CHAPTER 3

DESCRIPTION OF THE AFFECTED ENVIRONMENT

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3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

In Chapter 3, descriptions of the area within the Poker Flat Research Range (PFRR) provide the context for understanding the environmental consequences of the alternatives described in Chapter 4. The affected environment serves as a baseline from which any environmental changes that may be brought about by implementing the proposed alternatives can be identified and evaluated; the baseline conditions are the currently existing conditions.

The affected environment at Poker Flat Research Range (PFRR) is described for the following resource areas: air quality and climate; water resources; geology and soils; noise; visual resources; ecological resources; land use and recreation; cultural resources; subsistence use resources; transportation; hazardous materials and waste; health and safety; and socioeconomics and environmental justice. For simplicity and consistency with PFRR launch seasons, the affected environment is divided into two seasons for some resources areas: summer and winter. For this analysis, summer is defined as May through September and winter, as October through April. In addition, for some resource areas, the affected environment description is based on ecoregions. The following ecoregions are located within the PFRR launch site, launch corridor, and are discussed in this *Draft Environmental Impact Statement for the Sounding Rockets Program at Poker Flat Research Range (PFRR EIS)*: Beaufort Sea Ecoregion, Arctic Coastal Plain Ecoregion, Arctic Foothills Ecoregion, Brooks Range Ecoregion, Interior Forested Lowlands and Uplands Ecoregion, Interior Highlands Ecoregion, and Yukon Flats Ecoregion **(Gallant *et al.* 1995)**. For the purposes of discussion, PFRR is divided into two components: the launch site and launch corridor.

3.1 AIR QUALITY AND CLIMATE

3.1.1 Air Quality

Air pollution refers to the direct or indirect introduction of any substance into the air that could endanger human health; harm living resources, ecosystems, or material property (*e.g.*, buildings); or impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

The U.S. Environmental Protection Agency (EPA) has set National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, as shown in **Table 3–1**. The State of Alaska has adopted the standards, as indicated in the table.

The region of influence (ROI) for air quality is defined as the area within the PFRR launch site and launch corridor, both of which are within the Northern Alaska Intrastate Air Quality Control Region Number 9. None of these areas are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants **(40 CFR 81.302)**. The nearest nonattainment area is a part of Fairbanks North Star Borough, which has been designated nonattainment for particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$).

Table 3–1. Federal and State Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS[a]	Alaska Ambient Air Quality Standards
		(micrograms per cubic meter)	
Carbon monoxide	8 hours 1 hour	10,000 40,000	10,000 40,000
Lead	Quarterly 3 months	N/A 0.15	1.5 N/A[b]
Nitrogen dioxide	Annual 1 hour	100 188	100 N/A[b]
Ozone	8 hours 1 hour	147 N/A	N/A[b] 235
PM_{10}	Annual 24 hours	c 150	50 150
$PM_{2.5}$	Annual 24 hours	15 35	b b
Sulfur dioxide	Annual 24 hours 3 hours 1 hour	80 365 1,300 197	80 365 1300 N/A[b]

a. The more stringent of the primary and secondary standards is presented if both exist for the averaging period. The standards for carbon monoxide and the 24- and 3-hour standards for sulfur dioxide are not to be exceeded more than once per year. The annual arithmetic mean $PM_{2.5}$ standard is attained when the weighted annual arithmetic mean concentration (3-year average) does not exceed the standard value. The 24-hour $PM_{2.5}$ standard is met when the 98th percentile over 3 years of 24-hour average concentrations is less than or equal to the standard value. The 24-hour PM_{10} standard is met when the standard value is not exceeded more than once per year over a 3-year period. The annual arithmetic mean PM_{10} standard is attained when the weighted annual arithmetic mean concentration (3-year average) is less than or equal to the standard value. The Federal 1-hour nitrogen dioxide standard is met when the 3-year average 98th percentile of the daily maximum 1-hour average does not exceed the standard value. The Federal 1-hour sulfur dioxide standard is met when the 3-year average 99th percentile of the daily maximum 1-hour average does not exceed the standard value. The Federal 3-month lead standard is met when the maximum 3-month mean for a 3-year period does not exceed the standard value.

b. The State of Alaska has not yet adopted the Federal standard.

c. The U.S. Environmental Protection Agency revoked the annual PM_{10} standard.

Key: N/A=not applicable; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

Source: 18 AAC 50.010; 40 CFR 50; 71 FR 61144.

Routine monitoring of air pollutants is not conducted at PFRR. Monitoring of carbon monoxide and $PM_{2.5}$ is performed at monitors in Fairbanks North Star Borough. Monitored values for carbon monoxide are well below the ambient standards **(USEPA 2011a)**. Elevated concentrations of $PM_{2.5}$ have occurred in Fairbanks during the winter partially because of wood-fired devices and during summer because of wildfires. The state does not routinely monitor for other criteria pollutants nearby.

A summary of emissions of criteria pollutant emissions for Fairbanks North Star Borough is presented in **Table 3–2**. The primary sources of air pollutants in Fairbanks North Star Borough are power plants, refining, and airports **(USEPA 2011b)**. Other sources include traffic (snow machines, automobiles, aircraft, motorboats, and other vehicles) and fires.

Table 3–2. Fairbanks North Star Borough Criteria Pollutant Emissions, 2008

Pollutant	Metric Tons Per Year
Carbon monoxide	19,800
Lead	0.287
Nitrogen oxides	4,040
PM_{10}	14,700
$PM_{2.5}$	1,870
Sulfur dioxide	2,090
VOCs[a]	3,480

a. VOCs (volatile organic compounds) are a precursor of ozone.
Note: To convert metric tons to tons, multiply by 1.1023.
Key: PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.
Source: **USEPA 2011c.**

Activities at PFRR produce criteria air pollutants and other air pollutants in various quantities. Launch vehicles emit lead, carbon monoxide, particulate matter, and other pollutants into the lower atmosphere **(NASA 2000a)**. Emissions from various launch vehicles used in the National Aeronautics and Space Administration (NASA) Sounding Rockets Program (SRP) into the lower atmosphere and the upper atmosphere are presented in the *Supplemental Environmental Impact Statement for Sounding Rocket Program (SRP SEIS)* **(NASA 2000a)**, and emissions from launch vehicles used at PFRR are presented in Chapter 4. Some payloads of previous launches at PFRR have released TMA [trimethylaluminium] (a mixture of trimethyl aluminum and triethyl aluminum), barium, and calcium **(NASA 2000a)**. Other than launch vehicles, sources of air at PFRR include generators, heating systems, delivery vehicles, and employee vehicles **(NASA 2011a**). Search and recovery work also results in air pollutant emissions from aircraft operations and use of various vehicles. Estimated PFRR emissions are presented in **Table 3–3**. The table includes estimated carbon dioxide emissions resulting from production of electricity used for PFRR operations.

Table 3–3. Poker Flat Research Range Annual Emissions

Pollutant	Heating	Internal Combustion	Electric Generation[a]
	Metric Tons Per Year		
Carbon monoxide	0.022	15	NR
Nitrogen oxides	0.11	2.9	3.9
PM_{10}	0.0048	0.2	NR
$PM_{2.5}$	0.0037	0.2	NR
Sulfur dioxide	0.00094	0.02	1.9
Carbon dioxide	96	130	1,900

a. Indirect emissions from offsite electric generation were based on the air pollutant emission rate for the Alaska grid and average annual electric use at Poker Flat Research Range for the period from 2008–2010.

Note: To convert metric tons to tons, multiply by 1.1023.

Key: NR=Emission rates for particulate matter and carbon monoxide are not reported in eGRIDweb; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

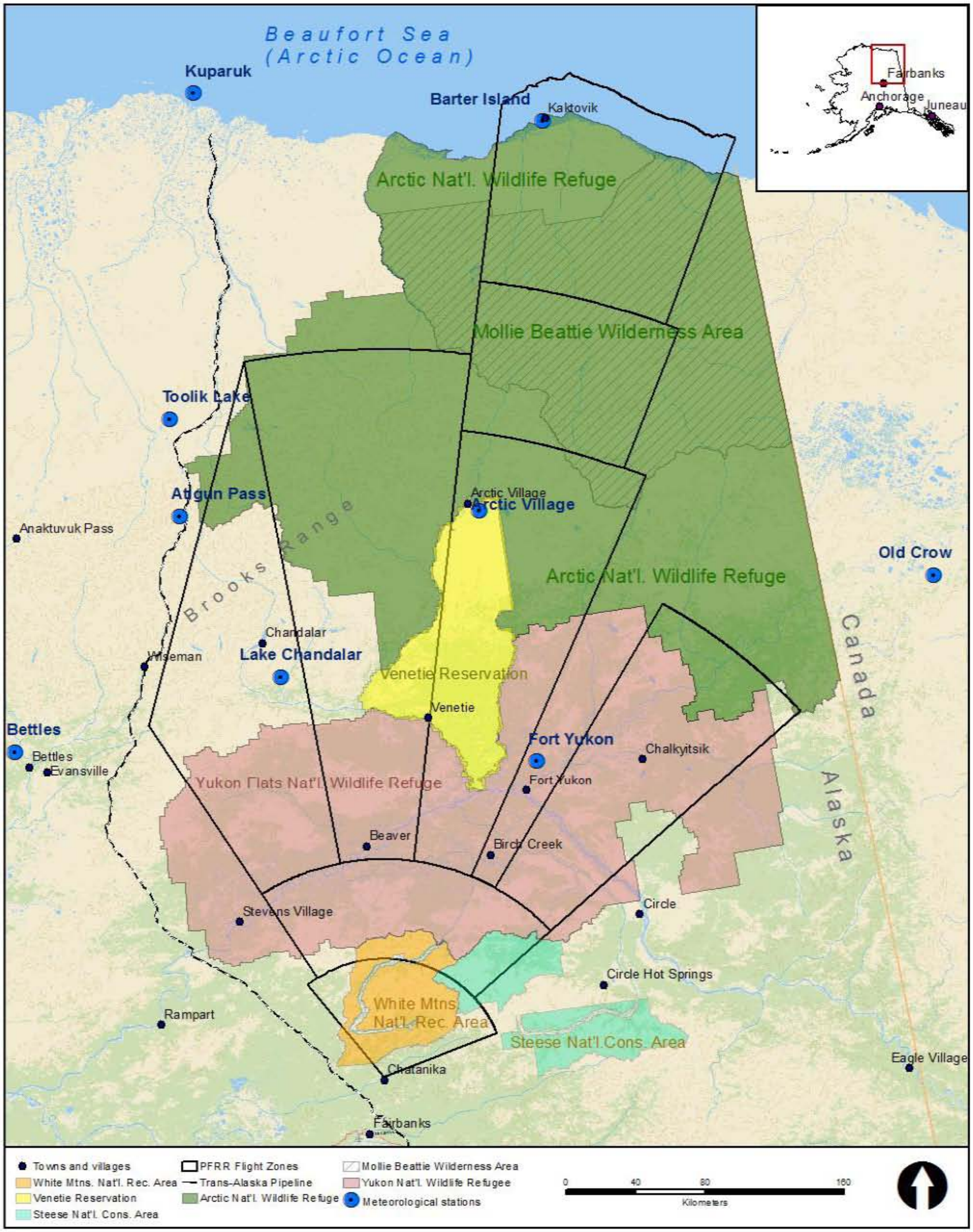
Source: NASA 2011a.

3.1.2 Climate

The climate within PFRR, shown in **Figure 3–1,** varies significantly from the south to the north and is dependent upon latitude, elevation, terrain, and proximity to the Beaufort Sea. The ROI can be divided into three different climate regimes: (1) the southern regime, which includes the PFRR launch site, White Mountains NRA, and Yukon Flats NWR; (2) the central regime, which includes the southern half of Arctic NWR, including Brooks Range and most of the Mollie Beattie Wilderness Area; and (3) the northern regime, which includes the northern half of Arctic NWR, including the Beaufort Sea Coastal Plain and the Brooks Range Foothills, and the northeast corner of the Mollie Beattie Wilderness Area. **Table 3–4** includes the monthly average temperatures and annual precipitation, including snowfall and snow depth, of representative areas in or near these climate regimes. **Table 3–5** includes monthly average snow depths for these stations as well.

3.1.2.1 *Southern Poker Flat Research Range Launch Corridor Climate Regime*

The climate in this region is similar to that of Fairbanks, Alaska, and is classified as “continental subarctic,” characterized by great seasonal extremes of temperature and daylight **(USFWS 2011c)**. In Fairbanks, from mid-May through the end of July, a period of 72 days, the sun is above the horizon from 18 to 22 hours each day, and the entire region never gets darker than civil twilight. Further north at Fort Yukon, the sun stays above the horizon for 31 consecutive days in June and July and the period of twilight lasts 86 days. In contrast, from late November through January, the period of daylight, including twilight, averages less than 5 hours per day **(Edwards 2011)**.



Note: To convert kilometers to miles, multiply by 0.6214.
Source: SAIC 2011.

Figure 3–1. Climate Stations Located in or Near the Poker Flat Research Range Launch Corridor

Table 3–4. Monthly Average Temperature, Precipitation, and Station Information at Climate Stations Located in or Near the Poker Flat Research Range Launch Corridor

	Barter Island	Kuparuk	Toolik Lake	Atigun Pass	Arctic Village	Old Crow	Bettles	Fort Yukon	Fairbanks	Lake Chandalar
Temperature (Celsius)										
January	–26	–26	–23	–21	–31	–31	–23	–28	–22	–26
February	–29	–27	–21	–18	–28	–28	–21	–26	–19	–24
March	–27	–25	–21	–19	–19	–22	–15	–17	–11	–19
April	–18	–16	–13	–11	–10	–11	–5	–6	0	–9
May	–6	–5	–1	–1	3	3	7	7	10	3
June	1	5	9	5	12	12	15	15	16	12
July	4	9	12	7	14	14	15	17	17	13
August	4	7	8	3	9	11	11	13	13	9
September	0	2	0	–3	0	3	5	5	7	2
October	–9	–9	–12	–12	–12	–9	–7	–7	–4	–10
November	–18	–19	–19	–17	–24	–23	–18	–21	–16	–21
December	–24	–23	–22	–18	–24	–27	–21	–27	–20	–23
Annual Average	–12	–10	–4	–9	–9	–9	–5	–6	–2	–8
Annual Precipitation (centimeters)										
Total[a]	15	10	–	61	23	28	38	18	27	21
Snowfall	107	84	–	–	124	130	230	107	170	120
Station Information										
Station Elevation (meters)	9	20	720	1,400	640	250	200	130	130	580
Period	1949–1988	1980–2010	1989–2007	1992–2009	1962–1996	1971–2000	1980–2010	1938–1990	1981–2010	1981–2010

a. Total precipitation per year is sum of rain and snow water equivalent.

Note: To convert centimeters to inches, multiply by 0.3937; meters to feet, by 3.2808; Celsius to Fahrenheit, use the formula (5/9) × (T Fahrenheit) – 32.

Key: –=missing data.

Source: Environment Canada 2011; NCDC 2011a; USFWS 2011c.

Table 3–5. Monthly Average Snow Depth for Climate Stations Located in or Near the Poker Flat Research Range Launch Corridor

	Barter Island	Kuparuk	Toolik Lake	Atigun Pass[a]	Arctic Village	Old Crow[b]	Bettles	Fort Yukon	Fairbanks	Lake Chandalar
Average Snow Depth (centimeters)										
January	31	20	–	18	43	48	64	48	43	48
February	36	20	–	18	43	56	74	56	53	58
March	36	23	–	20	53	59	79	58	51	56
April	38	23	–	10	53	55	66	41	25	56
May	25	13	–	3	15	17	10	5	0	18
June	3	0	–	0	0	0	0	0	0	0
July	0	0	–	0	0	0	0	0	0	0
August	0	0	–	0	0	0	0	0	0	0
September	3	0	–	0	3	5	0	0	0	0
October	13	8	–	10	10	13	10	5	5	10
November	20	15	–	13	23	26	31	23	20	25
December	25	18	–	13	33	36	51	36	33	36
Station Information										
Station Elevation (meters)	9	20	720	1,400	640	250	190	130	130	580
Period	1949–1988	1983–2010	1989–2007	1970–1980	1962–1996	1971–2000	1951–2010	1938–1990	1949–2010	1968–2010

a. Snow depth from Galbraith Lake Camp, located 13 kilometers (8 miles) northeast of Atigun Pass.
b. Snow depth estimated from monthly average snowfall and average temperatures.
Note: To convert centimeters to inches, multiply by 0.3937; meters to feet, by 3.2808.
Key: –=missing data.
Source: WRCC 2011.

During summer, daily average maximum temperatures reach the lower 20s in degrees Celsius (°C) (70 degrees Fahrenheit [°F]). Temperatures of 27 °C (80 °F) or higher occur on about 10 days each summer, and temperatures in the mid-30s °C (90 °F) have been recorded at Fairbanks on several occasions **(NCDC 2011a)**. Fort Yukon holds the state record high temperature of 38 °C (100 °F) **(USFWS 2008a)**. Average temperatures for July range from 17 °C (62 °F) in Fairbanks to 13 °C (55 °F) further north at Lake Chandalar **(NCDC 2011a)**. Precipitation averages around 27 centimeters (11 inches) for the year, with the majority of the precipitation falling in the summer months. With the exception of the highest elevations on the northern end of the region, winter snows have melted by the end of April, and river ice breakups occur in May **(NCDC 2011b)**. However, due to the combination of snowmelt and partial melting of the permafrost, the soils remain very wet throughout the summer.

Average temperatures across the entire region in winter are below –17 °C (0 °F), and temperatures of –40 °C (–40 °F) or colder are common. Fort Yukon has recorded a temperature as low as –59 °C (–75 °F). Average temperatures in January range from –22 °C (–9 °F) at Fairbanks to –28 °C (–19 °F) at Fort Yukon. Snow covers the ground from early October through April, with the maximum average monthly snow depth occurring in March, ranging from 53 centimeters (21 inches) in Fairbanks to near 80 centimeters (31 inches) in Bettles. However, winds are light most of the winter and blizzard conditions are rarely seen **(NCDC 2011b)**.

3.1.2.2 *Central Poker Flat Research Range Launch Corridor Climate Regime*

The climate in this region is also classified as “continental subarctic,” but with colder temperatures in both the winter and the summer as compared to the climate in the southern launch corridor. Summer daylight is longer, with approximately 53 days of continuous sunlight and twilight lasting 97 days. The winter is darker than the southern PFRR launch corridor climate regime, with the sun below the horizon for 27 days in December and January and twilight reduced to approximately 4 hours per day during this time **(Edwards 2011)**.

Summer temperatures can vary greatly between the higher elevations in Brooks Range and the valley floors. Average temperatures in July are only about 7 °C (44 °F) at Atigun Pass (elevation 1,400 meters [4,600 feet]), but climb to 14 °C (58 °F) at Arctic Village (elevation 640 meters [2,100 feet]) **(USFWS 2011c)**. With the colder temperatures and more mountainous terrain, winter snows are deeper and may not completely melt in the highest elevations in the summer. In the valleys and foothills, the snow generally melts by mid-May, and river ice breakup occurs in late May or early June. The climate is dry, with average annual precipitation ranging from around 25 centimeters (10 inches) in the lower elevations to as high as 66 centimeters (26 inches) in the mountainous regions, with the majority of the precipitation falling in the summer months as rain. However, steeper slopes and warmer temperatures in Brooks Range provide enhanced drainage for soils and drier habitats during the summer. However, the snowmelt over the continuous permafrost in this climate region results in wetland-type conditions in the valley regions from June through September **(USFWS 2011c)**.

Winter temperatures can be bitterly cold throughout the region, but particularly in the lower elevations, where clear skies and light winds allow temperatures to plummet. Average temperatures in January range from –21 °C (–5 °F) in the mountainous regions (Atigun Pass) to

–31 °C (–24 °F) near Old Crow just on the Canadian side of Brooks Range. Maximum monthly average snow depth is from 53–59 centimeters (21–24 inches) and occurs in March around Old Crow and Arctic Village **(WRCC 2011)**. However, much higher snow depths occur in the higher elevations of Brooks Range. Overall, the climate is dry, with average annual precipitation ranging from around 25 centimeters (10 inches) in the lower elevations to as high as 66 centimeters (26 inches) in the mountainous regions, with the majority of the precipitation falling in the summer months as rain.

3.1.2.3 *Northern Poker Flat Research Range Launch Corridor Climate Regime*

The climate in this region is classified as “Arctic” and is characterized by short, cool summers and long, cold winters with subfreezing temperatures and snow possible year round **(USFWS 2011c)**. The close proximity of this region to the Bering Sea results in a climate that is tempered somewhat and is not subject to the extreme temperature variations found in the southern and central launch corridor regions. Summer daylight is long, with approximately 72 days of continuous sunlight and twilight lasting 110 days. The winter is dark, with the sun below the horizon for 27 days in December and January and twilight reduced to approximately 4 hours per day during this time **(Edwards 2011)**.

Summer temperatures are significantly impacted by the Bering Sea. Average temperatures in July are around 4 °C (40 °F) along the coast, warming to around 12 °C (53 °F) inland near Toolik Lake **(USFWS 2011c)**. With the exception of north-facing slopes of the Brooks Range Foothills, the winter snowcover melts away by early June. The climate is very dry, with only about 15 centimeters (6 inches) of precipitation falling annually, most of which falls in the summer as rain. Evaporation rates are low due to low temperatures throughout the year, and the land is underlain by continuously frozen soil. As a result, soils are usually saturated during the summer in the coastal plain **(USFWS 2011c)**.

Temperatures in winter are the coldest in February along the north coast, with averages around –29 °C (–20 °F), but are warmer at the higher elevations (Toolik Lake), averaging –23 °C (–10 °F) in January. The region is under snowcover from mid-September through May. The maximum monthly average snow depth is 38 centimeters (15 inches) in April at Barter Island **(WRCC 2011)**.

Surface winds along the coast generally average 15 to 24 kilometers (9 to 15 miles) per hour from the northeast, with occasional intense storms generating winds exceeding 113 kilometers (70 miles) per hour **(USFWS 2011c)**.

3.1.2.4 *Global Climate*

Carbon dioxide and other gases in the atmosphere act like glass in a greenhouse, letting the sun’s rays through, but trapping some of the heat that would otherwise be radiated back into space **(NASA 2000a)**. This greenhouse effect and the Earth’s radiation balance are affected largely by water vapor; carbon dioxide; and other trace gases, including nitrous oxide, halocarbons, and methane. Increases in atmospheric concentrations of these pollutants are believed to influence the Earth’s global climate **(IPCC 2007)**. The Arctic is especially vulnerable to global climate change and increased ultraviolet radiation. The primary impacts are expected physical and biological changes. Changes that have been observed and changes that are expected are discussed in Chapters 6 through 9 of the *Arctic Climate Impact Assessment* **(ACIA 2004)**. Annual average temperatures have increased more rapidly in the Arctic than in other parts of the world. Warming of the Arctic climate has resulted in earlier spring snowmelt, reduced sea ice, widespread glacier retreat, insect outbreaks, permafrost warming, and changes in Arctic vegetation **(NOAA 2006a; USFWS 2011c)**.

From 2000 through 2005, worldwide use of fossil fuels was estimated to emit about 26.4 billion metric tons (29.1 billion tons) per year of carbon dioxide into the atmosphere **(IPCC 2007)**. Estimated U.S. carbon dioxide emissions in 2006 were 5.98 billion metric tons (6.59 billion tons) **(USEPA 2008)**. Annual carbon dioxide emissions and carbon dioxide equivalent emissions of other greenhouse gases related to activities at PFRR are estimated to be 2,100 metric tons (2,400 tons) per year.

3.2 ECOREGIONS

The ecoregion classification system, developed by **Gallant *et al.* (1995)**, was used as a spatial framework to organize, inventory, and characterize the ROI. This delineation of Alaska ecoregions was based on a qualitative assessment and synthesis of the distribution patterns and relative importance of landscape geography, geology, hydrology, soils, climate, and vegetation data. The system provides a unified approach for conducting natural resource and ecological risk assessments and environmental research, management, and monitoring. The ecoregions located within the PFRR launch corridor flight zones are listed in **Table 3–6** and are shown in **Figure 3–2**.

3.2.1 Beaufort Sea Ecoregion

The Beaufort Sea Ecoregion is the part of the Arctic Ocean that skirts the northernmost Arctic Coastal Plain Ecoregion and portions of the Arctic Foothills Ecoregion coastlines. Approximately 3 percent (330,000 hectares [820,000 acres]) of PFRR is within the Beaufort Sea Ecoregion (see Table 3–6 and Figure 3–2).

3.2.2 Arctic Coastal Plain Ecoregion

The Arctic Coastal Plain Ecoregion is a treeless, gently sloping plain and tundra gradually rising from the Beaufort Sea to the rolling plateaus and uplands of the Arctic Foothills Ecoregion and mountains of the Brooks Range Ecoregion. Approximately 2 percent (171,000 hectares [420,000 acres]) of PFRR is within the Arctic Coastal Plain Ecoregion (see Table 3–6 and Figure 3–2). Slope gradients are typically less than 2 percent **(Gallant *et al.* 1995)**.

Table 3–6. Poker Flat Research Range Flight Zones and Associated Ecoregions[a]

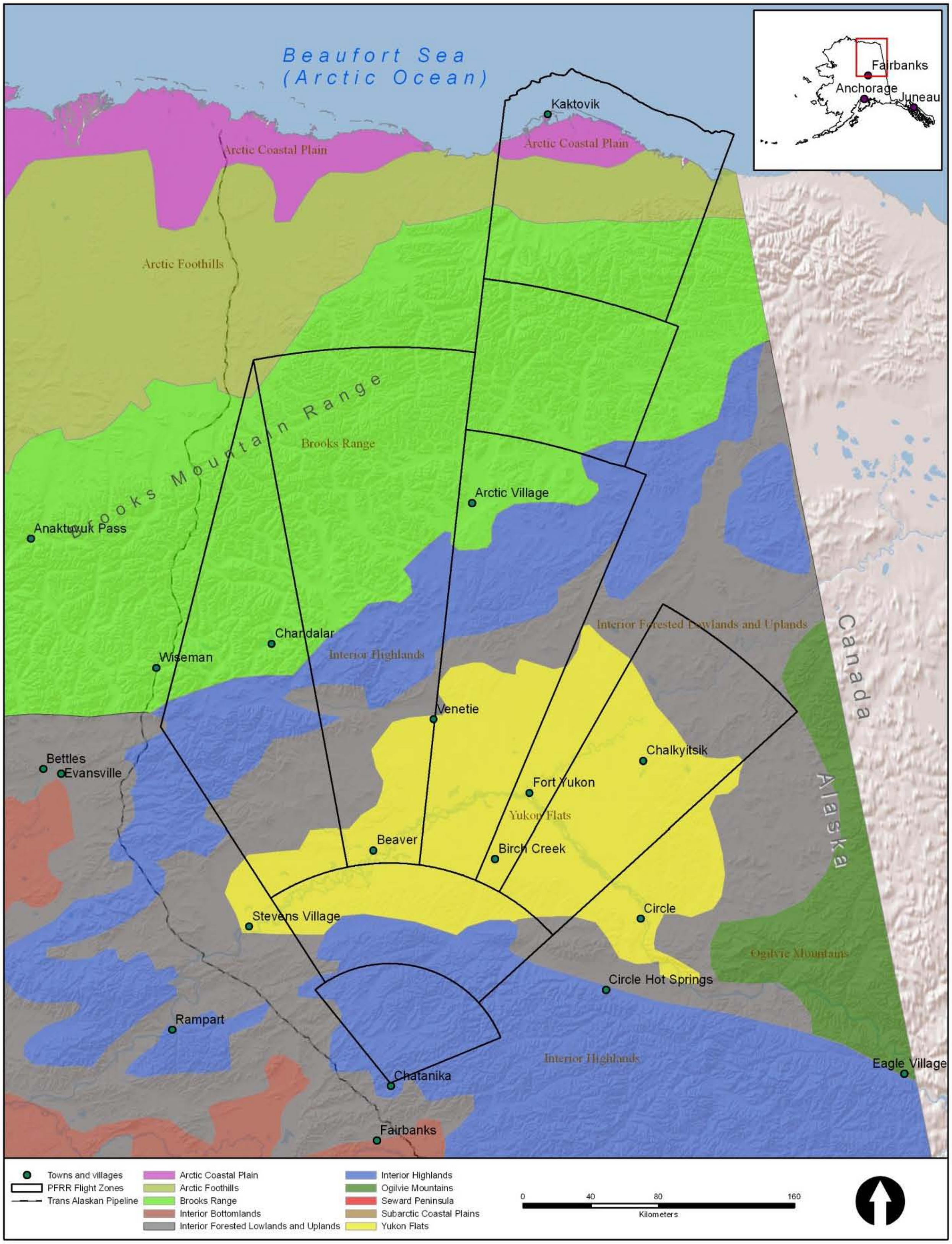
PFRR Flight Zones	Ecoregion Area (Ecoregion ID Number) (hectares)							Beaufort Sea	Total
	Arctic Coastal Plain (101)	Arctic Foothills (102)	Brooks Range (103)	Interior Forested Lowlands and Uplands (104)	Interior Highlands (105)	Yukon Flats (107)	Ogilvie Mountains (108)[b]		
1 South	0	0	0	5,200	460,000	0	0	0	460,000
1 North	0	0	0	61,000	350,000	420,000	0	0	830,000
2	0	9,000	770,000	370,000	410,000	130,000	0	0	1,700,000
3	0	14,000	1,600,000	290,000	430,000	300,000	0	0	2,600,000
4	0	0	340,000	250,000	610,000	650,000	0	0	1,900,000
4 Extended	0	0	930,000	0	26,000	0	0	0	957,054
4 Arctic Extension	171,000	440,000	540,000	0	0	0	0	330,000	1,500,000
5	0	0	0	500,000	0	900,000	18	0	1,400,000
Total	**171,000**	**470,000**	**4,200,000**	**1,500,000**	**2,300,000**	**2,400,000**	**18**	**330,000**	
Grand Total									**11,300,000**

a. Poker Flat Research Range flight zones and associated ecoregions are shown in Figure 3–3.

b. Due to the small amount of the Ogilvie Mountains Ecoregion within the region of influence, the Ogilvie Mountains Ecoregion is not discussed further in this *PFRR EIS*.

Note: To convert hectares to acres, multiply by 2.4710. Totals may not add up exactly due to rounding.

Source: Gallant *et al.* 1995.



Note: To convert kilometers to miles, multiply by 0.6214.
Source: SAIC 2011.

Figure 3–2. Poker Flat Research Range Ecoregions

3.2.3 Arctic Foothills Ecoregion

The Arctic Foothills Ecoregion is an area of broad, rounded ridges and plateau uplands (northern portion) and irregular buttes, mesas, ridges, and undulating tundra (southern portion) between the Arctic Coastal Plain Ecoregion and Brooks Range Ecoregion. East of the Kongakut River, the Arctic Foothills Ecoregion extends to the Beaufort Sea coast (see Figure 3–2). Approximately 4 percent (470,000 hectares [1.2 million acres]) of PFRR is within the Arctic Foothills Ecoregion (see Table 3–6 and Figure 3–2). This is described as a predominantly treeless region of moderately steep to steep hills and broad, sloping valleys and tundra **(USFWS 2011c)**.

3.2.4 Brooks Range Ecoregion

The Brooks Range Ecoregion, as the northernmost mountain group in Alaska, forms the drainage divide between the Arctic Slope to the north and the Kobuk and Yukon Rivers to the south. Mountains within the PFRR portion of the ecosystem include Phillip Smith, Franklin, Davidson, Sadlerochit, Shublik, and Romanzof Mountains **(Molnia 2008)**. Approximately 37 percent (4.2 million hectares [10 million acres]) of PFRR is within the Brooks Range Ecoregion (see Table 3–6 and Figure 3–2). The deeply dissected mountains have wide, flat-floored, steep-sided glacial alpine valleys **(USFWS 2011c)**. Mountain slopes are covered with exposed bedrock and rock debris and generally range from 10 to greater than 30 percent gradients. Elevations range from 500 meters (1,600 feet) in alpine valley floors to 2,400 meters (7,900 feet) at the higher mountain peaks.

