allow the MOA to focus development and management practices to reduce the risk or improve the recovery from local hazards.

Goal 3: Increase the survivability and resiliency of municipal structures and functions against local hazards

Action 7. Retrofit and enhance MOA-owned facilities that will be needed during and after a hazard.

- Purpose: To limit the amount of damage caused by an earthquake
- How Identified: Planning Team
- Coordinating Organization: M&O, Port, AWWU, ML&P, PM$E, Chugach Electric, SWS, Merril Field, ASD
- Objective: 3.3, 3.5
- Status/Timeline: 3 to 5 years
- Priority: Medium
- Cost: Depends on facility
- Potential Funding Sources: MOA Budget, CIP bonds, State and Federal Grants
- Benefit Cost: This action item has significant costs. The Hazard Mitigation Committee will have to use their best judgement to determine which facilities will receive priority for this funding. The benefit is survivability of functions and facilities in a hazard event.

Action 8. Identify critical infrastructure and other facilities that need to be seismically retrofitted or rebuilt to current seismic standards.
AFD Fire Stations 8,10,11, & 12 are the only stations that have not been upgraded to meet current seismic requirements.

- Purpose: To ensure emergency response capability and equipment after a hazard event.
- How Identified: AFD and APD Strategic Plans
- Coordinating Organization: AFD / APD / OEM / M&O/Development Services
- Objective: 3.1
- Status/Timeline: Initiate a survey of high priority municipal infrastructure not already evaluated within two years and develop a plan to address the retrofitting within three years.
- Priority: High
- Cost: Staff time to coordinate surveys of the buildings. The costs for the building analysis and retrofits are unknown.
- Potential Funding Sources: Capital Improvement Bonds, operations budget for smaller projects, state and federal funding sources for larger projects.
- Benefit Cost: This is a medium to high cost to implement. This action is essential for maintaining emergency services after a hazard event insuring public safety.

Action 9. Retrofit or enhance to improve the resiliency of police stations as listed in the APD's Strategic Plan and CIB/CIP plan.

- Purpose: To ensure the availability of emergency response and equipment after a hazard event.

- How Identified: APD Strategic Plan/CIB Budget
- Coordinating Organization: APD, M&O
- Objective: 3.3
- Hazard: All
- Status/Timeline: 3 – 5 years
- Priority: Medium to High
- Cost: Phase II (Storage building $13.5 million)
  Phase III (Evidence Warehouse/Tactical Storage $80 million)
  Phase IV (HQ retrofit $18 million)
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants.
- Benefit Cost: This is a medium to high cost to implement. This action is essential for maintaining emergency services after a hazard event insuring public safety

Action 10. Complete the Port of Anchorage modernization.

- Purpose: The port modernization project will replace the 55-year old port with updated, robust infrastructure and systems, making it more hazard-resistant than the existing port.
- How Identified: Port of Anchorage
- Coordinating Organization: Port of Anchorage
- Objective: 3.3
- Hazard: Earthquake, extreme weather, hazardous materials, transportation accident
- Status/Timeline: This project is ongoing and is expected to be completed between 2015 and 2024. The actual completion date will depend on a variety of factors, including the availability of funding.
- Priority: High
- Cost: Approximately $600 million
- Potential Funding Sources: Federal appropriations and grants, State grants, Port profits, revenue bonds
- Benefit Cost: The Port of Anchorage is the main hub for the majority goods and food delivered to Alaska. This infrastructure is critical to the daily lives of Alaskans. Improving the resiliency of this facility is a priority.

Action 11. Continue to strengthen the existing Port of Anchorage pilings until they can be replaced

- Purpose: The structural pile thicknesses are below standard and are likely to collapse during an earthquake.
- How Identified: Port of Anchorage Pile Condition – Seismic Vulnerability Study (R&M, 2014)
- Coordinating Organization: Port of Anchorage
- Objective: 3.3
- Status/Timeline: This project proceeds on an annual basis and will no longer be needed when the Port modernization is complete.
- Priority: High
- Cost: Between $1 and $3 million annually.

