CHAPTER 3
AFFECTED ENVIRONMENT

AFFECTED ENVIRONMENT

3.1 LAND USE

The lands affected by the proposed withdrawal renewal have been used by the military for approximately 50 years. Current use includes military maneuvering, training, equipment development and testing, and other defense-related purposes.

The Military Lands Withdrawal Act required the Army and Bureau of Land Management to prepare Resource Management Plans for the Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. Resource Management Plans were completed in 1994. The Army and Bureau of Land Management manage the natural resources on the withdrawal lands in accordance with the 1994 plans, recognizing the withdrawal is for military purposes.

U.S. Army Alaska is currently preparing Integrated Natural Resources Management Plans for Fort Wainwright and Fort Greely as required by the Sikes Act (Public Law 105-85, 16 U.S. Code 670a et seq.). It is working with the Bureau of Land Management, other State and Federal agencies, and the public in the development of these plans. The plans are written for a five year period. When the Integrated Natural Resources Management Plans are completed and approved, management of the withdrawal lands will continue under the new plans. At the end of each five year period, the plans are reviewed and updated by U.S. Army Alaska, Federal and State agencies, and the public.

This LEIS does not pre-empt or replace the existing Resource Management Plans completed in 1994. The Resource Management Plans will continue to be implemented on the withdrawal lands until November 6, 2001, through the approved Memorandum of Understanding (MOU) (AK-930-9508), or until the MOU is cancelled, extended, or renewed. Approval of the proposed Integrated Natural Resources Management Plans for Fort Wainwright and Fort Greely may require modification or replacement of the existing MOU.

3.1.1 Land Acquisition for Military Use

Fort Wainwright Yukon Training Area

In 1950, the Air Force obtained a permanent withdrawal of 22,600 acres through a Public Land Order (PLO) within what is now known as the Fort Wainwright Yukon Training Area. Additional permanent withdrawals were granted to the Air

Force in 1952 for 6,720 acres and in 1955 for 4,760 acres. These withdrawals were later transferred to the Army. In 1956, the Army obtained a permit from the Secretary of the Interior for use of 256,000 acres and two NIKE missile test sites, making up the remainder of the Yukon Training Area.

After passage of the Engle Act in 1958 (all withdrawals of more than 5,000 acres for defense purposes require Congressional approval), Congress passed legislation withdrawing 256,000 acres of the Fort Wainwright Yukon Training Area in 1961 for a 10 year term. That withdrawal was extended for an additional five years in 1971 through a Public Land Order. In 1976, the Yukon Training Area was segregated from public use pending renewal of the existing withdrawal by Congress. Congress renewed the withdrawal in 1986 for a 15 year term with the passage of the Military Lands Withdrawal Act (Public Law 99-606, 100 Stat. 3457 et seq.). At that time, the Army did not renew 1,600 acres and it is now part of the Chena River State Recreation Area. Figure 3.1.a shows the property acquisition history of Fort Wainwright.

Fort Greely West and East Training Areas

In 1950, the Army obtained a Special Land Use permit from the Department of the Interior for use of 572,000 acres now known as the Fort Greely West Training Area. The permit was granted six month extensions until passage of legislation in 1961 granting withdrawal for a 10 year term. The withdrawal was renewed in 1971 for five years, excluding a five acre Trade and Manufacturing site near the western edge of the West Training Area. In 1976, the West Training Area was segregated from public use pending renewal of the existing withdrawal by Congress. Congress renewed the withdrawal in 1986 for a 15 year term with the passage of the Military Lands Withdrawal Act.

The Army obtained permanent use of a 160 acre tract of the Fort Greely East Training Area in 1955 by a Public Land Order. In late 1958, the Army obtained the use of 51,750 acres of the East Training Area by a permit from the Department of the Interior (including the 160 acre tract). The permit was granted extensions until passage of Congressional legislation. The legislation passed in 1961, granting the Army use of 51,590 acres of the East Training Area for a 10 year term. That legislation excluded the 160 acre tract, which was returned to the Bureau of Land Management. The withdrawal was renewed in 1971 for five years. In 1976, the East Training Area was segregated from public use pending renewal of the existing withdrawal by Congress. Congress renewed the withdrawal in 1986 for a 15 year term with the passage of the Military Lands Withdrawal Act (Public Law 99-606, 100 Stat. 3457 et seq.). Figure 3.1.b shows the property acquisition history of Fort Greely.

For a more detailed summary of land acquisition for Fort Wainwright and Fort Greely see Appendix 1.B.

Submerged Lands
The State of Alaska, Department of Natural Resources, Division of Land, has indicated interest in the Delta River, including an ownership interest in the lands submerged under the Delta River. The United States Army Alaska is reviewing the Division of Land's ownership claim. The Division of Land has also requested cleanup of the Delta River. The United States Army Alaska will continue to use submerged lands for training purposes until the issue is resolved.

3.1.2 Existing Rights-of-Way

The Trans-Alaska Pipeline System transports crude oil from Prudhoe Bay to Valdez, Alaska. The Pipeline System right-of-way extends through the Fort Wainwright Yukon Training Area and the Fort Greely West Training Area. The right-of-way was authorized by the Trans-Alaska Pipeline Authorization Act of 1973. Its width is 50 feet plus the ground area occupied by the pipeline, which is approximately four feet.

A right-of-way for the Alaska Natural Gas Transportation System is adjacent to the Trans-Alaska Pipeline System on the Fort Wainwright Yukon Training Area. The right-of-way width for the natural gas pipeline is 50 feet.

A right-of-way has been approved by the Army and Bureau of Land Management for the proposed Trans-Alaska Gas System, which runs roughly parallel with the Trans-Alaska Pipeline System and the Alaska Natural Gas Transportation System through the Yukon Training Area and Fort Greely West Training Areas. (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a and 1994b).

3.1.3 Surrounding Land Use

The majority of land surrounding the Fort Wainwright Yukon Training Area is State land. Principal management of State land to the east of the Yukon Training Area is for fish and wildlife habitat, and public recreation. State lands to the south are managed for fish and wildlife habitat, and forestry. About 3,000 acres have been designated for agricultural sale and 200 acres for settlement. Private and Borough-owned land parcels exist south of the Yukon Training Area. Eielson Air Force Base adjoins the western boundary of the Yukon Training Area. North of Eielson Air Force Base is State land managed for public recreation, fish and wildlife habitat, and privately owned land.

The Chena River Recreation Area borders the Yukon Training Area to the north. Remaining State land west of the Recreation Area is managed for agriculture,

public recreation, fish and wildlife habitat, and for future recreational settlements or fee simple homesteads (approximately 490 acres). Borough-owned land and Tanana Valley State Forest land also exists north of the Yukon Training Area. The *Tanana Basin Area Plan for State Lands* (1991) indicates two small parcels of native-owned land along the northern boundary of the Yukon Training Area.

Fort Greely is surrounded by State land except for a tract of Federal land to the south of the West Training Area managed by the Bureau of Land Management. State lands to the north of Fort Greely are managed for forestry, fish and wildlife habitat, public recreation, and watershed maintenance. Up to 60,000 acres may be designated for agricultural disposal. An additional 1,000 acres is designated for future settlement. Privately owned land exists north of the State land. Adjacent to the eastern boundary of the Fort Greely East Training Area, the State has designated bison habitat to provide winter range and alter seasonal movement to minimize damage to area agricultural lands. State lands along the southern boundaries of the Training Areas are managed for public recreation, mineral exploration, and fish and wildlife habitat. State lands adjacent to the western boundary of the West Training Area are managed for fish and wildlife habitat, forestry, and mineral exploration. State lands located between the Training Areas are managed for public recreation and designated for settlement (ADNR 1991).

3.2 CLIMATE

The natural environment of Fort Wainwright and Fort Greely is greatly influenced by climate. The region is subject to vast annual temperature variations including short moderate summers and long cold winters with low precipitation, low humidity and extreme seasonal contrasts in sunlight duration. These characteristics are typical of the continental Subarctic climate region in which the entire withdrawal area is located.