3.2.5 Interior Forested Lowlands and Uplands Ecoregion

The Interior Forested Lowlands and Uplands Ecoregion is characterized by undulating lowlands, peat plateaus, and rolling hill uplands with slope gradients generally ranging from 0 to 10 percent **(Brabets *et al.* 2000)**. Approximately 13 percent (1.5 million hectares [3.6 million acres]) of PFRR is within the Interior Forested Lowlands and Uplands Ecoregion (see Table 3–6 and Figure 3–2). Elevations range from sea level to 700 meters (2,300 feet) for some of the higher hills.

3.2.6 Interior Highlands Ecoregion

The Interior Highlands Ecoregion is located between the Interior Forested Lowlands and Uplands Ecoregion and the Brooks Range Ecoregion. The Interior Highlands Ecoregion contains steep and rounded ridges, valleys, and low mountains with glaciated peaks that rise from approximately 1,500 meters (4,900 feet) to over 1,800 meters (5,900 feet) **(Gallant *et al.* 1995)**. Approximately 20 percent (2.3 million hectares [5.7 million acres]) of PFRR is within the Interior Highlands Ecoregion (see Table 3–6 and Figure 3–2). Slope gradients generally range from about 10 to greater than 30 percent **(Gallant *et al.* 1995)**.

3.2.7 Yukon Flats Ecoregion

The Yukon Flats Ecoregion is a relatively flat, marshy river basin characterized by numerous lakes, shallow ponds, sloughs, drainage basins, river meander scars, islands, river outwash fans, and braided stream floodplains surrounded by gently to strongly rolling terrain. Elevations range from 90 meters (300 feet) to greater than 250 meters (820 feet), and slope gradients are generally less than 2 percent. The Yukon Flats Ecoregion was not glaciated during the Pleistocene epoch **(Gallant *et al.* 1995)**. Approximately 21 percent (2.4 million hectares [5.9 million acres]) of PFRR is within the Yukon Flats Ecoregion (see Table 3–6 and Figure 3–2).

3.3 WATER RESOURCES

Surface waters typically include rivers, streams, bays, springs, lakes and ponds, and other wetlands. Groundwater includes the subsurface geohydrologic resources generally described as water tables and aquifers. The ROI for water resources is defined as the area within the PFRR launch site and launch corridor. Section 3.3.4 provides a description of the water resources within the ROI based on the ecoregions discussed in Section 3.2.

3.3.1 Wetlands, Floodplains and Coastal Zone

Wetlands are areas of transition between terrestrial and aquatic systems where the water table is usually at or near the surface. Wetlands are defined in the U.S. Army Corps of Engineers Wetlands Delineation Manual as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” **(USACE 1987)**. Wetlands are extremely common in Alaska; there are an estimated 71 million hectares (180 million acres) of wetlands, accounting for approximately 42 percent of the total surface area of the state **(ADEC 2010)**. In addition to permafrost areas, wetlands frequently occur within the riverine floodplains and can develop because of rainfall, melt water, beavers, and tides. In Alaska, melt water from snow and glaciers often causes streams to overflow their banks during spring and summer months. Ice jams, which may exacerbate flooding, are particularly common near the villages of Circle and Fort Yukon **(NOAA 2006b)**.

Within the PFRR launch site, much of the area in the Lower Range is designated as a palustrine wetland system composed primarily of scrub-shrub and forested class wetlands with saturated water regimes. Most areas facing north and northwest, downslope of the Upper Range ridgeline are also classified as wetlands. Details on wetlands at PFRR, including the associated vegetation, are given in the *Environmental Assessment, Improvement and Modernization Program, Poker Flat Research Range, Fairbanks, Alaska (Modernization EA),* published by the Geophysical Institute of UAF **(UAF 1993)**. Wetlands identified in the *Modernization EA* are listed in **Table 3–7**.

The Chatanika River originates north and east of the ROI and flows westward into the Tolovana River, which flows into the Tanana River. The main flood seasons are spring and summer. Spring floods are the result of an above-normal winter snowfall, coupled with a cold spring and a rapid snowmelt. Summer flooding results from extreme rainfall in a short period of time. The Lower Range of the PFRR launch site is located within the 100-year floodplain of the Chatanika River.

Table 3–7. Poker Flat Research Range Wetlands

Wetland	Description
Wet Graminoid Herbaceous	Vegetation is dominated by marsh five-finger, cottongrass, carex, and the sandbar willow.
Needleleaf Woodland	Consists predominantly of black spruce. The understory shrub includes Labrador tea, mountain carndary, cloudberry, and resin birch. The herbaceous stratum is predominantly clubmoss, but the lichen layer is prominent in open areas.
Mixed Woodland	Includes paper birch and black spruce. The understory is dominated by Labrador tea, bog blueberry, lowbush cranberry, spirea, and diamond-leaf willow. The herbaceous stratum is predominantly feathermoss. Lichen is prominent in open area. Also present are cottongrass, bluejoint, and horsetail.
Needleleaf Forest	Dominated by black spruce. Paper birch is also present. The understory consists of Labrador tea, lowbush cranberry, bog blueberry, and spirea. The herbaceous matt is thick with moss and lichens.
Closed Birch Forest	Dominated by paper birch, with small components of black spruce. The understory consists of Labrador tea, cranberry, and moss matt.
Mixed Forest	Dominated by quaking aspen, white spruce, and paper birch. The understory consists of bluejoint, Pyrola, and rose.
Closed Tall Scrub Shrub	Dominated by a dense canopy of green alder; however, paper birch and aspen are also present. Understory consists of raspberry and bluejoint.
Closed Broadleaf Forest	Dominated by paper birch, with scattering of quaking aspen and white spruce. In understory, green alder, lowbush cranberry, bog blueberry, fireweed, and bluejoint are common.

Source: NASA 2000a; UAF 1993.

The Coastal Zone Management Act (CZMA) of 1972, as amended **(16 U.S.C. 1451 *et seq.*)**, provides for the effective, beneficial use, protection, and development of the U.S. coastal zone. Section 307 of the CZMA requires Federal agencies conducting activities that potentially impact coastal zones to be consistent, to the maximum extent practicable, with the approved coastal management program of the respective state within which the activity would occur. The coastal zone is defined as coastal waters and adjacent shore lands strongly influenced by each other and in proximity to the several coastal states, including islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The Alaska Coastal Management Program was terminated on July 1, 2011, per **Alaska Statute 44.66.030**. Prior to its termination, NASA contacted the Alaska Coastal Management Program in April 2011 and was informed that a consistency determination would not be required for the alternatives under consideration in this EIS. Therefore, no additional coordination regarding coastal zone management is needed.

3.3.2 Wild and Scenic Rivers

The National Wild and Scenic Rivers System, established in 1968 by the Wild and Scenic Rivers Act **(P.L. 90–542)** and administered by the National Park Service (NPS), was created to enhance and protect the free-flowing condition; water quality; and remarkable natural, cultural, and recreational values and to fulfill the vital conservation of designated rivers and streams **(IWSRCC 1998)**. Alaska National Interest Lands Conservation Act (ANILCA) provides for the designation and conservation of public lands in the State of Alaska. In Alaska, designated wild river segment corridors outside Federal lands may not exceed an average of 259 hectares (640 acres) (0.8 kilometers [0.5 mile] from each river bank) per river mile. Corridor boundaries are established based on natural and manmade features and existing property lines. Within Federal lands, no new mining claims or mineral leases can be granted within designated wild river segments; however, existing mining claims and leases within designated river corridor boundaries remain in effect. River designation under the Wild Scenic River Act neither gives nor implies government control of private lands within the river corridor **(IWSRCC 2004, 2011)**. Designated wild rivers are to be maintained in natural, free-flowing, and undisturbed conditions. River segments added to the National Wild and Scenic Rivers System by ANILCA located within the PFFR launch corridor are shown in red on Figure 1–3 and summarized below in **Table 3–8**.

Table 3–8. Poker Flat Research Range National Wild and Scenic River Segments

Water Course	Description
Beaver Creek	The Beaver Creek watershed is located within the Yukon-Tanana uplands of the east-central Alaska interior. Approximately 216 kilometers of the upper portion Beaver Creek has been designated as a wild river. The moderately swift and shallow stream originates at the confluence of Bear and Champion Creeks of the White Mountains and flows approximately 430 kilometers to its confluence with the Yukon River. Once within the lowlands of the Yukon Flats, it is characterized as a sluggish meandering stream. Discharges from numerous springs contribute significantly to winter streamflow. Designated wild portions of Beaver Creek are located in the White Mountains NRA (133 kilometers) and Yukon Flats NWR (32 kilometers) and within PFRR.
Ivishak River	The Ivishak River originates in the Philip Smith Mountains and flows northward, where it merges with the Sagavanirktok south of Prudhoe Bay. Once in the Arctic Coastal Plain, the waterway is characterized as a low-gradient, braided stream with a broad floodplain. Of the total 180 kilometers of the Ivishak River, 96 kilometers of designated wild river flow through the Arctic NWR within PFRR. The designated wild portion of the river basin within PFRR encompasses approximately 80,000 hectares and 7,300 hectares outside of PFRR.
Sheenjek River	The Sheenjek River is a subbasin watershed of the Porcupine Basin and encompasses a drainage area of approximately 58,000 hectares. This water course originates in Brooks Range and merges with the Porcupine River near Fort Yukon. The upper segment of the river is within Arctic NWR and the lower segment flows through Yukon Flats NWR. Approximately 270 kilometers of the river have been designated as wild. The portion of the Sheenjek River that flows through Arctic NWR, including Mollie Beattie Wilderness Area within Arctic NWR (203 kilometers), is designated as wild and is located within PFRR. No portion of the Sheenjek River that flows through Yukon Flats NWR is designated as wild or scenic. This pristine low-gradient river meanders primarily through broad mountain valley tundra and is characterized by clear water, cutbanks, and gravel streambeds.

Table 3–8. Poker Flat Research Range National Wild and Scenic River Segments (*continued*)

Water Course	Description
Wind River	The Wind River originates in the Philip Smith Mountains and flows approximately 180 kilometers. The river basin covers approximately 79,000 hectares. The entire river (180 kilometers) is designated wild and is located within Arctic NWR and PFRR.

Note: To convert hectares to acres, multiply by 2.4710; kilometers to miles, multiply by 0.6214; square kilometers to square miles, multiply by 0.3861.
Key: NRA=National Recreation Area; NWR=National Wildlife Refuge; PFRR=Poker Flat Research Range.
Source: Brabets *et al.* 2000; Kostohrys 2005; Maurer 1997; Meyer 1995; USDOI 1983; USFWS 2011c.

3.3.3 Water Quality

Water quality is a measure of the physical, chemical, and/or biological characteristics of water compared with established standards. Water quality is considered impaired if it fails to meet physical, chemical, and/or biological or regulatory standards. The Clean Water Act of 1977, as amended (CWA) **(33 U.S.C. 1251 *et seq.*)**, regulates pollutant discharges. As authorized by CWA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES permit program is administered by the State of Alaska through the Alaska Department of Environmental Conservation (ADEC).

CWA requires individual states to develop programs to monitor and report on the quality of surface water and groundwater and prepare a report summarizing the status of its water quality. CWA Section 305(b) requires that the quality of all water bodies be characterized and Section 303(d) requires states to establish water quality standards for waterways, identify those that fail to meet the standards, and take action to clean up these waterways. Water quality standards are composed of designated present and future most beneficial uses and numerical and narrative criteria applied to the specific water uses or classification. Water bodies verified as not meeting one or more of their designated uses are placed on the state's 303(d) list, and a Total Maximum Daily Load (TMDL) or recovery plan is developed by the state to address water quality impairment issues **(ADEC 2010)**.

The state of Alaska has jurisdiction for surface-water quality standards for all waters of the state, in accordance with CWA provisions. The ADEC Division of Water is responsible for establishing water cleanliness standards, regulating discharges into water of the state, and monitoring and reporting on water quality. The State of Alaska Water Quality Standards are documented in the Alaska Administrative Code **(18 AAC 70)** and in an annual report. Alaska's 305(b) and 303(d) water quality data are combined and presented as an Integrated Water Quality Monitoring and Assessment Report that documents the status and health of water bodies within the state and identifies programs for maintaining and improving water quality. Alaska has 28 Category 5 303(d) listed water bodies with one or more designated uses not attained that require a TMDL or recovery plan **(ADEC 2010)**.

The overall water quality in Alaska is generally good to excellent. The state contains vast areas, such as those that comprise a major portion of PFRR, that are in pristine condition and are charactereized by excellent water quality. Yukon River water quality ranges from good to excellent. Except for seasonal turbidity, the river generally has low dissolved solids, near saturation dissolved oxygen, and neutral to moderately basic pH **(USDOI 2012a)**. Turbidity is a suspension of dissolved substances and inorganic and organic particles in the water column that results in the scattering and absorption of sunlight **(Henley *et al.* 2000)**. A water resource field reconnaissance of the eastern north slope in 1975 found that with few exceptions, water body water quality was generally very good **(Childers *et al.* 1977)**. There are limited water resource water quality data available for much of the Arctic North Slope and South Slope below Brooks Range **(USFWS 2011c)**. A summary of water quality parameters for select rivers within PFRR is presented in **Table 3–9**.

Table 3–9. Poker Flat Research Range Water Quality

River	Water Temperature (degrees Celsius)	pH (Standard Units)	Dissolved Oxygen (milligrams per liter)
Beaver Creek (at Big Bend)	10	7.3	11
Birch Creek (Upper Mouth)	14	7.5	9.2
Black River	13	7.7	9.5
Chandalar River	10	7.9	11
Hodzana River	11	7.7	9.8
Porcupine River	10	7.7	10
Yukon River (at Eagle)	13	8.1	9.6
Alaska Department of Environmental Conservation Standard	**Less than 15**	**6.0 to 8.5**	**Greater than 4.0**

Note: To convert Celsius to Fahrenheit, use the formula (5/9) × (T Fahrenheit) – 32.
Source: USDOI 2012a.

The Category 5 Section 303(d) listed water bodies within PFRR are contained in the Crooked Creek Watershed (Hydrologic Unit Code 19040402) and include Crooked, Bonanza, Deadwood, Ketchem, Mammoth, Mastodon, and Porcupine Creeks. The watershed was 303(d) listed in 1992 for nonattainment of turbidity standards **(ADEC 2010)**. The primary pollutant source was placer mining. Monitoring in the 1990s and a water quality assessment in 1995 documented water quality improvements and recommended the development of a water body recovery plan. ADEC is preparing a water quality monitoring and sampling plan for 2011 and 2012 to determine if a TMDL is required **(ADEC 2010)**.

3.3.4 Ecoregions

This section describes the water resources within the ROI based on the ecoregion descriptions provided in Section 3.2.

3.3.4.1 *Beaufort Sea Ecoregion*

The approximate area of ocean inland seas (bays and lagoons) within Beaufort Sea Ecoregion of the ROI is 9,100 hectares (22,000 acres). Coastal currents are driven by inflows from the Bering Strait, Beaufort Gyre, and intermediate water from the North Atlantic. Tide action is relatively minor, with a diurnal range of 10 to 30 centimeters (4 to 12 inches) **(ADNR 2006; USFWS 2011c)**. Storm surges (storm increases in sea elevation) can reach approximately 2.4 meters (8 feet) during severe storms **(ADNR 2006)**. Coastal lagoon waters begin to freeze in late September to early October and by April or May, the ice may be 2 meters (6 feet) or more thick. Approximately 40,000 hectares (100,000 acres) of the Beaufort Sea Ecoregion marine coast waters and lagoons within Arctic NWR are designated as marine protected areas under the auspices of the National Marine Protected Area System **(USFWS 2011c)**.

A defining characteristic feature of the Beaufort Sea is its cover of sea ice, which seasonally fluctuates in extent and thickness on interannual and long-term temporal scales. The sea ice cover generally includes a perennial ice zone where ice is present year-round, and a zone where ice is only present seasonally; much of the Arctic Ocean is considered perennial ice **(Kwok and Sulsky 2010)**. The maximum extent of Arctic sea ice cover is achieved by the end of winter, and the minimum extent occurs in September **(Wendler *et al.* 2010)**. For most of the year, ice covers the Beaufort Sea **(USDOI 1978)**. Typically, the breakup of coastal sea ice begins 8 weeks after melt processes begin **(USFWS 2011c)**.

Sea ice ranges from first-year, non-deformed ice to multi-year ice with thick, deformed, pressure ridges. Sea ice moves in response to wind and ocean currents and deforms due to fractures and cracks created by brittle failure. The mechanical movement and rearrangement of the ice directly affect its strength and behavior **(Kwok and Sulsky 2010)**. In contrast to the migrating ice packs of the distant Arctic Ocean, landfast ice is relatively immobile sea ice that is anchored to nearshore environments due to the sporadic contact of the ice with the sea floor **(Fissel *et al.* 2011)**. Sea ice is typically covered with snow for most of the year, except for when new ice forms and during the short Arctic summer. Because of its age, multi-year ice generally has deeper snow cover than first-year ice. Rougher-surfaced ice also tends to accumulate more snow cover **(Sturm *et al.* 2006)**.

Sea ice concentration (SIC) is the area of the ocean covered by ice **(Stone 2010)** and sea ice extent is the region of the ocean containing at least 15 percent SIC. SIC in seasonal zones varies dramatically, particularly along the southern sea ice margins **(Wendler *et al.* 2010)**. Seasonal fluctuations in the development, migration, and decay of sea ice are generally governed by the movement of the polar ice pack along the coastline and activity of major rivers **(USDOI 1978)**. In the Beaufort Sea, the average SIC is lowest from August through October **(Stone 2010)**.

The thickness of sea ice varies dramatically in temporal and spatial terms. In addition to thermodynamic forcing, research suggests that variations in Arctic ice thickness are strongly influenced by ocean and wind dynamic mechanical forcing **(Laxon *et al.* 2003)**. The discontinuous motion and behavior of ice influences it thickness distribution (**Kwok and Sulsky 2010)**. For the Arctic Ocean, the maximum thickness is generally cited as approximately 3 meters (10 feet). Typically, non-deformed first-year ice is as much as 2 meters (7 feet) thick and mulit-year ice is greater than 2 meters thick. Ice that has been deformed and exhibits ridge formation may be as thick as 20 to 30 meters (66 to 98 feet) **(Wendler *et al.* 2010)**. Southern Beaufort Sea ice thickness was observed to average 2.5 meters (8.2 feet) with variability ranging up to 2.7 meters (8.9 feet) **(Laxon *et al.* 2003)**. The thickness of landfast ice is primarily dependent on air temperature and snow cover **(Fissel *et al.* 2011)**.

A study by **Oikkonen and Haapala (2011)** found that Arctic sea ice has generally shifted toward thinner ice and exhibits a prevalent loss of thick, deformed ice. Although offshore regions of the Arctic pack ice are experiencing reduction in ice thickness associated with the net loss of old ice, shelf areas of the Southern Beaufort Sea dominated by highly deformed first-year ice exhibited no reductions in thickness for the years 2008 and 2009 **(Fissel *et al.* 2011)**. For the 1960s, 1970s, and 1990s there was a 1.3-meter (4.3-foot) decrease in the average thickness of Beaufort Sea ice **(Laxon *et al.* 2003)**.

Arctic ice has undergone a dramatic decline over recent years, with a well-documented general ice thinning, retreat of summer sea ice cover, and transition to a younger ice pack. Contributing factors include changes in atmospheric variables (temperature, circulation, and cloudiness), increased ice export and redistribution, storm events, and increased solar heating of the upper ocean **(Perovich *et al.* 2011; Wendler *et al.* 2010)**. The Northern Hemisphere's sea ice has been declining at an average rate of 3 percent per decade (1978 to present) and summer declines appear to be accelerating. The loss of old, multi-year ice is occurring at a higher rate of approximately 10 percent per decade; greater than two-thirds of the Arctic is currently covered by thinner seasonal ice **(Kwok and Sulsky 2010)**. From 1979 to 2005 the extent of Arctic Ocean sea ice decreased 9.2 percent per decade; the lowest extent being recorded in 2007 **(USFWS 2011c)**. From 2005 to 2009, multi-year ice decreased by a net 40 percent in volume while first-year ice gained volume due to the overall increased area covered **(Kwok and Sulsky 2010)**. A study of the Southern Beaufort Sea observed an increase in the mean annual area of open water from 14 percent in 1972 to 39 percent in 2007 **(Wendler *et al.* 2010)**. The floating ice pack is a critical component of the Arctic Ocean habitats and biological ecosystems. Changes in the extent and concentration of sea ice can directly affect the biological support capabilities of these systems **(Lindsay and Zhan 2005)**.

3.3.4.2 *Arctic Coastal Plain Ecoregion*

Prominent marine features within the Arctic Coastal Plain Ecoregion include shoals, mudflats, spits, shallow lagoons with low-lying barrier islands, bays, and river deltas **(USDOI 1978; USFWS 2011c)**. The coastline is low-lying and irregularly shaped and is dominated by low but steep coastal bluffs that typically range from 1.2 to 1.5 meters (4 to 5 feet) high, but in some instances may be as high as 7.6 meters (25 feet); in some cases, these bluffs are under active retreat **(Trawicki *et al.* 1991; USDOI 1978)**.

Recent increases in prevailing temperatures and storm frequency and reduced amounts of summer sea ice have created conditions amenable to increased coastal erosion **(USFWS 2011c)**. In some areas, the coastal bluffs are retreating as a result of thermal- and wave-induced erosion of permafrost soils **(USDOI 1978)**. Based on localized conditions, erosion rates vary from approximately 12 to 3 meters per year (38 to 10 feet per year) **(USFWS 2011c)**. **Wang and Overland (2009)** predicted drastic reductions in Arctic winter and summer ice over the next 30 years.

Water courses in the PFRR portion of the Arctic Coastal Plain Ecoregion tend to be low-gradient, braided, distributary systems that are classified as mountain, spring, and tundra streams **(Gallant *et al.* 1995; Greenwald *et at.* 2008; Schickhoff *et al.* 2002)**. Mountain streams normally have coarse gravel bottoms and transport discharge from springs and surface runoff. Spring streams are fed by mountain springs and are characterized by relatively stable temperatures and discharge volumes that allow channels to remain unfrozen through winter **(Parker 2004)**. Mountain and spring-fed streams have headwaters in Brooks Range. Tundra streams primarily drain the Arctic Coastal Plain Ecoregion and Arctic Foothills Ecoregion and are classified as alluvial, riffle-pool sequence streams or peat-bottom streams with beaded channel morphology **(Greenwald *et at.* 2008; Parker 2004)**. Groundwater seepage through taliks is a major contributor to stream flows **(Greenwald *et at.* 2008)**. Major Arctic Coastal Plain Ecoregion rivers intersecting PFRR include the Hulahula, Jago, Okerokovik, and Okpilak Rivers **(Childers *et al.* 1977)**.

The gentle slopes, poor drainage, perched water tables, and treeless landscape of the Arctic Coastal Plain Ecoregion often create wind-oriented thaw lakes and ponds particularly in river deltas. The melting of ground ice creates subsidence depressions that collect runoff. These relatively shallow (typically less than 1 meter [3 feet]); flat-bottom features most often have muck bottoms and freeze during winter. These generally impermanent surface features tend to follow dynamic annual cycles of development, expansion, drainage, and revegetation **(ADNR 2006; Gallant *et al.* 1995)**. The development of taliks beneath the lakes may contribute to their drainage in winter **(Riordan 2005)**. Most lakes within the Arctic Coastal Plain Ecoregion within the ROI are located within the Hulahula and Jago River deltas **(USFWS 2011c)**. In continuous permafrost areas, sources of groundwater are primarily concentrated within the unfrozen alluvium of thaw lakes and river deltas; however, the water is normally brackish or saline in bedrock beneath the permafrost **(Williams 1970)**.

3.3.4.3 *Arctic Foothills Ecoregion*

The Arctic Foothills Ecoregion is dissected by numerous beaded and meandering streams and partly braided rivers **(Schickhoff *et al.* 2002)**. Most streams originate in the mountains of the Brooks Range Ecoregion, derive their flow primarily from runoff, are underlain with permafrost, freeze during winter and flow approximately 5 months of the year north toward the Beaufort Sea within channels confined to bedrock catchments **(Gallant *et al.* 1995; Parker 2004)**. Most streambeds are lined with extremely course materials that include gravel, cobbles, and boulders **(Childers *et al.* 1977)**. Minor river flows caused by springs during winter create accumulations of icings or aufeis (overflow river ice) **(ADNR 2006)**. Even during the coldest winters, some groundwater continues to flow **(Hall 1979)**. Flooding and channel migration are common during spring melt, ice jams, and ice breakup **(Gallant *et al.* 1995)**. Major Arctic Foothills Ecoregion rivers within the ROI include the Aichilik, Ekaluakat, Egakstak, and Kongakut Rivers **(Childers *et al.* 1977)**. Lakes occur infrequently within the region and exist primarily as muck bottom, oxbow lakes within major river valleys **(Gallant *et al.* 1995)**.

3.3.4.4 *Brooks Range Ecoregion*

The Brooks Range Ecoregion, as the northernmost mountain group in Alaska, forms the drainage divide between the Arctic Slope to the north and the Kobuk and Yukon Rivers to the south.

Stream systems typically exhibit a trellis drainage pattern, with major rivers draining north and south and feeder tributaries draining east and west **(Gallant *et al.* 1995)**. Although infrequent, heavy summer rains in the mountains can trigger river peak flows and flooding **(ADNR 2006)**. Major Brooks Range Ecoregion rivers intersecting PFRR include the Canning, East Fork, Junjik, Kavik, Middle Fork, North Fork, Sheenjek, and Wind Rivers **(Childers *et al.* 1977)**. Although heavily glaciated, mountains lakes such as the Neruokpuk Lakes in the Hulahula River Basin and Lake Schrader occur infrequently but are prominent features **(USFWS 2011c)**. Most lakes occur in the rock basins of glaciated valleys, moraine areas, and river valley floodplains **(Gallant *et al.* 1995)**. The source of groundwater of the Brooks Range Ecoregion within the ROI is perennial springs associated with limestone faults **(Williams 1970)**.

3.3.4.5 *Interior Forested Lowlands and Uplands Ecoregion*

Major Interior Forested Lowlands and Uplands Ecoregion rivers intersecting PFRR include the Black, Chandalar, Christian, East Fork, Koness, Middle Fork, North Fork, Porcupine, Sheenjek, and Wind Rivers **(Childers *et al.* 1977; Daum and Troyer 1992)**. Thaw and oxbow lakes occur in the region but are not prominent features **(Gallant *et al.* 1995)**. In discontinuous permafrost areas, groundwater may occur in shallow talik-layer aquifers above the permafrost **(Williams 1970)**.

3.3.4.6 *Interior Highlands Ecoregion*

Water courses in the Interior Highlands Ecoregion tend to exhibit peak flows following the spring snowmelt, but moderate flows during the summer **(USFWS 2011c)**. Major Interior Highlands Ecoregion rivers within the ROI include the Chandalar, Christian, East Fork, Koness, Middle Fork, North Fork, Sheenjek, and Wind Rivers **(Childers *et al.* 1977; Daum and Troyer 1992)**. The approximately 2,100 hectares (5,200 acres) of the PFRR launch site are located in the Interior Highlands Ecoregion directly south of the Chatanika River in Chatanika, Alaska (see Figure 3–2). Facility flooding occurs infrequently and is minor in extent. The short-term flooding that does occur is normally associated with spring breakup when the ground is still frozen. The affected area is approximately 0.2 hectares (0.5 acres) in size and includes an area near the old Poker Inn and the field next to the C-Band Radar; flood waters persist for about a week.

3.3.4.7 *Yukon Flats Ecoregion*

The Yukon Flats Ecoregion is a relatively flat, marshy river basin characterized by numerous lakes, shallow ponds, sloughs, drainage basins, river meander scars, islands, river outwash fans, and braided stream floodplains surrounded by gently to strongly rolling terrain. The drainage patterns of the Yukon Flats Ecoregion generally follow a cyclic annual pattern of freeze-up; reduced winter base flow conditions; ice breakup spawning spring ice jams, scouring, and flooding of rivers and tributaries; and summer flows governed by precipitation, drought, and groundwater seepage. River and lake ice play a significant role in the hydrologic character of the region **(Woodward and Beever 2011)**. In addition to the Yukon River, there are approximately 11,000 kilometers (6,800 miles) of tributary streams and over 20,000 lakes and ponds within the Yukon Flats Ecoregion **(Woodward and Beever 2011)**. The area is drained by the Yukon River, which exhibits both meandering and braided stream flow patterns. A diversity of meandering stream tributaries flowing through the flats drains the surrounding uplands and mountainous regions. Major Yukon Flats Ecoregion streams and rivers within the ROI include Beaver and Birch Creeks and the Chandalar, Hodzana, Porcupine, and Yukon Rivers **(Brabets *et al.* 2000)**.

Lakes are an abundant and important component of the Yukon Flats Ecoregion ecosystems. Lakes were created primarily by the meandering of the Yukon River and its tributaries (oxbow lakes), accumulation of water within basins, beaver activity, and thermokarst development. Lakes have both closed and open drainage outlets and are frequently in contact with groundwater **(Heglund and Jones 2003)**. The Yukon Flats Ecoregion has an estimated lake area of 1,100 square kilometers (420 square miles) and lake density of 1 lake per 2 square kilometers (0.8 square miles) **(Arp and Jones 2009)**. A study by **Heglund and Jones (2003)** of 129 shallow riverine Yukon Flats Ecoregion lakes found that most were nearly circular in configuration and had depths that generally ranged from less than 0.5 meters (1.6 feet) to 6 meters (20 feet), with most lakes averaging less than 2 meters (7 feet).

3.4 GEOLOGY AND SOILS

Physical geography is defined by surface terrain patterns, forms, features, and hypsology (*i.e.,* study of the relative altitude of places). Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soils are natural bodies of solids (minerals and organic matter), gases, and liquids occupying the Earth's surface that have distinguishable layers and/or the ability to support rooted plants **(USDA 2010)**. The ROI for geology and soils is defined as the area within the PFRR launch site and launch corridor. Section 3.4.5 provides a description of the geology and soils within the ROI based on the ecoregions discussed in Section 3.2.

3.4.1 Permafrost

Permafrost is Arctic or subarctic region earth material (soil, rock, ice, and organic matter) that experiences continuous temperatures at or below 0 °C (32 °F) for 2 or more years; it is perennially frozen, rather than permanently frozen ground **(French 2007; USDA 2004)**. Permafrost typically exists in multiple layers that vary in thickness from a few centimeters to several hundred meters **(Williams 1970)**. Permafrost terrain contains three distinct layers (see **Figure 3–3**): (1) the *active layer* is the uppermost layer of soil from the surface to the top of the frozen ground, which experiences seasonal freezing and thawing; (2) the perennially frozen *permafrost layer* that extends from the base of the active layer to the soil layer where temperatures exceed 0 °C (32 °F); and (3) the *talik layer* of unfrozen soil typically between the active layer and permafrost layer **(Osterkamp and Jorgenson 2009)**. Most of the hydrological, biological, and biochemical activity occurs in the active layer, which may range from several meters to a few centimeters deep. Based primarily on the extent of soil ice content, the permafrost layer may be completely impervious or semi-permeable **(Hinkel and Nelson 2003; Riordan 2005)**. Permafrost may contain water with elevated salinity or oil seep hydrocarbons, which prevents hard freezing **(Clough *et al.* 1987)**. Taliks tend to form beneath water bodies that do not freeze in winter **(Riordan 2005)**. In Alaska, freezing soil temperatures have been observed to depths greater than 305 meters (1,000 feet) **(Clough *et al.* 1987; Ray 1950)**.

Approximately 75 to 80 percent of Alaska is underlain with permafrost **(Osterkamp and Jorgenson 2009)**.

The landscape extent and distribution of permafrost is defined as continuous, discontinuous, and sporadic. *Continuous permafrost* designates areas where permafrost occurs uninterrupted and is normally colder than –6 °C (21 °F) **(Osterkamp and Jorgenson 2009; Ray 1950)**. Shallow lakes and rivers within these areas freeze to the bottom and are underlain with permafrost **(Hall 1979; USFWS 2011c)**. *Discontinuous permafrost* regions have scattered areas free of permafrost **(Osterkamp and Jorgenson 2009; Ray 1950; USFWS 2010)**. Temperatures range from a fraction of a degree below freezing to –2 °C (28 °F) **(Ping *et al.* 2004)**. *Sporadic permafrost* regions exhibit isolated areas of permafrost within thawed ground **(Osterkamp and Jorgenson 2009)**. Continuous permafrost dominates Arctic regions, while discontinuous and sporadic permafrost is primarily found in subarctic regions **(Riordan 2005)**. No sporadic permafrost was identified within PFRR. Permafrost within PFRR is summarized in **Table 3–10** and shown in Figure 3–3.

