City of Kaktovik
Local All Hazard Mitigation Plan

Prepared by:
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Chapter I – Introduction

A. Purpose of the Plan:

The purpose of the All-Hazard Mitigation Plan is to fulfill the FEMA requirement under The Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Act), Section 322, Mitigation Planning enacted by Section 104 of the Disaster Mitigation Act of 2000 (DMA) (P.L. 106-390). This initiative provides new and revitalized approaches to mitigation planning. Section 322 emphasizes the need for State, local, and tribal entities to closely coordinate mitigation planning and implementation efforts. As part of the process of implementing the DMA, FEMA prepared an Interim Final Rule (the Rule) to clearly establish the mitigation planning criteria for States and local and tribal governments. This Rule was published in the Federal Register on February 26, 2002, at 44 CFR Part 201. This plan will identify hazards; establish community goals and objectives and develop mitigation strategies and activities that are appropriate for the City of Kaktovik.

The Disaster Mitigation Act of 2000 (DMA 2000), Section 322 (a-d), as implemented through 44 CFR Part 201.6 requires that local governments, as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities, identifying and prioritizing mitigation actions, encouraging development of local mitigation and providing technical support for those efforts.

The purpose of this plan is to produce a program of activities through actions and projects that will best deal with the City of Kaktovik hazard problems, while meeting other community needs. This plan will accomplish the following objectives consistent with FEMA planning process guidelines:

- Describe the planning process to include public involvement;
- Conduct an assessment of the risks;
- Determine what facilities, or portions of infrastructure, are vulnerable to a disaster;
- Develop a mitigation strategy to reduce potential losses and target resources;
- Describe how each entity will periodically evaluate, monitor maintain and update the plan; and,
- Describe the process for implementing the plan after adoption by the local governing body of the community and receiving FEMA approval.
B. Methodology

The approach used for the development and updating of the City of Kaktovik All-Hazard Mitigation Plan consisted of the following tasks:

1. Coordination with other agencies and organizations
2. Solicitation public involvement
3. Conduct hazard area inventory
4. Review and analysis of possible mitigation activities
5. Description of the update and review process and schedule for plan maintenance
6. Coordinating the Plan with the State Hazard Mitigation Plan
7. Submitting to the State Hazard Mitigation Officer for Review
8. Submitting to FEMA Region 10 for Review and Approval
9. Adoption of the Plan following a public hearing

This All Hazard Local Mitigation Plan contains a list of potential projects and a brief rationale or explanation of how each project or group of projects contributes to the overall mitigation strategy outlined in the plan.

This plan summarizes the activities outlined above to assess the effects of hazards in the City of Kaktovik such as: flooding, earthquake, wildfire and etc. and recommends mitigation strategies and activities.

The mitigation plan will be evaluated and updated every five years. In addition, the plan will be updated, as appropriate when a disaster occurs that significantly affects Kaktovik, whether or not it receives a Presidential Declaration. The update will be completed as soon as possible, but no later than 12 months following the date the disaster occurs.

Routine maintenance of the plan will include updating historical hazard information, completing hazard analysis and adding projects, as new funding sources become available or taking projects off the list when they are accomplished.
C. City of Kaktovik – Background

Community Overview


Pronunciation/Other Names: (kack-TOH-vick); includes Barter Island

Incorporation Type: 2nd Class City

Borough Located In: North Slope Borough

School District: North Slope Borough Schools

Regional Native Corporation: Arctic Slope Regional Corp.

Location:
Kaktovik lies on the north shore of Barter Island, between the Okpilak and Jago Rivers on the Beaufort Sea coast. It lies on the border of the19.6-million-acre Arctic National Wildlife Refuge, an occasional calving ground for the Porcupine caribou herd. It lays at approximately 70.131940° North Latitude and -143.62389° West Longitude. (Sec. 13, T009N, R033E, Umiat Meridian.) Kaktovik is located in the Barrow Recording District. The area encompasses 0.8 sq. miles of land and 0.2 sq. miles of water. The climate of Kaktovik is arctic. Temperatures range from -56 to 78. Precipitation is light, at 5 inches, with snowfall averaging 20 inches.

History:
Until the late nineteenth century the island was a major trade center for the Inupiat and other interior Alaskan Native groups, and was especially important as a bartering place for Inupiat from Alaska and Inuit from Canada. The City of Kaktovik was incorporated in 1971.

Culture:
Due to Kaktovik's isolation, the village has maintained its Inupiat Eskimo traditions. Subsistence is highly dependent upon caribou. Possession of alcohol is banned in the community.

Economy:
Economic opportunities in Kaktovik are limited due to the community's isolation, and unemployment is high. Most employment is in education, the North Slope Borough, or in providing City services. Part-time seasonal jobs, such as construction projects, provide income.

Facilities:
The North Slope Borough provides all utilities in Kaktovik. Water is derived
from a surface source, is treated and stored in a 680,000-gallon water tank. Water is delivered by truck to home holding tanks; approximately 80% of homes have running water in the kitchen. Village is still on water and sewage haul for the most part. Service connections are being installed. Preliminary funds have been provided to construct a piped system with flush toilets, showers, and plumbing for all residences. Homes not connected to the water/sewer system utilize holding tanks for water and sewage that are pumped and hauled regularly.