Weather patterns of the Fort Wainwright and Fort Greely region are determined by the mountain ranges framing the area on three sides. This restrictive barrier limits the flow of warm, moist, maritime air during most of the year and promotes the settling of cold Arctic air into the Tanana-Kuskokwim Lowlands. The inflow of polar air masses and the persistent snow cover create extreme low temperatures in the area and prevent the absorption of solar radiation. Over 80% of the year the sky above Fort Wainwright and Fort Greely is considered partly cloudy to cloudy.

Climatic data for Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas are collected at individual climatological stations near the withdrawal lands as shown in Figure 3.2.a. The information presented here should serve only as a relative picture of the current climate conditions. Local influencing factors, such as mountain ranges and upland areas, will have an effect on the normal and extreme values. Thus, climate values should not be considered the same for all of the withdrawal lands. Appendix 3.2 contains monthly climatic summaries for each climate station.

Fort Wainwright Yukon Training Area

Average monthly temperatures recorded at Eielson Air Force Base (AFB) range from a low of -10.5°F in January to a high of 60°F in July. Maximum temperatures are typically recorded within the months of June and July. The highest recorded daily temperature, 93°F, occurred on June 15, 1969. On average, one or less days per year have a temperature higher than 90°F. The lowest temperatures are typically recorded between November and March due to the low amount of daylight. Average monthly temperatures vary from below zero to 10°F, with a record low of -64°F occurring on January 23, 1971. Approximately 160 days each year have temperatures of 35°F or less.

Total annual precipitation averages 13 inches at Eielson AFB. Precipitation during the summer months is in the form of rain showers with maximum intensity and duration occurring in July. Precipitation events of 0.5 inches or more a day occur on average only four times during the summer. A noticeable decline in precipitation begins in August and continues through the month of April. Total annual snowfall averages 76.4 inches. A maximum of 58.7 inches fell in November 1990, and record seasonal snowfalls occurred in the spring and fall of 1992. Blizzard conditions are rarely experienced in the Fort Wainwright area. There is a cover of snow on the ground for more than six months of the year, with the average maximum snow depth of 18 inches occurring in March.

Wind velocity is relatively low at the Yukon Training Area. For approximately 60% of the year, the winds are calm (eight miles an hour or less). Wind speed averages five miles per hour with a prevailing direction of north. However, during the months of June and July, wind direction is southwest (Defense Mapping Agency 1978).

On average, the last date of freezing temperatures in the spring is May 21 and the first frost in the fall is August 30. The length of the growing season averages 100 days (Defense Mapping Agency 1978).

Fort Greely West and East Training Areas

Maximum temperatures are typically recorded within the months of June and July. During these months, the sun is above the horizon from 18 to 21 hours each day and the average temperatures reach 60°F. Average monthly temperatures recorded at Big Delta in Alaska range from -4.0°F in January to 60.2°F in July. The highest recorded daily temperature of 92°F occurred on June 15, 1969. On average, one or less days with extreme temperatures higher than 90°F are recorded. Lowest temperatures are typically recorded between November and March due to the low amount of daylight. Sunlight ranges from 10 hours to less than 4 hours per day. Average monthly temperatures vary from below zero to 15°F, with a record extreme daily low of -63°F occurring on January 30, 1947. Approximately 150 days having temperatures of 35 °F or less are recorded during the year.

Annual precipitation at Fort Greely totals 11.71 inches. Precipitation during the summer months is in the form of rain showers. The frequency and intensity of rain showers increase as the summer progresses, building to a maximum in August (Defense Mapping Agency 1978). Precipitation events of 0.5 inches or more a day occur on average only four times during the summer. A noticeable decline in precipitation begins in September and continues through the month of April. Total annual snowfall averages 44.5 inches. A maximum of 41.8 inches fell in November 1994 and the record seasonal snowfall occurred in the fall of the same year. Snow covers the ground for more than six months of the year, with the average maximum snow depth of 10 inches occurring in February.

Wind velocity at Fort Greely averages 11 miles per hour with a prevailing south direction. From October to March the wind direction is east-southeast switching to primarily south and south-southwest for the remainder of the warmer months. For approximately 14% of the year, the winds are calm, eight miles an hour or less (Defense Mapping Agency 1978).

Data regarding the last day of freezing, first day of frost, and length of growing season were unavailable for the Fort Greely area. However, values would be expected to be similar to those listed for Fort Wainwright.

3.2.1 Air Quality and Emissions

National Ambient Air Quality Standards (NAAQS) are set by the Clean Air Act to establish the maximum allowable concentrations of air pollutants. The NAAQS serve as the ultimate air quality goal for the entire nation. Six pollutants are regulated under the NAAQS program: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10}), and sulfur dioxide (SO_2). The State of Alaska also regulates ammonia and reduced sulfur

compounds. Primary and secondary standards have been established for the pollutants. Primary standards protect human health and secondary standards protect public welfare (Table 3.2.a).

Table 3.2.a National and State of Alaska Ambient Air Quality Standards (AAQS).

Pollutant	Averaging Period	Exceedance	Primary National AAQS	Secondary National AAQS	Alaska AAQS
Ozone (O_3)	1-hour Average 8-hour Average	Three year average not to exceed 1.0.	- 157 $\mu g/m^3$	- 157 $\mu g/m^3$	235 $\mu g/m^3$ -
Carbon Monoxide (CO)	1-hour Average 8-hour Average	Not more than once a year.	40 mg/m^3 10 mg/m^3	- -	40 mg/m^3 10 mg/m^3
Sulfur Dioxide (SO_2)	3-hour Maximum 24-hour Maximum Annual Arithmetic Mean	Not more than once a year.	- 365 $\mu g/m^3$ 80 $\mu g/m^3$	1,300 $\mu g/m^3$ - -	1,300 $\mu g/m^3$ 365 $\mu g/m^3$ 80 $\mu g/m^3$
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	Not more than once a year.	100 $\mu g/m^3$	100 $\mu g/m^3$	100 $\mu g/m^3$
Particulate Matter of 10 Microns or Less (PM_{10})	24-hour Average Annual Arithmetic Mean	Three year average not to exceed 1.0.	150 $\mu g/m^3$ 50 $\mu g/m^3$	150 $\mu g/m^3$ 50 $\mu g/m^3$	150 $\mu g/m^3$ 50 $\mu g/m^3$
Lead (Pb)	Annual Quarterly Average	Not more than once a year.	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
Ammonia	8-hour Average	Not more than once a year.	-	-	2.1 mg/m^3
Reduced Sulfur Compounds	30-minute Average	Not more than once a year.	-	-	50 $\mu g/m^3$

An additional Clean Air Act regulation that applies to the withdrawal lands is the Prevention of Significant Deterioration (PSD) program. This program preserves air quality in areas that already meet or exceed the NAAQS for clean air. This program primarily applies to industrial projects that build new facilities or increase emissions through the expansion and modification of existing facilities. Existing air quality is further protected by additional nitrogen dioxide, sulfur dioxide, and total suspended particulate matter limitations. The PSD program also classifies areas into three categories to establish the amount of protection needed to prevent future air pollution. The Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas are within a Class II designated

area (areas in attainment of the NAAQS or unclassifiable due to lack of data), which includes the majority of Alaska.

The State of Alaska is divided into four Intrastate Air Quality Control Regions based on common meteorological, industrial, and socioeconomic factors. The withdrawal lands are located in the Northern Intrastate Air Quality Control Region (AQCR9), which covers a total of 320,000 square miles and includes the northern half of the state. Areas within each control region can be classified as either attainment (local air quality meets or exceeds the established standards) or non-attainment (local air quality fails to meet the established standards) for each criteria pollutant. Occasional non-attainment episodes are experienced during the winter months during periods of strong temperature inversions. These poor air quality episodes involve increases in carbon monoxide and particulates.

The majority of local air quality information has been collected within the Fairbanks vicinity. Specific air quality data have not been collected at Fort Wainwright Yukon Training Area or Fort Greely West and East Training Areas. The closest non-attainment area to the withdrawal lands are the cities of Fairbanks and North Pole, including the developed portion of Fort Wainwright's Main Post area. These areas are designated as non-attainment for carbon monoxide. Table 3.2.b lists the highest carbon monoxide values recorded for each year at various Fairbanks monitoring stations. Generally, Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas air quality is good.

Table 3.2.b Carbon Monoxide Air Quality Values Collected at Fairbanks, Alaska (AIRSWeb 1998). Values are reported in parts per million (ppm).