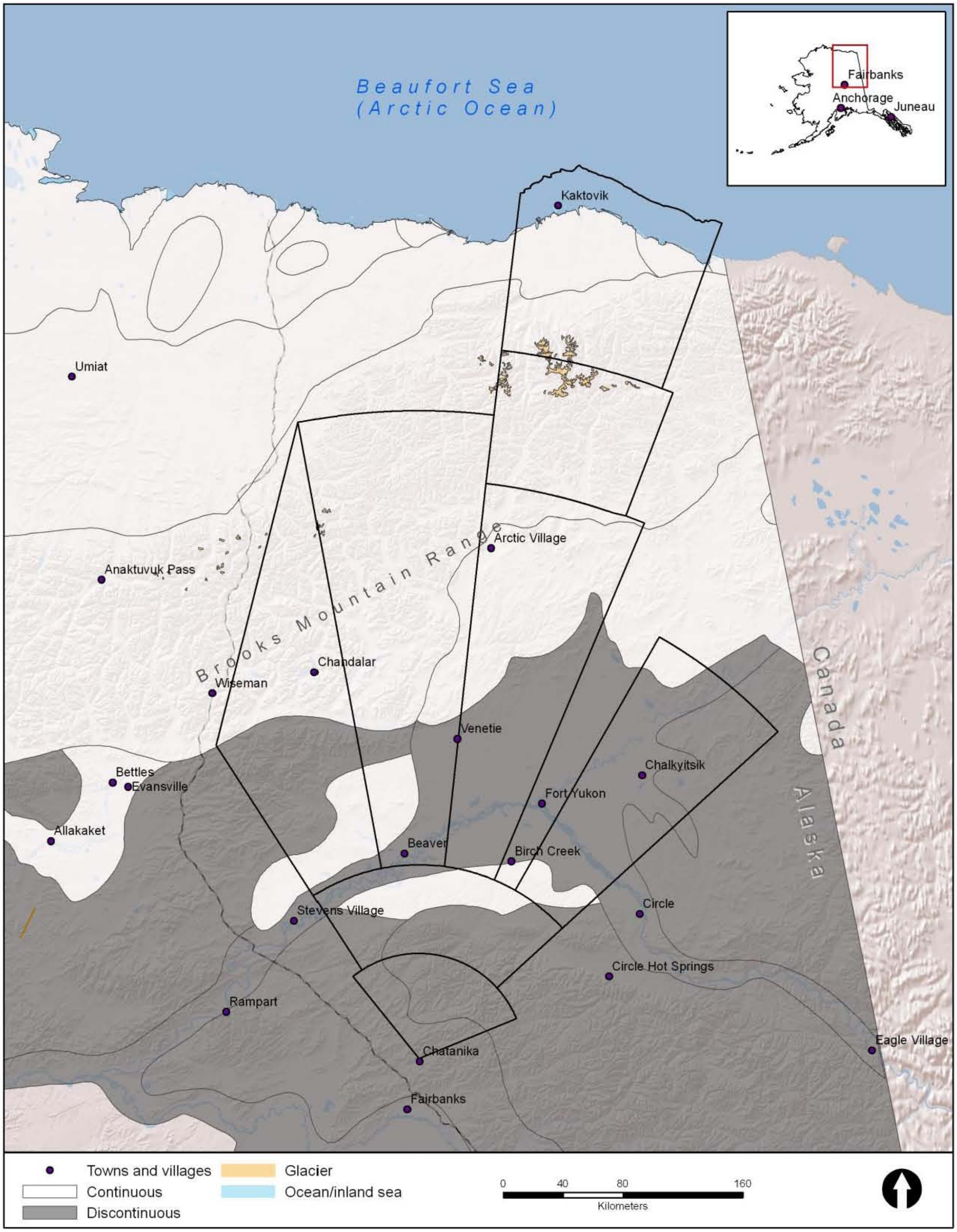
Table 3–10. Poker Flat Research Range Permafrost[a]

Ecoregion (ID Number)	Continuous Permafrost (hectares/percentage)[a]	Discontinuous Permafrost (hectares/percentage)	Total (hectares)
Arctic Coastal Plain (101)	160,000/100	0/0	160,000
Arctic Foothills (102)	460,000/100	0/0	460,000
Brooks Range (103)	4,100,000/100	0/0	4,100,000
Interior Forested Lowlands and Uplands (104)	480,000/32	990,000/68	1,500,000
Interior Highlands (105)	1,200,000/51	1,100,000/49	2,300,000
Yukon Flats (107)	500,000/21	1,900,000/79	2,400,000
Grand Total			**11,000,000**

a. Metrics denote the approximate area of permafrost in the Poker Flat Research Range portion of each ecoregion.
Note: To convert hectares to acres, multiply by 2.4710.
Source: Brown *et al.* 2001.

A major effect of permafrost soils is the presence of the frozen permafrost layer that causes water to saturate the active layer and perch on the surface of lowlands, creating wetlands. In some cases, frozen soil layers may contain large amounts of ground ice **(USDA 2004)**. In unconsolidated soils with poor drainage, ice masses range from small granules to ice wedges that can account for 50 to 80 percent of the permafrost **(French 2007; Ray 1950)**. Although the permafrost layer may impede or restrict water movement, it is not uncommon for the talik layer to contain unfrozen layers that facilitate groundwater movement through the soil, which often results in the formation of perennial springs **(French 2007)**.

Typically, permafrost thawing proceeds from the top downward and, eventually, from the bottom upward. Thawing discontinuous permafrost generally ranges from decades to millennia **(Bockheim and Hinkel 2007; Osterkamp and Jorgenson 2009)**. Cryoturbation (mixing of materials from various soil horizons due to freezing and thawing) is common to permafrost-affected soils and causes soil horizons to be broken and contorted **(USDA 2004)**.



Note: To convert kilometers to miles, multiply by 0.6214.
Source: SAIC 2011.

Figure 3–3. Poker Flat Research Range Permafrost

Climatic warming trends (see Section 3.1.2) resulting in the thawing of Arctic region permafrost could increase the depth of the active layer, increase groundwater discharge, soil drainage and drying, soil erosion, and landslides; release soil-sequestered carbon; and increase thermokarst terrain. Thermokarst is the thawing of permafrost with excessive ground ice, causing ground subsidence and irregular topography. Collect of water within pits or depressions leads to formation of small water bodies and growth of underlying taliks and further accelerates permafrost thawing **(Riordan 2005; USFWS 2011c)**. As soil temperatures increase, permafrost degradation is inevitable **(Bockheim and Hinkel 2007; Hinkel and Nelson 2003; Jorgenson *et al.* 2006; Osterkamp and Jorgenson 2009; von Hugues 2008)**. In addition, the disturbance of Gelisol organic active layers by wildfires – particularly in the Yukon Flats, Interior Highlands, and Interior Forested Lowlands and Uplands Ecoregions – may also affect permafrost environments **(Gallant *et al.* 1995)**. Because of frequent lightning strikes, wildfires are common to the subarctic boreal forest **(Riordan 2005)**.

Groundwater can occur above, below, and within permafrost **(Williams 1970)**. However, climate driven thawing of permafrost is altering the groundwater systems of the Arctic and subarctic regions. Studies by **Muskett and Romanovsky (2011)** found that the groundwater storage by bogs, depressions, and thaw lakes in the Arctic Coastal Plain Ecoregion (see Section 3.3.4.2) is increasing, whereas groundwater storage in the Yukon Flats Ecoregion (see Section 3.3.4.7) is decreasing. These changes are possibly linked to the development of taliks that are increasing the surface area of water bodies in the Arctic and reducing permafrost extent in the Yukon River basin. Talik layer water flows interact directly with the hydrology of surface water features. As an example, groundwater sources comprise approximately one-fourth of the water discharged by the Yukon River **(Walvoord and Striegl 2007)**.

3.4.2 Volcanoes

Of the approximately 140 volcanoes in Alaska that have been active over the last 2 million years, over 50 have been active since about 1700 **(Adleman 2011)**. Most volcanic activity has been located in the Aleutian Islands, Alaska Peninsula, and the mountains west of Cook Inlet **(Robar *et al.*)**. The U.S. Geological Survey, Alaska Volcano Observatory, monitors 27 active volcanoes on a daily basis. Since 1760, over 260 eruptions from 41 volcanoes have been reported **(Brantley *et al.* 2004)**. Mount Spur, the northernmost historically active volcano in Alaska **(Adleman 2011)**, is approximately 450 kilometers (280 miles) southwest of Fairbanks. No active volcanoes or volcanic fields are known to occur within PFRR.

3.4.3 Glaciers

The glaciations of the Pleistocene Epoch dramatically affected the landscape of Alaska through the construction of outwash terraces and moraines and erosion and sediment deposition processes **(Balascio *et al.* 2005; Briner and Kaufman 2008)**. The maximum extent of Pleistocene glaciations and current extent of glaciers cover the Philip Smith, Franklin, Sadlerochit, Shublik, Romanzof, and Davidson Mountains on the north and south sides of Brooks Range **(Balascio *et al.* 2005; Molnia 2008)**. There are approximately 41,000 hectares (101,000 acres) of glaciers within the Brooks Range Ecoregion. Most of the notable glaciers occur in higher-elevation cirques and valleys of the Franklin and Romanzof Mountains. Two prominent features include the Romanzof Mountains McCall and Okpilak Glaciers **(Molnia 2008)**. Since the early 1800s, McCall Glacier has retreated over 800 meters (2,600 feet) **(USFWS 2011c)**. Glacier melt water contributes considerably to the summer flow of Arctic rivers and streams **(Arendt 2006)**.

3.4.4 Soil Orders

The taxonomic classification used to describe soils within the ROI is soil order. **Table 3–11** lists the soil orders.

Table 3–11. Poker Flat Research Range Soil Orders

Soil Order	Description
Entisols	Entisols exhibit little or no soil-forming processes or development of soil horizons. Predominant textures include sand, sandy loam, sandy clay loam, and silty clay loam. In Alaska, these soils typically occur on river floodplains subjected to frequent sediment deposition, uplands adjacent to major rivers that receive windblown riverbed sediments, recently exposed glacial moraines, and very cold or steep areas prone to erosion.
Gelisols	Gelisols are defined as soils having permafrost within 100 centimeters of the soil surface or having gelic materials within 100 centimeters and permafrost within 200 centimeters of the soil surface if the top meter shows evidence of cryoturbation. Gelic materials include mineral or organic soil materials that show evidence of cryoturbation and/or ice segregation in the active layer and/or the upper part of the upper permafrost. Soils classified as Cryosols (perennial frozen or permafrost-affected soils) taxonomically key out at the Gelisol Order. Soil genesis is dominated by cryopedogenic processes, such as freeze-thaw cycles, cryoturbation, ice segregation, and frost cracking.
Inceptisols	Inceptisols are soils that have experienced relatively minor changes in parent materials, resulting in the leaching and accumulation of materials in subsurface layers or horizons. They form mainly under humid conditions in loamy and clayey parent materials. These soils range from poorly to excessively drained. Soil textures range from sandy loams to silty clays. Most soils in Alaska are Inceptisols.
Spodosols	Spodosols are poorly drained, naturally infertile soils in which materials such as organic matter, aluminum, and/or iron have leached through the soil profile and accumulated in a lower layer in the soil profile, called a spodic horizon. These soils form in relatively acidic soil materials. The soil texture class is mostly sandy, sandy-skeletal, coarse-loamy, loamy-skeletal, or coarse-silty. In Alaska, these soils are dominant in uplands, and, except for areas with very course materials and some tundra locations, typically occur in areas where the mean annual precipitation exceeds 38 centimeters.

Note: To convert centimeters to inches, multiply by 0.3937.
Source: Schickhoff *et al.* 2002; Osterkamp and Jorgenson 2009; Ping *et al.* 2004; Rieger *et al.* 1979; USDA 2010.

3.4.5 Ecoregions

This section describes the geologic and soil resources within the ROI based on the ecoregion descriptions provided in Section 3.2.

3.4.5.1 *Arctic Coastal Plain Ecoregion*

The area geology is defined by Quaternary deposits of alluvial, glaciofluvial, or aeolian unconsolidated sediments underlain with fluvial sands and silts and marine sediments near the coast **(Clough *et al.* 1987; Gallant *et al.* 1995)**. This ecoregion was never glaciated primarily because of the scarcity of precipitation **(Hall 1979; USFWS 2011c)**. The area is dominated by very poorly drained, organic Gelisol soils that developed under thick, low shrubby vegetation over fine silt loams and silty clay loams **(Gallant *et al.* 1995; Schickhoff *et al.* 2002)**. Typically, soils thaw to a depth of less than 46 centimeters (18 inches) in the summer **(Clough *et al.* 1987)**. These peat and loamy soils primarily occur in shallow depressions and drains and borders of the lakes formed from the thawing of ground ice **(Ping *et al.* 2004)**. Well to moderately drained gravelly soils have developed from stream channel deposits **(Gallant *et al.* 1995; Hall 1979)**.

Approximately 100 percent (160,000 hectares [404,000 acres]) of the PFRR portion of the Arctic Coastal Plan Ecoregion is underlain with continuous permafrost (see Table 3–10 and Figure 3–3) that generally ranges in thickness from 200 to 400 meters (650 to 1,300 feet). Continuous permafrost may extend to depths of greater than 400 meters (1,300 feet) in some areas **(Riordan 2005)**. Active layers generally range from 0.3 to 1.2 meters (1 to 4 feet) thick **(USFWS 2011c)**. Minor variations in tundra elevation due to freezing and thawing of the active layer are common **(ADNR 2006)**. Surface features include ice wedge polygons, thaw lakes, peat ridges, frost boils, icings, and pingos (mounds of earth-covered ice 6 to 70 meters [20 to 230 feet] high) **(Gallant *et al.* 1995)**. The continuous permafrost has a strong influence on the hydrologic cycles of the Arctic Coastal Plain Ecoregion **(French 2007)**. The permafrost functions as a relatively impermeable layer, creating shallow, wet tundra during summer that has severely limited water storage capacity. Water that accumulates above the permafrost is removed by evapotranspiration and surface runoff that generally drains toward the Beaufort Sea **(Schickhoff *et al.* 2002)**.

3.4.5.2 *Arctic Foothills Ecoregion*

This predominantly treeless region of moderately steep to steep hills and broad, sloping valleys and tundra are underlain with continuous permafrost **(USFWS 2011c)**. Approximately 100 percent (460,000 hectares [1,200,000 acres]) of the Arctic Foothills Ecoregion within the ROI is underlain with continuous permafrost (see Table 3–10 and Figure 3–3). The active layer is generally less than 1 meter (3 feet) thick **(Gallant *et al.* 1995; Ping *et al.* 2004)**. Slopes typically range from 0 to 10 percent, with some areas being much steeper. Elevations range from sea level to 900 meters (3,000 feet) **(Gallant *et al.* 1995)**.

The northern portion of the Arctic Foothills Ecoregion comprises Quaternary deposits of unconsolidated glacial alluvial and aeolian materials over Lower Cretaceous continental deposits. The higher southern portion of the foothills consists of undifferentiated alluvial and colluvial deposits overlying Jurassic and early Cretaceous formations. Parts of the southern portion of the Arctic Foothills Ecoregion near the Brooks Range Ecoregion were glaciated during the Pleistocene epoch **(Ping *et al.* 2004)**. Ice- and drainage-related surface features include patterned ground, gelifluction lobes, frost boils, ice-wedges, and pingos **(Schickhoff *et al.* 2002)**. Arctic Foothills Ecoregion soils are predominantly Gelisols. In the valleys and on broad slopes, soil parent materials are primarily loamy colluviums (slope deposits due to gravity), whereas on hills and ridges, the parent materials are primarily gravelly colluviums and weathered sedimentary rocks. Soil texture is primarily silt loam or silty clay loam in the northern portion and sandy loam in the southern portion of the foothills. Most soils on mild slopes and broad valleys are poorly drained **(Ping *et al.* 2004)**. Peaty soils often form in the valley floors and sandy soils occur in dunes along streams **(Clough *et al.* 1987)**. Surface tundra active layer depths generally range from a few centimeters to a meter, with an average of approximately 25 to 40 centimeters (10 to 16 inches) **(Greenwald *et at.* 2008)**. Thawed talik layers tend to develop in tundra and beneath streams during summer **(Greenwald *et at.* 2008)**.

3.4.5.3 *Brooks Range Ecoregion*

Approximately 100 percent (4.1 million hectares [10 million acres]) of the Brooks Range Ecoregion is underlain with continuous permafrost (see Table 3–10 and Figure 3–3). This ecoregion comprises a wide belt of rugged, linear mountain ranges carved primarily by numerous glacial advances and differential erosion from uplifted Paleozoic and Mesozoic sedimentary rock formations. Current glaciers only persist at high elevations (see Section 3.4.3). The region is drained by north- and south-flowing rivers. The southern section of the ecosystem is characterized by buttes, knobs, mesas, ridges, and undulating tundra, and the northern section has broad, rounded ridges and mesa-like uplands **(Schickhoff *et al.* 2002)**. Ice- and drainage-related features include moraine and grave outwashes, hillslope gelifucation lobes, ice push ridges, frost action scars, and soil erosion. Because of the permafrost, most soils in the ecoregion are poorly to very poorly drained and shallow to moderately deep Gelisols. Better-drained hillslopes generally formed from colluvium and valley floors, from gravelly glacial till. Gently sloping areas often have shallow, gravelly and stony soils **(Gallant *et al.* 1995; USFWS 2011c)**. Poorly drained loamy soils overlain with peat are primarily found in low areas near rivers **(Clough *et al.* 1987)**.

3.4.5.4 *Interior Forested Lowlands and Uplands Ecoregion*

The Interior Forested Lowlands and Uplands Ecoregion geology includes Mesozoic and Paleozoic sedimentary formations and areas of extensive volcanic deposits with minimal exposure of bedrock **(Brabets *et al.* 2000)**. The terrain has been strongly influenced by the mantling of undifferentiated alluvium (stream sediments) lowland deposits and colluvial upland deposits and thermokarsting of soils with high quantities of ground ice. Primary soils within the ecoregion include Entisols, Gelisols, and Inceptisols. The majority of lowland soils formed within broad river floodplains from silty alluvium and loess materials, whereas uplands soils were formed primarily from colluvial and loess deposits and bedrock weathering. Organic soils frequently occur on very acidic, nearly level peatland plateaus **(Gallant *et al.* 1995; Ping *et al.* 2004)**. Some areas experience extensive thermokarsting where permafrost soils contain large amounts of ground ice. Well-drained permafrost-free soils may occur within river floodplains **(Ping *et al.* 2006)**.

3.4.5.5 *Interior Highlands Ecoregion*

The northern section of the Interior Highlands Ecoregion within the ROI is underlain with approximately 51 percent (1.2 million hectares [2.9 million acres]) continuous permafrost and the remaining area, 49 percent (1.1 million hectares [2.7 million acres]) discontinuous permafrost (see Table 3–10 and Figure 3–3).

Geologic formations include metamorphic, volcanic, intrusive, and sedimentary rocks. Dominant soils are shallow, poorly drained Entisols, Gelisols, Inceptisols, and Spodosols that formed primarily from gravels weathered from local bedrock. Valley floor parent materials are alluvium and colluviums deposits **(Gallant *et al.* 1995)**. Stony and loamy tundra soils occur at higher elevations. Thermokarst is widespread in this ecoregion since permafrost soils are frequently ice-rich **(Ping *et al.* 2004)**. Compared to Arctic streams, water courses in the Interior Highlands Ecoregion tend to exhibit peak flows following the spring snowmelt, but moderate flows during the summer **(USFWS 2011c)**. Major Interior Highlands Ecoregion rivers within the ROI include the Chandalar, Christian, East Fork, Koness, Middle Fork, North Fork, Sheenjek, and Wind Rivers **(Childers *et al.* 1977; Daum and Troyer 1992)**.

3.4.5.6 *Yukon Flats Ecoregion*

The Yukon Flats Ecoregion contains Quaternary and earlier unconsolidated eolian (windblown sand or rock deposits), glaciofluvial, and fluvial sediments that have underlying bedrock. Dominant soils include Gelisols and Inceptisols that formed within the alluvium and loess materials of river floodplains that are frequently subject to flooding. Except for better-drained silt and sandy soils along river and stream natural levees, areas outside the basin floodplain are often poorly drained peatlands with shallow permafrost **(Gallant *et al.* 1995; USFWS 2008b)**. Terraces along the margins of the lowlands are covered with loess silt materials underlain with gravel **(Nakanishi and Dorava 1994)**. Except for larger rivers and lakes and recently abandoned meander belts **(Nakanishi and Dorava 1994)**, the ecoregion is underlain with continuous and discontinuous permafrost. The areas of the ROI within this ecoregion are underlain with approximately 21 percent (490,000 hectares [1.2 million acres]) continuous permafrost and 79 percent (1.9 million hectares [4.7 million acres]) discontinuous permafrost (see Table 3–10 and Figure 3–3).

3.5 NOISE

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment. The ROI for the noise analysis includes the PFRR launch site and launch corridor.

Sound is quantified in units called *decibels (dB).* The dB scale used to describe sound is a logarithmic scale that provides a convenient system for considering the large differences in audible sound intensities. On this scale, a 10 dB increase represents a perceived doubling of loudness to someone with normal hearing. Therefore, a 70 dB sound level will sound twice as loud as a 60 dB sound level. However, a doubling of sound energy only results in a 3 dB increase in sound level. For example, adding together two identical noise sources of 60 dB results in a total noise level of 63 dB (60 dB + 60 dB = 63 dB). Under ideal listening conditions, people generally cannot detect differences of 1 dB, while differences of 2 or 3 dB can usually be detected by people with normal hearing.

An adjustment, or weighting, of the high and low-pitched sounds is made to approximate the way that an average person hears sounds. The adjusted sounds are called "A-weighted levels" (dBA). The A-weighted decibel scale begins at zero. This represents the faintest sound that can be heard by humans with very good hearing. The loudness of sounds (that is, how loud they seem to humans) varies from person to person, so there is no precise definition of loudness.

Sound levels decrease as the distance increases from the sound source. This loss of energy, known as attenuation, is affected by geometrical spreading, atmospheric absorption, and the interaction of the sound waves with the ground surface. *Geometrical spreading* refers to the spreading of sound energy as a result of the expansion of the wavefronts. For a *point source*, such as a chainsaw, sound levels decrease due to spreading by approximately 6 dB for every doubling of distance from the source. An overflying aircraft is considered a *line source*, which typically results in a sound level reduction of 3 dB per doubling of distance.

Atmospheric absorption is the loss of sound energy as it travels through the air, which varies strongly with the frequency of the sound wave and the temperature, humidity, and, to a minor extent, the atmospheric pressure. This loss is greatest at high frequencies and in hot, dry air. Under normal conditions the atmosphere is cooler at higher altitudes, which results in sound waves being "bent" upwards, resulting in the formation of a shadow zone, which is a region in which sound does not penetrate. Under conditions of a temperature inversion (temperature increasing with increasing height), the sound waves will be refracted downwards, and therefore may be heard over larger distances. This frequently occurs in winter and at sundown. Variations in the atmosphere will also cause scattering, during which some of the sound energy is re-directed into many different directions. Scattering is caused by air turbulence, rough surfaces, and obstacles such as trees. Temperature and wind gradients can result in measured sound levels being very different to those predicted from geometrical spreading and atmospheric absorption alone. These differences may be as great as 20 dB **(Ingård 1953)**. These effects are particularly important where sound is propagating over distances greater than a few hundred meters.

The amount of *ground attenuation* depends on the nature of the ground, the frequency of the sound, the distance over the ground, and the source and receiver heights. Smooth, hard surfaces will produce little absorption, whereas thick grass may result in sound levels being reduced by up to about 10 dB per 100 meters at 2,000 hertz (Hz). Ground attenuation is typically limited to about 20 dB as the distance between the source and receiver increases, due to the effects of turbulence and scattering **(Sutherland and Daigle 1997)**. The presence of vegetation, particularly trees, provides some attenuation; however, trees of several hundred meters thick are required before substantial attenuation occurs **(Aylor 1971)**. High frequencies are generally attenuated more than low frequencies.

The propagation of sound can be affected greatly by terrain and the elevation of the receiver relative to the sound source. Noise travels in a straight line-of-sight path between the source and the receiver. The presence of an area of high terrain reduces the sound energy arriving at the receiver. Breaking the line of sight between the receiver and the sound source results in a sound level reduction of approximately 5 dB. If the source is depressed (*e.g.,* in a valley) or the receiver is elevated (*e.g.,* on a mountainside), sound generally will travel directly to the receiver. In some situations, sound levels may be reduced because the terrain crests between the source and the receiver, resulting in a partial sound barrier near the receiver. Level ground is the simplest case.

The importance of these various phenomena depends upon the situation under consideration. For example, for a chainsaw on the ground and a receiver close by, only geometrical spreading and large obstacles need to be considered. However, if the receiver is a large distance from the chainsaw, then ground effects and atmospheric effects must be considered. If an aircraft is flying overhead, then only geometric spreading and atmospheric effects need to be considered.

Areas near the PFRR launch site are used primarily for recreation, mineral recovery, and forestry. The closest noise-sensitive receptor, the Chatanika Lodge, is located about 1.6 kilometers (1 mile) south-southwest of the PFRR launch site adjacent to Steese Highway (Alaska Route 6). The primary source of noise in this area is traffic noise along Steese Highway. Recreation users and visitors at the Chatanika Lodge may be sensitive to noise produced by activities at PFRR. Areas near PFRR that are not close to the highway are naturally quiet. There are no ambient sound level survey data available for the area near the PFRR launch site.

Sources of noise from daily activities at the PFRR launch site include ventilation systems, delivery vehicles, and employee vehicles. Occasional noise sources include generators, rocket launches, and aircraft involved in recovery operations. Noise from rocket launches and recovery aircraft (*i.e.,* fixed wing propeller planes and helicopters) is discussed in Chapter 4. Based on the number of daily commuter trips to the PFRR launch site and the traffic volume on Steese Highway **(ADOT&PF 2010)**, the contribution of employee vehicles and delivery vehicles attributable to activities at the PFRR launch site to noise along Steese Highway is minor.

Areas within the PFRR launch corridor in which rocket debris and science payloads would land and search and recovery operations would be conducted include parts of Arctic NWR, Yukon Flats NWR, White Mountains NRA, Steese NCA, and various villages and other inhabited areas. Users of wildlife refuges and recreation and conservation areas may have the expectation of solitude **(USFWS 2011c)**. These refuges and recreation areas are naturally quiet except for natural sounds from wind and wildlife. Occasional aircraft overflights and snow machines in recreation areas interrupt the natural quiet in these areas. There are no ambient sound level survey data readily available for these refuges and recreation and conservation areas.

The inhabited areas, although generally quiet, are subject to vehicle noise, higher levels of aircraft activity, and other sounds of human activity. There are no ambient sound level survey data readily available for these inhabited areas.

The ambient sound in the Arctic Ocean under the ice results from the effects of wind, currents, ambient air temperature, sounds of marine mammals, and ice cracking. Ice cracking results from the combination of stresses on the ice, including wind, currents, and thermal stresses. Ice cracking creates a sharp broadband sound. The frequency characteristics of ice cracking vary with the age of the ice (first year or multi-year). The combination of many such events in the floating ice pack is the predominant noise source under the ice in the Arctic Ocean **(Xie and Farmer 1991)**. Mid-frequency sound from ice (centered on 600 Hz) has been best correlated with temperature, and lower-frequency sound (centered at 15 Hz) has been best correlated with wind, which moves ice granules on the surface of the ice pack **(Makris and Dyer 1986)**. The wind-generated wave interaction between open ocean and ice is a major source of sound near the ice/water boundary. Low-frequency sound from this interaction carries greater distances than the higher-frequency sound **(Diachok 1980)**.

Milne and Ganton (1964) report ice pack noise from ice cracking which when converted to sound pressure levels, ranges from about 90 dB (referenced to 1 micro Pascal) in the lower frequencies (1 Hz) to about 45 dB (referenced to 1 micro Pascal) in the higher frequencies (100–10,000 Hz). **Ganton and Milne (1965)** report noise under the ice pack from wind-induced sounds, which ranges from about 50–55 dB (referenced to 1 micro Pascal) in the higher frequencies (100–10,000 Hz) with a wind speed of 9.8 meters per second (22 miles per hour). Lower-frequency (10–100 Hz) sound levels of about 50 dB (referenced to 1 micro Pascal) under these conditions were the result of residual impulsive noise (from ice cracking and distant noise).

Sound levels (presented in decibels referenced to 1 micro Pascal at 1 meter) from various noise sources in the ocean include lightning strike on water surface, 260 dB; bowhead whale, 128–189 dB; and gray whale, 142–185 dB. Sound is attenuated in the ocean at a rate of about 6 dB for each doubling of distance **(USN 2011)**. Actual attenuation of sound is dependent on frequency; the presence of sound channels, which may result in transmission of sounds of certain frequencies over greater distances; and reflection of sound off the ice canopy **(Diachok 1980)**.

The State of Alaska and Fairbanks North Star Borough have no regulations that specify acceptable sound levels **(Fairbanks North Star Borough Code 2011)**.

3.6 VISUAL RESOURCES

Visual resources are the natural and manmade features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape; however, they exert varying degrees of influence. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape. The ROI for visual resources includes areas within the PFRR launch site and the PFRR launch corridor.

To provide a basis for the impact analysis in Chapter 4, visual resource assessments were made for the federally managed lands within the ROI based on a description of the viewshed and U.S. Bureau of Land Management (BLM's) visual resource management (VRM) classification **(USDOI 1986a)**. Classifications of visual contrast settings are provided in **Table 3–12**. Classifications were derived from an inventory of scenic qualities, sensitivity levels, and distance zones for particular areas.

Table 3–12. U.S. Bureau of Land Management Visual Resources Classifications

Classification	Visual Settings
Class I	Very limited management activity; natural ecological change.
Class II	Management activities may be seen, but should not attract the attention of the casual observer, such as solitary small buildings or dirt roads.
Class III	Management activities may attract attention, but should not dominate the view of the casual observer; the natural landscape still dominates buildings, utility lines, and secondary roads.
Class IV	Management activities may dominate the view and major focus of viewer attention, such as clusters of two-story buildings, large industrial or office complexes, primary roads, and limited clearcutting for utility lines or ground disturbances.

Source: USDOI 1986a.

3.6.1 Poker Flat Research Range Launch Site

The PFRR launch site includes the Lower, Middle, and Upper Ranges. The Lower Range includes range offices, rocket launch facilities, blockhouse, pad support, and a rocket storage building. The area is relatively flat, with an average elevation of 200 meters (660 feet) above mean sea level. The Middle Range includes the area with the telemetry buildings and optical observatory. It is approximately 200 meters (700 feet) higher in elevation than the Lower Range. The Upper Range includes the area on the ridge top above the Lower and Middle Ranges. The Upper Range's elevation extends to 500 meters (1,600 feet) above mean sea level. Facilities in the Upper Range include a self-contained trailer, which houses electrical gear, and a short radar tower **(NASA 2000a)** (see Chapter 2). The PFFR launch site is consistent with BLM VRM Class III or IV. Class III indicates areas in which there have been moderate changes in the landscape that could attract attention, but do not dominate the view of the casual observer. Class IV indicates areas in which major modifications to the character of the landscape have occurred. These changes may dominate features of the view and become the major focus of the viewer's attention **(USDOI 1986a)**.

3.6.2 Poker Flat Research Range Launch Corridor

The PFRR launch corridor encompasses a vast portion of interior and northern Alaska. Downrange from the launch site are White Mountains NRA; Steese NCA; Arctic NWR, including Mollie Beattie Wilderness Area; and Yukon Flats NWR (see Figure 3–1). Also located within the PFRR launch corridor are landmasses owned by Alaska Native organizations, including Doyon, Limited, and the Native Village of Venetie Tribal Government.