**Transportation:**
Air travel provides the only year-round access. The Barter Island Airport is owned by the Air Force and operated by the North Slope Borough. Marine and land transportation provide seasonal access. Funds have been requested to construct a dock and boat ramp. Skiffs, umiats and snow machines are used for local transportation.

**Climate:**
The climate is arctic. Temperatures range from -56 to 78. Precipitation is light, 5 inches annually, with snowfall of 20 inches. The Beaufort Sea is ice-free from late June until mid-September.
Chapter II – Adoption Process and Documentation

The City of Kaktovik All-Hazards Mitigation Plan was developed as a community plan in conjunction with the North Slope Borough Multi-Jurisdictional Plan; therefore, to meet the requirements of Section 322 the Kaktovik City Council, as well as the North Slope Borough Assembly adopted the plan. This section documents the adoption process of each local government in order to demonstrate compliance with this requirement (see appendices)

**Formal Adoption should occur after preliminary approval of the plan from the State Hazard Mitigation Officer (SHMO) and FEMA Region 10 Mitigation personnel. Refer to next page for a sample adoption resolution**
RESOLUTION 05-02

A RESOLUTION OF THE CITY OF KAKTOVIK APPROVING THE ALL HAZARDS MITIGATION PLAN

WHEREAS, the City of Kaktovik recognizes the threat that all hazards pose to people and property; and

WHEREAS, undertaking hazard mitigation actions before disasters occur will reduce the potential for harm to people and property and save taxpayer dollars; and

WHEREAS, and adopted all hazards mitigation plan is required as a condition of future grant funding for mitigation projects; and

WHEREAS, the City of Kaktovik participated jointly in the planning process with the other local units of government within the North Slope Borough to prepare an All Hazards Mitigation Plan;

NOW THEREFORE BE IT RESOLVED THAT: the Kaktovik City Council hereby adopts the City of Kaktovik All Hazards Mitigation Plan as an official plan; and

BE IT FURTHER RESOLVED, that the North Slope Borough Risk Management Division will submit on behalf of the participating municipalities the adopted All Hazards Mitigation Plan to the State of Alaska Division of Emergency Services and the Federal Emergency Management Agency officials for final review and approval.

PASSED AND APPROVED by a duly constituted quorum of the City Council of the City of Kaktovik on this 12th day of April, 2003.

Lon Sonsalla, Mayor

ATTEST:

Elizabeth S. Reynold, City Clerk & Treasurer
Chapter III – Planning Process

A. – How was it done? (Describe how the planning process was accomplished.)

The North Slope Borough Risk Management Division, using staff assets, developed the City of Kaktovik All-Hazard Mitigation Plan. The Risk Management Division coordinated with agencies to include; the Alaska Division of Homeland Security & Emergency Management (ADHS&EM), North Slope Borough Fire Department and the Kaktovik Volunteer Fire Department. These agencies provided information from existing plans including; Alaska State All Hazard Mitigation Plan, The North Slope Borough Oil Discharge Prevention and Contingency Plan and North Slope Borough Comprehensive Emergency Management Plan. The Risk Management Division compiled all pertinent data and completed a draft plan with subsequent review and input by all listed parties.

The North Slope Borough Planning Commission reviewed the submission, gathered additional data that included public comment (See Public Participation below), and an initial draft was completed.

B. Who were contributors?

The City of Kaktovik, The North Slope Borough, the North Slope Borough Local Emergency Planning Commission, the North Slope Borough Planning Commission, the Kaktovik Inupiat Corporation, the Native Village of Kaktovik, the North Slope Borough School District and private individuals contributed to the development of this plan.

C. Public Opportunity for Involvement

October – December 2003 - North Slope Borough Risk Management distributes community surveys (see appendices) throughout the community of Kaktovik. Six completed surveys were returned, with input received being incorporated into this plan.


December 7, 2004- Kaktovik City Council Meeting on the Hazard Mitigation Plan.
Chapter IV– Hazard Identification & Risk Assessment

A. Hazard Identification

Hazard Matrix – City of Kaktovik

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Flood</th>
<th>Wild land</th>
<th>Fire</th>
<th>Earthquake</th>
<th>Volcano</th>
<th>Snow Avalanche</th>
<th>Tsunami &amp; Seiche</th>
<th>Weather</th>
<th>Landslides</th>
<th>Erosion</th>
<th>Drought</th>
<th>Technological</th>
<th>Coastal Storm Surges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y-L</td>
<td>Y/L</td>
<td>Y/L</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Weather</td>
<td>N</td>
<td>Y/H</td>
<td>N</td>
<td>Y/M</td>
<td>Y/H</td>
</tr>
</tbody>
</table>

Hazard Identification:

Y: Hazard is present in jurisdiction but probability unknown
N: Hazard is not present
U: Unknown if the hazard occurs in the jurisdiction

Risk:

L: Hazard is present with a low probability of occurrence
M: Hazard is present with a moderate probability of occurrence
H: Hazard is present with a high probability of occurrence

It should be noted that the community of Kaktovik is a small, relatively compact community. Therefore, the hazard profiles and corresponding risk assessments contained in the following section pertain to the entire community, rather than any one neighborhood or division.