- Potential Funding Sources: Port Capital Budget, State and Federal Grants.
- Benefit Cost: This infrastructure is critical to the daily lives of Alaskans. Improving the resiliency of this facility is a priority.

Action 12. Install gas shut-off valves in MOA-owned public facilities used in response/recovery efforts.

- Purpose: To reduce the possibility of gas leaks after a hazard event.
- How Identified: Planning Committee
- Coordinating Organization: M&O
- Objective: 3.3
- Status/Timeline: In progress; several MOA facilities have already been retrofitted.
- Priority: Medium
- Cost: To be completed (approximately $5,000 to $7,000 per facility)
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: The MOA is currently funding portions of this project. Installing gas shut-off valves reduces the risks to people and facilities during and after a seismic event.

Action 13. Perform seismic and structural analysis of all ASD owned facilities

- Purpose: To identify and prioritize structural deficiencies.
- How Identified: ASD's Capital Improvement Planning process.
- Coordinating Organization: ASD
- Objectives: 3.1
- Hazard: Earthquake
- Status/Timeline: Within 1 Year.
- Priority: High
- Cost: $500,000.00
- Potential Funding Sources: ASD General Funds, Bonds, State and Federal Grants.
- Benefit Cost: The school facilities are occupied by our children a majority of the time and are planned to be used as shelters after a hazard event if necessary. Determining which structures need seismic upgrades and which building need upgrades the most, allow proper prioritization for the use of available funds. This analysis may also be used to determine if a facility should not be planned for use as a shelter. This will improve safety for the citizens in the community.

Action 14. Construct necessary seismic and structural upgrades of all ASD owned facilities.

- Purpose: To address deficiencies and identified in the districtwide seismic analysis.
- How Identified: Future district wide seismic analysis.
- Coordinating Organization: ASD
- Objectives: 3.3
- Hazard: Earthquake
- Status/Timeline: As funds become available
- Priority: High
- Cost: To be determined
- Potential Funding Sources: ASD General Funds, Bonds, State and Federal Grants.

- Benefit Cost: The school facilities are occupied by our children a majority of the time and are planned to be used as shelters after a hazard event if necessary. Conducting the seismic and structural upgrades insures safety of the building occupants (children) and will insure resilient structures to be used as shelters for the community post-earthquake.

Goal 4: Improve the resiliency of essential private sector functions.

Action 15. Develop a recovery plan for essential private sector functions.

- Purpose: Develop a plan to determine which private sector functions are essential and will receive priority from the MOA for re-construction after a hazard event
- How Identified: Planning Team
- Coordinating Organization: Development Services and Planning Department
- Objective: 4.1, 4.2
- Hazard: All
- Status/Timeline: This will be work into department schedules as time allows
- Priority: Low
- Cost: Unknown
- Potential Funding Sources: MOA Budget, State or Federal Grants
- Benefit Cost: Local government must plan for or determine which private service functions/facilities must receive priority to re-establish operations to serve the public after a hazard event. These services would probably be focused on medical and food distribution facilities which would be essential for a post hazard event recovery.

Goal 5: Land Use Planning, Develop land use regulations to reduce the hazard risk to the general population and property.

Action 16. Continue to implement the policies and strategies in Anchorage 2020-Anchorage Bowl Comprehensive Plan that address crime prevention and public safety, natural and manmade hazards, and emergency response.

- Purpose: To implement community safety/hazard mitigation in Anchorage 2020 through applicable functional, neighborhood, and district plans. Update the APD 5 year Strategic Plan and the APD Emergency Management Plan.
- How Identified: Through interagency coordination, Anchorage 2020 Plan, AO-2002-119.
- Coordinating Organization: OEM/APD/AFP/Planning Department/Development Services
- Objective: 5.1, 5.2
- Hazard: All
- Status/Timeline: 3 to 5 years
- Priority: High
- Cost: MOA staff and GIS resources.
- Potential Funding Sources: MOA budget, State and Federal Grants
- Benefit Cost: Land use planning that considers hazards as an integral component to policies cans be established that will ensure reductions of loss and damage to structures.

Action 17. Incorporate the action items identified in the Downtown Seismic Risk Assessment into local ordinances.