3.6.2.1 *White Mountains National Recreation Area*

White Mountains NRA is administered by BLM. ANILCA **(P.L. 96-487)** directs that White Mountains NRA be administered to provide for public outdoor recreational use; for the conservation of scenic, historic, cultural, and wildlife values; and for other uses if they are compatible or do not significantly impair the previously mentioned values **(USDOI 1986b)**. BLM manages White Mountains NRA to enhance and protect the important resource values that make White Mountains NRA unique. These values include, among others, the outstanding scenic quality of the viewshed and unique landforms and geologic formations such as the White Mountains, Windy Gap Arch, Serpentine Slide, and Victoria Mountain **(USDOI 1986b)**. BLM manages the Beaver Creek viewshed as a VRM Class I area and the White Mountain Trail as VRM Class II area. The objective of this class is to retain the existing character of the landscape and maintain a low level of change to the landscape. Management activities in VRM Class II areas may be seen but should not attract the attention of the casual observer **(USDOI 1986b)**. Other areas within White Mountains NRA, such as portions of the Semi-Primitive Management Unit, are managed as VRM Class III areas **(USDOI 1986b)**.

3.6.2.2 *Steese National Conservation Area*

Steese NCA is administered by BLM and includes Birch Creek, a designated Wild River, crucial caribou calving grounds and home range, and Dall sheep habitat. Various land uses are allowed in Steese NCA; however, it is managed to protect its scenic, scientific, cultural, and other resources **(USDOI 2011a)**. BLM manages the Birch Creek National Wild River Corridor within Steese NCA as a VRM Class I area. The objective of this VRM class is to preserve the existing character of the landscape so that it appears unaltered by man. The level of change to the landscape should be extremely low because only very limited management activities should occur. BLM manages the viewshed of Birch Creek as a VRM Class II area. BLM manages the Semi-Primitive Motorized Restricted Management Unit within Steese NCA as a VRM Class III area, with areas of the unit determined to be within the critical viewshed for Birch Creek managed to VRM Class II objectives **(USDOI 1986c)**.

3.6.2.3 *Arctic National Wildlife Refuge*

Administered by USFWS, Arctic NWR was established for the purpose of preserving its unique wildlife, wilderness, and recreational values **(USFWS 2011c)**. The Neruokpuk Lakes Public Use Natural Area, within Arctic NWR, is the only public use natural area in Arctic NWR. It is located in Brooks Range, entirely in the designated Wilderness area. It was chosen as a public use natural area because of its relative ease of access, scenic beauty, and abundant wildlife. The Ivishak, Sheenjek, and Wind Rivers are located within the boundaries of Arctic NWR and are designated as wild rivers under the Wild and Scenic Rivers Act. USFWS manages these water bodies in natural, free-flowing, and undisturbed conditions, where the evidence of human activities is minimized. Mollie Beattie Wilderness Area is located within Arctic NWR and contains more than 40 percent of Arctic NWR. The Wilderness area’s character includes natural and scenic conditions. Because of distinctive scenic and scientific features within Arctic NWR, several rivers, valleys, canyons, lakes, and a rock mesa have been recommended as National Natural Landmarks **(USFWS 2011e)**. Arctic NWR is consistent with the BLM and VRM Class I and Class II.

3.6.2.4 *Yukon National Wildlife Refuge*

The Yukon River flows through the center of Yukon Flats NWR and drains a broad floodplain patterned with braided tributaries and pocked with lakes and ponds. The basin floor gently slopes up to the White Mountains to the south of Yukon Flats NWR and Brooks Range to the north. Beaver Creek is a clear, sinuous river that flows out of the White Mountains and empties into the Yukon River. The White Mountains are scenic white limestone mountains; rugged and isolated, they receive only limited use and remain virtually undisturbed by human development. The environment consists mainly of geographic landmarks, Alaska Native villages, fishing and hunting grounds, lakes, wetlands, creeks, and riverway landscapes. The topography of the region is characteristic of flat to undulating lowlands, surrounding uplands, and encompassing highlands and mountains. The land cover is a mixture of spruce forests, white birch, quaking aspen, balsam poplar, shrubs, and bogs, including tussock tundra. Because of the flat to gently sloping topography of the majority of the Yukon Flats NWR landscape, and successional forests in many areas, views are principally composed of foreground to middle-ground scenery elements that are consistent with recreation, hunting, and fishing. The foreground and middle ground are areas that can be seen from each travel route for a distance of up to 8 kilometers (5 miles), where management activities might be viewed in detail.

The extensive network of rivers and historic trails affords residents and visitors with viewing opportunities throughout Yukon Flats NWR. Views along rivers and trails typically range from foreground (up to 1 kilometer [0.6 miles] from the viewer) to middle ground (up to 6 kilometers [4 miles] from the foreground) and background (area beyond the foreground-middle ground zone that can be seen from each travel route to the horizon, or approximately 24 kilometers [15 miles]); it does not include areas in the background that are so far distant that the only thing discernible is the form or outline). There are several "special designation areas" in the Yukon Flats region that are afforded special status to preserve certain outstanding values. Special designations in the region include Beaver Creek Wild River (26 kilometers [16 miles] of which are within Yukon Flats NWR) and Birch Creek Wild River (no section of Birch Creek within Yukon Flats NWR holds special designation) and possibly the Lower Sheenjek River (160 kilometers [99 miles] of which are within Yukon Flats NWR), if designated in the future as a Wild River by Congress. These locations fit recognized standards for designation as areas of high aesthetic value. In addition, a portion of Yukon Flats NWR bordered by the White and Crazy Mountains has been recommended for Wilderness designation **(USFWS 2010a)**. Yukon Flats NWR is consistent with the BLM VRM Class I and Class II.

3.7 ECOLOGICAL RESOURCES

Ecological resources include plant and animal species, along with the habitats in which they occur. This section discusses vegetation, wildlife, and special status species. Water resources, including wetlands, are discussed separately in Section 3.3. The ROI for ecological resources includes the PFRR launch site, as well as the entire launch corridor. Wildlife descriptions focus primarily on large mammals (both terrestrial and marine), birds (migratory and resident), and fish. Vegetation found within the ROI is discussed within the ecoregion descriptions. For a more in depth description of vegetation found within the ROI and the vicinity, refer to **Viereck *et al.* (1992)**. Special status species refer to all plants or animals with a designation of endangered, threatened, or candidate status from USFWS, NOAA Fisheries Service, or the State of Alaska. Additionally, sensitive species identified by BLM are discussed.

3.7.1 Vegetation

Due to the extent and complexity of ecological resources occurring within the ROI, a description of ecoregion divisions has been employed to simplify the discussion. Ecoregions can best be described as geographical units identified by their environmental conditions, such as climate, soil type, and species composition. Ecoregion descriptions in this section follow the designations and descriptions set forth in **Gallant *et al.* (1995)**, as discussed in Section 3.2 and shown in Figure 3–2.

The Arctic Coastal Plain Ecoregion is the northernmost ecoregion. It is a true Arctic climate, characterized by very low temperatures and precipitation. Many thaw lakes are present with thick permafrost below the surface. The area is poorly drained and treeless, with strong persistent winds. The Arctic Coastal Plain Ecoregion is dominated by wet graminoid herbaceous communities with a low chance of wildfire **(Gallant *et al.* 1995)**.

The Arctic Foothills Ecoregion also has an Arctic climate with low temperatures and precipitation. This area has better drainage than the coastal plain, with rolling hills and plateaus. It is still mostly treeless with thick permafrost. Mesic graminoid herbaceous and dwarf scrub communities dominate the vegetation. Occurrence of wildfires in the Arctic Foothills Ecoregion is very low. Fire sizes have historically ranged from less than 1 hectare (2.5 acres) to 1,600 hectares (4,000 acres), with an average size of 190 hectares (470 acres) **(Gallant *et al.* 1995)**.

Elevation in the steep, rugged Brooks Range Ecoregion varies from 800 meters (2,600 feet) to 2,400 meters (7,900 feet). Some small glaciers still exist in its highest regions. There is sparse dwarf scrub vegetation in this Arctic climate. There is a moderate amount of precipitation here, with more falling on the south-facing slopes near the summits. Occurrence of wildfires in the Brooks Range Ecoregion is common. Fire sizes have historically ranged less than 1 hectare (2.5 acres) to 109,000 hectares (270,000 acres), with an average size of 1,800 hectares (4,400 acres) **(Gallant *et al.* 1995)**.

Interior Forested Lowlands and Uplands Ecoregion have a continental climate with short, warm summers and long, cold winters. They are forest dominated with thaw and oxbow lakes, rivers, scrub communities, bogs, and swamps. Needleleaf forests are dominated by white spruce *(Picea glauca)* or black spruce *(Picea mariana)*; broadleaf forests are dominated by balsam poplar *(Populus balsamifera)*, quaking aspen *(Populus tremuloides)*, or both; and mixed forests are dominated by combinations of spruce, paper birch *(Betula papyrifera)*, and quaking aspen **(Gallant *et al.* 1995)**. Wildfires are common in this region. Other features include hills of moderate elevation and discontinuous permafrost. Precipitation ranges from 25 to 55 centimeters (9.8 to 22 inches) annually. Winter temperatures average from –35 °C to –22 °C (–31 °F to –7.6 °F) and from 11 °C to 22 °C (52 °F to 72 °F) in the summer. The PFRR launch corridor slightly intersects the westernmost edge of this ecoregion. Wildfires occur regularly in the interior forested lowlands and uplands region. Fire sizes have historically ranged from 1 hectare (2.5 acres) to 260,000 hectares (640,000 acres), with an average size of 1,600 hectares (4,000 acres). Low annual precipitation, relatively high summer temperatures, low humidity, and frequent lightning strikes make the ecoregion especially prone to wildfires. The fire season lasts from June to August **(Gallant *et al.* 1995)**.

The Interior Highlands Ecoregion is slightly mountainous, ranging from 500 to 1,500 meters (1,600 to 4,900 feet) in elevation. The ground is barren or has dwarf scrub vegetation, dominated by willows or ericaceous species, or open spruce stands dominated by white spruce or both white and black spruce **(Gallant *et al.* 1995)**. In poorly drained areas, graminoid herbaceous vegetation, dominated by sedges, persists. The area has a continental climate and permafrost in northern areas. Occurrence of fire in the interior highlands is very common due to the relatively warm summer temperatures and high number of lightning strikes. Fire sizes have historically ranged from less than 1 hectare (2.5 acres) to over 82,000 hectares (203,000 acres), with an average size of 640 hectares (1,600 acres). Similar to the Interior Forested Lowlands and Uplands Ecoregion, the wildfire season lasts from June until August **(Gallant *et al.* 1995)**.

The flat, marshy basin called the Yukon Flats Ecoregion supports needleleaf, broadleaf, and mixed forests (dominant species described above under the Interior Forested Lowlands and Uplands Ecoregions) as well as tall scrub communities and wet graminoid herbaceous communities. The tall scrub communities are dominated by a variety of willows (*Salix* spp.) and alders (*Alnus* spp.) or a mix of willows and alders. The variation exists in the climate type. Temperatures are more extreme here: summers are warmer and winters are colder. There is also less precipitation, averaging 17 centimeters (6.7 inches) per year. Occurrence of wildfires in the

Yukon Flats Ecoregion is common. Fire sizes have historically ranged from less than 1 hectare (2.5 acres) to over 32,000 hectares (79,000 acres), with an average size of 690 hectares (1,700 acres) **(Gallant *et al.* 1995)**.

Seasonal Considerations

Because of the length and north-south orientation of PFRR, the launch corridor extends over areas having considerable variation in climates, terrain, and vegetation. All areas under the corridor have an extended season during which the ground and water bodies are frozen and there is little plant growth. During this season, overland access, with minimum damage to vegetation, soils, or aquatic, is facilitated by the frozen ground and water surfaces, which will support a variety of vehicles adapted for travel on ice and snow. During the summer months, the surfaces thaw and plant growth is facilitated by the long day lengths, warmer temperatures, and availability of free water. The thawed soil and water surfaces make overland vehicular access very difficult in lowlands, which cause vehicles to bog down and can have substantial impacts on vegetation and soil. Because soils are generally underlain by permafrost, the thawed water on the surface is prevented from percolating downward, thereby creating swampy habitat. During the summer, rivers become important travel corridors for vessels and aerial access is possible by helicopter or float plane. Generally the more northerly areas have shorter warm seasons and shallower permafrost. The possibility of wildfire occurrence is very low, except during the summer months.

3.7.2 Wildlife

Although all wildlife within the ROI is ecologically important, this section focuses primarily on large mammals (terrestrial and marine), birds (migratory and resident), and fish. A more detailed description of ecological resources found in and around PFRR can be found in the *Proposed Land Exchange Yukon Flats National Wildlife Refuge Final Environmental Impact Statement* **(USFWS 2010a)**, as well as the *Arctic National Wildlife Refuge Draft Revised Comprehensive Conservation Plan, Draft Environmental Impact Statement, Wilderness Review, Wild and Scenic River Review* **(USFWS 2011c)**.

3.7.2.1 *Terrestrial Mammals*

The following provides a discussion of terrestrial mammals found within the ROI and adjacent areas. It focuses on big game and subsistence species.

Caribou

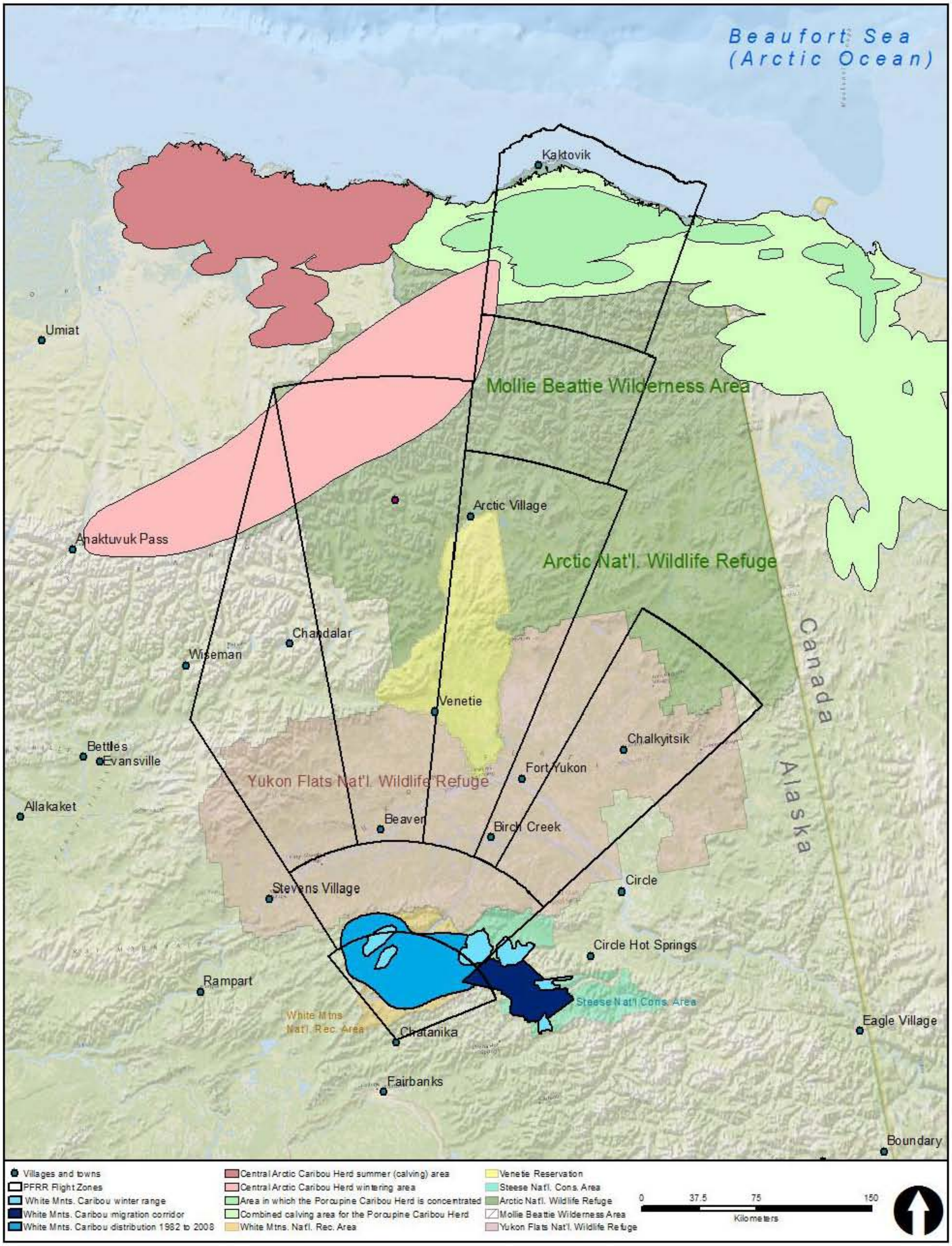
The PFRR launch corridor intersects the range of two of the four major North Slope barren-ground caribou *(Rangifer tarandus)* herds: the Porcupine Caribou Herd (PCH), which contained an estimated 169,000 animals in 2010 (**PCMB 2012**), and the westernmost portion of the range of the Central Arctic Herd (CAH), which contained an estimated 67,000 animals in 2008 (**AKRDC 2009**).Caribou are nomadic grazing animals and an important subsistence food for the Inupiat Natives of the North Slope of Alaska and the Gwich'in Natives of Canada. A herd uses a calving area that is separate from the calving areas of other herds, but different herds may mix together on winter ranges **(ADF&G 2008a)**. Caribou calves are born during the months of mid-to late-May in interior Alaska and in early June in northern and southwestern Alaska **(ADF&G 2008a)**. At times, caribou move to elevated areas and river deltas from July to August, seeking windy areas as relief from biting insects. In general, caribou herds, including PCH, are dispersed over a wider portion of their range during winter. A portion of PCH overwinters in northern Yukon Territory, Canada. Another portion of the herd winters in Alaska south of Brooks Range. Wolves *(Canis lupus)* are a major predator of caribou in wintertime **(USFWS 2008c)**. In addition to the PCH and CAH, the White Mountains caribou herd (WHM), estimated to be approximately 800 individuals, occupy the ROI year-round, primarily in the White Mountains NRA and the North Unit of the Steese NCA **(USDOI 2012a)**. **Figure 3–4** depicts the breeding (calving) and wintering (non-breeding) ranges for both the PCH and CAH, as well as the calving and post-calving range of the WMH.

Muskoxen

Muskoxen *(Ovibos moschatus)* are the only large mammals that overwinter on the Arctic Coastal Plain Ecoregion **(USFWS 2008d)**. Muskoxen were extirpated from northern Alaska in the early 20th century but were re-introduced to Arctic NWR in 1969. They have since expanded their range to the east and west of the Arctic NWR boundaries. Thick, hairy wool and other winter adaptations allow them to withstand the extreme cold of the Arctic winter. Adult females, young animals, and some males live in social groups year-round. Other males are solitary in summer and live together in winter **(USFWS 2008d)**. **Figure 3–5** shows the range of muskoxen, moose, and Dall sheep within the ROI.

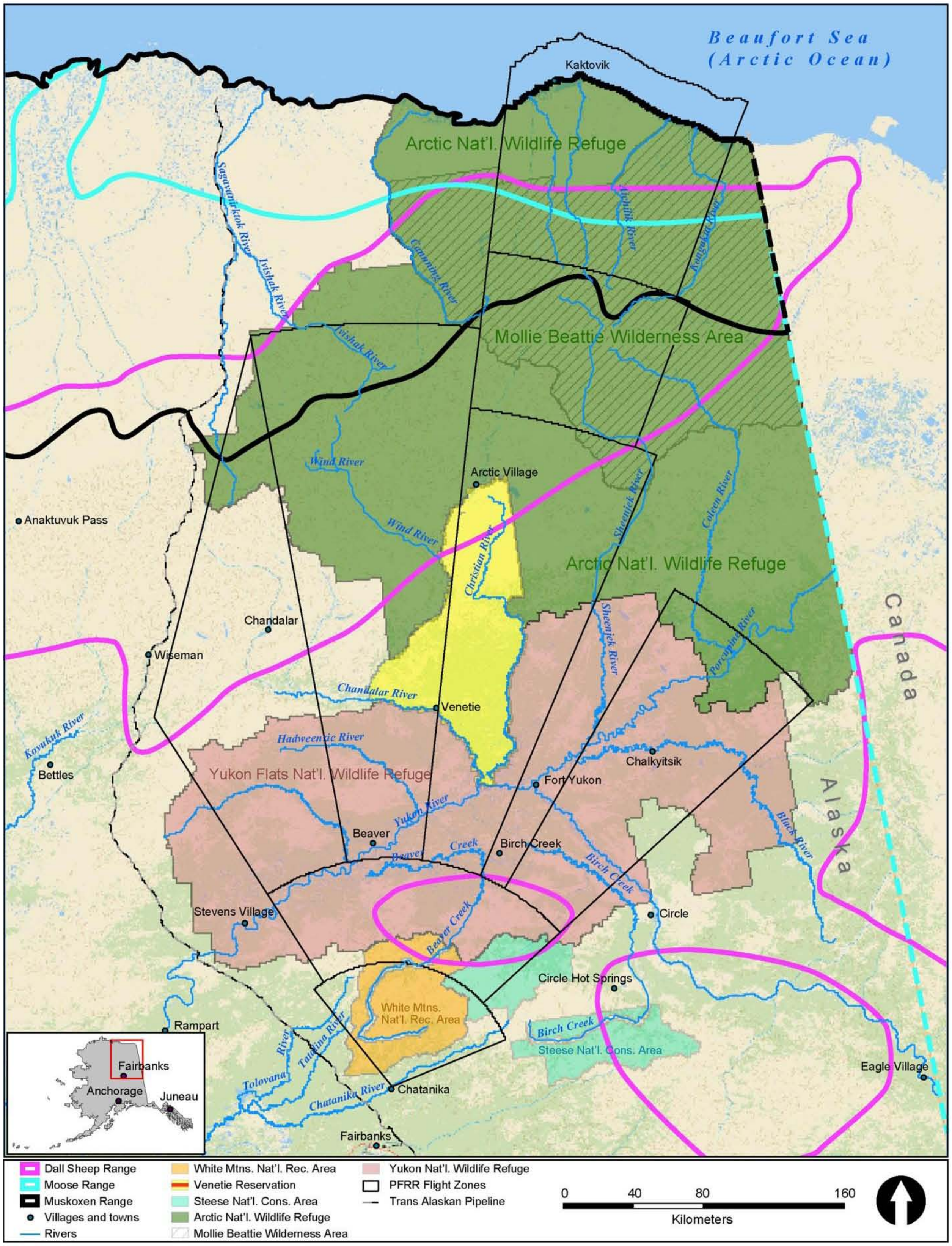
Moose

Moose *(Alces alces)*, the largest member of the deer family, is typically associated with interior Alaska, where they are prevalent. However, they are also present seasonally in the valleys of Brooks Range (including portions of Arctic NWR), where they overwinter **(Mauer 1998)**. The North Slope is the northernmost edge of distribution for this species **(USFWS 2008e)**. During fall and winter, moose consume large quantities of willow, birch, and aspen twigs **(ADF&G 2008b)**. Spring is the time of grazing and browsing **(ADF&G 2008b)**. Moose eat a variety of foods, particularly sedges, equisetum (horsetail), pond weeds, and grasses **(ADF&G 2008b)**. During summer, moose feed on vegetation in shallow ponds, forbs, and the leaves of birch, willow, and aspen **(ADF&G 2008b)**. Moose are most abundant in recently burned areas that have propagated dense stands of willow, aspen, and birch shrubs; on timberline plateaus; and along the major rivers of south-central and interior Alaska **(ADF&G 2008b)**. Hunters target moose throughout Alaska each fall. Black bears *(Ursus americanus)*, brown bears *(Ursus arctos)*, and wolves are major predators of calves and adult moose **(ADF&G 2008b)**. The range of moose within the ROI is shown in Figure 3–5.



Source: USFWS 2011c.

Figure 3–4. Central Arctic, Porcupine, and White Mountains Caribou Herd Distribution



Source: ADF&G 2012a; 2012b; 2012c.

Figure 3–5. Distribution of Muskoxen, Moose, and Dall Sheep Within the Poker Flat Research Range

Dall Sheep

Dall sheep *(Ovis dalli dalli)* occur in the PFRR launch corridor above timberline on ridges, dry meadows, and steep mountain slopes **(USFWS 2008f)**. Sheep are typically found adjacent to "escape terrain," which can be rocky outcrops or cliffs where predators like bears and wolves cannot easily follow. Although they generally inhabit high-elevation areas, Dall sheep are sometimes observed in rocky gorges below timberline **(ADF&G 2008c)**. Dall sheep eat grasses, sedges, broad-leafed plants, and dwarf willows **(USFWS 2008f)**. In winter, when other plants are not available, Dall sheep subsist on lichens and dry grasses **(ADF&G 2008c; USFWS 2008f)**. Movements between summer and winter feeding areas occur seasonally. Hunting is permitted only on large mature males (rams). Females are called ewes and young sheep are called lambs. Lambs are born in May or early June. Predators of Dall sheep are golden eagles *(Aquila chrysaetos)*, wolves, and coyotes *(Canis latrans)* **(ADF&G 2008c)**. Sheep numbers typically fluctuate irregularly in response to a number of environmental factors. Sheep populations tend to increase during periods of mild weather. Then, sudden population declines may occur as a result of unusually deep snow, summer drought, or other severe weather. Low birth rates, predation (primarily by wolves, coyotes, and golden eagles), and a difficult environment tend to keep Dall sheep population growth rates lower than for many other big game species **(ADF&G 2008c)**. The range of Dall sheep within the ROI is shown in Figure 3–5.

Wolves

Wolves are canids that live and hunt in packs throughout approximately 85 percent of Alaska's land area, including the PFRR launch corridor. Densities are lowest in the coastal portions of western and northern Alaska, especially after periodic rabies epidemics **(ADF&G 2008d)**. Wolves are social animals and usually live in packs that include adults and pups of the year. The average pack size is 6 or 7 animals, but much larger packs (of 20 to 30 animals) sometimes occur **(ADF&G 2008d)**. The home range of an individual pack occasionally overlaps that of a neighboring pack **(ADF&G 2008d)**. Wolves normally breed in February and March, and a litter averaging approximately 5 pups is born in May or early June. Wolf dens are usually excavated in well-drained soils to a depth of 3 meters (10 feet). Wolves are carnivores that prey primarily on moose, caribou, and Dall sheep **(ADF&G 2008d; USFWS 2008g)**. When large game is scarce, wolves rely on other prey animals like beavers *(Castor canadensis)* and snowshoe hares *(Lepus americanus)* and occasionally fish **(ADF&G 2008d)**.

Grizzly Bears

Grizzly bears are omnivorous large game animals that hibernate during the winter. Cubs are born during this hibernation period in January and February **(ADF&G 2008e)**. Long claws and a muscular shoulder-hump are adaptations that make grizzly bears (also known as brown bears) excellent at digging for roots and ground squirrels. Other food sources are salmon, carrion, berries, green vegetation, caribou calves, and moose calves. Bears may also be attracted to human camps and homes by improperly stored food and garbage, as well as domestic animals **(ADF&G 2008e)**. Due to limited food resources, grizzly bears of northern Alaska, including those within Arctic NWR, are fewer in number (one bear for every 780 square kilometers [300 square miles]), smaller in size, have lower reproduction rates, and produce cubs that mature more slowly than grizzlies in more southern populations **(ADF&G 2008e)**. Despite these disadvantages, the northern grizzly population is stable within Arctic NWR **(USFWS 2009a)**. Further south in the PFRR launch corridor is the domain of the interior grizzly. Interior grizzly bear densities are higher, with one bear every 39–65 square kilometers (15–25 square miles) **(ADF&G 2008e)**.

Black Bears

Black bears are the most abundant bear species living within the PFRR launch corridor. They are smaller in size than the grizzly, adapt to a wider range of environmental conditions (sea level to alpine), but are most often found in forested areas throughout Alaska. In Arctic NWR, the range of the black bear is limited to the south side of Brooks Range **(USFWS 2009b)**. Cubs are born in a winter hibernation den following a gestation period of 7 months **(ADF&G 2008f)**. Black bears are opportunistic feeders and may forage on green vegetation, carrion, berries, salmon, insects, and grubs and may prey on newborn moose calves and other small prey when available **(ADF&G 2008f)**. Their objective is to build up a fat reserve that enables them to survive the long, cold winter in a dormant state within their dens. Bear–human conflicts are common in urban areas in Alaska, and black bears are often attracted to garbage dumps and improperly stored food or waste **(USFWS 2009b)**.

Seasonal Considerations

Seasonality, or the presence and activity of wildlife based on time of year, is an important factor in determining species composition and relative abundance of wildlife within and around the ROI. During winter months, many wildlife species are absent or less active than in the spring, summer, and fall. Winters in Alaska are harsh, cold, and long. Many species have adapted specifically to endure these adverse conditions. Certain species of mammals, such as the black bear, endure the winter months by hibernation. Other species, such as muskoxen, develop a thick coat of fur enabling them to withstand the extreme winter conditions and remain in the Arctic throughout the year.

3.7.2.2 *Marine Mammals*

Marine mammals in the ROI live in the Beaufort Sea, which is in the eastern portion of the Arctic Ocean off of Alaska's north coast and within the PFRR launch corridor (Zone 4 and Zone 4 Arctic Extension; see Figure 3–4). The most commonly observed marine mammal species in the Alaskan Beaufort Sea are bowhead *(Balaena mysticetus)*, beluga *(Delphinapterus leucas)*, and gray *(Eschrichtius robustus)* whales; ringed *(Phoca hispida hispida)*, bearded *(Erignathus barbatus barbatus)*, and spotted *(Phoca largha)* seals; walruses *(Odobenus rosmarus)*, and polar bears *(Ursus maritimus)*. All marine mammals are protected by MMPA. The polar bear and bowhead whale are listed under the ESA as threatened and endangered, respectively. Additionally, the ringed seal and the bearded seal subspecies that have the potential to occur under the launch corridor have been proposed for listing as endangered or threatened. Accounts for these two species are included below in Section 3.7.2.7. Most marine mammal species, such as bowhead and beluga whales and ringed, bearded, and spotted seals (collectively referred to as "ice seals") are an important subsistence resource for local communities and villages.

Spotted Seals

Spotted seals are distributed along the continental shelf of the Beaufort Sea. Spotted seals are easily mistaken for harbor seals *(Phoca vitulina)*. However, only the spotted seal is regularly associated with pack ice. Spotted seal pups are born on drifting pack ice in the Bering Sea **(Boveng *et al.* 2009)**. When the pack ice melts and disperses in the Bering Sea, spotted seals migrate north toward the Beaufort Sea. As ice cover thickens with the onset of winter, spotted seals leave the Beaufort and northern Chukchi Seas and move south into the Bering Sea **(Frost *et al.* 1988)**. Hence, they are not expected to occur in the PFRR launch corridor from roughly October through spring. Spotted seals have been documented as capable of traveling long distances **(Rugh 1997)**. They have been described as extremely shy, wary, and difficult to observe, even by overflying aircraft **(Rugh 1997)**.

Pacific Walruses

Pacific walruses *(Odobenus rosmarus)* are the largest pinnipeds in the Arctic and subarctic areas. Currently, the population size of the Pacific walrus is unknown **(USFWS 2008h)**. In general, most of this population is associated with the moving pack ice year-round. Walruses spend the winter in the Bering Sea; the majority of the population summers throughout the Chukchi Sea, including the westernmost part of the Beaufort Sea. Although a few walruses may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open-water season, the majority of the Pacific population occurs outside of the ROI west of 155 West longitude north and west of Barrow, with the highest seasonal abundance along the pack-ice front. Solitary animals occasionally may overwinter in the Chukchi Sea and in the eastern Beaufort Sea. Predators of walruses are killer whales *(Orcinus orca)*, polar bears, and man **(USFWS 2008h)**.