Prior to documenting the history of hazardous events in Kaktovik it should be noted that this is difficult at best, due to the relatively short span of recorded history in the area. While the communities of Barrow and Point Hope have been settled for centuries, Westerners did not begin to permanently settle the area until the early 1900’s. Even with the advent of western civilization in the area, little historical record exists for the period of time prior to the 1930’s. Therefore it is not an understatement that any time prior to 1950 in the North Slope Borough is in essence “pre-contact”.

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B. Hazard Profile

Flood

Flooding is a natural event and damages occur when humans interfere with the natural process by altering the waterway, developing watersheds, and/or building inappropriately within the floodplain. Most of Alaska’s communities and transportation facilities are located along large rivers and are subject to flooding. This flooding threatens life, safety and health; causes extensive property loss; and results in damage in excess of three-quarters of a million dollars annually.

Flooding in Alaska can be broken into a number of categories including rainfall-runoff floods, snowmelt floods, ground-water flooding, ice jam floods, flash floods, fluctuating lake levels, alluvial fan floods and glacial outburst floods. Alaska also experiences coastal flooding from storm surge but this will be discussed in the Weather section. These are not exclusive categories as a flood event could have elements of more than one type. As no river or major stream runs through the community of Kaktovik, flooding, other than that related to coastal storm surges, is a limited threat to the community.

Rainfall-Runoff Floods

As no river or major stream runs through the community of Kaktovik, this form of flooding poses no threat to the community.

Snowmelt Floods

Although no river or major stream runs through the community of Kaktovik, this form of flooding poses some threat to the community. During the month of, melting snow and ice causes large amounts of water to accumulate in the east end of the community. Homes on Pipsuk Road, Barter, Kaktovik, Hula Hula and First Streets are surrounded by water. During June 2004 the water level rose within four inches of flooding at least one home. Community residents advise that additional, and larger culverts need to be installed in this area.

Ground-water Floods

Ground water flooding occurs when water accumulates and saturates the soil. The water table rises and floods low-lying areas, including homes, septic tanks, and other facilities. Although the potential exists for this form of flooding, the elevated construction of buildings in the community minimizes the risk this type of event poses.
Ice Jam Floods
Again, as no river or major stream runs through the community of Kaktovik, flooding is not a major threat to the community.

Flash Floods
These floods are characterized by a rapid rise in water. They are often caused by heavy rain on small stream basins, ice jam formation or by dam failure. They are usually swift moving and debris filled, causing them to be very powerful and destructive. As no river or major stream runs through the community, and no history of such incidents occurring in Kaktovik have been discovered, this form of flooding is not a major threat to the community.

Wild land Fires
Wild land fires occur in every state in the country and Alaska is no exception. Each year, between 600 and 800 wild land fires, mostly between March and October, burn across Alaska causing extensive damage.

Fire is recognized as a critical feature of the natural history of many ecosystems. It is essential to maintain the biodiversity and long-term ecological health of the land. In Alaska, the natural fire regime is characterized by a return interval of 50 to 200 years, depending on the vegetation type, topography and location. The role of wild land fire as an essential ecological process and natural change agent has been incorporated into the fire management planning process and the full range of fire management activities is exercised in Alaska to help achieve ecosystem sustainability, including its interrelated ecological, economic, and social consequences on firefighter and public safety and welfare, natural and cultural resources threatened, and the other values to be protected dictate the appropriate management response to the fire. Firefighter and public safety is always the first and overriding priority for all fire management activities.

Hazard Analysis/Characteristics
Fires can be divided into the following categories:
  Structure fires – originate in and burn a building, shelter or other structure.
  Prescribed fires - ignited under predetermined conditions to meet specific objectives, to mitigate risks to people and their communities, and/or to restore and maintain healthy, diverse ecological systems.
  Wild land fire - any non-structure fire, other than prescribed fire, that occurs in the wild land.
  Wild land Fire Use - a wild land fire functioning in its natural ecological role and fulfilling land management objectives.
  Wild land-Urban Interface Fires - fires that burn within the line, area, or zone where structures and other human development meet or intermingle with undeveloped wild land or vegetative fuels. The potential exists in areas of wild land-urban interface for
extremely dangerous and complex fire burning conditions that pose a tremendous threat to public and firefighter safety.

Fuel, weather, and topography influence wild land fire behavior. Wild land fire behavior can be erratic and extreme causing fire whirls and firestorms that can endanger the lives of the firefighters trying to suppress the blaze. Fuel determines how much energy the fire releases, how quickly the fire spreads and how much effort is needed to contain the fire. Weather is the most variable factor. Temperature and humidity also affect fire behavior. High temperatures and low humidity encourage fire activity while low temperatures and high humidity help retard fire behavior. Wind affects the speed and direction of a fire. Topography directs the movement of air, which can also affect fire behavior. When the terrain funnels air, like what happens in a canyon, it can lead to faster spreading. Fire can also travel up slope quicker than it goes down.