Monitor	1992	1993	1994	1995	1996	1997
Carbon Monoxide 8-hour Value - Highest Value Recorded in Each Year *EPA and State of Alaska Air Quality 8-hour Standard for Carbon Monoxide - 9 ppm*						
020900002-1	10.2	12.0	13.5	15.2	9.8	13.3
020900013-1	9.2	10.3	10.7	10.6	9.1	12.2
020900020-1	10.3	10.9	12.4	12.1	8.8	12.8
Carbon Monoxide 1-hour Value - Highest Value Recorded in Each Year *EPA and State of Alaska Air Quality 1-hour Standard for Carbon Monoxide - 35 ppm*						
020900002-1	16.0	22.8	20.7	24.3	12.2	17.7
020900013-1	11.0	19.5	15.8	20.9	12.3	18.2

Table 3.2.b Carbon Monoxide Air Quality Values Collected at Fairbanks, Alaska (AIRSWeb 1998). Values are reported in parts per million (ppm).

Monitor	1992	1993	1994	1995	1996	1997
020900020-1	12.9	15.6	14.4	15.0	13.2	14.7

The primary source of carbon monoxide in Fairbanks is vehicle emissions. The levels of carbon monoxide are highest in the winter when cold spells accompanied by low winds produce temperature inversions. The topography of the area (Fairbanks lies in the Tanana River Valley) contributes to these climate conditions (U.S. Army Corps of Engineers Alaska District 1997). Appendix 3.2 contains an estimate of carbon monoxide emissions resulting from military mobile sources. Estimates of daily wintertime carbon monoxide emissions for Fairbanks during 1990, 1995, and 2000 are also included in Appendix 3.2.

The Fairbanks area has a relatively high suspended particulate concentration, even though it is an attainment area for particulate matter (Table 3.2.c). Main sources of suspended particulates are coal-burning power plants, residential wood and coal burning, road dust, and vehicle emissions. Particulate concentrations are highest in the winter (U.S. Army Corps of Engineers Alaska District 1997).

Table 3.2.c Particulate Matter Air Quality Values Collected at Fairbanks, Alaska (AIRSWeb 1998). Values are reported in micrograms per cubic meter of air ($\mu g/m^3$).

Monitor	1992	1993	1994	1995	1996	1997
Particulate Matter 24-hour Value - Highest Value Recorded in Each Year *EPA Air Quality 24-hour Standard for Particulate Matter - 150 $\mu g/m^3$*						
020900025-2	115	92	76	102	98	60
020900010-2	60	74	65	99	57	56
Particulate Matter Annual Mean Value *EPA Air Quality Annual Mean Standard for Particular Matter - 50 $\mu g/m^3$*						
020900025-2	29.6	27.3	27.3	29.3	28.5	26.5
020900010-2	24.3	23.8	21.1	23.8	21.6	23.3

3.2.2 Ice Fog

The phenomenon of ice fog is primarily a human-made atmospheric condition. Its primary source is water vapor output from combustion activities such as automobile exhaust, household chimneys, power plant stacks, dust particles, and other sources associated with urban environments, which include human and animal breath and urban open water bodies such as settling ponds.

Ice fog is a unique condition within an urban area such as Fairbanks. Ice fog consists of supercooled water droplets that have crystallized as a result of temperatures falling below -22°F. During this cooling cycle, water is gradually condensed out of the air until the droplets freeze, forming ice fog. The formation of ice fog is rapid and widespread. It persists as long as the cold spell lasts and a continual source of moisture from human activities is present. The frequency of ice fog formation varies from 5 to 20 times per year with a duration of several hours to several days (Benson 1965).

Ice fog occurs in concentrated population centers where extremely strong temperature inversions are able to form. Population centers create a net loss of heat from the earth's surface by outgoing longwave radiation. Temperature inversions form when temperatures fall below -22°F. The surrounding topography contributes to the severity of the inversions. Air within the lowlands is typically colder and denser than the air moving in from the uplands. The incoming air cannot penetrate and moves across the cooler, low-lying air. As a result, the lower air is trapped causing the air to stagnate and cool.

Ice fog is generally 30 feet thick, rarely exceeding thicknesses of 90 feet. Both its vertical thickness and density increase as temperatures decrease. This is especially evident when temperatures plunge below -40°F. At this point, street-level visibility in Fairbanks is reduced to less than 90 feet (Benson 1965). Ice fog seldom reaches 1,000 feet above the ground level.

3.3 TERRAIN

Fort Wainwright Yukon Training Area

The Fort Wainwright Yukon Training Area is located entirely within the Yukon-Tanana Upland section of the larger Northern Plateaus physiographic province. Rounded, even-topped ridges with gentle side slopes characterize this section of broad, undulating divides and flat-topped spurs. Ridges are usually 3,000 to 5,000 feet in elevation, but some have domes as high as 6,800 feet. The entire Yukon-Tanana Upland section lies within the larger Yukon River catchment

(Figure 3.3.a). Most streams originating in the Yukon Training Area flow south and west to the Tanana River, which is a tributary of the Yukon River. The few lakes present in the area are primarily thaw lakes located in valley floors. No glaciers exist within the uplands, but the entire section is underlain by discontinuous permafrost (Wahrhaftig 1965).

Fort Greely West and East Training Areas

The Fort Greely West and East Training Areas are separated into two physiographic provinces: Western Alaska and Alaska-Aleutian. The northern section of the Training Areas are located within the Tanana-Kuskokwim Lowland section of the Western Alaska province (Figure 3.3.b). The Tanana-Kuskokwim Lowland is a broad depression located just north of the Alaska Range. Coalescing outwash fans spread northward from the Alaska Range at a slope of 20 to 50 feet per mile towards the floodplain of the Tanana River. Braided glacial streams flow from these fans across the lowland at intervals of 5 to 20 miles. Over time, glacial outwash has pushed the Tanana River against the rolling hills of the uplands to the north. Although the Tanana-Kuskokwim Lowland contains no glaciers, the area is generally underlain by permafrost and contains numerous thaw lakes and sinks. In the outwash areas, the alluvium consists of porous gravel and has a deep water table allowing for substantial infiltration (Wahrhaftig 1965).

The southern portion of the Training Areas is located within the Northern Foothills of the Alaska Range section of the larger Alaska-Aleutian province (Figure 3.3.b). Topographic features within this section include flat-topped, east-trending ridges 2,000 to 4,000 feet in elevation, 3 to 7 miles wide, and 5 to 20 miles long. These foothills are separated by rolling lowlands 700 to 1,500 feet in elevation and 2 to 10 miles wide. Most streams flowing through the foothills originate in the Alaska Range and flow north in rugged V-shaped canyons and across the broad terraced valleys of the Tanana-Kuskokwim Lowland. Although no local glaciers originate in the Northern Foothills, a few glaciers from the Alaska Range terminate there and permafrost is extensive (Wahrhaftig 1965).

3.3.1 Glaciers

Glaciers are important and influential natural features located in the Fort Greely region. A glacier is defined as a large mass of snow and ice on the land that persists for many years. Glaciers are a product of local climate regimes. They are formed over a number of years when more snow falls than melts. As the snow accumulates, it is compressed into solid ice. Eventually this solid mass begins to flow outward due to its own weight. Glaciers are present south of Fort Greely, originating in the Alaska Range. Valley glaciers located in this rugged

topography include Gilliam, Trident (whose terminus is within Fort Greely West Training Area), and Hayes Glaciers (Figure 3.3.c).

3.4 GEOLOGY

Fort Wainwright Yukon Training Area and Fort Greely are located within a large geological province known as the Yukon-Tanana (Y-T) terrane. This is a region of deformed and faulted metamorphic rocks of Paleozoic and possibly Precambrian age. (See Appendix 3.4 for an explanation of technical geologic terms and ages.) The rocks have been intruded by plutons of Mesozoic and Cenozoic age, and overlain by younger sedimentary formations of Tertiary and Quaternary age.

The Y-T terrane extends from the Denali fault in the south to the Tintina fault in the north, and from western Alaska to western Canada. It encompasses three major physiographic provinces (Yukon-Tanana Upland, Tanana-Kuskokwim Lowland, and Northern Foothills) that are previously described in Chapter 3.3 of this Legislative Environmental Impact Statement.