- Purpose: To help ensure the action items identified in this assessment are coordinated with other MOA activities
- How Identified: Consultant, Planning Team
- Coordinating Organization: Planning Department and Development Services
- Objective: 5.1, 5.2
- Status/Timeline: By 2019
- Priority: Medium
- Cost: Under $10,000
- Potential Funding Sources: MOA Budget, State and Federal Grants
- Benefit Cost: Land use planning that considers hazards as an integral component to policies cans be established that will ensure reductions of loss and damage to structures.

Action 18. Update snow avalanche mapping for Chugiak/Eagle River, Anchorage Bowl, and Turnagain Arm/Girdwood.

- Purpose: Update snow avalanche hazard maps.
- How Identified: From 2011 Plan, Public Requests and the Planning Committee.
- Coordinating Organization: Planning Department, Development Services
- Objective: 5.1, 5.2
- Status/Timeline: 3 years
- Priority: Low
- Cost: Staff and GIS resources, Avalanche Consultant
- Potential Funding Sources: MOA Budget, State or Federal Grants
- Benefit Cost: This would allow for more accurate hazard maps for the community to protect people and structures. This would also allow for improved land use planning as the community expands into more rural areas.

Goal 6: Reduce the flood risk to the community

Action 19. The MOA shall continue to apply floodplain management regulations for development in the flood plain and floodway.

- Purpose: To continue to minimize vulnerability to flooding.
- How Identified: NFIP requirement
- Coordinating Organization: PM&E
- Objective: 6.1
- Status/Timeline: Ongoing
- Priority: Mandatory function
- Cost: Included in the PM&E Watershed Management Budget.
- Potential Funding Sources: MOA Budget
- Benefit Cost: This is an ongoing function that protects people and structures from flood hazards.

Action 20. The MOA shall continue to utilize the FEMA Flood Insurance Rate Map to define the special flood hazard area, the floodway, and the floodplain.

- Purpose: To define the special flood hazard area, the floodway, and the floodplain in a consistent manner.
- How Identified: NFIP requirement
- Coordinating Organization: PM&E
- Objective: 6.1
- Status/Timeline: Daily Function
- Priority: Mandatory function
- Cost: Staff Time included in the PM&E Watershed Management Budget.
- Potential Funding Sources: MOA Budget
- Benefit Cost: This is an ongoing function that protects people and structures from flood hazards.

Action 21. Annually review and amend, as appropriate, a list of potential flood mitigation projects such as culvert replacement, channel rehabilitation and property acquisition.

- Purpose: To identify sites the MOA would like to consider purchasing.
- How Identified: PM&E Drainage Studies
- Coordinating Organization: PM&E
- Objective: 6.3, 3.1, 3.3
- Status/Timeline: Part of ongoing activities.
- Priority: Low
- Cost: Staff time
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants.
- Benefit Cost: This is an ongoing function that protects structures from localized flooding.

Action 22. Annually identify and prioritize Flood Insurance Rate Maps that need to be updated.

- Purpose: Because all the FIRMs cannot be updated simultaneously, having a prioritized list would tell the city what to update when resources are available.
- How Identified: Planning Team, Community Input
- Coordinating Organization: PM&E
- Objective: 6.2
- Status/Timeline: Initial list should be developed within one year of plan adoption.
- Priority: Low
- Cost: Staff time
- Potential Funding Sources: MOA Budget, State and Federal Grants
- Benefit Cost: This allows the local government to better mitigate the flood risk to the community and to allow the community to benefit from flood hazard mitigation projects.

Action 23. Update the Flood Insurance Study.

- Purpose: To update information about the flooding hazard in the MOA.
- Coordinating Organizations: PM&E
- Objective: 6.2, 2.5

- Status/Timeline: to be completed in early 2021
- Priority: Medium
- Cost: Depends on the scope of the update.
- Potential Funding Sources: MOA Budget, Bonds, State or Federal Grants
- Benefit Cost: This allows the local government to better mitigate the flood risk to the community and to allow the community to benefit from flood hazard mitigation projects. It would also allow for improved land use planning for flood hazards.