Beluga Whales

The beluga whale is an Arctic and subarctic species that includes several populations in Alaskan waters. Within the PFRR launch corridor, only individuals of the Beaufort Sea stock and perhaps the eastern Chukchi Sea stock may be encountered. Some eastern Chukchi Sea animals enter the Beaufort Sea in late summer **(Suydam *et al.* 2005)**. Based on a correction factor of 2 to account for bias related to animals that may be underwater and unavailable to count during surveys, **Angliss and Allen (2009)** estimated the Beaufort Sea stock to consist of about 39,258 animals. Most of this population winters in the Bering Sea and migrates toward the eastern Beaufort Sea starting in April or May. However, some whales may pass Point Barrow as early as late March and as late as July. The spring migration routes through lanes of open water in the ice pack, known as ice leads, are similar to those of the bowhead whale. The majority of the Beaufort Sea population concentrates in the Mackenzie River estuary in Canada during July and August. The eastern Chukchi Sea stock currently is estimated to be about 3,710 whales **(Angliss and Allen 2009)**. In the Arctic, belugas feed primarily on Arctic cod *(Arctogadus glacialis)* and saffron cod *(Eleginus gracilis)*, whitefish *(Coregonus nelsonii)*, char *(Salvelinus alpinus)*, and benthic invertebrates **(Hazard 1988)**. Fall migration through the western Beaufort Sea occurs generally in September and October. Surveys of fall distribution strongly indicate that most belugas migrate offshore along the pack-ice front **(Frost *et al.* 1988; Suydam *et***

***al.* 2005)**, although large groups of whales have been observed in nearshore waters of the Alaskan Beaufort Sea. Beluga whales are an important subsistence resource of Inuit Natives in Canada and also are important locally to Inupiat Natives in Alaska.

Gray Whales

Gray whales are large baleen whales that feed on benthic organisms in or on the sea floor. Gray whales that occur along the Alaskan coast belong to the eastern Pacific stock and migrate annually from the Bering, Chukchi, and Beaufort Seas to their breeding grounds in the southern Gulf of California and Baja **(ADF&G 2008g)**. Gray whales occur regularly near Point Barrow, but historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow. Gray whales were hunted nearly to extinction by 1850 **(ADF&G 2008g)**. The north Atlantic population is extinct. The International Whaling Commission provided the gray whale partial protection in 1937 and full protection in 1947 **(ADF&G 2008g)**. This species was also protected under the ESA until 1994, when it was removed from the ESA list due to steady population increases. Since that time, the eastern north Pacific gray whale population increased to an estimated maximum of 29,758 in 1997–1998 **(Rugh *et al.* 2005)**.

Seasonal Consideration

Spotted seals are absent from the ROI during the winter, walruses and beluga whales may move through the area during the summer, and gray whales may be present during the winter, if at all.

3.7.2.3 *Birds*

Resident birds live in the same location for the entire year, where they hatch, fledge, molt, breed, nest, and raise their young. Birds that are migratory spend a shorter amount of time in the PFRR launch corridor than the residents. Typically, migratory birds spend time in Arctic NWR or Yukon Flats NWR in the summer months to rest, molt, breed, and/or nest. Birds that include Alaska in their migration path travel mostly long distances. For example, the bar-tailed godwit *(Limosa lapponica)* flies more than 11,000 kilometers (7,000 miles) nonstop to New Zealand; the northern wheatear *(Oenanthe oenanthe)* migrates across Asia to spend its winter in Africa; and the Dunlin's *(Calidris alpina)* winter destination is Japan **(USFWS 2008i)**.

Areas in which migratory or resident birds congregate are also ecologically significant. Forty-six species of seabirds, totaling over 80 million individuals, breed in Alaska and the Russian Far East. During the summer months, along the coast of the Beaufort Sea and within Zone 4AX of the PFRR launch corridor, colonies of sea birds, including glaucous gulls *(Larus hyperboreus)*, Arctic terns *(Sterna paradisaea)*, and Sabine's gulls *(Larus sabini)*, return from wintering grounds to congregate in breeding colonies. In the fall, seabirds return to their wintering grounds in areas such as coastal Washington, Oregon, and California to escape the severe Alaskan winters **(USFWS 2011f)**.

Approximately 36 species of waterfowl, totaling over 20 percent of the entire U.S. population, breed in Alaska. Duck species, such as the canvasback *(Aythya valisineria)*, northern pintail *(Anas acuta)*, and redhead *(Aythya americana)*, congregate in areas within PFRR, including the

Yukon River Delta, during the summer months to breed, and, like the seabirds, migrate south in the fall **(USFWS 2011g)**.

Shorebirds also congregate in large numbers during the breeding season. Due to its size, northerly latitude, and vast amount of shoreline, Alaska hosts more breeding shorebirds than any other state. Seventy-one species of shorebirds breed in Alaska for a total of between 7 and 12 million individuals, or approximately 50 percent of the world's shorebird population. Not all shorebird species nest along the coastal regions of Alaska. Species such as the semipalmated sandpiper *(Calidris pusilla)*, black-bellied plover *(Pluvialis squatarola)*, and bar-tailed godwit also occur in large numbers farther inland in wet marshy habitats such as the Copper River Delta. A vast quantity of suitable habitat for shorebird exists within the ROI. The shoreline of the Yukon River Delta has an especially large and diverse shorebird population. As with the previous two groupings, seabirds and waterfowl, shorebirds also migrate south during the fall **(USFWS 2011h)**.

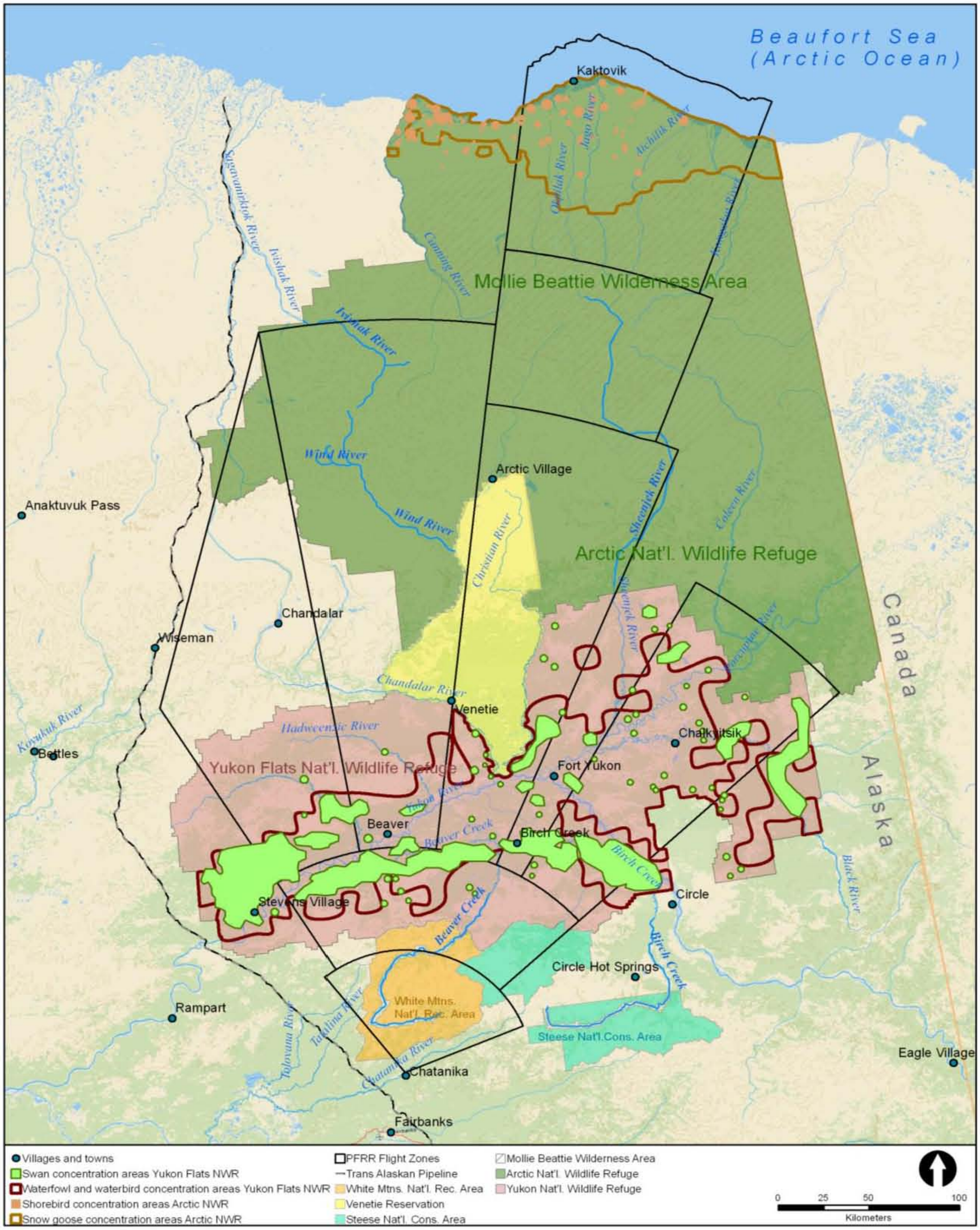
Terrestrial songbirds such as warblers, flycatchers, and thrushes also breed in Alaska and migrate south in the winter, but in general do not congregate in such large groups or colonies **(USFWS 2011h)**.

Several species of raptor also occur within the PFRR launch corridor. Common breeding species include red-tailed hawk, Cooper's hawk, and Swainson's hawk. Less common species include the gyrfalcon and two subspecies of peregrine falcon: the Arctic and American. The bald eagle and osprey are commonly found along coastal areas in the northern part of the PFRR launch corridor **(USFWS 2011g)**.

Certain areas within the ROI, such as the Arctic NWR and Yukon Flats NWR, contain especially high concentrations of birds, including waterfowl and shorebirds. **Figure 3–6** includes these two groupings as an example to illustrate locations with particularly high bird concentrations. Specifically, Figure 3–6 shows snow goose and shorebird concentrations within Arctic NWR and waterfowl and swan concentrations within Yukon Flats NWR.

Seasonal Considerations

The majorities of the bird species present within the PFRR launch corridor are migratory and are present only during the summer months. During winter, the abundance and number of species decline within the ROI. Sensitivity of bird species to disturbance is greatest during the breeding season (summer) and when congregated at rest during migration.



Source: **USFWS 2008j, 2011c.**

Figure 3–6. Waterfowl and Shorebird Bird Congregation Areas Within Arctic and Yukon Flats National Wildlife Refuges

3.7.2.4 *Fish*

A total of 42 fish species have been documented within the waters of the PFRR launch corridor. These fish can be classified in terms of three principal life histories: freshwater, diadromous, or marine. By definition, freshwater species spend their entire lives in rivers and lakes of the North Slope and generally avoid saline waters. In practice; however, most freshwater species on the North Slope, such as Arctic grayling *(Thymallus arcticus)* and round whitefish *(Prosopium cylindraceum)*, exhibit annual movements downriver to low-salinity estuarine and nearshore waters, particularly during early summer, when freshwater runoff to coastal habitats is at a peak **(Hemming 1993; Moulton and Fawcett 1984)**.

Fish distribution is dependent on water quality factors, including dissolved oxygen levels, temperature, turbidity, depth, current velocity, and substrate type **(USFWS 2010a)**. Freshwater fish in Yukon Flats NWR typically overwinter in deepwater areas of rivers and lakes and travel short distances to spawn in the open-water season **(USFWS 2010a)**. Burbot *(Lota lota)* are the only exception, which spawn in January and February beneath the ice.

The term diadromous is used to describe fish species that migrate between freshwater and estuarine or marine habitats on an annual basis **(Gallaway and Fechhelm 2000)**. The most important of these are anadromous species, which spend part of their lifecycle in the marine environment and swim upstream to spawn in freshwater habitats. Anadromous species include fish such as salmon that leave marine waters to return to the freshwater habitats to spawn where they were born. In the Pacific Northwest, some stocks of Chinook and Coho salmon are considered threatened or endangered, but no Alaskan stocks have yet been listed **(USFWS 1990)**. However, BLM considers the Beaver Creek stock of Chinook to be a sensitive species **(USFWS 2010a)**. A sensitive species is one that can easily become threatened or endangered. The northern extent of the range of some species, including Pacific salmon, has been expanding, and some salmon runs have been established in streams that drain into the western Beaufort Sea (outside of the launch corridor boundaries) **(Craig and Haldorson 1986; Moulton 2001)**. This trend is coincidental to global climate change and an Arctic warming trend. Other diadromous species, such as Dolly Varden *(Salvelinus malma malma)*, Arctic cisco *(Coregonus autumnalis)*, broad whitefish *(Coregonus nasus)*, and least cisco *(Coregonus sardinella)*, migrate back and forth each summer between upriver overwintering areas and feeding grounds in Beaufort Sea coastal waters. This life strategy takes advantage of prey abundance in the nearshore zone that can be nine times higher than freshwater habitats **(Craig 1989)**.

Most marine species inhabit deeper offshore waters are either rarely reported in the North Slope coastal zone or move inshore following breakup of shorefast ice. Arctic cod, fourhorn sculpin, and Arctic flounder, for example, specifically migrate into shallow, low-salinity coastal waters and estuaries during summer **(Craig 1989)**. Very little is known about marine fish distribution, abundance, diversity, or habitat use pattern in the winter.

Marine species of the Beaufort Sea nearshore waters are sporadically distributed and typically occur in very low numbers during summer **(Fechhelm *et al.* 2006)**. The exceptions are Arctic cod, Arctic flounder *(Liopsetta glacialis)*, and fourhorn sculpin *(Myoxocephalus quadricornis)*. Arctic flounder and fourhorn sculpin migrate into brackish coastal habitats during summer to feed, and may travel considerable distances up rivers. The open-water season of the Beaufort Sea is typically from mid-July to mid-October, meaning that the sea is covered with ice for the majority of the year. The Alaska Native Village of Kaktovik is situated on the shore of the Beaufort Sea in Arctic NWR. Fish is an important subsistence resource for Kaktovik, and the people fish the rivers and sea surrounding them with set nets and seines **(Pederson and Linn 2005)**.

Some of the fish in the launch corridor regions have commercial, recreational, or subsistence uses (e.g., salmon, cisco, Dolly Varden, whitefish, cod, herring, grayling, smelt, pike). Fish are especially important to Alaska Natives because, in many cases, they are available throughout the entire year. During years of poor salmon or caribou harvest, resident fish species are particularly vital as a subsistence food source. They are often captured beneath the frozen surface of lakes, streams, and the ocean. Recreationists enjoy sport fishing in the summer and ice-fishing in the winter for lake- and stream-dwelling freshwater fish.

Seasonal Considerations

The most important seasonal consideration for this analysis is the presence of ice. When water bodies, including lakes, rivers, and the ocean, are frozen, fish are isolated from launch or recovery activities by the ice layer. During summer, many species move to shallow water and upstream to feed and/or breed and are more easily captured by humans and wildlife under these conditions (*e.g.,* salmon). Fish species would have some minimal chance of coming into contact with project-related activities (*e.g.,* recovery activities) during the summer season.

3.7.2.5 *Fishery Management Plans and Essential Fish Habitat*

The Fishery Resource Management Plan (FMP) for the Fish Resources of the Arctic Management Area was recently approved in August 2009 by the U.S. Secretary of Commerce **(74 FR 56734)**. This plan presently prohibits commercial fishing in the Arctic waters of the Chukchi and Beaufort Seas until more information is available to support sustainable fisheries management. Only target species are part of the fishery management unit for this FMP, requiring status determination criteria and Essential Fish Habitat (EFH) descriptions. Target species under the Arctic FMP are Arctic cod, saffron cod, and snow crab *(Chionoecetes opilio)*. All other finfish and invertebrates are classified as “ecosystem component species” until further information is available. Pacific salmon and Pacific halibut are part of the ecosystem component for this FMP only for purposes of managing bycatch of these species in any commercial fishery that may develop in the future in the Arctic Management Area. The Magnuson-Stevens Fishery Conservation and Management Act (MSA) **(P.L. 94-265)** mandates identification and conservation of EFH for managed species. The National Marine Fisheries Service (NMFS) and North Pacific Fishery Management Council have issued the *Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska* **(NOAA 2005)**. The definition of EFH is those waters and substrate necessary for fish spawning, breeding, feeding, or growth to maturity. Any new FMPs must include EFH designations. To protect EFH, certain EFH habitat conservation areas may be designated. A habitat conservation area is an area where fishing restrictions are implemented for the purposes of habitat conservation. No EFH habitat conservation areas have been designated in the Arctic Management Area except those for Pacific salmon under MSA. If commercial fishing is authorized, EFH habitat conservation measures may be included in the amended FMP.

Salmon EFH includes all those freshwater streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone. This habitat includes waters of the continental shelf (to the 200-meter [660-foot] isobaths). In the deeper waters of the continental slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 meters (160 feet). Chinook and chum salmon *(Oncorhynchus keta)* use deeper layers, generally to about 300 meters (980 feet), but on occasion to 500 meters (1,600 feet) **(NOAA 2005)**.

3.7.2.6 *Subsistence Fisheries*

The Arctic FMP does not apply to subsistence fishing. Subsistence fisheries in Alaska are managed by the state or through the Federal Subsistence Board, if occurring on Federal lands. Many of these fisheries take place primarily in state waters. Subsistence fishing is an important sociocultural activity in Arctic waters. Because the Arctic FMP governs commercial fishing, the Arctic FMP would not affect these subsistence fisheries. Thus, the current commercial fishing ban does not apply to subsistence fisheries that are exclusively coastal in nature and centered on settlements like Wainwright, Barrow, Kaktovik, and Nuiqsut along Alaska's northern coast and nearshore waters. Subsistence fishermen harvest freshwater, marine, and anadromous fish in the area at differing times of the year, although the majority is harvested in summer and fall. Capelin *(Mallotus villosus)*, char, Arctic and saffron cod, Arctic grayling *(Thymallus arcticus)*, salmon, sculpin, trout, and whitefish are harvested. Subsistence fishing harvest represents a consistent year-to-year yield when compared to other subsistence resources (e.g., caribou), which may fluctuate widely on an annual basis. This consistency increases the importance of subsistence fisheries to the residents of native villages. Subsistence activities are discussed further in Section 3.10.

3.7.2.7 *Listed, Proposed, and Candidate Species under the U.S. Endangered Species Act*

Table 3–13 lists the federally listed, proposed, and candidate species that may occur under the PFRR launch corridor **(USFWS 2011i)**. Brief accounts of these species are provided following the table. Note that there are no federally listed, proposed, or candidate plant species known to be located at the PFRR launch site. Lists of federally listed, proposed and candidate species potentially in the PFRR launch corridor were provided by USFWS **(USFWS 2011j)** and NOAA Fisheries **(NOAA 2011)** in response to NASA's requests. This section addresses the species identified by those agencies.

Table 3–13. Federally Listed, Proposed, and Candidate Species with the Potential to Occur Under the Poker Flat Research Range Launch Corridor

Common Name	Scientific Name	ESA Listing Status	Potential Seasonal Occurrences[a]
Bowhead whale	*Balaena mysticetus*	Endangered	Summer[b]
Polar bear	*Ursus maritimus*	Threatened	Year-round
Ringed seal	*Phoca hispida hispida*	Proposed	Year-round
Bearded seal	*Erignathus barbatus barbatus*	Proposed[c] (Beringia DPS)	Summer
Spectacled eider	*Somateria fischeri*	Threatened	Accidental[d]
Steller's eider (Alaska breeders)	*Polysticta stelleri*	Threatened	Accidental
Yellow-billed loon	*Gavia adamsii*	Candidate	Summer

a. Seasonal occurrence identifies the times of the year when the species would most likely be encountered in the PFRR launch corridor.
b. "Summer" for this analysis is May through September.
c. The Beringia DPS, the distribution of which includes the Beaufort Sea area under the PFRR launch corridor, was proposed for listing as endangered on December 10, 2010.
d. "Accidental" refers to species having unpredictable presence in the PFRR area.
Key: DPS=distinct population segment.
Source: USFWS 2011i.

Under the ESA, endangered species are determined to be in danger of extinction throughout all or a significant portion of their range. Threatened species are determined to be likely to become endangered within the foreseeable future throughout all or a significant portion of their range. Proposed species are species for which a proposed rules to list the species as either threatened or endangered has been published in the *Federal Register*. Candidate species are species for which USFWS or NOAA Fisheries Service has indicated it has sufficient information on biological vulnerability and threat(s) to support proposals as threatened or endangered. Delisted species are species that have been removed from the list of threatened and endangered species. USFWS and NOAA Fisheries monitor delisted species for a period of at least 5 years following delisting. The Alaska Department of Fish and Game (ADF&G) also maintains a list of special status species. Although the Federal and Alaska lists have several species in common, the State of Alaska listings are specific to only Alaska and are discussed separately at the end of this section.

Bowhead Whales

The western Arctic stock of bowhead whales *(Balaena mysticetus)* was listed as endangered on June 2, 1970, and has been on the endangered species list since then. Because of the ESA listing, the stock is classified as a depleted and a strategic stock under MMPA **(Angliss and Allen 2009)**. However, the western Arctic bowhead whale population appears to be healthy and growing under a managed hunt and has recovered to historic abundance levels. NMFS will use criteria developed for the recovery of large whales in general **(Angliss *et al.* 2002)** and bowhead whales in particular in the next 5-year ESA status review to determine if a change in listing status is needed **(Shelden *et al.* 2001)**.

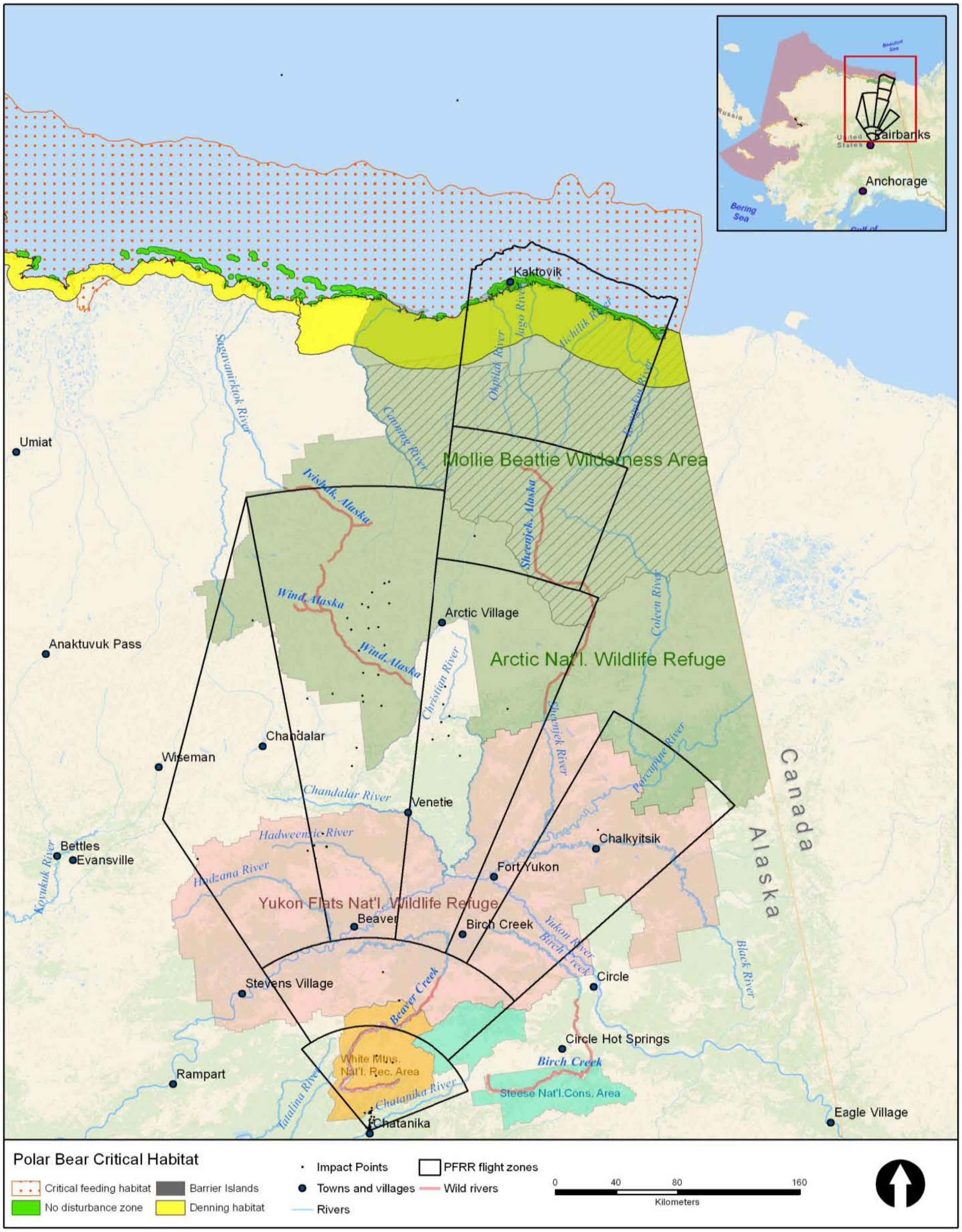
The bowhead whale spends its entire life in the Arctic. There are four stocks recognized, of which the Bering-Chukchi-Beaufort stock occurs within the PFRR launch corridor. Based on a bowhead whale census in 2001, the population growth rate was estimated to be about 3.4 percent and the estimated population size, 10,470 **(George *et al.* 2004)**, revised to 10,545 by **Zeh and Punt (2005)**. Most of the western Arctic bowhead whales migrate annually from wintering areas in the northern Bering Sea, through the Chukchi Sea in the spring, and into the Beaufort Sea, where they spend the summer. In autumn, they migrate through nearshore and offshore waters of the Beaufort Sea to return to their wintering grounds in the Bering Sea. Alaskan coastal villages along this migratory route, mainly Kaktovik, participate in traditional subsistence hunts of these whales **(Angliss and Allen 2009)** along the coast of the Beaufort Sea and within the PFRR launch corridor. Bowheads appear to migrate farther offshore during heavy-ice years and nearer shore during years of light sea ice **(Treacy *et al.* 2006)**.

Polar Bears

Polar bears *(Ursus maritimus)* are classified as marine mammals because of their dependence on sea ice; as such, they are protected under MMPA, as well as the ESA. On May 15, 2008, USFWS listed the polar bear as threatened throughout its range under the ESA **(73 FR 28212)**. The listing is in part a response to increased concerns about the effect of climate change on sea ice. Sea ice provides a hunting platform for polar bears and has been in decline in recent years. A polar bear’s diet is made up almost exclusively of marine mammals, mainly ice seals that also depend on sea ice habitat. Additionally, sea ice provides a portion of winter denning habitat for pregnant female polar bears. On November 24, 2010, USFWS announced the designation of 484,000 square kilometers (187,000 square miles) of polar bear critical habitat containing sea ice, terrestrial denning habitat, and barrier islands. The designated critical habitat occurs under the northern portion of the PFRR launch corridor (see **Figure 3–7**). The critical habitat includes the Beaufort Sea and land within 32 kilometers (20 miles) inland from the Beaufort Sea coast within the PFRR launch corridor. For purposes of this EIS, USFWS assumes polar bears may occur up to 40 kilometers (25 miles) inland from the Beaufort Sea coast **(USFWS 2011k)**.

Figure 3–7 also shows impact points from NASA SRP launches from PFRR from 1994 through 2010. No spent stages or payloads are predicted to have landed within this designated critical habitat.

Polar bears have a circumpolar Arctic distribution and are the top predator in the Arctic ecosystem. Polar bears are also the largest land carnivore in the world. Polar bear movements are influenced by sea ice conditions and follow a predictable seasonal pattern. In July and August, polar bears move offshore as the pack ice recedes. In the case of the SBS and CBS populations, polar bears may move hundreds of miles to stay with the ice during summer. From August through October, polar bears hunt ringed seals (their most important prey species) near shore in areas of unstable ice and leads between ice floes. From November to June, male polar bears remain on offshore ice. Years with less sea ice seem to result in bears being on land for longer periods of time.



Note: To convert kilometers to miles, multiply by 0.6214.

Source: SAIC 2011; USFWS 2011j.

Figure 3–7. Designated Critical Habitat for Polar Bears, Showing PFRR Launch Zones and Predicted Impact Points for Past PFRR Launches Between 1994 and 2010

Mating occurs from March to May **(Ramsay and Stirling 1986)**. Approximately 50 percent of females den on drifting pack ice from November until April, although evidence suggests that this number is decreasing with recent changes in sea ice extent and distribution **(Fischbach *et al.* 2007)**. The remaining females that are in reproductive condition den on land from November through April, then move offshore.

November through April is the most sensitive period of the year for polar bears. Dens are dug in snow drifts in areas of shallow relief along sea ice pressure ridges, creek and stream banks, river bluffs, and shorelines. Cubs are born in December and continue to develop in the den until April. Dens have been located up to 40 kilometers (25 miles) inland in landscape features that trap drifting snow in sufficient depth to allow a female polar bear to dig a den **(Durner *et al.* 2006)**. The highest density of land dens in Alaska occurs along the coastal barrier islands of the eastern Beaufort Sea and within Arctic NWR **(Angliss and Allen 2009)**.

Denning females are sensitive to disturbance and may abandon cubs if disturbed. Cubs are very vulnerable at this stage, so protection of the maternal den habitat is vital to polar bear conservation **(Angliss and Allen 2009)**. The results of surveys for polar bears confirm that large numbers of polar bears aggregate around Barter Island (on which Kaktovik is located) and Cross Island (west of the ROI between Prudhoe Bay and Point Barrow), probably due to the presence of hunter-harvested bowhead whale remains, which provide an alternate food source for polar bears.

Ringed Seals

Ringed seals *(Phoca hispida)* have a circumpolar distribution and are year-round residents of the Beaufort Sea, where they are the most commonly encountered seal species in the area. No reliable population size estimate of the Alaska ringed seal stock is currently available **(Angliss and Allen 2009)**. Ringed seal population estimates in the Bering-Chukchi-Beaufort area ranged from 1–1.5 million **(Frost 1985)** to 3.3–3.6 million **(Frost *et al.* 1988)**. **Frost and Lowry (1981)** estimated the population in the Alaskan Beaufort Sea to be 80,000 during the summer and 40,000 during the winter. More recent estimates based on extrapolation from aerial surveys and on predation estimates for polar bears **(Amstrup 1995)** suggest an Alaskan Beaufort Sea population of approximately 326,500 animals. NOAA Fisheries is considering listing the Alaska stock of ringed seals species under the ESA due to the potential loss of seal habitats resulting from current warming trends. On December 10, 2010, NOAA Fisheries published a proposed rule to list three subspecies of the ringed seal as threatened under the ESA. This proposed listing includes the Arctic subspecies *(Phoca hispida hispida)*, the distribution of which includes the Beaufort Sea. Ringed seal densities depend on food availability, water depth, ice stability, and distance from human disturbance. Seal densities reflect changes in the ecosystem's overall productivity in different areas **(Stirling and Oritsland 1995)**. When sexually mature, they establish territories during the fall and maintain them during the pupping season (time of year seals give birth to seal pups). Pups are born in late March and April in lairs that seals excavate in snowdrifts and pressure ridges. During the breeding and pupping season, adults on shorefast ice (floating ice attached to land) usually move less than individuals in other habitats. In this habitat, they depend on a relatively small number of holes and cracks in the ice for breathing and foraging. During nursing (4 to 6 weeks), pups usually stay in the birth lair. This species is a major resource harvested by Alaskan subsistence hunters. Ringed seal is also the chief prey species for polar bears.

Bearded Seals

Bearded seals *(Erignathus barbatus)* are the largest of Alaska's seals, weighing up to 340 kilograms (750 pounds). Bearded seals are found throughout the Arctic Ocean and usually prefer areas of less stable or broken sea ice, a zone where breakup occurs early **(Cleator and Stirling 1990)**. Most of the 300,000 to 450,000 bearded seals estimated to occur in the Alaskan outer continental shelf area are found in the Bering and Chukchi Seas **(USDOI 1996)**. Reliable estimates of the abundance of bearded seals in Alaska Beaufort Sea waters currently are unavailable, although bearded seals are reported annually during aerial surveys for other marine mammals. Seasonal movements of bearded seals are directly related to water depth and the advance and retreat of sea ice **(Boveng *et al.* 2009)**. During winter, most bearded seals in Alaskan waters are found in the Bering Sea. Favorable conditions are more limited in the Chukchi and Beaufort Seas, and consequently, bearded seals are not abundant there during winter. Pupping takes place on the ice from late March through May, mainly in the Bering and Chukchi Seas, although some pupping might take place in the Beaufort Sea. Bearded seals do not form herds, but sometimes form loose groups. Bearded seals are a main subsistence resource and a highly valued food of subsistence hunters. The form of bearded seal that occurs in the Beaufort Sea under the PFRR launch corridor is part of the Beringia Distinct Population Segment of *Erignathus barbatus barbatus*, which was proposed for listing as endangered on December 10, 2010.