For many years, the older metamorphic and igneous rocks in interior Alaska were known collectively as the Birch Creek Schist. However, this nomenclature has been abandoned by the scientific community and the mineral industry. The Y-T terrane is now recognized as a complex assemblage of many rock types with a very complicated geologic history (Hansen and Dusel-Bacon 1998).

Moderate seismic activity occurs throughout the region. However, the earthquakes have not been linked to movement along known faults. They may be associated with block rotation between the Tintina and Denali faults resulting from the collision of the Pacific and North American plates (Page et al. 1991, Page et al. 1995, Hammond, pers. com. 1998).

There has not been much geologic fieldwork on Fort Wainwright or Fort Greely since the lands were withdrawn in the 1950s. In interior Alaska, geologic mapping has always been challenging due to difficult access, poor exposures, dense vegetation, thick surficial deposits, complex structures, and lack of fossils (Foster 1992, Foster et al. 1994). However, modern geochemical and geophysical techniques are leading to a better understanding of the region's geologic history, structural relationships, and mineralization (Newberry et al. 1996).

Fort Wainwright Yukon Training Area

The general geology of the Fort Wainwright Yukon Training Area is shown on Figure 3.4.a. Major rock units are color-coded, and identified by abbreviated symbols such as Pzq, Pzsg, etc. The withdrawal area is underlain by altered and deformed rocks of Paleozoic and possibly Precambrian age that were originally deposited offshore in a continental margin environment (Foster et al. 1994). They were intruded in the late Cretaceous Period by the Eielson pluton. The area is cut by northeast-trending, high-angle faults. Bedrock is largely obscured by extensive deposits of wind-blown sand and loess, locally as much as 150 feet thick (Dusel-Bacon et al. 1998a, Foster et al. 1979, Weber et al. 1978).

Fort Wainwright Yukon Training Area is in the Salcha seismic zone, a distinct northeast-trending band of epicenters about 50 kilometers long (Page et al. 1991, Alaska Earthquake Information Center and U.S. Geological Survey 1997). Although the epicenters form a conspicuous pattern, no associated fault movement has been identified (Page et al. 1991). The Salcha Earthquake of 1937 was one of the largest ever recorded in the Interior, with a magnitude of 7.3. Its epicenter was less than 10 miles from the southwest corner of the Yukon Training Area (Figure 3.4.a). In 1996, an earthquake with a magnitude of 4.2 occurred on the Yukon Training Area east of Eielson Air Force Base (U.S. Geological Survey National Earthquake Information Center 1998, Alaska Earthquake Information Center 1998). Many smaller earthquakes, not shown on Figure 3.4.a, are routinely detected.

Earthquakes to the west of the Yukon Training Area are associated with the Fairbanks seismic zone, another northeast-trending band of activity. An average of five or six earthquakes a year are actually felt in this zone, and swarms of micro-earthquakes occur (Page et al. 1991). In June 1967, a series of three earthquakes of about magnitude 6 had epicenters to the west of the withdrawal lands. Two other moderate (magnitude 4.0-4.6.) quakes occurred in this zone in 1977 (U.S. Geological Survey National Earthquake Information Center 1998, Alaska Earthquake Information Center 1998).

Fort Greely West and East Training Area

The general geology of the Fort Greely area is shown on Figure 3.4.b. Major rock units are color-coded, and identified by abbreviated symbols such as Kgd, Pzs, etc. The Fort Greely area is underlain by altered sedimentary and volcanic rocks of Paleozoic age (see Appendix 3.4), which were later intruded by granitic plutons. These rocks were subsequently overlain by Tertiary-age sediments of continental origin. The oldest of the Tertiary sediments contains coal. As the Alaska Range rose to the south, the exposed Tertiary sediments were eroded, then covered by massive gravel deposits known as the Nenana gravel. Glaciers

flowed northward from the Alaska Range during the Quaternary Period, depositing moraine and outwash material in the withdrawal area. Deposits of loess were laid down between glacial periods (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a).

Structural features, such as faults, are masked by recent deposits of sand, gravel, and silt. The withdrawn lands lie immediately north of the active Denali fault, which runs roughly west-northwest near the southern boundary of the West Training Area and the northern edge of the Alaska Range.

The northwest corner of Fort Greely West Training Area is at the edge of the Salcha seismic zone (described previously in this chapter). Since 1973, only three earthquakes larger than magnitude 4 have been recorded in or immediately adjacent to Fort Greely (Figure 3.4.b). These include a 1994 quake of magnitude 4.1 east of One Hundred Mile Creek in the West Training Area, and a magnitude 4.5 quake near the northeast boundary of the West Training Area in 1992. The third earthquake was west of the Little Delta River, outside Fort Greely (U.S. Geological Survey National Earthquake Information Center 1998, Alaska Earthquake Information Center 1998).

3.5 MINERAL RESOURCES

Mineral resources on the withdrawn lands are managed by the Bureau of Land Management (BLM) under Federal regulations found in 45 CFR 3000. Sale and/or free use of mineral materials require National Environmental Policy Act review, and military concurrence. Unauthorized use of mineral materials is considered trespass and will be resolved jointly by the military and BLM. The BLM identifies three categories of mineral resources on Federal lands:

Locatable minerals include most metals, metallic ores, and some non-metallic minerals. If the land is open to mineral location under the Federal mining laws, private citizens may stake or "locate" a claim, perform assessment work, and develop the resource. Valid mining claims can result in private ownership of the mineral resource. The withdrawn areas have been closed to mineral location since the 1950s. There are no valid or existing mining claims within the withdrawals (Keill, pers. com. 1998).

Leasable minerals include oil, gas, coal, geothermal resources, oil shale, gilsonite, phosphate, potassium, and sodium. These mineral resources are leased from the Federal government for a period of time and do not become the

developer's property. The withdrawn areas have been closed to mineral leasing since the 1950s. There are no valid leases on the withdrawn lands.

Saleable minerals consist basically of construction materials such as sand, gravel, riprap, cinders, pumice, clay, limestone, and dolomite. They are purchased outright from the Federal government. Saleable minerals on the withdrawn lands have been used locally by the Army and other authorized agencies, but have not been extracted commercially since the lands were first withdrawn in the 1950s.

There has been little active mineral exploration or development within the withdrawn lands, either before or after the military withdrawals. The areas are largely obscured by floodplain deposits, loess, and heavy vegetation, and there has been no compelling evidence of major mineralized trends (Foster et al. 1979, Bundtzen, pers. com. 1998, Weber, pers. com. 1998).

However, interior Alaska is one of the State's most important regions for mineral production (Swainbank and Clautice 1998). The Fairbanks Mining District, which encompasses Fort Wainwright and a portion of Fort Greely West Training Area, is the largest historic gold producer in the State (McCoy et al. 1997). The Fairbanks District has experienced a resurgence in activity with the development of the giant Fort Knox gold mine, about 15 miles northeast of Fairbanks. Fort Knox began commercial gold production in 1997. In addition to gold, other potentially economic mineralization has been identified in the Fairbanks Mining District, including silver, bismuth, antimony, tungsten, tin, and lead (Newberry 1996).

To the north of Fort Greely West Training Area, the Richardson District has produced placer gold since the turn of the century (Menzie and Foster 1978) and is presently being evaluated for its lode (hardrock) gold potential.

Forty miles east of Delta Junction, active delineation work is taking place in the Goodpaster District, at the Pogo prospect, where substantial amounts of gold occur within underground quartz veins (Smith et al. 1998, Swainbank and Clautice 1998).

Fort Wainwright and Fort Greely lie within an area with abundant surficial deposits of sand and gravel for construction, as well as silt and peat for agricultural use (Newberry et al. 1996). Near North Pole, Alaska, basalt has been quarried commercially for several years, providing high-quality decorative stone and riprap for local projects (Bundtzen, pers. com. 1998).

Fort Wainwright Yukon Training Area
Locatable Minerals

Figure 3.5.a shows potential locatable mineral resources within Fort Wainwright Yukon Training Area. These potential resources are, generally, associated with certain geologic units depicted on Figure 3.4.a.