Action 24. Convert the local vertical datum to a national standard vertical datum

- Purpose: To reduce the risk to people and property from flooding.
- How Identified: by FEMA
- Coordinating Organization: PM&E
- Objective: 6.1, 6.2, 2.5
- Status/Timeline: 3 years
- Priority: Medium
- Cost: $300 - $500 Thousand
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grant
- Benefit Cost: This is the first step in obtaining updated Flood Insurance Rate maps and Flood Insurance Studies for the community. It will allow for protection against flooding.

Action 25. Annually review the list of drainage studies that need updating.

- Purpose: To identify which drainage studies need to be updated and the order in which they should updated
- How Identified: AHMP Planning Committee, community input
- Coordinating Organization: Watershed Management
- Objective: 6.2, 6.3, 3.2
- Status/Timeline: Ongoing
- Priority: Low
- Cost: To be completed
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: This will allow for better planning of performing and implementing drainage studies to prevent localized flooding. This will prevent property damage and improve quality of life in poorly drained neighborhoods.

Action 26. Map estimated dam inundation areas within the Municipality and evaluate alternative methods to mitigate the potential risk of a dam failure in these areas.

- Purpose: To assess and recommend alternative methods to mitigate the risk of dam failure on residents and structures located within estimated dam inundation areas
- How Identified: Planning Team
- Coordinating Organization: PM&E, Development Services
- Objective: 6.2, 4.4
- Status/Timeline: A GIS layer for the Lake O' the Hills Dam is completed. An electronic version of the Eklutna Lake Dam inundation area by 2018.
- Priority: Low

- Cost: 1 week of staff time (may be less if the GIS layer can be acquired from the firm that developed the inundation area map)
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: This will allow the MOA to meet a State of Alaska Dam Safety Requirement and will allow local government to use the inundation studies to determine if additional pre-disaster mitigation planning should be done.

Goal 7: Emergency Management

Action 27. Identify ways to improve local public information and warning capabilities.

Purpose: To provide improved warnings to the residents of Anchorage

- How Identified: By OEM
- Coordinating Organization: OEM
- Objective: 7.1, 2.1
- Hazard: All
- Status/Timeline: Ongoing
- Priority: Medium
- Cost: To be completed
- Potential Funding Sources: Current funding, although grants and other funds may be needed to implement the improvements
- Benefit Cost: This will allow local government to better prepare the public for local hazards and warn them of imminent disasters.

Action 28. Update the MOA Continuity of Operations Plan (COOP)

Purpose: To ensure essential functions of Municipal Government during a crisis

- How Identified: By OEM
- Coordinating Organization: OEM
- Objective: 7.1, 7.3, 2.3
- Hazard: All
- Status/Timeline: 2 years
- Priority: Medium
- Cost: To be completed
- Potential Funding Sources: MOA Budget, State or Federal grants
- Benefit Cost: This will allow local government to update the COOP for current needs and situations. This will allow the MOA to continue essential government and or emergency functions during and after a disaster event.

Goal 8: Reduce the urban rural wildfire risk

Action 29. Review existing zoning ordinances to determine if additional wildfire mitigation measures could be incorporated to address wildfire mitigation which has been proposed for inclusion in updates to Title 21. Consider adoption of the International Code Council Wildland Urban Interface Code (current edition).

- Purpose: To help incorporate wildfire mitigation measures into future development
- How Identified: AFD Wildfire Strategic Plan

- Coordinating Organization: AFD, Development Services, Planning Department
- Objective: 8.1,
- Status/Timeline: Tied to the update of Title 21
- Priority: medium
- Cost: Staff time to develop code language and code adoption process
- Potential Funding Source: Operations budget, Bonds, State and Federal Grants
- Benefit Cost: Land use planning that considers hazards as an integral component to policies cans be established that will ensure reductions of loss and damage to structures and safety of the public.

Action 30. Conduct fire-wise home assessments.