Spectacled Eider

Spectacled eider *(Somateria fischeri)* is known as a rare breeder and uncommon visitor along Alaska's north coast. Nesting and breeding typically occur to the west of the PFRR launch corridor, although the historical range extended along the Arctic coastal plain, including the coastal portion of the PFRR launch corridor, nearly as far east as the Canadian border **(USFWS 2011l)**. Critical habitat designated for this species is far outside the boundaries of the PFRR launch corridor. Spectacled eiders winter at sea in flocks **(USFWS 2011l)**.

Steller's Eiders

Although formerly considered locally common at a few sites on both the Yukon-Kuskokwim Delta in western Alaska and the Arctic coastal plain of northern Alaska, Steller's eiders *(Polysticta stelleri)* have nearly disappeared from most nesting areas in Alaska **(USFWS 2011m)**, and the Alaska population is listed as threatened. Of the world breeding population of Steller's eiders, most nest in Russia. The nearest known nesting area is located to the west of the ROI at Prudhoe Bay. Molting and wintering is in the southern Alaska from the eastern Aleutians to the lower Cook Inlet.

Yellow-Billed Loon

The yellow-billed loon *(Gavia adamsii)* is listed as a candidate species. It breeds in low densities within Arctic NWR and may also migrate through the region. According to the list of species provided by USFWS **(USFWS 2011k)**, no listed species or designated critical habitats occur in Yukon Flats NWR, Steese NCA, or White Mountains NRA.

The American peregrine falcon *(Falco peregrinus anatum)* was delisted in 1999, the Arctic peregrine falcon *(Falco peregrinus tundrius)* was delisted in 1994, and the gray whale *(Eschrichtius robustus)* was delisted in 1993.

3.7.2.8 *Endangered Species, Species of Special Concern, and Fish Stocks of Concern Recognized by the Alaska Department of Fish and Game*

ADF&G maintains a list of special status species, including endangered species, species of special concern, and fish stocks of concern **(ADF&G 2011a)**. Although believed to be extinct, the state-listed endangered Eskimo curlew's *(Numenius borealis)* range in eastern Alaska could potentially overlap with the ROI. No other state-listed endangered species occur within the ROI or surrounding area. Several state species of special concern have the potential to occur within the ROI, including the spectacled eider, bowhead whale, and the blackpoll warbler (*Dendroica striata*). The Yukon River Delta subspecies of Chinook salmon is the only state fish stock of concern with the potential to occur within the ROI.

3.7.2.9 *Sensitive Species Recognized by the Bureau of Land Management*

BLM studies all animal species that thrive on BLM lands. When a particular animal species becomes in danger of rapidly dwindling to extinction, the BLM lists that animal on a BLM Sensitive Species List. National policy directs BLM state directors to designate BLM sensitive species in cooperation with the State fish and wildlife agency (BLM Manual 6840). The sensitive species designation is normally used for species that occur on BLM public lands and for which BLM has the capability to significantly affect the conservation status of the species through management **(USDOI 2012b)**.

The American peregrine falcon nests in the region, as does the bald eagle; both are BLM sensitive species. Other BLM-sensitive species with potential to be found in the PFRR launch corridor include: Canada lynx (*Lynx canadensis*), trumpeter swan (*Cygnus buccinator*), grey-cheeked thrush (*Catharus minimus*), olive-sided flycatcher (*Contopus cooperi*), and blackpoll warbler. However, most species are not present during the rocket launching period. Canada lynx occur in the area during all seasons. No BLM-sensitive plant species are known to occur in the White Mountains NRA or Steese NCA **(USDOI 2007)**.

Bald Eagle

The bald eagle is a year-round resident within Alaska and PFRR. Although the species may nest in preferred habitat throughout PFRR, there is a particularly high concentration of nesting individuals in the northern portion of the range, especially along coastal regions. Bald eagles tend to congregate in large groups during the winter months in aquatic habitat that remains ice-free. Although bald eagle numbers (both in Alaska and globally) fell to a historical low in the 1970s' following widespread use of certain pesticides, specifically DDT, the population appears to be recovering to pre-decline numbers following the ban of DDT, as well as recovery efforts from agencies such as USFWS, BLM, and ADF&G **(USFWS 2011h)**.

American Peregrine Falcon

The American peregrine falcon occurs in and nests within PFRR. Typically this species nests in crevices found along high cliff walls and river bluffs. However, ground nesting has also been documented along the north slope of Alaska. This species is known to migrate long distances and spend winters as far south as South America. However, in recent years, it has been observed that certain segments of the Alaskan population have spent the entire year (both breeding and non-breeding seasons) in Alaska. As with the bald eagle, population numbers decreased in the 1970s' due to pesticide use. Similarly, the population appears to be recovering to pre-decline numbers due to the banning of DDT and multi-agency recovery efforts **(ADF&G 2012d; USFWS 2011n)**.

Trumpeter Swan

The trumpeter swan occurs and nests within PFRR. The species breeds in coastal regions from Cook Inlet south to the Chilkat Valley, as well as in the interior forested wetlands. Typically, wintering trumpeter swans prefer freshwater wetlands, bays, and estuaries from Cook Inlet to the Columbia River in Washington. In the early 1900s, trumpeter swans in Alaska, as well as globally, experienced a severe population decline due to exploitation of market hunters. Since that time, the population appears to have increased, although it is still listed as a sensitive species in many locations throughout the United States **(USFWS 2008j)**.

Grey-Cheeked Thrush

The grey-cheeked thrush is known to occur and breed within PFRR. In Alaska it tends to occur in coniferous woods consisting mostly of white spruce, black spruce, and some tamarack. The grey-cheeked thrush is not a winter resident in Alaska and typically migrates south to warmer climates, *i.e.,* Venezuela and Columbia. Although the global population experienced historical declines in the mid-twentieth century, the exact causes are not known, but may include nest predation, loss of habitat, and collisions with manmade structures **(NPS 2012)**.

Olive-Sided Flycatcher

The olive-sided flycatcher is known to occur and breed within Alaska and PFFR. Preferred breeding habitat typically consists of openings and edges in coniferous forest habitats. Since the 1960s, this species has experienced a precipitous decline in numbers. Although the exact cause of the population decline is not known, habitat loss through fire suppression and habitat fragmentation are potential factors. Typically, olive-sided flycatchers winter in Panama and the northern Andes from northern Venezuela to western Bolivia, with the highest densities in Colombia **(BSI 2007)**.

Blackpoll Warbler

The blackpoll warbler occurs and breeds in Alaska and within PFRR. Preferred habitat, including nesting habitat, includes tall shrubs (riparian woodland) or in coniferous or deciduous forest or woodland mainly in western and northern Alaska. The species has experienced a population decline in the past 40 years, which is thought to be a result of tropical deforestation in areas where the blackpoll warbler winters in South America **(USGS 2010)**.

Canada Lynx

The Canada lynx is a year-round resident mammal of Alaska and also PFRR. It is the only cat native to the state. This medium-sized predator prefers remote habitats and ranges over the entire state, except the Aleutian Islands, Kodiak archipelago, the islands of the Bering Sea, and some islands of Prince William Sound and Southeast Alaska. Although the species is not commonly reported during the winter months, it is commonly seen during long periods of summer daylight, especially during years that they are abundant **(ADF&G 2008h)**.

3.8 LAND USE AND RECREATION

The ROI for land use and recreation is defined as the area within the PFRR launch site and launch corridor. Portions of the White Mountains NRA, Steese NCA, Arctic NWR, Yukon Flats NWR, and Alaska state lands are located within the PFRR launch corridor. Recreational opportunities are available within these federally and state-managed areas. Alaska Native-owned lands are not open to use by the general public and are not included in the recreation ROI.

3.8.1 Poker Flat Research Range Launch Site

The PFRR launch site occupies approximately 2,100 hectares (5,200 acres) of land directly south of the Chatanika River within the Fairbanks North Star Borough and include the Lower, Middle, and Upper Ranges **(NASA 2000a)** (see Chapter 2, Figures 2–12, 2–17 and 2–18). The PFRR launch site is zoned as Educational Exempt.

3.8.2 Poker Flat Research Range Launch Corridor

The PFRR launch corridor encompasses a vast portion of interior and northern Alaska. **Table 3–14** lists the approximate areas of land ownership within the PFRR launch corridor.

Table 3–14. Lands Within Poker Flat Research Range Launch Corridor

Managed Land	Total Area (hectares)	Area Within Poker Flat Research Range (hectares)
U.S. Department of the Interior		
White Mountains National Recreation Area	376,000	354,000
Steese National Conservation Area	461,000	125,000
Arctic National Wildlife Refuge	8,030,000[a]	4,900,000[b]
Yukon Flats National Wildlife Refuge	4,500,000	3,300,000
Villages		
Beaver	96,000	96,000
Birch Creek	93,000	53,000
Chalkyitsik	150,000	150,000
Fort Yukon	109,000	47,000
Kaktovik	60,000	60,000
Stevens Village	90,000	10,000
Other		
Arctic Slope Regional Corporation	2,040,000	4,600
Doyon Limited	3,900,000	560,000
Venetie Indian Corporation and Neets'ai Corporation	790,000	790,000
State of Alaska	47,000,000	1,200,000
Private	84,000	1,040
Total	**60,000,000**	**12,000,000**

a. Includes all of Mollie Beattie Wilderness Area (2.9 million hectares [7.2 million acres]).
b. Includes portion of Mollie Beattie Wilderness Area within PFRR (1.6 million hectares [4 million acres]).
Note: To convert hectares to acres, multiply by 2.4710.
Source: SAIC 2011.

3.8.2.1 *White Mountains National Recreation Area*

White Mountains NRA is located approximately 97 kilometers (60 miles) northwest of Fairbanks. It is bounded on the east by Steese NCA and on the north by Yukon Flats NWR. White Mountains NRA is administered by BLM. ANILCA **(P.L. 96-487)** directs that White Mountains NRA is to be administered to provide for public outdoor recreational use and for the conservation of scenic, historic, cultural, and wildlife values and for other uses if they are compatible or do not significantly impair the previously mentioned values **(USDOI 1986a)**. The overall management strategy for White Mountains NRA is to provide for a variety of public outdoor recreation opportunities, emphasizing existing primitive and semi-primitive values; to protect and/or improve the water quality of Beaver Creek National Wild River and its tributaries; and to provide for multiple uses of other resource values that are compatible with the recreation goals. The primary recreation attractor in White Mountains NRA is Beaver Creek National Wild River **(USDOI 1986a)**. As shown in Table 3–14, White Mountains NRA encompasses approximately 376,000 hectares (930,000 acres), and approximately 354,000 hectares (880,000 acres) of White Mountains NRA are located within the PFRR launch corridor.

Recreational activities within the White Mountains NRA during the summer include panning for gold, fishing, hiking, off-highway vehicle use, and camping. BLM manages over 64 kilometers (40 miles) of summer trails, including the Summit and Quartz Creek Trails. Thirteen public recreation cabins are located within the White Mountains NRA. The cabins are accessed most easily during the winter, but a few cabins can be reached during the summer by foot, mountain bikes, four-wheelers, boats, and airplanes. The cabins are open year-round, with most visitors using the cabins February through April **(USDOI 2012c)**. Most of the Beaver Creek Wild River is located within the White Mountains NRA. Beaver Creek is a popular destination for river adventurers. White Mountains NRA is open to sport hunting. Game species include moose, caribou, black bear, grizzly bear, sheep, wolf, and wolverine. A portion of White Mountains NRA is open to the use of motorized vehicles during designated time periods. Activities during the winter include skiing, snowshoeing, dog sledding, skijoring (cross-country skiing while being pulled by dogs), snowmobiling, and winter mountain biking **(USDOI 2011b, 2011c)**.

White Mountains NRA receives roughly 35,000 visits per year, with many of the visitors being repeat users. Peak use periods include early March through mid-April for winter activities, based on longer days and warmer temperatures, and late summer for activities such as berry picking and hunting. Unlike many other areas around Alaska, White Mountains NRA does not have a large targeted salmon run and is not located on a primary travel and tourism route **(USDOI 2012a)**.

3.8.2.2 *Steese National Conservation Area*

Steese NCA is located approximately 160 kilometers (100 miles) northeast of Fairbanks and is administered by BLM. Steese NCA was created by ANILCA in 1980 and includes the Birch Creek Wild and Scenic River, crucial caribou calving grounds and home range, and Dall sheep habitat. Steese NCA is split into the North and South Units, located on either side of Steese Highway (Alaska Route 6). Pinnell Mountain National Recreation Trail skirts the edge of the North Unit. Various land uses are allowed in Steese NCA; however, it is managed to protect its scenic, scientific, cultural, and other resources **(USDOI 2011a)**. As shown in Table 3–14, Steese NCA encompasses approximately 460,000 hectares (110,000 acres), and approximately 130,000 hectares (309,000 acres) of Steese NCA are located within the PFRR launch corridor.

Recreational activities within Steese NCA during the summer include hiking and backpacking, hunting and wildlife viewing, bird-watching, canoeing and rafting, fishing, and rock climbing. The Pinnell Mountain National Recreation Trail is located within the North Unit of Steese NCA. It is a primitive trail marked with wooden mileposts and rock cairns. The trail has two emergency trail shelters and is closed to all motorized vehicles **(USDOI 2011d)**. Part of Birch Creek Wild and Scenic River is located within Steese NCA. River float trips offer visitors opportunities to view scenery and experience remoteness.

Most recreational activities within Steese NCA are conducted during the summer; however, many winter activities, including snowmobiling, dog mushing, trapping, and cross-country skiing, are popular in March and April. Sled dog racers in the Yukon Quest International Sled

Dog Race traverse the western corner of the South Unit of Steese NCA each February **(USDOI 2011e)**.

Steese NCA receives an estimated 10,000 visits per year. The largest number of users arrives during the caribou and moose hunting season, from August 10 to September 15. A noticeable increase in use has occurred over the past 10 years **(USDOI 2012a)**.

3.8.2.3 *Arctic National Wildlife Refuge*

Encompassing approximately 8 million hectares (20 million acres), Arctic NWR is located in northeastern Alaska and is administered by USFWS as a unit of the National Wildlife Refuge System. On December 6, 1960, Arctic Range was established for the purpose of preserving its unique wildlife, wilderness, and recreational values; in 1980 it was renamed and expanded pursuant to ANILCA **(USFWS 2011c)**. Mollie Beattie Wilderness Area, also established by ANILCA, is located within Arctic NWR, and contains more than 40 percent of the Refuge's land area. It is centered around eastern Brooks Range, an area of Arctic, subarctic, and alpine ecosystems. The Wilderness Act of 1964 **(16 U.S.C. 1131–1136)**, Section 2(a), states that wilderness areas are to be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness. Further, Section 4(c) of the Wilderness Act restricts the use of temporary roads, motor vehicles, and motorized equipment or motorboats; landing of aircraft; other forms of mechanical transport; and structures and installations within a wilderness area. Arctic NWR manages the Mollie Beattie Wilderness Area to preserve the area's natural, scenic condition and the wild character of its creatures and natural processes **(USFWS 2011c)**.

Approximately 4.9 million hectares (12 million acres) of Arctic NWR (including 1.6 million hectares [4.0 million acres] of Mollie Beattie Wilderness Area) are located within the PFRR launch corridor. Two areas of Arctic NWR have been designated Research Natural Areas (RNAs) and are managed to preserve examples of major ecosystem types, to provide opportunities for research and education, and to preserve a full range of genetic and behavioral diversity in native plants and animals. These RNAs include the Firth River-Mancha Creek RNA and the Shublik Springs RNA. Both RNAs are located within Mollie Beattie Wilderness Area **(USFWS 2011c)**.

Recreational activities within Arctic NWR include river floating, hiking, backpacking, camping, long-distance expeditions, mountaineering, dog sledding, berry picking, wildlife viewing, hunting, fishing, and photography. Hunting is a popular activity at Arctic NWR, and most recreational hunters visit to hunt Dall sheep, caribou, moose, and/or brown bears. Hunters usually hike, camp, and float rivers while hunting. River floating is the most frequently reported activity for commercially supported visitors to Arctic NWR. Most people visit Arctic NWR during the summer and fall seasons in June, July, August, and September. This recreational season is short due to weather and river conditions, with a total of 6 to 8 weeks when water levels in most rivers are adequate for floating and the weather is ideal for backpacking. The primary means of access for all visitors in and out of Arctic NWR is by aircraft **(USFWS 2011c)**. Mollie Beattie Wilderness Area is managed to provide challenging recreational activities like hiking, backpacking, climbing, kayaking, canoeing, rafting, horse packing, bird watching, stargazing, and extraordinary opportunities for solitude. Unless specified, no motorized equipment or mechanical transport, except wheelchairs, is allowed within Mollie Beattie Wilderness Area **(Wilderness.net 2011)**. In 2010, an estimated 720 people visited Mollie Beattie Wilderness Area **(USFWS 2011c)**.

Visitors may come and go from Arctic NWR without campsite assignments or registration requirements. Arctic NWR has no formal registration system to comprehensively track visitor use and recreation trends, and managers currently use no formal methods to document visitors who access the refuge on their own without the commercial services of a guide or commercial air operator. An unknown number of visitors enter Arctic NWR each year by private planes and boats or by hiking. In 2009, estimated that the total number of documented visitors was approximately 1,000 people. The number of visitors who do not use commercial services to access the Arctic NWR is most likely higher than what is reflected by the voluntary reports collected at these locations **(USFWS 2011c)**.

3.8.2.4 *Yukon Flats National Wildlife Refuge*

Yukon Flats NWR is situated in the northeastern part of the interior of Alaska south of Brooks Range and north of the Crazy and White Mountains of the Alaska Range. Yukon Flats NWR is administered by USFWS as a unit of the National Wildlife Refuge System and was established in 1980 under ANILCA to conserve fish and wildlife populations and habitats in their natural diversity, including nesting waterfowl, other migratory birds, Dall sheep, bears, moose, wolves, wolverines, other furbearers, caribou, and salmon; to fulfill international treaty obligations; to provide for continued subsistence uses; and to ensure necessary water quality and quantity **(USFWS 2011d)**. Yukon Flats NWR encompasses most of the area known as the Yukon Flats and extends 350 kilometers (220 miles) east-west along the Arctic Circle from the Dalton Highway and Trans-Alaska Pipeline System in the west to within 48 kilometers (30 miles) of the Canadian border in the east, and about 190 kilometers (120 miles) north-south. The Yukon River flows through the middle of Yukon Flats NWR and is the dominant physical feature within Yukon Flats NWR **(USFWS 2008b)**. Within the exterior boundaries are approximately 1.0 million hectares (2.5 million acres) of land selected by, or conveyed to, Native Corporations and Native allotment holders. Five villages—Beaver, Birch Creek, Chalkyitsik, Fort Yukon, and Stevens Village—are within the Yukon Flats NWR boundary. As shown in Table 3–14, Yukon Flats NWR encompasses approximately 4.5 million hectares (11 million acres), and approximately 3.3 million hectares (8.2 million acres) of Yukon Flats NWR are located within the PFRR launch corridor.

Recreational activities within Yukon Flats NWR include fishing, hunting and trapping, photography, camping, hiking, wildlife viewing, and scenic flights. Yukon Flats NWR is open to hunting and is subject to Alaska state regulations (subsistence hunting is addressed in Section 3.10). Most of the fishing that occurs within Yukon Flats NWR also includes non-recreational subsistence activities. Forty permitted cabins, situated along rivers and streams, are located within Yukon Flats NWR. These cabins are permitted for trapping-related activities only. Trappers access these cabins by snowmobile or ski plane **(USFWS 2008b)**.

River boating, for both recreation and transportation of goods and people, is one of the main modes of transportation within Yukon Flats NWR during the summer and fall. Most of the recreational use on the Yukon Flats NWR involves float trips, often combined with hunting expeditions **(USFWS 2008b)**.

In 1980, USFWS estimated that recreational use of Yukon Flats NWR totaled fewer than 1,000 visitor days per year. Yukon Flats NWR staff estimated 500 visitor days of recreation use in Yukon Flats NWR in 2003. Recreational visitation in 2004 and 2005 was believed to be lower than in 2003 due to the large number of wildfires in the area **(USFWS 2010a)**. Recreational visits on Yukon Flats NWR are difficult to quantify because of its size and remoteness, and because only users with permits from Yukon Flats NWR are required to report their use of Yukon Flats NWR lands and waters. Therefore, only users brought onto Yukon Flats NWR by air taxi or on a guided excursion are reported. Most of the visitation to Yukon Flats NWR reported in 2003 was in the vicinity of Beaver Creek **(USFWS 2010a)**.

3.8.2.5 *Alaska State Lands*

The Upper Chatanika River State Recreation Site, an ADNR state park unit, is located in the PFRR launch corridor. This recreation area is located on the banks of the Chatanika River. ADNR manages this area to develop, conserve, and enhance natural resources for present and future Alaskans. The Upper Chatanika State Recreation Area consists of 30 hectares (73 acres), and activities within the recreation area include camping, boating, and fishing **(ADNR 2011)**. No visitor estimates were found for the Upper Chatanika River State Recreation Site.

The ADNR Poker Flat North and South Special Use Areas (ADL 412457 and ADL 414364) are located within the ROI **(ADNR 1990a, 1990b)**. These special use areas include over 20,000 hectares (49,000 acres) of land north and east of the PFRR launch site **(NASA 2000a)**. These areas are described as lands where rocket and rocket booster impacts as a result of research conducted at PFRR are allowed without further authorization **(ADNR 1990a, 1990b)**.

3.8.2.6 *Alaska Native Land Holdings*

Arctic Slope Regional Corporation (ASRC) was established pursuant to the Alaska Native Claims Settlement Act (ANCSA). ASRC is owned by Inupiat Eskimo shareholders, who primarily live in eight villages on Alaska’s North Slope, above the Arctic Circle. ASRC owns title to nearly 2 million hectares (5 million acres) of land on Alaska’s North Slope that contain a high potential for oil, gas, coal, and base metal sulfides. Additionally, ASRC owns subsurface rights to certain lands and surface rights to other lands. As a steward of the land, ASRC continuously strives to balance management of cultural resources with management of natural resources **(ASRC 2011)**.

Doyon, Limited, is the largest private landowner in Alaska and one of the largest private landowners in North America. Doyon owns and manages nearly 4 million hectares (10 million acres), primarily around the 34 villages in the Fairbanks region. Management of Doyon lands focuses on protection of traditional shareholder uses and responsible economic development of natural resources **(Doyon Limited 2011)**.

Venetie is located on the north side of the Chandalar River approximately 72 kilometers (45 miles) northwest of Fort Yukon. In 1971, Venetie and Arctic Village obtained the title to

730,000 hectares (1.8 million acres) of land, which they own as tenants in common through the Native Village of Venetie Tribal Government. Subsistence activities are an important part of the local culture **(ADCRA 2011)**. Subsistence uses are discussed further in Section 3.10.

The villages of Beaver, Birch Creek, Chalkyitsik, Fort Yukon, Kaktovik, and Stevens Village are located within the PFRR launch corridor. Native villages within the ROI are discussed in detail in Section 3.9.3.4.

3.9 CULTURAL RESOURCES

Cultural resources are any prehistoric or historic district, site, building, structure, or object considered important to a culture or community for scientific, traditional, religious, or other purposes. They include archaeological resources, historic architectural resources, and traditional resources. Archaeological resources are locations where prehistoric or historic activity measurably altered the earth or produced deposits of physical remains (*e.g.,* arrowheads, bottles). Historic architectural resources include standing buildings and other structures of historic or aesthetic significance. Architectural resources generally must be more than 50 years old to be considered for inclusion in the National Register of Historic Places (NRHP), although resources dating to defined periods of historical significance, such as the Cold War era (1945–1989), may also be considered eligible. Traditional cultural resources are associated with cultural practices and beliefs of a living community that are rooted in its history and are important in maintaining the continuing cultural identity of the community. Properties of traditional or religious cultural importance may be determined to be eligible for inclusion in NRHP **(16 U.S.C. 470 *et seq.*)**.

Historic properties (as defined in **36 CFR 60.4**) are significant archaeological, architectural, or traditional cultural properties that are either listed in, or eligible for listing in, NRHP. Historic properties, including traditional cultural properties and other significant traditional resources identified by Alaska Natives, are evaluated for potential adverse impacts from an action.

The ROI for cultural resources is defined as the PFRR launch site and launch corridor. As required by the implementing regulation of Section 106 of the National Historic Preservation Act (NHPA), NASA is currently consulting with the Alaska State Historic Preservation Office (SHPO).

3.9.1 Regulatory Setting

The foundation for general legislation for preservation of cultural resources is NHPA **(16 U.S.C. 470 *et seq.*)**. Two sections of NHPA, Sections 106 and 110, outline the processes Federal agencies must follow to manage and protect cultural resources or historic properties. Under NHPA and its implementing regulations, only significant cultural resources are considered when assessing the possible impacts of a Federal undertaking or action. Significant archaeological, architectural, and traditional cultural resources are those that are listed or eligible for listing in NRHP. Section 106 requires Federal agencies to consider the effects of actions on historic properties through a consultation process. Processes outlined in Section 106 include resource identification/inventory, evaluation of significance, assessment of adverse effects on significant historic properties, and resolution of adverse effects.

Cultural resources are protected under a number of other laws, including the Antiquities Act of 1906 **(16 U.S.C. 431–433)**, the Historic Sites Act of 1935 **(16 U.S.C. 461–467)**, the American Indian Religious Freedom Act of 1978 **(42 U.S.C. 1996)**, the Archaeological Resources Protection Act of 1979 **(16 U.S.C. 470aa–470mm)**, and the Native American Graves Protection and Repatriation Act of 1990 **(25 U.S.C. 3001 *et seq.*)**. In addition, Executive Order 13287, *Preserve America*, signed March 3, 2003, directs Federal agencies to increase their knowledge of historic resources in their care and to enhance the management of these assets and promote intergovernmental cooperation and partnerships for the preservation and use of historic properties.

Several Presidential Memoranda and Executive Orders address the requirement of Federal agencies to notify or consult with American Indian tribes or otherwise consider their interests when planning and implementing Federal undertakings. In particular, on April 29, 1994, President William J. Clinton issued the *Memorandum on Government-to-Government Relations with Native American Tribal Governments*, which specifies a commitment to developing more effective day-to-day working relationships with sovereign tribal governments. This has been reinforced by subsequent administrations through additional memoranda (President George W. Bush, 2004, *Government-to-Government Relationship with Tribal Governments*, and President Barack H. Obama, 2009, *Tribal Consultation*). In addition to the memoranda, Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments* (November 6, 2000), reaffirms the U.S. Government's responsibility for continued collaboration and consultation with tribal governments in the development of Federal policies that have tribal implications, to strengthen the government-to-government relationships with American Indian tribes, and reduce the imposition of unfunded mandates upon American Indian tribes. Executive Order 13007, *Indian Sacred Sites*, issued May 24, 1996, requires that in managing Federal lands, agencies must accommodate access to, and ceremonial use of, sacred sites, which may or may not be protected by other laws or regulations, and must avoid adversely affecting the physical integrity of these sites.

The Alaska Office of History and Archaeology implements the Alaska Historic Preservation Act **(Alaska Statute 41.35.70)** and works to preserve sites and buildings that reflect the heritage of Alaska. NASA also has several policy documents that address or include cultural resources.

3.9.2 Historic Background

Discussion of the cultural landscape of Alaska is commonly divided into two general periods: prehistory and history. **Table 3–15** broadly outlines the dates and characteristics of the prehistoric and historic periods of Alaska.

Prehistory refers to the period for which no documentary (*e.g.*, written) evidence exists of the events or people living during that time. Alaskan prehistory varies regionally due to natural conditions that either enhanced or limited human occupation in a given area of the state. The extent of glacial coverage and the rate and direction of glacial retreat greatly influenced the capacity of a region to support prolonged human occupancy and activity. Evidence suggests that interior portions of Alaska were inhabited at least 13,000 years ago, and coastal regions were inhabited later.

Table 3–15. Summary of History and Prehistory Periods of Interior and Northeastern Alaska

Era	Dates	Description
Prehistoric Era		
Paleoindian	14,000–10,000 BP	Small, mobile bands of big game hunters camped at sites with views of the plains. Artifacts include fluted projectile points.
Paleoarctic Tradition	12,000–8,000 BP	Early inhabitants camped on terraces and bluffs above treeless steppes, hunted large mammals such as bison and mammoth. Artifacts include tools fashioned from stone, bone, antler, and ivory; microblades; and microblade cores.
Northern Archaic Tradition	8,000–3,000 BP	Adaptations due to boreal forest expansion, such as side-notched projectile points. Tools include bifacial knives, microblades, end scrapers, and side-notched points. Possibly ancestral to modern Athapaskans of the region.
Arctic Small Tool Tradition	5,000–2,400 BP	Broad-based economy relied on maritime, land, and riverine resources. Tools include small, well-made, flaked stone microblades; burins; and other tools of chert and obsidian. Possibly ancestral to modern Inupiat Eskimos of the region.
Athapaskan Tradition	2,500–European contact	Varied settlement patterns, often nomadic culture, subsisting primarily on terrestrial animals; subgroups exhibit distinct cultural characteristics. Modern villages have descendants of historic residents.
Inupiat Tradition (Birnirk and Thule cultures)	2,000–European contact	Increased reliance on marine resources, but continuity in material, tool traditions similar to Arctic Small Tool Tradition suggests direct descent from Thule culture. Semi-subterranean winter houses; seasonal hunting of seal, walrus, caribou, occasionally whales. Kaktovik residents are descendants of Thule culture.
Historic Era		
Early Contact	1820s–1850s	Contact between Alaska Native groups and Russian or English whalers, often at trading posts; introduction of trade goods and disease.
Gold Rush	1860s–1920s	Period of influx of Euroamerican settlement in interior Alaska in response to multiple gold discoveries.
Development of Infrastructure	1890s–1940s	Establishment of roads and railway connecting interior Alaska with other areas; advances in air travel open interior and far north to more contact and commerce.
World War II and post-World War II development	1939–Present	World War II and Cold War led to military increases. Increased military presence in interior, beginning with the establishment of Ladd Field, Fairbanks. Statehood in 1959 and discovery of oil led eventually to enactment of ANCSA and ANILCA. Poker Flat Research Range established by the University of Alaska–Fairbanks in 1968.

Key: ANCSA=Alaska Native Claims Settlement Act; ANILCA=Alaska National Interest Lands Conservation Act; BP=Before the Present.
Source: Alaska Humanities Forum 2011; NPS 2011; USFWS 2011c.

Alaska's earliest inhabitants were nomadic hunters who traveled in small bands. This social organization persisted through the arrival of European traders in the late 1810s, and their habitation in the region continues to the present day. The nomadic nature of the state's earliest inhabitants, coupled with the organic nature of the materials they manufactured and used and changing environmental conditions, has presented difficulties in finding evidence of their activities. Archaeological evidence is usually limited to lithic (stone) artifacts, such as projectile points, cutting tools, scrapers and waste flakes, and hearths.

Historic refers to the period following the introduction of written records. The transition from the prehistoric to the historic period in Alaska varies from region to region. Western trade goods and diseases began to enter the interior of Alaska prior to actual contact, and definitely by the early 1800s. For interior Alaska, the historic period begins with the migration of Russian fur traders around the 1830s. The early historic period is marked by the continuation of traditional activities, with the addition of a limited European presence in the region. Gold rushes began in the late 1880s and substantially altered the regional demographics and economy.