Lode deposits of copper, lead, zinc, silver, and gold could potentially occur in the northeast portion of the withdrawal, within the units identified as Pzq and Pzsg. These units include rocks of volcanic and sedimentary origin that may contain so-called volcanogenic ("VMS") and shale-hosted ("sedex") sulfide deposits.

In the 1970s, the U.S. Geological Survey (USGS) studied the Big Delta Quadrangle, which encompasses most of the Fort Wainwright Yukon Training Area. Weber and others (1978) mapped the Pzq unit within the withdrawal area (Figure 3.4.a). O'Leary and others (1978) collected stream samples for chemical analysis, and found that streams flowing from the Pzq unit (Figure 3.4.a) had anomalously high concentrations of zinc and copper. The Pzq unit was identified as a target for sedex-type mineralization (Menzie and Foster 1978).

Lead-zinc mineralization has been studied in similar rocks over a broad area of eastern Alaska and the Yukon Territory. To the northeast of the Fort Wainwright Yukon Training Area, recent drilling in the Pzq by WGM, Inc. has identified up to 13 feet of 0.92% zinc, 0.32% lead, and up to 38 grams per ton silver (Dusel-Bacon et al. 1997 and 1998a, b, c).

The Pzsg unit (Figure 3.4.a) contains volcanic and sedimentary rocks that could also potentially host VMS mineralization with concentrations of copper, lead, zinc, silver, and gold. The Pzsg unit is exposed in the eastern part of the Training Area, but VMS-type mineralization has not yet been documented in the withdrawn lands. Currently, exploration for VMS deposits is taking place in the Bonnifield District, along the north flank of the Alaska Range, in rocks of similar age (Newberry et al. 1997, Smit 1998).

The geochemistry of the granitic Eielson pluton (Forbes and Weber 1975) is not considered favorable for gold deposits such as those found in plutonic rocks at Fort Knox (Burns et al. 1991, Solie et al. 1990). However, geochemical indicators are not always conclusive (McCoy et al. 1997, Newberry and McCoy 1997).

Portions of Fort Wainwright Yukon Training Area have a moderate to high potential for placer gold and tin deposits. Historic placer mines are reported on Beaver Creek and Pine Creek in the northeast corner of the Training Area

(Figure 3.5.a). One small placer mine was located to the north of the withdrawal area at Nugget Creek. These mines were small, and no production records are available (Menzie and Foster 1978).

Leasable Minerals
Fort Wainwright Yukon Training Area was previously evaluated for leasable mineral potential by the U.S. Dept. of the Interior and U.S. Dept. of Defense (1994b). The area has an unfavorable geologic setting for oil, gas, or other leasable mineral deposits. A long history of intrusive activity has altered and deformed the sedimentary rocks, making them unsuitable hosts. Because of this low potential, no map of leasable resources has been included in this Legislative Environmental Impact Statement.

The U.S. Dept. of the Interior and U.S. Dept. of Defense (1994b) assigned moderate potential for geothermal resources, based on similarities to the geology of Chena Hot Springs and Circle Hot Spring, to the north. A geothermal test hole drilled seven miles from Fort Wainwright Yukon Training Area (near North Pole) yielded heat flow values of 75 to 100 milliwatts per square meter. The worldwide average is 62.8 milliwatts per square meter. A geothermal gradient of 31.5°C per kilometer was measured in a deep test hole drilled on the north side of the Eielson pluton. The geothermal gradient in the earth's crust averages 25°C per kilometer.

Saleable Minerals
Within the Fort Wainwright Yukon Training Area, the Army has extracted sand and gravel locally for road and runway construction. Sand and gravel have not been mined commercially (Griffen, pers. com. 1998) but have been made available to other authorized agencies.

Fort Greely West and East Training Area
Locatable Minerals
Figure 3.5.b shows areas with potential locatable mineral resources in the Fort Greely area. These resources may be associated with certain rock units, which are depicted on Figure 3.4.b. The geology in this area could be favorable for VMS or sedex sulfides (see above), copper-molybdenum porphyry (Nokleberg et al. 1990), lode gold similar to Pogo (Smith et al. 1998, Dusel-Bacon et al. 1998a, Foster et al. 1987), and placer deposits. Gold, silver, lead, zinc, copper, tungsten, molybdenum, and tin could be present.

Lode mineral deposits are most likely to be found in the Paleozoic and Mesozoic-age rocks (see Appendix 3.4) exposed in the southwest and northwest part of the West Training Area. In the southwest, the granite intrusive shown as

Kgd (Figure 3.5.b) contains the Ptarmigan Creek molybdenum prospect (Smith 1942, Martin 1920) (Figure 3.5.b), which was discovered in 1914. Molybdenum is associated with quartz veins in the granite, at the contact between granite and black slate. Ore samples from the prospect reportedly contained up to 2.7% molybdenum. Traces of gold were also reported. About 32 claims were located along Ptarmigan Creek (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a) prior to the withdrawals. Although ore was stockpiled on site, there are no records of any being shipped.

In the 1980s, the U.S. Geological Survey mapped and conducted mineral sampling on Fort Greely (Nokleberg et al. 1990). Results of the sampling indicate that the Kgd and TKg intrusives have reasonable potential for hosting lode deposits of gold, molybdenum, tungsten, tin, and silver. Based on geochemical data, Burns and others (1991) gave these intrusives a high probability for association with gold. The geology and geochemistry in this area of the withdrawal are similar to the Pogo deposit (Smith et al. 1998).

There is also reasonable potential for VMS deposits (see above) within the altered volcanic units shown as Dmv and MDt on Figure 3.4.b, southeast of Fort Greely. Nokleberg and others (1990) reported locally intense iron staining associated with sulfide minerals in the Dmv. The MDt unit, known as the Totatlanika schist (Wilson et al. 1998), is host to VMS mineralization currently being explored to the west in the Bonnifield District (Newberry et al. 1997, Smit 1998). The Totatlanika schist is exposed to the east of the Fort Greely West Training Area and most likely extends across the withdrawal, but is buried under Tertiary and Quaternary cover. The DPzmp unit has moderate potential for sedex deposits, based on its age, rock types, geochemistry, and proximity to the Dmv.

Portions of the withdrawal have moderate to high potential for placer gold deposits. The Pzs unit, in the northwest portion of the Training Area, may correlate with rocks which have yielded placer gold in the Richardson District.

Localized placer deposits may also occur in streams draining the granites and Tertiary-age gravel benches. Some small placer mines, concentrated in the Tertiary gravels, are located southeast of Fort Greely in the Jarvis-Ober Creek area (Cobb 1972, Mulligan 1974). No production records are available. Several small placers are also reported on the west side of the withdrawal, but no information is available concerning production or activity.

An area just east of Delta Creek was noted by Curtin and others (1990) as having good potential for placer gold. Nokleberg and others (1990) suggest that the same area has some potential for placer tin.

Leasable Minerals

Figure 3.5.c shows generalized leasable mineral potential on Fort Greely. The U.S. Dept. of the Interior and U.S. Dept. of Defense (1994a) considered Fort Greely to have low to moderate potential for leasable minerals.

The Nenana coal basin trends across the southern half of Fort Greely West Training area (Figure 3.5.c). The Ts unit (Figure 3.4.b) correlates with the formation that hosts the Jarvis Creek coal fields, just to the southeast, and the Healy coal farther to the west (Merritt and Hawley 1986). The Middle Tanana basin contains coal to the west of Fort Greely, but no coal has been documented on Fort Greely (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). The potential of finding economic deposits of Tertiary coal on Fort Greely is unknown due to poor outcrops, a lack of subsurface information, the extensive erosion of Tertiary sediments, and structural deformation of the bedrock.

Coal and organics within the Tertiary sediments could generate and trap gas under suitable geologic conditions. The Nenana Basin, with its known coal deposits, has moderate potential for producing gas.

The igneous and metamorphic rocks on Fort Greely have no potential for leasable minerals. Geologic conditions are not favorable for oil.

Saleable Minerals

Throughout the northern and central portion of Fort Greely there are extensive sand and gravel deposits associated with glacial moraines, glacial outwash, stream beds, and river floodplains (Figure 3.5.c). Readily accessible sand and gravel occurs along the drainages and floodplains of Jarvis Creek, Granite Creek, and the Delta River.