In the summer of 1993 a lightning strike caused a tundra fire near the neighboring community of Wainwright. The Wainwright Volunteer Fire Department responded to the fire, but were forced to call upon the Alaska Smokejumpers for assistance. Even with the combined efforts of the local and state firefighters, it took approximately two weeks to extinguish the fire.

In the approximate year of 1984, sparks from the chimney of a hunting cabin caused a small wild land fire in an area approximately 15 miles north of the neighboring village of Point Hope. Residents and neighbors of the cabin rapidly extinguished this fire.

Although community residents can recall no event that threatened the community, a number of them advise that large forest fires in the interior often lead to poor air quality in the village. During the community meeting held December 7, 2004, community residents advised that air quality and visibility were exceedingly poor throughout the summer of 2004 due to the large fires near the community of Fairbanks.

As illustrated by the previously mentioned events, the risk of wild land fire does exist in the community of Kaktovik. The Risk of wild land fire in Kaktovik is limited to the months of June through September, as the terrain is snow covered during the remaining months of the year.

**Weather**

Weather is the result of four main features: the sun, the planet's atmosphere, moisture, and the structure of the planet. Certain combinations can result in severe weather events that have the potential to become a disaster.

In Kaktovik there is great potential for weather disasters. Wind-driven waves from intense storms crossing the Beaufort Sea produce coastal flooding and can drive large chunks of sea ice inland threatening buildings near the shore. High winds can combine with loose snow to produce a blinding blizzard and wind chill temperatures to 75°F below zero! Extreme cold (-40°F to -60°F) and ice fog may last a week at a time.

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Winter Storms
Winter storms originate as mid-latitude depressions or cyclonic weather systems. High winds, heavy snow, and cold temperatures usually accompany them. To develop, they require:

- Cold air - Subfreezing temperatures (below 32°F, 0°C) in the clouds and/or near the ground to make snow and/or ice.
- Moisture - The air must contain moisture in order to form clouds and precipitation.
- Lift - A mechanism to raise the moist air to form the clouds and cause precipitation. Lift may be provided by any or all of the following:
  - The flow of air up a mountainside.
  - Fronts, where warm air collides with cold air and rises over the dome of cold air.
  - Upper-level low pressure troughs.

Snow Terminology

<table>
<thead>
<tr>
<th>Snow Terminology</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Snow</td>
<td>Steady fall of snow for several hours or more.</td>
</tr>
<tr>
<td>Heavy Snow</td>
<td>Snowfall accumulating to 4 inches or more in depth in 12 hours or less.</td>
</tr>
<tr>
<td>Snow Squalls</td>
<td>Periods of moderate to heavy snowfall, intense, but of limited duration, accompanied by strong, gusty surface winds and possibly lightning.</td>
</tr>
<tr>
<td>A Snow Shower</td>
<td>Short duration of moderate snowfall.</td>
</tr>
<tr>
<td>Snow Flurries</td>
<td>Intermittent light snowfall of short duration with no measurable accumulation.</td>
</tr>
<tr>
<td>Blowing Snow</td>
<td>Wind-driven snow that reduces surface visibility.</td>
</tr>
<tr>
<td>Drifting Snow</td>
<td>Uneven distribution of snowfall and snow depth caused by strong surface winds.</td>
</tr>
<tr>
<td>A Blizzard</td>
<td>Sustained wind or frequent gusts to 35 miles/hour or greater.</td>
</tr>
<tr>
<td>Freezing Rain/Drizzle</td>
<td>Occurs when rain or drizzle freezes on surfaces such as the ground, trees, power lines, motor vehicles, streets, highways, etc.</td>
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</tbody>
</table>

Heavy Snow
Heavy snow, generally more than 12 inches of accumulation in less than 24 hours, can immobilize a community by bringing transportation to a halt. Until the snow can be removed, airports and major roadways are impacted, even closed completely, stopping the flow of supplies and disrupting emergency and medical services. Accumulations of snow can cause roofs to collapse and knock down trees and power lines. Heavy snow can also damage light aircraft and sink small boats. The cost of snow removal, repairing damages, and the loss of business can have severe economic impacts the community.

Injuries and deaths related to heavy snow, although extremely rare, usually occur as a result of vehicle accidents. Casualties can also occur due to overexertion while shoveling snow and hypothermia caused by overexposure to the cold weather.

As previously stated, heavy snow is a rare event in Kaktovik, where an average of 20 inches of snowfall occurs annually. High winds in Kaktovik can combine with loose snow to produce...
blinding blizzard conditions and dangerous wind chill temperatures. High winds, coupled with the moderate snowfall in Kaktovik often causes the development of snowdrifts. Local residents report that such drifts frequently inhibit vehicle movement, including school busses, ambulances and fire trucks, as well as preventing airplanes from landing in the community. The interruption of air traffic is particularly troubling, as this is the sole form of medical transportation available to the community.

**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 Kaktovik, extreme cold usually involves temperatures below –40 degrees Fahrenheit. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity.