Native people still compose a large part of the population of Arctic Alaska, as well as the population of interior Alaska. Inuit Eskimos occupy the Arctic coastal region, while Athapaskans occupy the interior. The Athapaskans of the ROI are primarily Gwich'in Athapaskans. Native indigenous occupation dates back more than 10,000 years, to the end of the last ice age, and possibly as far back as 20,000 years. Coastal Inuit culture is, in large part, a sea mammal hunting culture, with land animals also playing a part in subsistence. Athapaskan culture is based largely on harvesting caribou, moose, and salmon.

World War II and the Cold War drew thousands of people to Alaska for military service and deployment. Military installations were constructed throughout Alaska during and in the years directly following World War II. Since the statehood of Alaska in 1959, the Trans-Alaska Pipeline, Alaska Native land claim settlements, and public lands legislation have each had profound influences on the region.

PFRR was established by the Geophysical Institute of UAF in 1968. NASA and the Geophysical Institute established a cooperative operating agreement in 1979. The area near PFRR saw the largest gold dredging operation conducted by the Fairbanks Exploration Company (F.E. Co.) from the late 1920s to the late 1950s **(Sattler *et al.* 1993)**. The remnants of the F.E. Co. dredging operations and patented ground lie adjacent to the southern property boundary of the PFRR launch site. Private lands next to PFRR include the NRHP-eligible former Chatanika Camp (Alaska Heritage Resources Survey No. LIV-023) and Seppala Cabin (LIV-117). Other historic properties within 2 or 3 miles of the PFRR launch site include the remnants of the mining boom town Old Chatanika (LIV-087), and the former town site of Cleary (LIV-021) **(Sattler *et al.* 1993)**.

3.9.3 Existing Conditions

Cultural resources in the PFRR launch corridor include prehistoric archaeological sites; historic archaeological sites and properties; and properties of traditional, religious, and cultural importance that reflect the history described in Section 3.9.2. Prehistoric sites are often found in locations that are higher in elevation than the surrounding landscape, such as bluffs and terraces, and usually in proximity to water, including rivers, drainages, and lake margins. Historic sites in the region are often associated with historic roads or trails, rivers, drainages, and lake margins. Cold War era historic properties are found on military installations and scattered in villages in this region. Properties of traditional religious and cultural importance are found throughout the region and are identified through consultation with tribes that have knowledge of the geographical area of interest.

3.9.3.1 *National Register of Historic Places*

There are no NRHP-listed properties within the PFRR launch site. One NRHP-listed resource lies beneath the PFRR launch corridor. The Mission Church, built in 1916 or 1917 by residents of Arctic Village, was listed in NRHP in 1976 (NPS Reference No. 77001578) **(NRHP 2011)**. No other listed properties are present directly beneath the PFRR launch corridor, and there are no National Historic Landmarks. The Old Mission House (NPS Reference No. 78000539, listed in 1978) and Sourdough Inn (NPS Reference No. 97001585, listed in 1997) lie between Flight Zones 4 and 5, in Fort Yukon **(NRHP 2011)**. The Chatanika Gold Camp (NPS Reference No. 79003753) is located adjacent to Steese Highway just south of the PFRR entrance road and outside the PFRR launch site **(NRHP 2011)**.

3.9.3.2 *Archaeological Sites*

Two historic trails were documented within the PFRR launch site. The trails date at least to 1907 and are considered to be eligible for listing in NRHP **(Sattler *et al.* 1993)**.

There are many prehistoric and historic native sites and historic properties within the PFRR launch corridor. Most have not been evaluated for NRHP eligibility. However, it is likely that many of these resources are eligible for listing in NRHP, and thus are treated as such until such time as they might be formally evaluated. Alaska Native archaeological resource types include remains of habitations, sometimes with stone tent rings; driftwood or whalebone house frames; cemeteries; caribou drive lines or fences and corrals; and camps (sometimes characterized by lithic scatters or housepits).

There are also many historic era archaeological sites in the PFRR launch corridor, including artifacts from the U.S. military (World War II and Cold War), gold mining, mineral and oil exploration, homesteading, transportation and aviation, cemeteries, and architecture.

3.9.3.3 *Structural Resources*

Remnants of the early mining days are evident near the PFRR launch site. Three manmade diversions are part of the NRHP-eligible Davidson Ditch. Davidson Ditch runs for over 110 kilometers (70 miles) and was created to bring sluicing water to the mines on lower Cleary Creek and Chatanika Flats. The middle Davidson Ditch was constructed in 1909. The upper Davidson Ditch was constructed in 1925. The ditches at the PFRR launch site are now overgrown with vegetation and breached at various points along their length. The lower ditch is nearly completely obliterated. Despite this deterioration, these structures are eligible for listing in NRHP **(Sattler *et al.* 1993)**.

Several historic structures were documented during the 1993 survey **(Sattler *et al.* 1993)**. A compound that includes a former telemetry station was determined not eligible for listing in NRHP. A telegraph line may be eligible for NRHP. A small mining drift and telephone pole, as well as three prospects, were not assigned state numbers and are not eligible.

Structural remains beneath the PFRR launch corridor include numerous cabins, some of which may be eligible for listing in NRHP.

3.9.3.4 *Native Villages*

The cultural makeup of Arctic Alaska is Inupiat Eskimo, in large part a sea mammal hunting culture. Interior villages are home to people of Athapaskan descent: Gwich'in, Koyukon, and Tanana Athapaskan Indian. Their culture is based largely on harvesting caribou, moose, and salmon. Most of the communities beneath or near the PFRR launch corridor are occupied by Alaska Natives, and many are the seat of federally recognized tribes (see Figure 3–1). Native villages that are in close in proximity to the PFRR launch corridor own land, along with Doyon, Limited, in Yukon Flats NWR. About 1 million hectares (2.5 million acres) of land in Yukon Flats NWR are under native ownership **(USFWS 2011c)**. Kaktovik, in the far north and within Arctic NWR, is part of the Arctic Slope Corporation. The Village of Venetie owns land as a reservation, rather than as part of one of the Alaska Native corporations. Federally recognized Alaska Native groups under or near the PFRR launch corridor include those listed in **Table 3–16**. Native life in most of these villages retains a strong reliance on subsistence activities. Winter subsistence activities for these communities include hunting, trapping and fishing. See Section 3.10 for information regarding subsistence uses.

Table 3–16. Villages Beneath or Near the Poker Flat Research Range Launch Corridor

Village	Federally Recognized Tribe or Other	Federal Management Area
Beneath Poker Flat Research Range Launch Corridor		
Arctic Village	Native Village of Venetie Tribal Government; Neets'aii Gwich'in of Arctic Village	At the southern boundary of Arctic National Wildlife Refuge
Beaver	Beaver Village. Predominantly mixed Gwich'in/Koyukuk Athapaskan and Inupiat Eskimo.	Yukon Flats National Wildlife Refuge
Chalkyitsik	Chalkyitsik Village. Traditional Gwich'in Athapaskan village	Yukon Flats National Wildlife Refuge
Kaktovik	Kaktovik Village (also known as Barter Island). Inupiat Eskimo traditions.	At the northern boundary of the Arctic National Wildlife Refuge in the North Slope Borough on the Arctic (or Beaufort) coast

Table 3–16. Villages Beneath or Near the Poker Flat Research Range Launch Corridor (*continued*)

Village	Federally Recognized Tribe or Other	Federal Management Area
Beneath Poker Flat Research Range Launch Corridor (*continued*)		
Venetie	Village of Venetie; Native Village of Venetie Tribal Government (Arctic Village and Village of Venetie. Largely descendants of Neets'ai Gwich'in and to lesser extent, Gwichyaa and Dihaii Gwich'in. Village council combined with Arctic Village.	At northern border of Yukon Flats National Wildlife Refuge
Between Launch Corridors		
Birch Creek	Birch Creek Tribe; Dendu Gwich'in Tribal Council; local residents are Dendu Gwich'in Athapaskans.	Yukon Flats National Wildlife Refuge
Fort Yukon	Native Village of Fort Yukon; Canyon Village Traditional Council (not federally recognized). Most descendents of Yukon Flats, Chandalar River, Birch Creek, Black River, and Porcupine River Gwich'in Athapaskan tribes.	Yukon Flats National Wildlife Refuge
Outside Poker Flat Research Range Launch Corridors		
Central	None	East of launch corridor
Chatanika	None	At base/apex of launch corridor
Chena Hot Springs	None	South of launch corridor
Circle	Circle Native Community. Predominantly Athapaskan.	East of launch corridor and east of Yukon Flats National Wildlife Refuge
Circle Hot Springs	None	East of launch corridor
Eureka	None	West of launch corridor, Dalton Highway
Livengood	None	West of launch corridor
Miller House	None	East of launch corridor
Olnes	None	Southwest of Chatanika
Rampart	Rampart Village. Predominantly Koyukon Athapaskan.	West of launch corridor, Dalton Highway
Stevens Village	Native Village of Stevens. Predominantly Kutchin (Gwich'in) Natives.	West of the launch corridor and in Yukon Flats National Wildlife Refuge
Wiseman	None	West of launch corridor

Arctic Village

Arctic Village lies at the north end of the PFRR launch corridor Flight Zone 4, at the southern boundary of Arctic NWR, on the east fork of the Chandalar River. Archaeological evidence indicates the location of Arctic Village may have been first occupied as long ago as 6,500 years before present. The semi-nomadic life of the Neets'aii Gwich'in included seasonal rounds that took them to the Arctic Coast, Rampart, Old Crow, the Coleen River, and Fort Yukon. Some semi-permanent camps were also established in locations such as Arctic Village, Christian, Venetie, and Sheenjak. The Neets'aii Gwich'in traded with the Inupiat Eskimos on the Arctic coast, and also provided caribou meat to Fort Yukon **(ADCRA 2011)**. As one of the communities of the former Venetie Indian Reservation (established in 1943), a branch of the federally recognized Native Village of Venetie tribal government is located in Arctic Village. The Neets'aii Gwich'in of Arctic Village continue to lead a subsistence-based lifestyle, hunting caribou, moose, sheep, porcupine, rabbit, ptarmigan, freshwater fish, and waterfowl and harvesting berries **(ADCRA 2011)**.

Beaver

At the southern end of the PFRR launch corridor Flight Zone 3, Beaver sits on the north bank of the Yukon River. Although originally established in 1907 as a trading post and jumping-off point for the gold fields to the north, Beaver is also home to a federally recognized tribe. The Beaver Village members are a mix of Gwich'in/Koyukuk Athapaskan and Inupiat Eskimo. Subsistence forms an important part of their lifestyle, with activities including hunting moose, salmon, freshwater fish, bear, and waterfowl. Gardening and berry harvesting are also important activities **(ADCRA 2011)**.

Chalkyitsik

The Alaska Native Village Chalkyitsik underlies the PFRR launch corridor Flight Zone 5 on the Black River. Archaeological excavations indicate this region may have been first used as early as 12,000 years ago. This village on the Black River has traditionally been an important seasonal fishing site for the Gwich'in. Village elders remember a highly nomadic way of life where, from autumn into the spring, they lived at the headwaters of the Black River, and fished downriver in the summer. Contact with early explorers was limited, and the Black River Gwich'in receives scant mention in early records. The location of the village at its present site is due in part to low water in the Black River in the 1930s. A boat carrying materials intended for a school to be built in Salmon Village had to be unloaded at the Chalkyitsik seasonal fishing camp that then consisted of four cabins. Rather than reload the construction materials, the school was built at Chalkyitsik, and the Black River people began to settle around the school. The federally recognized Chalkyitsik Village is composed of Gwich'in Athapaskans who live a subsistence lifestyle, hunting primarily moose, caribou, sheep, salmon, and whitefish.

Kaktovik

The community of Kaktovik lies on the Beaufort Sea of the Arctic Ocean, on Barter Island, at the northern extent of the PFRR launch corridor Flight Zone 4AX. Although the city was not incorporated until 1971, Barter Island has long been a trading center for commerce between the

Inupiat of Alaska and the Inuit of Canada. The federally recognized tribe of Kaktovik Village is located in Kaktovik, made up primarily of Inupiat Eskimo who lives a traditional, subsistence-based life, centered on caribou **(ADCRA 2011)**.

Venetie

This community lies on the north side of the Chandalar River on the boundary between the PFRR launch corridor Flight Zones 3 and 4, at the northern boundary of Yukon Flats NWR. The federally recognized Village of Venetie is also part of the Native Village of Venetie Tribal Government that includes Arctic Village. The village was founded in 1895, the central location for a small grouping of cabins. The people living there were seasonally nomadic, following food sources. A gold rush in 1906 brought miners to the Chandalar gold region, but the boom did not last, as the gold was mostly played out by 1910. The residents of Venetie joined with those of Arctic Village, Christian Village, and Robert's Fish Camp to establish the Venetie Indian Reservation in 1943. When ANCSA provided a corporate organization for Alaska Natives, the members of the Venetie Indian Reservation opted to maintain title to their reservation lands, rather than join the corporation. Subsistence activities, including hunting of salmon, whitefish, moose, caribou, bear, waterfowl, and small game, remain an important part of the lifestyle for the Neets'ai Gwich'in, Gwichyaa, and Dihaii Gwich'in, who are part of the Village of Venetie **(ADCRA 2011)**.

Birch Creek

The community of Birch Creek lies in the gap between the PFRR launch corridor Flight Zones 4 and 5, south-southwest of Fort Yukon. Although there are records of semi-permanent camps in the area, the first documentation of settlement here was in 1862, as a camp that provided fish to the Hudson's Bay Company in Fort Yukon. The Dendu Gwich'in who lived here might have been annihilated by scarlet fever in the 1880s, but the records are inconsistent, and ethnographic accounts document use of the region throughout the latter part of the 19th century. By the 1950s, establishment of a school encouraged families to adopt a less nomadic lifeway. Today, the federally recognized tribe, the Birch Creek Tribe Dendu Gwich'in Tribal Council, represents members who are Dendu Gwich'in, and who also depend heavily on a subsistence economy. They harvest salmon, whitefish, moose, black bear, waterfowl, and berries **(ADCRA 2011)**.

Fort Yukon

Located at the confluence of the Yukon and Porcupine Rivers, Fort Yukon is the largest of the Alaska Native villages in the PFRR region. Like Birch Creek, it lies in the gap between the PFRR launch corridor Flight Zones 4 and 5. The town was established in 1847 as a Canadian outpost in what was then Russian territory. After the United States purchased Alaska, survey showed that Fort Yukon was in the United States. Fort Yukon held an important role as a trading center for this part of Alaska from its founding into the mid 20th century. Despite challenges from flooding and disease in the first half of the century, by the 1950s, Fort Yukon was incorporated and hosted a White Alice Communications System and Air Force station. The federally recognized tribe of the Native Village of Fort Yukon has its home here, as well as the non-recognized Canyon Village Traditional Council. The Council of Athapaskan Tribal Governments also is headquartered in Fort Yukon. Alaska Natives in Fort Yukon are descendants of the Yukon Flats, Chandalar River, Birch Creek, Black River, and Porcupine River Gwich'in Athapaskan tribes **(ADCRA 2011)**. Subsistence plays a major role in the economy, with meat obtained from salmon, whitefish, moose, bear, caribou, and waterfowl **(ADCRA 2011)**.

3.9.3.5 *Properties of Traditional or Religious Cultural Importance*

No specific properties of traditional or religious cultural importance have been defined within the ROI. This is not to say that such localities do not exist. They are typically identified by Alaska Natives through consultation under NHPA Section 106 and government-to-government consultation guidelines. Locations of traditional use may be considered properties of traditional or religious cultural importance, as defined under NHPA **(16 U.S.C. 470a(d)(6))**. Traditional land use inventories in other regions of Alaska have identified hundreds of potentially significant locations. For example, the inventory for the Northeast National Petroleum Reserve to the west of PFRR identified over 220 such locations. It is highly likely that similar resources are located throughout the ROI and might include fishing and hunting areas, cabins, and ruins of other structures, such as sod houses or fences, gravesites, and landmarks. An overlapping list of this resource type may be obtained through the compilation of place names. Over 500 place names were identified for the *Yukon Flats Land Exchange Environmental Impact Statement* **(USFWS 2010a)**, many of which lie under PFRR **(USFWS 2008b)**. NASA is currently in consultation with Alaska Native tribes to identify resources of this type.

3.10 SUBSISTENCE USE RESOURCES

Subsistence plays a vital role in the lifestyles of Alaskan residents, particularly rural residents and Alaska Natives, and is a unique characteristic of life in Alaska. "Subsistence Management Regulations for Public Lands in Alaska" **(36 CFR 242)** defines subsistence as the "customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade." In the rural regions of Alaska, services and products are not always accessible; subsistence fishing and hunting are important to supplement employment and nutrition in these regions. Approximately 50 percent of the food for three-quarters of the Alaska Native families in the state's smaller communities is acquired through subsistence activities. Other important uses of subsistence products are as follows:

- Clothing, including the use of wild furs and hides for ruffs, mitts, parkas, clothes lining, and winter boots.
- Fuel, specifically wood, is a major source of heat for rural homes, which do not have access to centralized utilities. Wood is also used for smoking and preserving fish or meat.
- Fish, seals, and other products are used to feed dog teams, which are used as transportation.

- Construction materials, specifically spruce, birch, hemlock, willow, and cottonwood, are used for house logs, sleds, and fish racks, among other items.

- Hides are often used as sleeping mats, seal skins are used to store food, and wild grasses are made into baskets and mats.

- Specialized products like seal oil are bartered and exchanged in traditional trade networks between communities. Furs are sold to outside markets to provide an important source of income for rural communities. Ivory, grass, wood, skins, and furs are also crafted into items for use and sale in outside markets.

For Alaska Natives, many of the subsistence products are used in traditional ceremonies such as funerals, potlatches, marriages, native dances, and other ceremonial occasions.

Under state regulations, subsistence is open to all Alaska residents on state or private land, but under Federal regulations, subsistence is limited to rural residents on federally owned lands. Due to the disparity between Federal and state subsistence regulations, the jurisdiction for managing subsistence has been divided between the State of Alaska and the Federal Subsistence Board. Under Federal regulations, all communities and areas in Alaska are considered rural, with the exception of major towns and cities and their surrounding areas. Access to subsistence resources using a preference system is tied to the permit system for hunting and takes limits.

In 1978, the State of Alaska passed legislation regulating subsistence and applying subsistence to rural residents. Additional state legislation was passed in 1989, extending subsistence to all residents. In 1980, Congress passed ANILCA, a priority subsistence law for Federal lands in Alaska. State and Federal law defines subsistence as the “customary and traditional uses” of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade. Under these laws and related regulations, Alaska residents are given priority in harvesting game and nongame resources for personal use over individuals harvesting game and nongame resources for sport or commercial reasons.

ANILCA obligates Federal agencies to manage their lands to support customary and traditional subsistence activities on Federal land, with preference for rural Alaskans to harvest fish and wildlife on Federal lands, particularly when resources are scarce, as evaluated for each species traditionally harvested for subsistence **(16 U.S.C. 314)**.

The ROI for subsistence use resources includes communities under or within 37 kilometers (20 nautical miles) of the PFFR launch site and launch corridor. The ROI includes these areas because there are communities in the vicinity of the PFRR launch corridor that may travel into the launch corridor to harvest subsistence resources in response to wildlife availability. A distance of 37 kilometers (20 nautical miles) was used as a best estimate for the maximum distance traveled without the use of aircraft to harvest subsistence resources. Detailed characteristics of these communities, including characteristics of the state and Federal subsistence uses, are provided in **Table 3–17**. Locations of the game management units (GMUs) are shown in **Figure 3–8**. The state subsistence information is provided by the ADF&G and presents the information for the most representative year for each community. As discussed previously, state subsistence is open to Alaska residents on state or private land. Regional and village Native Corporation lands are considered private lands and are managed under state subsistence guidelines. ADF&G attempted to survey the maximum number of households in each community to gain an adequate sampling of the community and their subsistence habits. Several of these communities have more up-to-date data; however, the information may not provide the most accurate description of the community's reliance on subsistence. Therefore, only the most representative year is presented in Table 3–17 even though the data may be dated. Regulations regarding the state subsistence priority, amount of harvest, harvest season, and methods used in the harvest are dictated by the Alaska Board of Fisheries and the Alaska Board of Game.

Federal subsistence is open on Federal public land only to Alaska residents living in rural communities. Federal public land includes land owned and managed by BLM, NPS, the U.S. Forest Service (USFS), and USFWS. Regulations regarding Federal subsistence priority, amount of harvest, harvest season, and methods used in harvest are dictated by the Federal Subsistence Board, which includes agency heads of BLM, NPS, USFS, USFWS, and the U.S. Bureau of Indian Affairs. Table 3–17 provides information on the Federal subsistence management areas for hunting and fishing for each community. Information on subsistence harvests on Federal public land near these communities is not available. Other GMUs included in the PFRR launch corridor are GMUs 20F, 25B, and 26B. Within GMU-20F, subsistence harvests are permitted for bison, black and brown bear, caribou, moose, sheep, beaver, coyote, fox, hare, lynx, muskrat, wolf, wolverine, grouse, and ptarmigan. Within GMU-25B subsistence harvests are permitted for black and brown bear, caribou, moose, muskox, beaver, coyote, fox, hare, lynx, muskrat, wolf, wolverine, grouse, and ptarmigan. Within GMU-26B subsistence harvests are permitted for black and brown bear, caribou, moose, muskox, sheep, coyote, fox, hare, lynx, wolf, wolverine, and ptarmigan. The USFWS regularly publishes materials indicating the GMU in which specific subsistence harvests are permitted; the manner of harvest, such as trapping or hunting; and the harvest limits for each GMU. Some of these limitations include restrictions of subsistence activities to residents in particular villages or the harvest of subsistence resources only in specific areas. All subsistence participants are required to have appropriate permits prior to subsistence harvesting.

Within the ROI many subsistence participants rely on fishing for both salmon and non-salmon species, large and small land mammals, and a variety of bird species. Fish is one of the most reliable sources of meat that can be harvested nearly year round either through nets or ice fishing. The Yukon River, the Chandalar River, the Black River, and the Porcupine River are main providers of salmon species **(Caulfield 1983)**. A number of other lakes and creeks within the PFRR launch corridor provide non-salmon species. Subsistence fisheries are discussed further in Section 3.7.2.6. Land mammals such as caribou, moose, and Dall sheep in particular, are used as sources of meat. These species are often hunted by boat or snowmachine as they are usually found in close proximity to rivers. Marine mammals can be harvested for subsistence purposes, but only by Alaska Natives, as permitted in the MMPA. The regulations governing subsistence harvests of marine mammals are co-managed by Alaska Natives, USFWS, and NMFS. In addition to caribou, Dall sheep, other small mammals, migratory birds, and fish, the Kaktovik community is dependent on the subsistence hunting of marine mammals, including bowhead whale, bearded seal, ringed seal, and occasionally polar bears **(Bacon *et al.* 2009)**.

Table 3–17. Subsistence Activities in the Vicinity of the PFRR Launch Corridor

Village	2010 Population	Percentage Alaska Native	State Subsistence			Federal Subsistence
			Year	**Species**	**Estimated Harvest (kilograms)**	**Hunting and Fishing Subsistence Areas**
Arctic Village	150	95	1997	Fish (non-salmon species)	880	Yukon-Northern Area Subsistence Fishing
				Large land mammals (bear, caribou, moose, Dall sheep)	3900	GMU-25A, Fort Yukon
				Small land mammals (beaver)	4	
				Birds and eggs, including migratory birds	250	
Beaver	83	98	1996	Fish (salmon and non-salmon species)	950	Yukon-Northern Area Subsistence Fishing
				Large land mammals (black bear, moose)	1,800	GMU-25D, Fort Yukon
				Small land mammals (beaver, hare, snowshoe hare)	80	
				Birds and eggs, including migratory birds	54	
Birch Creek	33	100	1997	Fish (non-salmon species)	170	Yukon-Northern Area Subsistence Fishing
				Large land mammals (black bear, moose)	8,700	GMU-25D, Fort Yukon
				Small land mammals (beaver, hare, snowshoe hare, lynx, squirrel)	500	
				Birds and eggs, including migratory birds	660	

Table 3–17. Subsistence Activities in the Vicinity of the PFRR Launch Corridor (*continued*)

Village	2010 Population	Percentage Alaska Native	State Subsistence		Federal Subsistence	
			Year	Species	Estimated Harvest (kilograms)	Hunting and Fishing Subsistence Areas
Central-Circle Hot Springs	96	6.3	2005[a]	Fish (non-salmon species)	620	Yukon-Northern Area Subsistence Fishing
						GMU-25C, Fort Yukon
Chalkyitsik	69	86	1997	Fish (non-salmon species)	330	Yukon-Northern Area Subsistence Fishing
				Large land mammals (black bear, moose)	3,000	GMU-25D, Fort Yukon
				Small land mammals (hare, snowshoe hare, lynx)	103	
				Birds and eggs, including migratory birds	84	
Circle	104	85	1997	Fish (salmon and non-salmon species)	2,900	Yukon-Northern Area Subsistence Fishing
				Large land mammals (black bear, caribou, moose)	2,300	GMU-25D, Fort Yukon
				Small land mammals (beaver, hare, snowshoe hare, lynx)	230	
				Birds and eggs, including migratory birds	480	
Coldfoot	10	10	N/A	N/A	N/A	Yukon-Northern Area Subsistence Fishing
						GMU-24B, Koyukuk

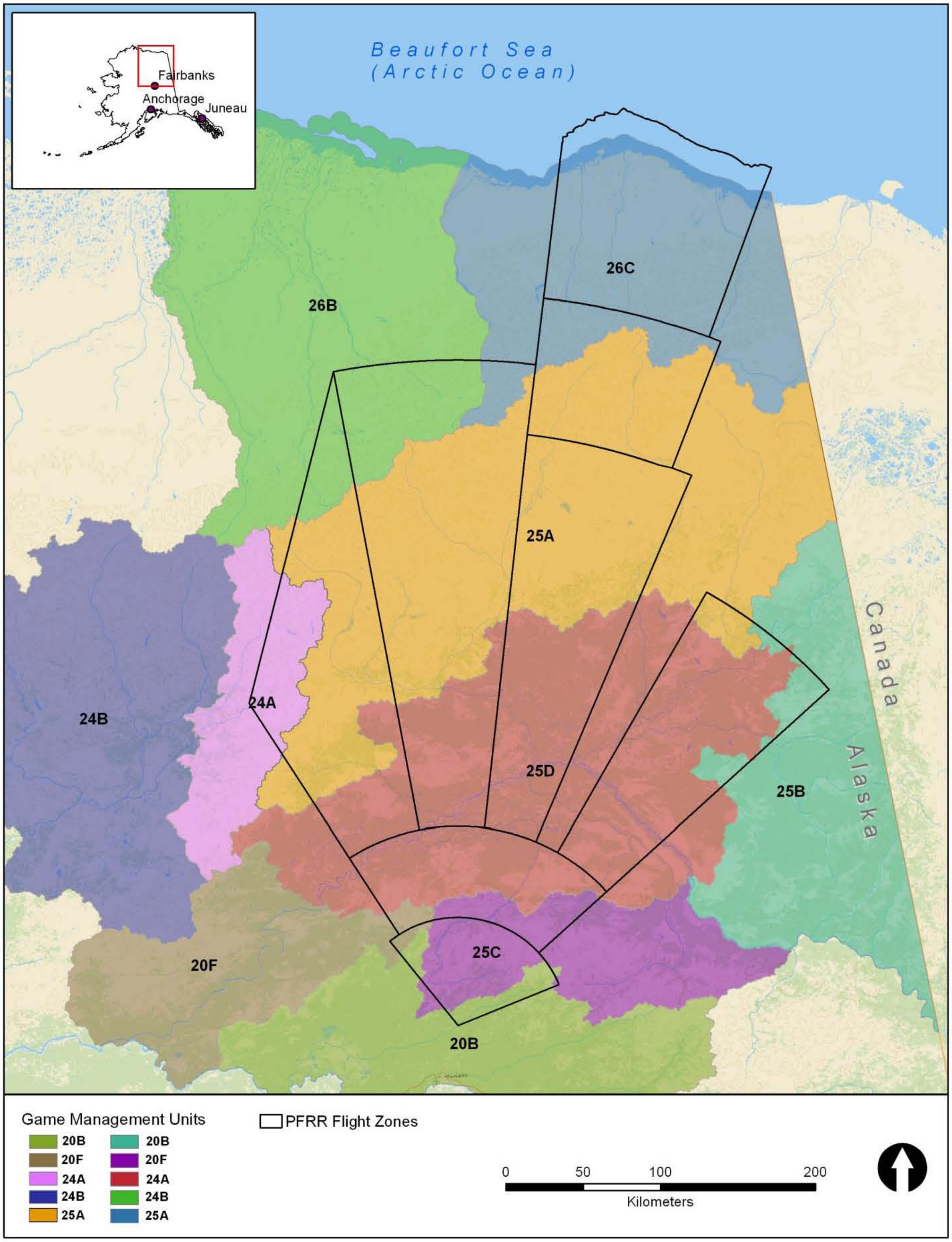
Table 3–17. Subsistence Activities in the Vicinity of the PFRR Launch Corridor (*continued*)

Village	2010 Population	Percentage Alaska Native	State Subsistence			Federal Subsistence
			Year	Species	Estimated Harvest (kilograms)	Hunting and Fishing Subsistence Areas
Fort Yukon	580	90	1997	Fish (salmon and non-salmon species)	26,000	Yukon-Northern Area Subsistence Fishing
				Large land mammals (black bear, caribou, moose)	11,000	GMU-25D, Fort Yukon
				Small land mammals (beaver, hare, snowshoe hare, lynx, squirrel)	770	
				Birds and eggs, including migratory birds	1,400	
Kaktovik	240	90	1992	Fish (salmon and non-salmon species)	10,000	Yukon-Northern Area Subsistence Fishing
				Large land mammals (brown bear, caribou, moose, muskox, Dall sheep)	13,000	GMU-26C, Arctic Slope
				Small land mammals (marmot, squirrel)	73	
				Marine mammals (polar bear, seal species, walrus, bowhead whale)	52,000	
				Birds and eggs, including migratory birds	1,500	
Livengood	13	31	N/A	N/A	N/A	Yukon-Northern Area Subsistence Fishing
						GMU-20B, Fairbanks-Central Tanana

Table 3–17. Subsistence Activities in the Vicinity of the PFRR Launch Corridor (*continued*)

Village	2010 Population	Percentage Alaska Native	State Subsistence			Federal Subsistence
			Year	Species	Estimated Harvest (kilograms)	Hunting and Fishing Subsistence Areas
Stevens Village	78	90	1994	Fish (salmon and non-salmon species)	2,100	Yukon-Northern Area Subsistence Fishing
				Large land mammals (moose)	1,700	GMU-25D, Fort Yukon
				Small land mammals (snowshoe hare)	210	
				Birds and eggs, including migratory birds	47	
Venetie	170	96	1997	Fish (salmon species)	120	Yukon-Northern Area Subsistence Fishing
				Large land mammals (moose)	4,800	GMU-25D, Fort Yukon
				Small land mammals (beaver, snowshoe hare, squirrel)	140	
				Birds and eggs, including migratory birds	45	
Wiseman	14	7.1	N/A	N/A	N/A	Yukon-Northern Area Subsistence Fishing
						GMU-24B, Koyukuk

a. Only year of data available.
Note: To convert kilograms to pounds, multiply by 2.2046.
Key: GMU=Game Management Unit; N/A=not applicable.
Source: ADF&G 2011c; Census 2011; USFWS 2010a, 2011o.



Note: To convert kilometers to miles, multiply by 0.6214.
Source: SAIC 2011.

Figure 3–8. Poker Flat Research Range Game Management Units Ecoregions

In general, subsistence activities occur year-round. Harvesting vegetation such as berries or other roots or vegetables typically occurs in late summer as the vegetation ripens. Subsistence hunting and trapping are regulated by the hunting and trapping seasons established by species. These seasons can vary among the GMUs and between Federal and state regulations, depending on the population of the species in question. For example, on Federal and state lands, there is no closed season for black bears in GMU-25 **(ADF&G 2011a; USFWS 2010b)**. For caribou, open season in GMU-25 is different, depending on the GMU subunit. In portions of GMU-25A, there is no closed season for hunting caribou bulls; however, hunting caribou cows is not permitted between early July and mid-May **(ADF&G 2011a; USFWS 2010b)**. Therefore, subsistence activities occur year-round, depending on the open seasons and availability of the variety of vegetation and wildlife species harvested.