Eight mineral material sites, all of which are now closed or inactive, have been located at Fort Greely. Other gravel pits are located near Fort Greely along the Richardson Highway and the Trans-Alaska Pipeline System.

3.6 SOILS

Soil is a dynamic medium, with its characteristics continually altered by natural processes. Soil is produced by the continual interaction of five soil forming factors: climate, vegetation, organisms, parent material, and topography. The most influential factor on soil formation in interior Alaska is climate. Climate affects soil formation in three principle ways: weathering and transportation of parent material, development of internal soil processes, and erosion of the soil body. Weathering of parent material involves the physical and chemical alteration of the medium directly or indirectly by climate. Delivery of precipitation to the soil body and the rate at which drainage occurs affects the development of internal soil processes. The transportation or erosional agents of this weathered material are gravity, ice, wind, and surface water, the last three being components of the climatic system.

Fort Wainwright Yukon Training Area

Several soil associations exist in the Yukon-Tanana Upland. The largest of these associations is soil map unit 4 (Figure 3.6.a and Table 3.6.a) classified as a silt loam. This soil type is well drained with thin bands of fine silty or clayey material underlain by silt loess deposits. It is located on the mid-slopes of hills. Saturated, gravelly silt loams are underlain by permafrost and are located on the north-facing portions of valley bottoms, lower hillside drainages, and lower slopes. Steeper portions of these north-facing features also have poor-draining, shallow loess deposits underlain by permafrost. These areas usually have a thick surface mat of peat. Silt loams are present in areas other than north-facing locations with higher elevations. Loess is found in areas distant from the Tanana floodplain.

In the extreme northwestern portion of the Yukon Training Area, along the low terraces adjoining the Tanana and Chena Rivers, lies a band of well-drained silty to sandy loams (shown as soil map unit 3 in Figure 3.6.a). In lower lying areas, these silty to sandy loams are covered by a layer of peat and are underlain by permafrost.

To the west of the Tanana River and in the Upper Salcha River Valley, soils are characterized as silt loams underlain by sandy to gravelly deposits (shown as soil map unit 2 in Figure 3.6.a).

Ridge tops and steep upper slopes at higher elevations are covered by well-drained gravelly loams (shown as soil map unit 5 in Figure 3.6.a). Drainage is poor in some areas and permafrost is present on north-facing slopes.

Fort Greely West and East Training Areas

In general, the Tanana-Kuskokwim Lowlands have very gravelly to loamy soil on nearly level to rolling slopes. Soils adjacent to the Tanana River floodplain (shown as soil map unit 1 in Figure 3.6.b and Table 3.6.b) are found on terraces, outwash plains, and low moraines within the area. There is usually a layer of silt loam over a thick deposit of very gravelly sand. These soils are well drained in areas of no permafrost, but exhibit poor drainage and peat deposits in areas with permafrost.

Silt loams are present in the western portion of Fort Greely on low terraces in broad valleys and on long footslopes of the Alaska Range (shown as soil map unit 2 in Figure 3.6.b).

Soils along the floodplains of the Tanana and Delta rivers (shown as soil map unit 3 in Figure 3.6.b) are characterized as silt loams to fine sands with organic surface horizons. They are found in low areas including meander scars and natural levees along the existing and former river channels.

Further south along the Delta River, surface elevation increases and the soil composition shifts to a very gravelly and stony silt loam (shown as soil map unit 8 in Figure 3.6.b). These soils are well drained on hillsides and footslopes, and poorly drained in valley bottoms.

Further to the east along the gently sloping surfaces of glacial moraines and alluvium near Jarvis Creek, a layer of silt loam underlain by very gravelly sand exists (shown as soil map unit 9 in Figure 3.6.b). This soil is well to excessively drained.

Soils within the Northern Foothills of the Alaska Range are generally poorly-drained silt loams with a layer of peat. In the southern portion of Fort Greely, along the north-facing ridges, valleys, and foot slopes, soils are poorly drained gravelly silt loams with a surface organic mat (shown as soil map unit 6 in Figure 3.6.b). On the south-facing slopes, a well-drained silt horizon with very gravelly silt loams exist.

In the western drainageways and broad outwash plains of Fort Greely, poorly-drained silt and sandy loams with a surface organic mat can be observed (shown as soil map unit 7 in Figure 3.6.b). Permafrost is generally present in these areas.

In the higher elevations of the Alaska Range directly south of Fort Greely, rockland consisting of very gravelly shallow soils exists (shown as soil map unit

11 in Figure 3.6.b). These soils are typically frozen and permanent ice fields are present.

3.6.1 Soil Limitation Ratings

Soils delineated by the Exploratory Soil Survey of Alaska (1979) for the Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas have been assigned limitation ratings for particular land uses. These ratings are based on general, widely known soil properties and related factors. This information can be used for broad land use planning to determine areas with the highest potential for a specific use or areas with unfavorable soil properties. However, the suitability ratings should be applied in a conservative manner and should not be used to determine if an area is suitable for military activities due to the small scale of the soil survey. Additionally, these ratings should be applied only to the individual components of the map units and not to the map unit as a whole. Soils within any mapped area may have properties and limitations that differ from those described for the entire unit. Soil limitation ratings discussed in this study include those developed for recreation, road location, and off-road trafficiability (Table 3.6.c).

Table 3.6.c Definition of Soil Limitation Ratings for the Fort Wainwright Yukon Training Area and the Fort Greely West and East Training Areas (Rieger et al. 1979).

Land Use	Slight	Moderate	Severe	Very Severe
Recreation	Soil limitations, if any, are easily overcome.	Soil limitations need to be recognized but can be overcome with careful planning and design. Modifications, such as ground leveling or stone removal, may be necessary.	Soil limitations interfere seriously with intensive recreational use and are difficult to overcome and may not be economically feasible.	Soil limitations are too severe to overcome. These soils are generally not suitable for development for recreational use.
Road Location	Soil limitations, if any, are easily overcome.	Soil limitations can be overcome but result in difficult and costly modifications in road design and construction.	Soil limitations are difficult to overcome and may affect road alignment and location. Special design requirements may result in excessive construction costs.	Soil limitations are so difficult or expensive to overcome that the soils should be avoided if possible.

Table 3.6.c Definition of Soil Limitation Ratings for the Fort Wainwright Yukon Training Area and the Fort Greely West and East Training Areas (Rieger et al. 1979).

Land Use	Slight	Moderate	Severe	Very Severe
Off-road Trafficiability	Soil limitations, if any, do not restrict the movement of overland vehicles.	Soil limitations need to be recognized but can generally be overcome with careful route planning. Some special equipment may be required.	Soil limitations are difficult to overcome, and special equipment and careful route planning are required. These soils should be avoided if possible.	Soil limitations are generally too difficult to overcome. Generally these soils are unsuitable for conventional off-road vehicles.

Soil limitation ratings for recreational use include intensive activities such as campgrounds, picnic areas, golf courses, and playgrounds. The principle soil characteristics that affect ratings for recreational use are internal drainage, slope, consistence under use, stoniness, susceptibility to flooding, and depth to bedrock (Rieger et al. 1979).

Soil limitation ratings for road location on withdrawal lands are based on soil features that affect the design, construction, and performance of roads and highways. Soils with the greatest limitation for roads are those underlain by permafrost, organic soils, and other poorly-drained soils. These ratings are based on the properties of undisturbed soil to a depth of five feet (Rieger et al. 1979).

Off-road trafficability refers to the overland movement of conventional wheeled and tracked vehicles. Soil features of greatest importance in relation to off-road vehicular movement are duration of wet conditions; soil texture as it relates to its ability to support loads, to traction and to production of dust by traffic; and erodibility of the soil (Rieger et al. 1979).

All of the listed soil units within the Fort Wainwright Yukon Training Area have a limitation rating of severe or very severe, and eight out of 11 listed soil units of the Fort Greely Training Areas are classified as severe or very severe for at least one of the land use activities (Tables 3.6.d and 3.6.e). Soils are most susceptible to damage during the spring and summer months due to their saturated, unstable state. However, the use of all areas within the Fort Wainwright and Fort Greely region should be evaluated on a seasonal basis regardless of their limitation rating.

Table 3.6.d Estimated Soil Limitation Ratings for Fort Wainwright Yukon Training Area (Rieger et al. 1979).