- Purpose: Conduct Firewise home assessments to enable homeowners in certain parts of the MOA to obtain insurance.
- How Identified: AFD Wildfire Strategic Plan
- Coordinating Organizations: AFD
- Objective: 8.2, 8.1, 2.1, 4.4
- Status/Timeline: ongoing
- Priority: Medium
- Cost: Varies by year
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: This ongoing program improves the safety of residents and structures in areas with limited firefighting capabilities. It encourages homeowners to develop and maintain their property in a manner that reduces the fire risk.

Action 31. Update the wildfire risk model.

- Purpose: The 2009 wildfire risk model is currently in use. AFD needs to update the model to 2016
- How Identified: AFD Wildfire Strategic Plan
- Coordinating Organization: AFD
- Objective: 8.1, 8.4, 2.1, 2.3, 2.5
- Status/Timeline: The update will be completed if Federal Wildland Urban Interface grant is secured.
- Priority: medium
- Cost: Staff time to make the necessary updates
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: The current risk model is outdated. Updating the model will allow local government to plan and manage firefighting resources for the current needs of the community and will provide information for land use planning inputs.

Action 32. Continue and maintain vegetation management.

- Purpose: To provide public lands vegetation management when DOF has personnel available for mitigation; To provide homeowner assessments and education so that homeowners can manage vegetation on their private property; and to provide wood lots for the disposal of vegetation from private properties through rant funds and business partnerships.

- How Identified: Wildfire Strategic Plan
- Coordinating Organization: AFD/SOA Division of Forestry
- Objective: 8.1, 8.2, 8.3
- Status/Timeline: The vegetation management is an ongoing program that supported with federal funding. This is an AFD long term project
- Priority: Medium
- Cost: Staff resources to manage the vegetation, funding for the wood lot usage and funding for the Firewise Program to encourage private homeowners to address residential areas
- Potential Funding Sources: MOA Budget, Bonds, State and Federal Grants
- Benefit Cost: This ongoing program improves the safety of residents and structures in areas with limited firefighting capabilities. It encourages homeowners to develop and maintain their property in a manner that reduces the fire risk. It allows local government to reduce the fire hazard of publicly owned greenbelts thereby reducing the risk to adjoining structures.

Action 33. Develop additional water resources for wildfire response purposes.

- Purpose: Develop additional water resources would assist in fighting wildfires.
- How Identified: AFD Strategic Plan
- Coordinating Organization: AFD/AWWU
- Objective: 8.1, 8.5
- Status/Timeline: No action has been taken due to insufficient funding and staff resources.
- Priority: Medium
- Cost: AFD Staff resources to identify locations. The development of water resources for firefighting is very costly (drilling wells, installing hydrant systems, installing drafting equipment).
- Potential Funding Sources: MOA Budget, Bonds, State or Federal Grants.
- Benefit Cost: Large sections of the local community do not have public water systems which make firefighting in extremely difficult due to limited water supply. Having an adequate water supply can mean the difference between containing a fire or extinguishing the fire.

CHAPTER 6 PLAN MAINTENANCE

6.1 PLAN ADOPTION

The Municipality of Anchorage's Assembly will be responsible for adopting the Anchorage All-Hazards Mitigation Plan Update.

Prior to being adopted, the department responsible for the plan will submit it to the State Hazard Mitigation Officer (SHMO) at DHS&EM for review and approval. The SHMO will then submit the plan to the FEMA Region X for review and pre-adoption approval. The plan will be adopted for approval by the Anchorage Assembly. FEMA will then grant full approval of the plan and the MOA will be eligible for Hazard Mitigation Grant Programs funds.

6 .2 MONITORING AND EVALUATION

The Anchorage All-Hazards Mitigation Plan, like all plans, requires periodic review to ensure that it remain up to date, reflects current information, and still meets the goals of Anchorage. The MOA Hazard Mitigation Planning Committee will review the plan annually and after every federally declared disaster. The review will determine if there have been any significant changes in the Municipality that affect the Plan. If it is determined that significant changes have occurred, the plan will be amended in order to remain current.

Issues that may be addressed during the evaluation include:

- Are new or different goals, objectives, and action tasks needed?
- Are there any implementation problems?
  - Not enough funding?
  - Conflicts with other goals?
  - Is the plan achieving the desired result?
- Should other hazards be addressed?
- Do we have new information that should be incorporated?
- Does the prioritization of tasks/goals reflect current priorities?