Within the PFFR launch corridor, many subsistence participants rely on fishing for both salmon and non-salmon species, large and small land mammals, and a variety of bird species. Land mammals such as caribou, moose, and Dall sheep in particular are used as sources of meat. Marine mammals can be harvested for subsistence purposes, but only by Alaska Natives, as permitted in the MMPA. The regulations governing subsistence harvests of marine mammals are co-managed by Alaska Natives, USFWS, and NMFS. The Kaktovik community is heavily dependent on the subsistence hunting of marine mammals.

In general, subsistence activities occur year-round, depending on the open seasons and availability of the variety of vegetation and wildlife species harvested. Harvesting vegetation such as berries or other roots or vegetables typically occurs in late summer as the vegetation ripens. Subsistence hunting and trapping are regulated by the hunting and trapping seasons established by species. These seasons can vary among the GMUs and between Federal and state regulations, depending on the population of the species in question. For example, on Federal and state lands, there is no closed season for black bears in GMU-25 **(ADF&G 2011b; USFWS 2010b)**. For caribou, open season in GMU-25 is different, depending on the GMU subunit. In portions of GMU-25A, there is no closed season for hunting caribou bulls; however, hunting caribou cows is not permitted between early July and mid-May **(ADF&G 2011b; USFWS 2010b)**.

3.11 TRANSPORTATION

Alaska Route 3, or Parks Highway, provides road access from the south (Anchorage area) to Fairbanks, Alaska. Alaska Route 2 provides access to Fairbanks from the southeast from Canada. PFRR is accessible from Fairbanks by traveling from Alaska Route 2 on the northeast side of Fairbanks to Alaska Route 6, also known as Steese Highway. PFRR is located off of Steese Highway about 48 kilometers (30 miles) northeast of Fairbanks. Steese Highway is a paved road between Alaska Route 2 and PFRR.

Alaska Route 11, or Dalton Highway, is the main land link between Fairbanks and the Prudhoe Bay oil fields and basically follows the Trans-Alaska Pipeline to the west of the PFRR launch corridor. Alaska Statute prohibits the use of off-road-vehicles within 5 miles of the Dalton Highway right-of-way in the Dalton Highway Corridor Management Area **(USFWS 2011c)**.

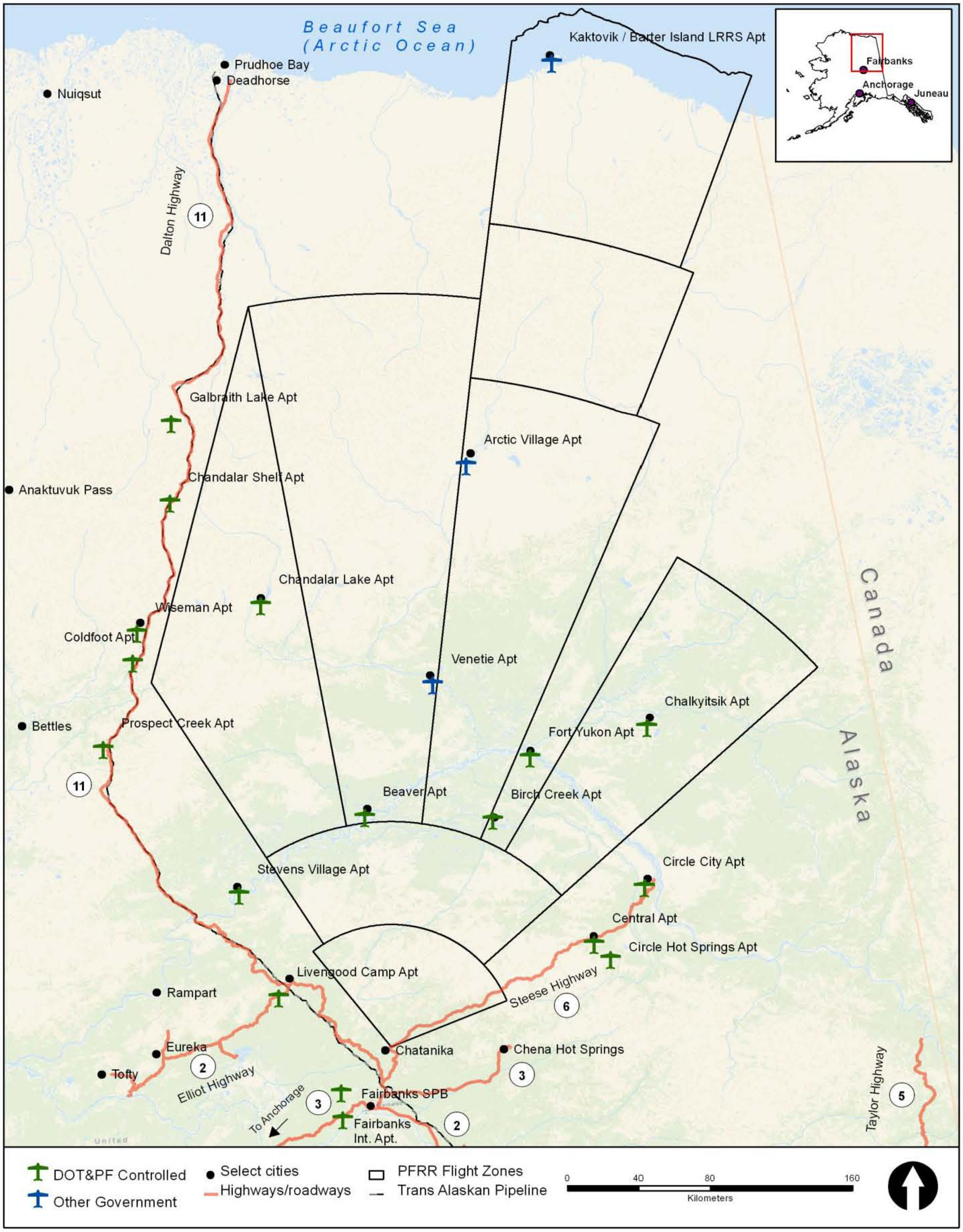
Traffic counts are recorded on Steese Highway north of Fox and annually reported. Between 2007 and 2009, the annual average daily traffic count for this location ranged from 1,500 to 1,800 vehicles, with the traffic equally split for each direction **(ADOT&PF 2010)**. This volume is considered light and free-flowing.

Because of the long distances, remoteness, and climate, much of the state of Alaska is accessible only by general aviation aircraft. The Alaska Department of Transportation and Public Facilities owns 254 airports, with other government airports also present throughout the state. Two of the airports are commercial airports: the Ted Stevens Anchorage International Airport and the Fairbanks International Airport. The Fairbanks International Airport is located on the west side of Fairbanks and provides passenger, cargo, and general aviation services. The remaining 252 state-owned airports are rural airports that have either paved or gravel runways. There are 18 rural airports in or near the PFRR launch corridor, many of which are located along the Dalton Highway/Trans-Alaska Pipeline corridor **(ADOT&PF 2011)**. Three of these airports in the launch corridor are owned by tribal governments (Venetie, Arctic Village, and Kaktovik). Frequency of air service varies, but several communities have regularly scheduled air service, and air-taxi charter services are also available **(USFWS 2011c)**. Light aircraft equipped with either wheels, skis, or floats can be used to access areas that are not near airports, depending upon the season. During summer months, wheel planes can land on some river gravel bars, beaches along the Beaufort Sea coast, and other flat areas to access more remote regions. Floatplanes can access some of the larger lakes **(USFWS 2011c)**. Helicopters can also be used to access areas within the launch corridor.

The Alaska Railroad provides rail access from Anchorage to Fairbanks. **Figure 3–9** shows the primary roads associated with operations at PFRR and commercial and rural airports in or near the launch corridor.

3.12 WASTE MANAGEMENT

This section discusses forms and management of wastes generated or released at the PFRR launch site and within the launch corridor. Hazardous wastes or hazardous materials are substances that are defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act **(42 U.S.C. 9601 *et seq.*)** and the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act **(42 U.S.C. 6901 *et seq.*)**. In general, these substances may present substantial danger to the public health or welfare or the environment when released into the environment because of their quantity, concentration, or physical, chemical, or infectious characteristics or radiation exposure. The ROI for hazardous materials and hazardous waste at PFRR would extend to all locations where these substances are used, stored, transported, or disposed of. Even when disposal does not occur on site, waste generators are responsible for waste disposed of offsite; thus, the ROI encompasses the PFRR launch site and any offsite disposal locations.



Note: To convert kilometers to miles, multiply by 0.6214.

Source: SAIC 2011.

Figure 3–9. Major Roadways and Airports in or Near the Poker Flat Research Range Launch Corridor Area

3.12.1 Hazardous Waste Generation and Storage

The UAF Risk Management Office manages the removal and disposal of hazardous waste **(USA 2001)**. PFRR has conditionally exempt small-quantity generator status (EPA ID No. AKO 0000374959); as such, UAF and PFRR can generate no more than 100 kilograms (220 pounds) of hazardous waste and accumulate no more than 1,000 kilograms (2,200 pounds) of hazardous waste per month **(USA 2001)**. PFRR does not have a Hazardous Waste Contingency Plan or a Spill Prevention Control and Countermeasures Plan because of the small quantity of materials kept on site, so procedures set forth in the UAF Health, Safety and Risk Management Policies are followed **(UAF 2003b)**. The UAF Fire Marshall and Range Safety Officer are responsible for inspecting all hazardous materials storage facilities at PFRR, documenting the findings, verifying corrective actions, and maintaining accurate records. At a minimum, the Range Safety Officer/Hazardous Material Coordinator conducts an annual inventory of hazardous materials and monthly inspections of material storage conditions **(USA 2001)**.

Typical hazardous wastes generated at the PFRR launch site are petroleum, oils, lubricants, battery acid (H_2SO_4), alkalis (potassium hydroxide [KOH]), neon batteries, lithium batteries, alcohols, and acetone. Some payloads may contain explosives or chemicals. PFRR has a 45,000-kilogram (100,000-pound) limit on the storage of explosives **(USA 2001)**. Mission-specific materials (*e.g.*, TMA) are shipped in specialized containers to the launch site on an as-needed basis in only those quantities necessary for the scientific objectives.

There are four aboveground bulk fuel storage tanks at PFRR, as follows: one 19,000-liter (5,000-gallon) diesel tank, one 19,000-liter (5,000-gallon) regular unleaded gasoline tank, one 5,700-liter (1,500-gallon) super unleaded gasoline tank, and one 5,700-liter (1,500-gallon) jet-B fuel tank. Explosives at PFRR are stored in the Explosive Storage Building. Helium is stored outside the Balloon Inflation Building in mobile canisters. All of these facilities are located at the PFRR launch site **(USA 2001)**.

A small diesel spill occurred at the PFRR launch site in December 1999. This contaminated site was cleaned up and listed as "closed" in January 2010, according to the State of Alaska's Contaminated Sites Database **(ADEC 2011)**.

3.12.2 Hazardous Materials Used in Rocket Launches

Hazardous materials, toxic substances, and explosives, which are regulated substances used in launching or part of the payload (scientific experiments), include paints, oils, solvents, photographic and cleaning chemicals, bottled gases and, at times, small quantities of radioactive materials. Some payloads may contain explosives or chemicals **(NASA 2000a; USA 2001)**. Propellants typically include ammonium perchlorate and aluminum or nitrocellulose and nitroglycerine. Chapter 2, Section 2.2, of the *SRP SEIS* **(NASA 2000a)** defines these propellants and their exhaust products in full detail. Rocket motors typically contain insulation materials to protect the rocket case and nozzle from the heat of the burning propellant. A variety of insulation types have been used, including asbestos encapsulated in a resin that partially burns away during rocket motor firing **(Hesh 2011)**. Nickel-cadmium batteries, pressure systems or vessels, and hazardous circuits are also used as part of the stages or payload **(NASA 2009)**.

Chapter 4, Section 4.12 of this *PFRR EIS* provides greater detail, including the typical quantities and potential hazards, of such items commonly used on sounding rockets.

The use of surplus solid propellant rockets, such as Nike, Orion, Taurus, Terrier, and Aries, in the NASA SRP launch vehicles reduces the commitment of new raw materials and provides for the beneficial use of already expended resources that could become hazardous waste. Propellant systems currently used at PFRR are based either on an ammonium perchlorate/aluminum (AP/AL) combination or a nitrocellulose/nitroglycerin (NC/NG) combination. The emissions from the AP/AL propellant combination include hydrogen chloride and aluminum oxide and are generally considered to be more environmentally damaging than emissions from the NC/NG propellant combination **(NASA 2000b)**. The potential impacts on water resources and geology and soils are discussed further in Chapter 4, Sections 4.3 and 4.4.

3.12.3 Existing Stages and Payloads within the Poker Flat Research Range Launch Corridor

As shown in **Table 3–18**, past NASA SRP launch operations from PFRR have resulted in the deposition of approximately 680 stages and payloads (estimated based on launch information in **UAF 2011a**). Fifty payloads have been recovered, and an estimated 78 spent stages have been recovered from the launch corridor and returned to the PFRR launch site for disposal (estimated based on information in **UAF 2011a**). Therefore, approximately 550 NASA spent stages and payloads are estimated to remain in the launch corridor. Non-NASA items estimated to remain in downrange lands are discussed in Chapter 4, Section 4.15.11 of this *PFRR EIS*.

Table 3–18. Spent Stages and Payloads Launched by NASA into the Poker Flat Research Range Launch Corridor

Area Within Launch Corridor	Number of Spent Stages	Number of Spent Payloads
ADNR Poker Flat North and South Special Use Areas	202	1
White Mountains National Recreation Area	50	43
Mainly in Yukon Flats NWR	46	46
Arctic NWR, Native Village of Venetie Lands, and ADNR lands	127	93
Beaufort Sea/Arctic Ocean	34	34
Unknown	2	1
Subtotal	461	218
Less Recovered	(78)	(50)
Estimated Total	**383**	**168**

Key: ADNR=Alaska Department of Natural Resources; NWR=National Wildlife Refuge.

3.12.4 Waste Treatment and Disposal Practices

Recovered stages are cleaned per Local Work Instruction BM54138, which includes the inspection, removal, and steam cleaning of contaminated residue/materials within the rocket motors **(Cornwell 2005)**. Hazardous materials that could be encountered during cleaning include spent fuel residue, asbestos insulation, paint, and batteries. Pressure washing of the spent stages generates rinsate that would be considered hazardous and is disposed of through the Environmental Health and Safety Risk Management Department at PFRR **(UAF 2011)**. The cleaned stages and other nonhazardous waste are disposed of or recycled at the Fairbanks North Star Borough's landfill.

3.13 HEALTH AND SAFETY

3.13.1 Occupational Health and Safety at Poker Flat Research Range

PFRR is owned by UAF and operated by the Geophysical Institute under a contract with NASA. PFRR operates under the health and safety policies and procedures of the University of Alaska, the Federal Occupational Safety and Health Administration's industrial and occupational safety rules and regulations, and the State of Alaska Occupational Safety and Health standards **(UAF 2011a, 2011b)**. UAF developed internal safety policies and the PFRR Health and Safety Plan **(UAF 2011b)** to address specific challenges associated with working with equipment and procedures specific to sounding rocket launches.

During periods when rockets are not being assembled and readied for launch, the number of personnel at PFRR is limited and typically consists of UAF and maintenance and support contractors.

During periods when launch preparations are under way, personnel from the NASA SRP also are present at PFRR. In addition, visiting scientists associated with the launch may also be present. The *NASA Sounding Rocket Program Handbook* **(NASA 2005)** lays out the roles and responsibilities for all parties. NASA personnel and all rocket and launch activities also fall under NASA health and safety policies and procedures. These policies include typical occupational health and safety requirements in addition to specific requirements associated with the handling of rocket components and hazardous materials and the launch of sounding rockets.

Operations and launches at PFRR are conducted in accordance with NASA guidelines and procedures. *NASA Wallops Flight Facility Occupational Safety and Health Manual* requirements **(NASA 2006)** apply to NASA SRP rocket preparation and launch operations at PFRR. Prelaunch and launch operations are conducted in accordance with standard hazardous procedures used by NASA Sounding Rocket Operations Contract (NSROC) and WFF.

3.13.2 Public Health and Safety Within Poker Flat Research Range Launch Corridor

The public is protected from the impacts of sounding rockets and their components through the safety policies and practices of NASA and SRP. The primary policies that protect the public are encompassed in the Range Safety Program and NASA's *Range Safety Manual* **(NASA 2008)**. These range safety policies and practices are consistent with similar range safety requirements of other Federal agencies. These range safety policies and practices ensure that the probability of an accident that impacts the public is extremely low. See Chapter 4, Section 4.13 for additional detail on probabilities of an accident.

All NASA SRP first-stage spent rockets launched from PFRR land between 0.3 and 1.5 kilometers (0.2 and 0.9 miles) from the launch pad with impact weights in the 270- to 800-kilogram (600- to 1,800-pound) range. The small weather and test spent rockets (with an impact weight of 7 to 9 kilograms [15 to 20 pounds]) land between 2.8 and 5.5 kilometers (1.7 and 3.4 miles) from the launch pad. Therefore, an area with a radius of 1.5 to 5.5 kilometers (0.9 to 3.4 miles), depending on the mission, is cleared around the launch pad to prevent injury or damage to personnel or facilities.

3.13.3 Poker Flat Research Range Safety Process

The NASA Goddard Space Flight Center (GSFC) WFF and NSROC team provide mission management and engineering support. All personnel working directly with or in support of the NASA SRP are required to comply with Federal, state, and NASA health, safety, and environmental regulations and procedures applicable to the operation being performed.

The NASA Range Safety Officer, the NSROC Mission Manager, the WFF Project Manager, and the NASA Operations Safety Supervisor share responsibility (within the limits of their jurisdiction) for the safe performance of operations associated with a NASA SRP mission.

All NASA SRP missions are required to prepare both Ground and Flight Safety Plans to minimize risk to human life, property, and natural resources. The Ground Safety Plan identifies the hazardous systems, which exist on the NASA vehicle/payload, and defines the NASA safety category for each hazardous system. Depending on the safety category during various launch operations, restrictions may be imposed on NASA personnel, NASA contractors, and experimenters.

The NASA Range Safety Officer and NASA Operations Safety Supervisor are responsible for ensuring implementation of the Flight and Ground Safety Plans and mission team compliance with these requirements and that there are no violations of the NASA safety requirements, as stated in the GSFC WFF Range Safety Manual **(NASA 2008)**.

A Flight Safety Risk Assessment is also prepared for each mission. Both impact and overflight criteria are considered in the Flight Safety Plans and, while risk cannot be entirely eliminated, they are reduced to an acceptable margin. All flights must be designed so that the impact or reentry of any part of the launch vehicle over any landmass, sea, or airspace will not produce a casualty expectancy of 10^{-6} unless a Safety Analysis Report is prepared or one of the following conditions are met: (l) the reentry vehicle will be completely consumed by aerodynamic heating; (2) the momentum of the solid pieces reentering the atmosphere will be reduced to a degree which precludes injury or damage; or (3) a formal agreement is reached with the landowners to allow the use of the landmass for impact or reentry **(NASA 2008)**.

At all times, there is strict adherence to the NASA GSFC WFF Safety Manual. All launches are evaluated on an individual basis. NASA and UAF use a variety of safety criteria to evaluate launch parameters and potential risks associated with each launch. The criteria are evaluated for each mission and considered by UAF and NASA in making the decision on whether to proceed with the mission and launch. Details of the PFRR safety processes and operations are provided in Chapter 2, Section 2.1.6.

3.13.4 NASA Sounding Rocket Program at Poker Flat Research Range Accident History

3.13.4.1 *Poker Flat Research Range Occupational Injuries*

The most prominent health and safety metric is the accident rate. A strong, effective program has the potential to limit the occurrence of accidents and keep what incidents do occur to minor consequences. The last major accident at PFRR occurred in the early 1980s. No accidents resulting in lost work days have occurred since 2005. The last accident that occurred at PFRR was in 2009. The accident involved a slip on ice resulting in a sprained ankle and a trip to the doctor.

All reportable accidents are captured in a report that is submitted through the UAF Geophysical Institute's Operations Office. None of these injuries were Occupational Safety and Health Administration recordable injuries **(UAF 2011b)**.

3.13.4.2 *NASA Sounding Rocket Program at Poker Flat Research Range Rocket Failures*

NASA sounding rockets have maintained a historical success rate of 87 percent **(NASA 2005)**. A successful flight is defined as one that meets the minimum success criteria. When the minimum success criteria for any given flight are not met, the flight is officially considered a failure **(NASA 2005)**. While operations at PFRR have been quite safe, there have been launches with malfunctions in which the rockets did not perform as expected (see **Table 3–19**). Of 219 NASA SRP launches at PFRR since 1971, 14, or 6.4 percent of the total launched, had some sort of vehicle failure that resulted in failure of the mission and the experiment **(UAF 2011a)**. In general, these failures resulted in some portion of the rocket stage or payload landing in a location other than its planned impact point. All stages and rocket components did; however, land within the PFRR launch corridor. Limited data are available regarding early NASA failures; no detailed records of the approximately 10 non-NASA rocket failures are available. The available information is presented below.

Table 3–19. Rocket Failure History at Poker Flat Research Range

Launch Date	Mission Number	Vehicle Type	Organization	Cause	Landing
March 19, 1971	18.094	Nike-Tomahawk[a]	University of Alaska	Unknown	Unknown
October 13, 1972	14.506	Nike-Apache[a]	GCA	Unknown	Unknown
April 4, 1975	18.172	Nike-Tomahawk[a]	GSFC	Second stage failure at T+21 sec.	Unknown
September 30, 1976	18.180	Nike-Tomahawk[a]	GSFC	Ceramic nosecone shattered at T+14 sec.	Unknown

Table 3–19. Rocket Failure History at Poker Flat Research Range (*continued*)

Launch Date	Mission Number	Vehicle Type	Organization	Cause	Landing
January 18, 1977	29.004	Terrier-Malemute	University of Wisconsin	Unknown	Unknown
January 26, 1979	29.013	Terrier-Malemute	Rice University	Unknown	Unknown
April 15, 1982	35.003	Black Brant X	GSFC	Second stage casing ruptured at T+31 sec.	White Mountains NRA
March 7, 1987	35.018	Black Brant X	University of California at Berkeley	Second stage casing ruptured at T+20 sec.	Unknown
October 20, 1988	33.049	Taurus-Orion	University of Colorado	Second stage failed to ignite	ADNR Poker Flat Special Use
April 30, 1991	31.080	Nike-Orion[a]	University of Pittsburg	First stage fins broke off	Unknown
January 27, 1993	40.003	Black Brant XII	University of New Hampshire	Unknown	Unknown
March 7, 1994	31.071	Nike-Orion[a]	University of Houston	Premature ignition of second stage	Unknown
March 27, 2003	41.028	Terrier-Orion	Clemson University	Second stage did not separate properly	White Mountains NRA
March 6, 2005	40.017	Black Brant XII	Dartmouth	Third stage failed to ignite	White Mountains NRA

a. Rocket platform no longer in service.
Source: Truitt 2011.

3.14 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

This section addresses the existing socioeconomic conditions and characteristics in the ROI. The area most likely to experience socioeconomic impacts from PFRR operations is the area that supplies the majority of the inputs required for the facility's operation. All of the employees at PFRR reside within the Fairbanks North Star Borough. PFRR employs 13 full-time employees, 2 part-time employees, and 6 seasonal employees. PFRR is host to approximately 35 visiting scientists and payload personnel during launch operations, whose accommodations are also within the Fairbanks North Star Borough. The vast majority of labor at PFRR is supplied from within the Fairbanks North Star Borough; therefore, the Fairbanks North Star Borough is the ROI for this socioeconomic analysis.

3.14.1 Population and Housing

From 2000 to 2010, the population of Fairbanks North Star Borough increased approximately 18 percent to 97,581. Over the same period of time, the population of Alaska increased approximately 13 percent to 710,231 **(Census 2001a, 2011)**. In 2010, the minority population of the ROI and the State of Alaska constituted approximately 25.9 percent and 35.9 percent of the total population, respectively **(Census 2001a, 2011)**. Comparatively, the total minority population percentage of the ROI and Alaska is very similar to that of the United States (approximately 36.3 percent). **Table 3–20** displays the demographic characteristics of Fairbanks North Star Borough and the State of Alaska.

Table 3–20. Demographic Composition of Fairbanks North Star Borough and the State of Alaska

Population	Fairbanks North Star Borough	Percentage of Total Population	Alaska	Percentage of Total Population
Total Population	**97,581**	**100.0**	**710,231**	**100.0**
White non-Hispanic	72,259	74.1	455,320	64.1
Total Minority Population	**25,322**	**25.9**	**254,911**	**35.9**
Black or African American[a]	4,423	4.5	23,263	3.3
American Indian and Alaska Native[a]	6,879	7.0	104,871	14.8
Asian[a]	2,591	2.7	38,135	5.4
Native Hawaiian and other Pacific Islander[a]	396	0.4	7,409	1.0
Some other race[a]	1,446	1.5	11,102	1.6
Two or more races[a]	6,671	6.8	51,875	7.3
White Hispanic[a]	2,916	3.0	18,256	2.6
Hispanic or Latino (of any race)[b]	5,651	5.8	39,249	5.5

a. Includes persons self-identified as Hispanic or Latino.

b. Includes all persons self-identified as Hispanic or Latino, regardless of race.

Source: Census 2011.

The number of housing units in Fairbanks North Star Borough increased approximately 26 percent to 41,783 between 2000 and 2010, slightly faster than the population growth rate **(Census 2001b, 2011)**. Both the homeowner vacancy rate and the renter vacancy rate of the borough were higher than that of Alaska. A large portion of vacant housing in the ROI and Alaska is for seasonal, recreational, or occasional use and therefore is not included in the homeowner or rental inventory **(Census 2011)**. Housing characteristics of the ROI and Alaska are presented in **Table 3–21**.

Table 3–21. Housing Characteristics of the Region of Influence and the State of Alaska

Housing Characteristics	Fairbanks North Star Borough	Alaska
2000 Housing units	33,291	260,978
2010 Housing units	41,783	306,967
Percentage change	26	18
Vacant	5,342	48,909
Seasonal	1,676	27,901
Vacant units for sale	509	2,876
Owner-occupied units	21,502	163,771
Homeowner vacancy rate	2.3	1.7
Vacant units for rent	1,502	6,729
Renter-occupied units	15,110	95,960
Renter vacancy rate	9.0	6.6

Source: Census 2001b, 2011.

3.14.2 Regional Economic Characteristics

Total government (Federal, state, and local) was the largest employment industry in the Fairbanks North Star Borough, accounting for 31.2 percent of all employment in 2010. The largest private sector industry in the Fairbanks North Star Borough was education and health services, accounting for 12.7 percent of total employment, followed by retail trade at 11.8 percent **(DOLWD 2011a)**. The largest employers in the Fairbanks North Star Borough are the University of Alaska, the Fairbanks North Star School District, and the State of Alaska **(DOLWD 2011b)**.

As of July 2011, the unemployment rate of the Fairbanks North Star Borough was 6.1 percent. Similarly, the statewide unemployment rate of Alaska was 6.9 percent **(DOLWD 2011c)**. By comparison, the unemployment rate of the United States, 9.1 percent in July 2011, is much higher than that of the ROI or Alaska **(BLS 2011a)**. In 2009, the median income of the Fairbanks North Star Borough and the State of Alaska was $28,234 and $28,739, respectively.

3.14.3 Environmental Justice

The goal of environmental justice from a Federal perspective is to ensure fair treatment of people of all races, cultures, and economic situations with regard to the implementation and enforcement of environmental laws and regulations and Federal policies and programs. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (and the February 11, 1994, Presidential Memorandum providing additional guidance for this Executive Order) requires Federal agencies to develop strategies for protecting minority and low-income populations from disproportionate and adverse effects of Federal programs and activities. Minority and low-income populations are typically defined by comparing the demographics of potentially affected communities to those at the state, county, or local levels. The assessment of potential effects encompasses a broad range of resources, including those of the physical or natural environment and interrelated social, cultural, and economic factors.

To ensure compliance with Executive Order 12898, NASA prepared an Environmental Justice Implementation Plan (EJIP) in 1996 for activities managed by WFF, including those at remote sites such as PFRR. In the EJIP, NASA committed to incorporating environmental justice considerations in all its activities. A key component of NASA's environmental justice program is its continuing outreach activities. During project planning, NASA regularly holds public meetings and issues announcements to ensure that members of the public are aware of upcoming activities. These announcements are published through a variety of outlets, including the Internet, local radio, local (free) newspapers, and local town hall meetings. This outreach effectively ensures that people of all incomes and ethnicities have the opportunity to provide input on NASA's activities.

3.14.3.1 *Potentially Affected Communities*

A total of nine Alaska Native communities are located within or immediately adjacent to the launch corridor: Arctic Village, Beaver, Birch Creek, Chalkyitsik, Circle, Fort Yukon, Kaktovik, Stevens Village, and Venetie. These communities are discussed in detail in Section 3.9.3.4. The city of Chandalar has also been identified as within the launch corridor; however, very little information is available for this area as it is not an officially recognized place. **Table 3–22** displays population characteristics of the Alaska Native communities, the Fairbanks North Star Borough, and Alaska.

Table 3–22. Population Characteristics of Potentially Impacted Alaska Native Communities, the Fairbanks North Star Borough, and the State of Alaska

Alaska Native Village	Population in 2000	Population in 2010	Percentage Change	Alaska Native Population in 2000	Alaska Native Population in 2010	Alaska Native Population as a Percentage of Total Population	Percent Low-Income Population
Arctic Village	150	150	0	131	135	89	37
Beaver	84	84	0	72	82	98	34
Birch Creek	28	33	18	28	33	100	50
Chalkyitsik	83	69	–17	81	59	86	23
Circle	100	104	4	76	88	85	45
Fort Yukon	600	580	–2	510	520	89	18
Kaktovik	290	240	–18	220	210	89	10
Stevens Village	87	78	–10	83	66	85	16
Venetie	202	150	–26	190	140	91	26
Fairbanks North Star Borough	83,000	98,000	18	5,700	6,900	7.0	7.8
Alaska	630,000	710,000	13	98,000	105,000	15	9.0

Source: Census 2001a, 2010a, 2010b, 2011.

The total populations of most of these areas decreased between the 2000 and 2010 census, a few remained stable, and one community, Birch Creek, increased. Demographically, the proportion of minority and low-income people within the populations of these communities is high. As can be seen in the above table, the Alaska Native population constitutes the majority of the total population of these villages **(Census 2001a, 2011)**. Homeowner vacancy rates in all of the Alaska Native communities listed above are essentially zero. Similarly, renter vacancy rates for most of the communities are also zero. Arctic Village, Beaver, Fort Yukon, and Venetie all have renter vacancy rates higher than the Fairbanks North Star Borough and Alaska. However, the higher rates are primarily due to a small rental inventory and not a large number of vacant units **(Census 2011)**.

Both the median income and per-capita income of the potentially affected Alaska Native communities are much lower than those of the Fairbanks North Star Borough and Alaska. **Table 3–23** displays income characteristics of the native communities, the Fairbanks North Star Borough, and the State of Alaska. Most native communities exhibit a per-capita income that is much higher than the median income. This is an indication of higher-than-average unemployment and a large percentage of the working population employed in the public sector.

Table 3–23. Income Characteristics of the Potentially Affected Alaska Native Communities, the Fairbanks North Star Borough, and the State of Alaska

Location	Median Income	Per-Capita Income
Arctic Village	6,806	9,893
Beaver	6,641	12,267
Birch Creek	13,750	9,821
Chalkyitsik	12,019	19,761
Circle	2,917	13,503
Fort Yukon	17,468	19,254
Kaktovik	15,750	19,022
Stevens Village	10,982	20,437
Venetie	8,542	11,236
Fairbanks North Star Borough	28,234	28,482
Alaska	28,739	29,504

Source: Census 2010c, 2010d, 2010e, 2010f.

Villages, towns, and cabins are considered "special protection zones" during rocket mission planning and operations. Some villages have individual agreements with UAF (*e.g.*, Venetie and Arctic Village) and receive monetary compensation if the probability of a rocket landing on native property is above a stated threshold. The village of Fort Yukon is a "no fly zone."

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