Soil Map Unit	Soil Type	Recreation	Road Location	Off-road Trafficability
2	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
3	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
	Typic Cryofluvents	Moderate [2]	Moderate [2]	Slight
4	Alfic Cryochrepts	Severe [6]	Severe [6]	Moderate to Severe [6]
	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
5	Typic Cryochrepts	Slight	Slight	Slight
	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]

[2] - Soil is susceptible to flooding.
[5] - Soil has perennially frozen substratum.
[6] - Steep slopes or rough terrain.
[7] - Soils are wet; high water table or seepage during all of the frost-free season.

Table 3.6.e Estimated Soil Limitation Ratings for Fort Greely West and East Training Areas (Rieger et al. 1979).

Soil Map Unit	Soil Type	Recreation	Road Location	Off-road Trafficiability
1	Typic Cryochrepts	Slight	Slight	Slight
	Aeric Cryaquepts	Slight	Moderate [3,4]	Moderate [1]
2	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
3	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
	Typic Cryofluvents	Moderate [2]	Moderate [2]	Slight
4	Alfic Cryochrepts	Severe [6]	Severe [6]	Moderate to Severe [6]
	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
5	Typic Cryochrepts	Slight	Slight	Slight
	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]

Table 3.6.e Estimated Soil Limitation Ratings for Fort Greely West and East Training Areas (Rieger et al. 1979).

Soil Map Unit	Soil Type	Recreation	Road Location	Off-road Trafficiability
6	Pergelic Cryaquepts	Severe [6,7]	Severe [6,7]	Severe [6,7]
	Pergelic Cryochrepts	Severe [6]	Severe [6]	Severe [6]
7	Histic Pergelic Cryaquepts	Severe [7]	Very Severe [5,7]	Severe [7]
8	Typic Cryochrepts	Slight	Slight	Slight
	Histic Pergelic Cryaquepts	Severe [6,7]	Severe [6,7]	Severe [6,7]
9	Typic Cryochrepts	Slight	Slight	Slight
10	Typic Cryochrepts	Slight	Slight	Slight
	Aeric Cryaquepts	Slight	Moderate [3,4]	Moderate [1]
12	Typic Cryochrepts	Slight	Slight	Slight
	Histic Pergelic Cryaquepts	Severe [6,7]	Severe [6,7]	Severe [6,7]

[1] - Soil is dusty when dry and soft or slippery when wet.
[2] - Soil is susceptible to flooding.
[3] - Soil is susceptible to frost action.
[4] - Soil has low load-supporting capacity.
[5] - Soil has perennially frozen substratum.
[6] - Steep slopes or rough terrain.
[7] - Soils are wet; high water table or seepage during all of the frost-free season.

3.7 PERMAFROST

Permafrost is defined as soil material with a temperature below freezing which has existed continuously for two or more years. The base of permafrost is the lower limit of ground temperatures that are below 32°F. The upper surface of permafrost is called the permafrost table. The active layer is the zone above the permafrost table that thaws in summer and freezes again in winter (Williams 1970).

Permafrost forms when the balance between net heat lost to the atmosphere at the earth's surface and heat received at the surface from sources within the earth produces a negative ground temperature below the base of the active layer. Thus, existing permafrost results from fluctuations in the heat balance at

the ground surface over a period of a few to thousands of years. The local configuration of permafrost and its thickness arise from local differences in mean annual ground-surface temperature (Williams 1970).

Several natural features, such as vegetation, lakes, rivers, groundwater, and glaciers, may control the occurrence of permafrost on the withdrawal areas. In areas of discontinuous permafrost, vegetation may influence the thickness of the active layer and may determine whether permafrost is present or absent by controlling the temperature at the ground surface. The warming effect of water bodies on the ground surface temperature adjacent to and beneath glaciers also determine permafrost temperature, thickness, and areal extent. Thick accumulations of snow cause similar local variations in permafrost characteristics (Williams 1970).

Vegetation type is an indicator of the extent and location of permafrost. Permafrost initially forms in white spruce stands with a thick layer of mosses. These mosses insulate the ground more efficiently during hot summers when the moss is dry than in cold winters when the moss is frozen and saturated. Over time, the underlying soil becomes colder and eventually becomes perennially frozen. The resulting shallow permafrost layer creates cold, wet conditions that are more conducive to black spruce growth. Eventually the white spruce stands are replaced by black spruce and forest mosses are replaced by more water-tolerant sphagnum mosses and sedges. It is possible that the black spruce will eventually be replaced by sphagnum or sedge bogs. This succession can be used as a permafrost indicator. In general, black spruce, larch, and bogs indicate the presence of permafrost within less than a foot of the surface. White spruce and aspen usually indicate a permafrost-free area or an area in which the active layer is several feet thick. Paper birch is typically found in permafrost-free areas or where the active layer has temporarily deepened as a result of burning or clearing (Pewe and Reger 1983).

Chapters 3.9, 3.10, and 3.11 offer further discussions of permafrost and its influence on surface water, groundwater, and wetland functions, respectively.

Fort Wainwright Yukon Training Area

Fort Wainwright Yukon Training Area is in the discontinuous permafrost zone of Alaska where perennially frozen ground is widespread. Figure 3.7.a illustrates the distribution of permafrost within Fort Wainwright Yukon Training Area. This permafrost map is based on vegetation type. Permafrost typically exists in multiple layers of varying thickness and ranges from less than one foot to more than 15 feet. In undisturbed areas, depth to permafrost varies from two to three feet (Williams 1970).

Permafrost is thickest in valley bottoms and on lower slopes and can extend to the summit of north-facing slopes. Sediments beneath the floodplain of the Tanana and Chena Rivers are perennially frozen as deep as 265 feet. Permafrost is generally absent on hilltops and moderate to steep south-facing slopes. Unfrozen zones that perforate permafrost lie beneath most deep lakes and large and medium-sized rivers (Williams 1970).

Fort Greely West and East Training Areas
The area between the alluvial apron of the Alaska Range, south of Fort Greely and the Tanana River, located north of Fort Greely, is also located within the discontinuous permafrost zone of Alaska. A specific permafrost map of Fort Greely is not available. Isolated masses of frozen ground exist in areas of sandy gravel from three to 40 feet below the ground surface with a base ranging from 10 to 118 feet in depth. Most permafrost lies above the water table, but the frozen ground is so thin and sporadic that it has little effect on the groundwater hydrology. Unfrozen zones that perforate permafrost lie beneath most deep lakes and large and medium-sized rivers. Recently abandoned river channels may also have underlying unfrozen zones (Williams 1970).

3.8 SURFACE WATER

Fort Wainwright Yukon Training Area
Surface water originating in the northern and northeastern portions of Fort Wainwright Yukon Training Area drain into the Chena River and its tributaries: the South Fork Chena River, Hunts Creek and Horner Creek. Tributaries of the South Fork Chena River include Globe Creek , Stuart Creek, and Beaver Creek. The southern portion of the Yukon Training Area is drained by tributaries of the Salcha River including Ninety-eight Creek, Redmond Creek, and McCoy Creek. Some streams draining the southern portion of the Yukon Training Area, such as the Little Salcha River, flow directly into the Tanana River. Others, such as French and Moose creeks, reach the Tanana River by way of Piledriver Slough. All of the streams within the Yukon Training Area originate in the rolling, glacier-free terrain of the Yukon-Tanana Upland at elevations of less than 2,000 feet. Figure 3.8.a shows the major waterways of the withdrawal area.

Fort Greely West and East Training Areas
The Delta River, which flows northward through Fort Greely for approximately 80 miles, originates at Tangle Lakes (approximately 50 miles south of the southern boundary of Fort Greely) and ends at its confluence with the Tanana River at Big Delta. The Delta River drains an area of 1,665 square miles. As the

Delta River flows through the Alaska Range, it receives melt water from Cantwell, Castner, and Black Rapids glaciers. When the Delta River enters Fort Greely, it flows across a north-sloping alluvial fan into which the river is entrenched up to 200 feet. The Delta River has virtually no tributaries once it leaves the confines of the Alaska Range, with the exception of Jarvis Creek, which enters on the east bank about 10 miles above the Delta River's mouth.