6.3 UPDATING

This plan is intended to be a "living" document that will help inform all interested parties about the MOA's natural hazard mitigation policies and projects. It will be reviewed and updated on a regular basis. The mitigation strategies identified will act as a guide for MOA departments in determining projects for which to seek FEMA and other mitigation funds from outside sources.

6.3.1 ANNUAL REVIEW

The Responsible Department will oversee an annual plan review to make sure that all information is current. The review and update process is as follows:

1. The MOA Hazard Mitigation Committee will meet to consider:
    - Progress made on plan recommendations during the previous 12 months;
    - Mitigation accomplishments in projects, programs, and policies;
    - Status of mitigation projects included on the MOA's CIP list;
    - New mitigation needs identified;
    - Cancellation of planned initiatives, and the justification for doing so; and
    - Changes in membership to the Committee.

    The meeting should occur approximately four months before FEMA PDM grants are due, to allow the MOA enough time to develop a grant application should they wish to apply.

2. The Responsible Department will request input from other departments and outside entities not represented on the MOA Hazard Mitigation Planning Committee on issues listed above. A special effort will be made to gather information on non-capital projects and programs important to mitigation.

3. The Responsible Department will make "minor" changes to the Plan, such as updates to the CIP, without seeking outside approval.

4. "Major" changes—those related to new policies or recommended projects—will go through a more formal review process, including a possible review by the MOA Hazard Mitigation Planning Committee.

5. To allow for ongoing public input, the Responsible Department will post the plan permanently on the MOA's website along with contact information that will encourage people to submit questions or comments.

6.3.2 FOLLOWING A MAJOR DISASTER

If disaster warrants Presidential Disaster Declaration, the Responsible Department will convene the MOA Hazard Mitigation Planning Committee within 2 months of the declaration date. For other events, the Responsible Department will determine if the committee should meet. Because recovery can be a long process and the full impact of a disaster may not be known for many months, this initial meeting may need to be followed by additional meetings over time.

The annual update process described above will also be used following a major disaster. However, post-disaster deliberations will also consider the following:

- "Lessons Learned" from the disaster, and what new initiatives should be added to the plan to help reduce the likelihood of similar damage in the future
- Follow-up needed on items relevant to mitigation from any after-action reports produced by the Municipality
- Integration of mitigation into the recovery process

6.3.3 FIVE YEAR UPDATE

Every five years, the plan will be updated and re-submitted for adoption to the MOA Assembly. Prior to this, the Responsible Department will use the following process to make sure all relevant parties are involved:

1. ***At year three the responsible department will make an application to the State/FEMA for a grant to fund the 5 year update of this plan.***

2. Follow steps 1 and 2 of the Annual Review process (Section 6.3.1).

3. Incorporate all relevant issues raised via the forums identified.

4. Hold public meetings and meetings with identified groups of interested parties and outside organizations to gain input and feedback.

5. Integrate relevant feedback and circulate revised plan to the Hazard Mitigation Committee.

6. Upon incorporation of the Assembly's comments, the revised plan will be submitted to the Alaska State Hazard Mitigation Officer for their review. The plan will be updated based on their comments.

7. The revised plan will then be submitted to FEMA for review. The plan will be updated based on FEMA's comments and re-submitted to FEMA if necessary to obtain a Criteria Met/Plan Not Adopted determination.

8. Submit the plan to the MOA Assembly for adoption by resolution.

9. Submit the adopted plan to FEMA.

The next five-year update process should begin in 2020, with Assembly Adoption occurring in 2021.

6.4 CONTINUED PUBLIC INVOLVEMENT

Before the Assembly approves the plan, it will be presented to the public. A public meeting will be held and a 30-day comment period provided before the plan is presented to the Assembly. However, because the plan is a living document, public involvement in the plan should be encouraged at all times. The MOA website will have a page devoted to the Anchorage All-Hazards Mitigation Plan. This page will have the most recent approved plan, a method of providing feedback on the plan, and notices about plan activities such as updates.

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