Extreme cold can bring transportation to a halt in Kaktovik for days or sometimes weeks at a time. Aircraft may be grounded due to extreme cold and ice fog conditions, cutting off access as well as the flow of supplies to northern villages. Extreme cold also interferes with a community’s infrastructure. Extreme cold may cause fuel to congeal in storage tanks and supply lines, stopping electric generation. Without electricity, heaters do not work, causing water and sewer pipes to freeze or rupture. If extreme cold conditions are combined with low or no snow cover, the ground’s frost depth can increase disturbing buried pipes.

The greatest danger from extreme cold is to people. Prolonged exposure to the cold can cause frostbite or hypothermia and become life threatening. Infants and elderly people are most susceptible.

The risk of hypothermia due to exposure greatly increases during episodes of extreme cold, and carbon monoxide poisoning is possible 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 98.6°F. When body temperature drops to 95°F, however, immediate medical help is needed. Hypothermia also can occur with prolonged exposure to temperatures above freezing.

**Ice Storms**

The term ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. They can be the most devastating of winter weather phenomena and are often the cause of automobile accidents, power outages and personal injury. Ice storms result from the accumulation of freezing rain, which is 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.
Freezing rain develops as falling snow encounters a layer of warm air in the atmosphere deep enough for the snow to completely melt and become rain. As the rain continues to fall, it passes through a thin layer of cold air just above the earth’s surface and cools to a temperature below freezing. The drops themselves do not freeze, but rather they become super cooled. When these super cooled drops strike the frozen ground, power lines, tree branches, etc., they instantly freeze.

Although freezing rain does present a risk for the community of Kaktovik, it is a very infrequent event, occurring on the average of twice a year. Community residents reported that an inch of ice accumulated on power lines, buildings and vehicles during such a storm in 2003. During a community meeting held December 7, 2004, community residents reported that accumulating ice during this storm caused a power line attached to the Sims Store to be pulled down. The owner of Sims Store reports that she experienced loss of inventory and damage to equipment and supplies as a result of the storm.

High Winds

In Kaktovik high winds (winds in excess of 60 mph) occur rather frequently because of coastal storms. High winds in Kaktovik can also combine with loose snow to produce blinding blizzard conditions and dangerous wind chill temperatures.

High Winds in Kaktovik can reach hurricane force and have the potential to seriously damage homes and community infrastructure (especially above ground utility lines).

Localized downdrafts, downbursts & microbursts, are also important in Alaska, but rare in Kaktovik. Downbursts and microbursts can be generated by thunderstorms. Downburst winds are strong concentrated straight-line winds created by falling rain and sinking air that can reach speeds of 125 mph. The combination induces a strong wind downdraft due to aerodynamic drag forces or evaporation processes. Microburst winds are more concentrated than downbursts and can reach speeds up to 150 mph. They can cause significant damage as both can last 5 – 7 minutes. Because of wind shear and detection difficulties, they pose a big threat to aircraft landings and departures.

As previously stated high winds are a frequent event in the community of Kaktovik, often causing minor damages to homes and buildings. As such, high winds could be classified as a moderate risk.

Thunderstorms & Lightning

Thunderstorms are caused by the turbulence and atmospheric imbalance that arise from combining:

- Unstable rising warm air.
- Lift.
- Adequate moisture to form clouds and rain.

They are composed of lightning and rainfall and can intensify into a severe thunderstorm with

<table>
<thead>
<tr>
<th>Stages of Development</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Developing</strong></td>
<td>A towering cumulus cloud develops as air rises. The cloud extends to about 20,000 feet above the level of freezing temperatures. Usually there is little if any rain, but occasionally lightning occurs during this stage, which lasts about 10 minutes.</td>
</tr>
<tr>
<td><strong>Mature</strong></td>
<td>During this stage, the storm builds to heights of 40,000 feet or more. This is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The mature stage lasts an average of 10 to 20 minutes, but may last much longer.</td>
</tr>
<tr>
<td><strong>Dissipating</strong></td>
<td>Downdrafts begin to choke off the supply of air that feeds the storm; the storm stops building, loses height, and dissipates. Rainfall decreases in intensity, but some thunderstorms produce a burst of strong winds in this stage, and lightning remains a danger.</td>
</tr>
</tbody>
</table>
damaging hail, high winds, and flash flooding. A thunderstorm is considered severe if wind reach or exceed 58 mph, produces a tornado, or drops surface hail at least 0.75 inches in diameter.

Thunderstorms affect relatively small areas. The average thunderstorm is about 15 miles in diameter and lasts less than 30 minutes in any given location.

Lightning exists in all thunderstorms. It is caused by a buildup of charged ions within the thundercloud. When lightning connects with a grounded object, electricity is released which can be harmful to humans and can start fires.

The thunderstorms that occur in Alaska are usually the single-cell or “pulse” variety. They usually develop due to a combination of atmospheric instability and moisture triggered by surface heating from the sun. These storms generally last only 20-30 minutes and do not usually produce severe weather. But rarely, a pulse thunderstorm may produce brief high winds, hail, or weak tornadoes. Multi cell thunderstorm and squall line tornadoes are rare in Alaska and super cell thunderstorms are almost unheard of here.

A much more common impact of thunderstorm activity in Alaska is wildfire. BLM sensors positioned across the interior have located an average of 26,000 cloud-to-ground lightning strikes per year. Very active thunderstorm days may feature 2,000 to 5,000 lightning strikes, mainly occurring during the late afternoon hours during the end of June – beginning of July. Many of these lightning strikes occur in the northern boreal forests of the Alaska interior occasionally leading to wildfires.

Kaktovik historically has a low frequency of thunderstorm occurrence, with said storms occurring on the average of only once a year. During a community meeting held December 7, 2004 community residents advised that such storms were becoming much more frequent, with at least six occurring in each of the past four years. Community residents report that no known damage has occurred due to such an event. As such, thunderstorms could be classified as a very minor risk to the community.
Hail

Hailstorms are an outgrowth of thunderstorms in which ball or irregular shaped lumps of ice greater than 0.75 inches in diameter fall with rain. The size and severity of the storm determine the size of the hailstones. In Alaska, hailstorms are fairly rare and cause little damage, unlike the hailstorms in Mid-western states. The extreme conditions of atmospheric instability needed to generate hail of a damaging size (greater than ¼ inch diameter) are highly unusual in Kaktovik. Kaktovik does experience hail on the average of two times a year, with the hailstones generally measuring 1/16th to 1/8th of an inch in diameter. Community residents report on incident of large hail falling near the community, with event occurring 30 miles south during the spring of 2004. One resident reported finding hailstones “the size of a silver dollar accumulated three inches deep.” Community residents advise that no known damage due to hail has ever occurred, and as such hailstorms could be classified as a very minor risk to Kaktovik.

Coastal Storms

From the fall through the spring, low pressure cyclones either develop in the Bering Sea or Gulf of Alaska or are brought to the region by wind systems in the upper atmosphere that tend to steer storms in the north Pacific Ocean toward Alaska. When these storms impact the shoreline, they often bring wide swathes of high winds and occasionally cause coastal flooding and erosion.

The intensity, location and the land’s topography influence the storm’s impact. Another factor that influences the damage done to the shoreline by coastal storms in Kaktovik is whether or not the shore ice is solid enough to protect against erosion and physical damage to community infrastructure.

The September 1986 storm created surges of sufficient height to completely submerge the Barter Island Airport. The runway at the airport now experiences annual flooding as a result of summer and fall storms.

Storm Surge

Storm surges, or coastal floods, occur when the sea is driven inland above the high-tide level onto land that is normally dry. Often, heavy surf conditions driven by high winds accompany a storm surge adding to the destructive force of the flooding waters. The conditions that cause coastal floods also can cause significant shoreline erosion as the floodwaters undercut roads and other structures. Storm surge is a serious threat to the community of Kaktovik.
The meteorological parameters conducive to coastal flooding are low atmospheric pressure, strong winds (blowing directly onshore or along the shore with the shoreline to the right of the direction of the flow), and winds maintained from roughly the same direction over a long distance across the open ocean (fetch).

Communities, such as Kaktovik, that are situated on low-lying coastal lands with gradually sloping bathymetry near the shore and exposure to strong winds with a long fetch over the water are particularly susceptible to coastal flooding.

Most coastal flooding occurs during the late summer or early fall season in these locations. As shore fast ice forms along the coast before winter, the risk of coastal flooding abates.

The community of Kaktovik has had intermittent flood activity over the years, mostly caused by coastal storm surges. During a major storm in September 1957, waves estimated at 6 to 12 feet caused substantial road damage on Barter Island, and caused 4,400 barrels of fuel to be swept away.

One of the most significant cases of coastal flooding occurred in Barrow on March 10, 1963. A deepening low-pressure system moved eastward across the Arctic Ocean and Beaufort Sea, and a storm surge developed traveling west by northwest. Barrow experienced a surge of 11-12 feet, which damaged several homes, buildings, airplanes, and the electrical plant. Barrow’s
freshwater supply was also contaminated with seawater due to the flooding. Although located much further east, the community of Kaktovik was hammered by this storm as well.

During another substantial storm in August 1972, coastal storm surges led to the runway of the Barter Island airport being covered with approximately four inches of water, causing the temporary closure of the runway.

The September 1986 storm created surges of sufficient height to completely submerge the Barter Island Airport. The runway at the airport now experiences annual flooding as a result of summer and fall storms.

A storm occurring in August 2000 caused water levels to rise 3.76 feet above the mean sea level, causing at least half of the Barter Island Airport runway to be submerged. This storm caused the airport to be closed for approximately three days, inhibiting transport of persons and supplies to and from the community. Minor flooding of the runway occurred again during falls storms in 2002, 2003 and 2004.

A just-completed study of Alaskan storm surges, conducted by James L. Wise, Albert L. Comiskey and Richard Becker, Jr. of the University of Alaska's Arctic Environmental Information and Data Center, shows that positive storm surges up to 13 feet in height have occurred during the past four decades. According to the authors of the study, much of the Chukchi Sea and Beaufort Sea coastlines possess the combination of wind and topography that are conducive to strong storm surges. This study, coupled with the history of Kaktovik would indicate that coastal storms pose a significant risk to the community.

Ivu

Few incidents where ice override has caused damage have been documented in North Slope Borough communities, however the following illustrates that it is a real, however infrequent threat.

In his memoirs, entitled “50 Years Below Zero”, Charles Brower provides the following description of the Ice Override event he witnessed in 1890. “On Reaching Utkiavie a couple of days later the first thing we saw was a great ridge of ice piled up all along shore, with what was left of the old Ino smashed and twisted and buried underneath. If we hadn’t built our house on the hill..!

Even the fifty-foot bluff on which the village stood couldn’t always be depended on for safety, according to Mungie. A few years before I came among them, a strong west wind, coupled with just the right current, had forced heavy ice almost to the beach; and this in turn pushed thinner inshore ice onto the very top of the bluff-right into the village. Several houses near the edge of were crushed with everyone inside. It had all happened in one night.”

In 1978, another ivu event occurred in the community of Barrow where a 450-foot on shore movement was reported. There is evidence that other events in the area that have gone a significant distance inland.
Ice override may occur when storm wind conditions are coupled with sufficient open water. Both the Chuckchi and Beaufort Seas are covered with ice for the months of November through June. Heavy southwestern winds could cause ice override to occur in the community of Kaktovik. Although no such event has caused damage to the community in recorded history, ice override could be characterized as a low to moderate hazard in Kaktovik.

**Climate Change:**

According to a report recently published by the Arctic Council, climate change is occurring much more rapidly in the Arctic than in the rest of the world. The report states that the annual average amount of sea ice in the Arctic has decreased by approximately 8% over the past 30 years, resulting in a loss of 386,100 square miles of sea ice. To place this loss in perspective, the 386,100 square miles of lost sea ice is actually larger than the states of Arizona and Texas combined.

In addition to the lost ice, the report finds that average annual temperatures in Alaska have increased 3.6 degrees Fahrenheit, while winter temperatures in Alaska have increased by 5 degrees Fahrenheit. While this trend is troubling to the scientific community, it is even more troubling to the residents of Arctic Alaska.

If the current trend of climate change continues, the consequences for the community of Kaktovik could be dire indeed. Higher temperatures could lead to melting of the permafrost upon which homes, power plants and fuel tanks farms are built. Higher temperatures may cause the ice to retreat even further, allowing larger and more damaging coastal storms. Increased erosion rates would undoubtedly accompany an increase in coastal storms. An increase in temperatures may also impact the wildlife upon which the Inupiat people depend for subsistence, thereby altering their way of life forever.

Although there is nothing the people of Kaktovik can do to alter the weather pattern, it would be safe to say that climate change, along with its peripheral effects, is easily the single largest risk to the community.

**Landslides**

Ground failure can occur in many ways. Types of ground failure in Alaska include landslides, land subsidence, and failures related to seasonally frozen ground, erosion, and permafrost.

Landslide is a generic term for a variety of down slope 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.

Landslides usually occur in steep areas but not always. They can occur as ground failure of river bluffs, cut-and-fill failures associated with road and building excavations, collapse of mine-waste piles, and slope failures associated with open-pit mines and quarries. Underwater landslides
usually involve areas of low relief and slope gradients in lakes and reservoirs or in offshore marine setting.

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. They can be caused by long-term climate change that results in increased precipitation, ground saturation and a rise in groundwater level, which reduces the shear strength and increases the weight of the soil. Erosion that removes material from the base of a slope can also cause naturally triggered 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: topography, geology and precipitation. Topology and geology are associated with each other, the steeper the slope, and the greater the influence from gravity. 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. If precipitation is absorbed into the ground, it increases the pore water pressure and lubricates weak zones of rock or soil. Due to the relatively flat terrain on which the city is located, combined with the lack of previous landslide impacting the community events indicates the risk of landslide activity is extremely low.
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. It is a widespread problem in Alaska, but a very rare event in the community of Kaktovik, due to its location in an area of perennally frozen soil and rock.

Permafrost

Ground failure related to permafrost is a significant problem in Alaska, but again a rare occurrence in Kaktovik. Permafrost is frozen ground in which a naturally occurring temperature below 32o Fahrenheit (0o Centigrade) has existed for two or more years. Measured recorded depths extend from 1,330 feet near Pt. Barrow to 350 feet at Nome, 265 feet at Fairbanks, and 100 feet near Tok. Permafrost is continuous in extent over the area surrounding Kaktovik. Permafrost can form an extremely strong and stable foundation material if it is kept in the frozen state, but if it is allowed to thaw, the soil becomes extremely weak and fails. During a community meeting held December 7, 2004 community residents reported continued subsidence in ground levels during the previous four years, and attribute it to the current weather pattern. Community residents report that houses and other buildings are beginning to settle as a result, with floors and structures now becoming uneven.

Snow Avalanches

Due to the fact that the community of Kaktovik is located in an area of relatively flat topography, the risk of snow avalanche occurrence is near zero probability
Erosion

Erosion is a process that involves the wearing away, transportation, and movement of land. Erosion rates can vary significantly as 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 Kaktovik coastal erosion is the most destructive, while riverine erosion and wind erosion pose little or no risk to the community.

Classifying erosion can be confusing, as there are multiple terms 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 two separate processes. The same goes for beach erosion. For this annex, coastal erosion encompasses bluff and beach erosion while riverine erosion will be considered synonymous for stream erosion, stream bank erosion and riverbank erosion.

Coastal Erosion

Coastal erosion is the wearing away of land resulting in loss of beach, shoreline, or dune material from natural activity or human influences. 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 the position or horizontal displacement of a shoreline over a period of time. Bluff recession is the most visible aspect of coastal erosion because of the dramatic change it causes 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 Kaktovik, 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 shore fast ice, driving it onto the beach. The ice will then gouge the beach and cause other damage.

Coastal erosion in the North Slope Borough is limited to the 4-5 months of ice-free water. Although this is a relatively brief period of time, a study published in 2003 (Brown, J.; M.T. Jorgenson; O.P. Smith & W. Lee 2003 Long-term rates of coastal erosion and carbon input, Elson Lagoon, Barrow, Alaska. In Proceedings of the Eighth International Conference on Permafrost, v.1. M. Phillips, S.M. Springman and L.U. Arenson (eds.). Zurich.) states that extreme rates of 10 meters per year have been documented along many Arctic coastlines, and that average coastal erosion rates of 2 to 6 meters per year are common. It is important to note that although the term coastal erosion rate is used, that erosion itself is episodic rather than constant. This is to say that the amount of coastal erosion may vary from year to year, based upon the length of the time the seas are ice free, the number of storms experienced during that time and the severity of each of the storms.

The previously mentioned study centers on the area around the Elson Lagoon in Barrow. Data gathered for the study spans the years of 1948 through 2000, thereby giving a long term look at coastal erosion rates, as well as depicting current patterns in erosion rates. The study found that the area near Point Barrow lost an average of .48 meters of coastline due to erosion annually during the period spanning from 1948-1979, but

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. They are 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. Designed to dissipate the force of storm waves and prevent undermining of a seawall, dune or placed fill.

| Bottomfast ice | Ice that has frozen to the ocean floor. |
| Shorefast ice | Ice that has frozen only to the shore. |
that this figured increased to .86 meters per year of lost coastline due to coastal erosion during the period spanning 1979-2000. The figures previously stated illustrate a 47% increase in annual coastal erosion rates from the period spanning 1948-1979 to the period spanning 1979-2000.

Although the data cited is largely specific to the Barrow area, some preliminary erosion studies have been conducted in Kaktovik. In a report entitled “Design Analysis For Landfill Protection, Long Range Radar Site (LRRS Barter Island, Alaska” completed by the U. S. Army Corps of Engineers in December 1998, bluffs along the northerly limit of the radar site were identified as having receded between 25 to 30 feet during the years of 1991 and 1995. The U. S. Army Corps of Engineers estimated that the area of the bluffs was receding at the rate of 5 to 8 feet annually.

The U. S. Army Corps of Engineers was particularly concerned as erosion had actually encroached upon the site of the decommissioned landfill from the old DEW line site. As part of the decommissioning, the DEW line landfill was closed by encapsulation, however erosion had exposed the landfill by the year 2000. According to the U. S. Army Corps of Engineers, “miscellaneous debris from the landfill including barrels, scrap metal, and other unknown materials have washed out into the Beaufort Sea” as a result of the continued erosion in the area.

Erosion has also threatened other infrastructure in the community of Kaktovik. In the early 1980’s, the North Slope Borough was forced to build a seawall along the lagoon in order to prevent erosion from encroaching upon newly built roadways in the community.

Erosion related to annual fall and summer storms have also threatened the Barter Island Airport. Storms outlined in the Coastal Storm section have repeatedly submerged portions of the runway, and have continued to eat away at the natural barriers protecting the airport. Although the North Slope Borough has previously attempted to protect the north side of the runway with the installation of geo-grid material, erosion appears to be continuing. In September of 1986, a large fall storm caused the Barter Island airport’s runway to be completely submerged. Due to the substantial erosion that occurred during this event, the flooding of the airport is now occurring on an average of every two years.

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...

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City of Kaktovik
Local All Hazard Mitigation Plan

**Erosional and depositional processes:**

- **Degradation:** Lowering of the channel bed on a substantial reach length occurring over a relatively long period of time in response to disturbances that affect general watershed conditions, such as sediment supply, runoff volume, and artificial channel controls.
- **Aggradation:** Raising of the channel bed as a result of disturbances in watershed conditions that produce the opposite effect to those leading to degradation.
- **General Scour:** Lowering of the streambed in a general area as consequences of a short duration event such as the passage of a flood. Examples are the erosion zones near bridge abutments and those in the vicinity of gravel pits.
- **Local Scour:** Lowering of the bed due to localized phenomena such as vortex formation around bridge piers.
- **Deposition:** Raising of the streambed due to specific episode. An example is the formation of a sand bar after a flood event. Deposition is used in this document as the counterpart of general scour.
- **Lateral Migration:** Shifting of the streambank alignment due to a combination of the above vertical erosional and depositional processes. The most common example is meander migration in the floodplain. Bank retreat due to mass failure is another example.