Jarvis Creek originates at the terminus of Jarvis Glacier on the north side of the Alaska Range and flows northward for 40 miles through a narrow valley. Jarvis Creek drains an area of 248 square miles and receives melt water from the glaciers of Mount Silvertip and the Alaska Range. Non-glacial streams enter Jarvis Creek from Granite Mountain. Jarvis Creek flows across the same alluvial fan as Delta River into which it is also entrenched.

The remaining streams of Fort Greely are glacier-fed and originate within the Alaska Range, with the exception of Granite Creek. Granite Creek flows from Granite Mountain to form the eastern border of the Fort Greely East Training Area. The southwestern border of Fort Greely West Training Area is formed by Buchanan Creek, which eventually combines with the West and East Forks of the Little Delta River to form the main stem. The East Fork receives melt water from Hayes and Gilliam Glaciers, and the West Fork receives melt water from unnamed glaciers near Mount Deborah. The Little Delta River constitutes the remainder of the West Training Area border and eventually empties into the Tanana River. Delta Creek drains the interior portion of the West Training Area and receives melt water from Trident and Hayes Glaciers and the Alaska Range. It flows directly into the Tanana River. Several other small tributaries originating in the Alaska Range flow throughout Fort Greely and ultimately empty into the Tanana River or another large tributary. Figure 3.8.b shows the major waterways of the Fort Greely withdrawal area.

3.8.1 Streamflow

All tributaries within the Tanana River basin can be classified as either non-glacial or glacial. This is an important distinction because of the unique seasonal streamflow variations associated with each type. In general, both stream varieties within the withdrawal areas experience high flows during the spring and summer and low flows during the fall and winter. Specifically, streamflow on non-glacial streams exhibits sharp rises in discharge during May due to spring snowmelt, a general recession during the summer months, a slight increase during the early fall rainy period, and low winter flows. On the other hand, the maximum stream discharge on glacial streams occurs in June and July following a rapid rise in the spring, which coincides with the peak melting of glaciers.

Fort Wainwright Yukon Training Area
All streams originating in the Yukon-Tanana Upland within Fort Wainwright Yukon Training Area, such as Stuart Creek, French Creek, and Moose Creek, are non-glacial. Stream discharge data for the smaller, non-glacial streams of the Yukon Training Area are unavailable. However, general trends exhibited by the Little Chena, Chena, and Salcha rivers give an indication of the seasonal trends that would be expected on smaller, non-glacial streams. Average monthly discharge values for the Little Chena, Chena, and Salcha rivers are presented in Appendix 3.8.A. Figure 3.8.a shows stream gaging station locations. Drainage characteristics and discharge values of selected streams on Fort Wainwright Yukon Training Area are presented in Table 3.8.a.

Fort Greely West and East Training Areas
A majority of the larger streams flowing through Fort Greely, such as the Delta and Little Delta rivers and Jarvis and Delta creeks are glacial. Long term surface water discharge data were unavailable for the Delta River and Jarvis Creek. However, data recorded for the Tanana River should give an indication of the seasonal trends that would be expected for the glacier-fed streams of Fort Greely. Appendix 3.8.A contains a graph showing average monthly discharge for the Tanana River at Big Delta and Fairbanks. Figure 3.8.b shows stream gaging station locations.

3.8.1.1 Base Flow
Base flow is defined as the water that enters the stream channel from persistent, slowly varying sources and maintains streamflow between water-input events. Large base flows occur in drainage basins with extensive groundwater storage, thus the minimum monthly flow (or baseflow) of the Tanana River at Big Delta has been about 30% of the average flow. Within the Yukon-Tanana Upland, base flows are extremely small because of the limited groundwater storage associated with that area. The minimum monthly flow of the Salcha River, which flows south of the Fort Wainwright Yukon Training Area, has been about 5% of the average flow (Anderson 1970).

3.8.1.2 High Flow/Floodplains
The magnitude and frequency of floods of smaller streams in the Tanana River Basin is not well known because streamflow records are short or periodic, and there are few gaging stations. Also, local floods can occur in remote areas without economic loss and may pass unnoticed. In general, floods commonly occur in the spring from snowmelt or in late summer from rain. The most severe flooding should be expected from rain concurrent with rapid snowmelt. Floods are aggravated during the early spring when channels are constricted with ice.

Fort Wainwright Yukon Training Area

Figure 3.8.c shows the 100-year, 500-year, and outside of the 500-year floodplain boundaries surrounding Fort Wainwright Yukon Training Area, as determined by the Federal Emergency Management Agency. The upper northwest portion of the Yukon Training Area relies on the Chena River Lakes Flood Control Project for flood protection. Additional floodplain information can be found in Appendix 3.8.B.

Fort Greely West and East Training Areas

Floodplain boundaries have not been developed by the Federal Emergency Management Agency for the Fort Greely West and East Training Areas. It is known, however, that the east bank of the Delta River is higher than the west bank. As a result, the low west bank, as well as the large flood plain, creates very low probabilities of overbank flooding to the east (Nelson 1995). The principal risk to local communities is not from river flooding, but from lateral erosion of the east bank of the Delta River.

Historically, Jarvis Creek has overflowed into an old channel, located approximately 14 miles above the confluence of Jarvis Creek and the Delta River, running through the City of Delta Junction. Flooding from Jarvis Creek may occur due to ice jams (Federal Emergency Management Agency 1982b). Additional floodplain information can be found in Appendix 3.8.B.

3.8.1.3 Low Flow/Aufeis

Low flow is defined as the minimum amount of discharge measured at a location. Low flow conditions occur during the months of October through May. Information about low flow occurrences on streams within the withdrawal areas is unavailable because of the lack of discharge data. In addition, winter streamflow data is limited because of the complexity of stream-ice formation and its control of the flow regimen.

In general, minimum weekly average discharge of basins smaller than 500 square miles, which include most of the basins within the withdrawal areas, ranged from 0.018 to 0.470 cubic feet per second per square mile and averaged between 0.1 and 0.2 cubic feet per second per square mile (Anderson 1970).

The smaller basins do not have sufficient discharge to maintain a free-flowing channel in the winter. Freezing is so extensive that most streamflow is converted to aufeis. Aufeis is an ice sheet that forms on a floodplain in winter when normal channels freeze solid or are otherwise dammed so that water spreads out over the floodplain and freezes (A.G.I Glossary 1960 *in* Dingman et al. 1971). Ice may start forming in October and generally breaks up in May. These stream

icings can achieve large dimensions, both in thickness and areal extent, because they are composed of a large percentage of the total winter flow. Thus, ice may be over three feet thick. Of all the withdrawal area streams, only the Tanana and Chena rivers typically flow year round (Anderson 1970).

Streams can also cease to flow in the winter because of losses due to influent seepage into groundwater aquifers. Jarvis Creek is an example of an influent stream. Channel losses occur when Jarvis Creek passes over the large alluvial fan at the base of the Alaska Range. Near its mouth, Jarvis Creek is dry during the winter.

3.8.1.4 Runoff

Runoff is defined as the amount of precipitation on land that ultimately reaches streams. Runoff is typically reported as the average depth at a place of origin. Runoff includes meltwater from glaciers.

The greatest contribution of runoff to the Tanana River (about 84 inches) is from areas above 5,000 feet within the Alaska Range. In the 3,000 to 5,000 feet elevation range, average runoff is approximately 100% of precipitation, or about 12 to 24 inches. From 3,000 feet to the valley bottom, runoff is about 60% of precipitation or eight to 12 inches. Within the poorly-drained valley bottoms, average annual runoff is estimated to range between zero and eight inches. In general, the maximum amount of runoff results from snowmelt with little runoff resulting from rainfall. The lowest amount of runoff occurs in lake and wetland areas where evapotranspiration rates are the highest (Anderson 1970).

3.8.2 Water Quality

All freshwaters of the State of Alaska are considered to be in their original and natural condition, and as such they are considered suitable to serve all the uses established under each class. State water is protected for the following use classes:

(1) Fresh water
- (A) Water supply
  - (i) drinking, culinary, and food processing
  - (ii) agriculture, including irrigation and stock watering
  - (iii) aquaculture
  - (iv) industrial
- (B) Water recreation
  - (i) contact recreation
  - (ii) secondary recreation

(C) Growth and propagation of fish, shellfish, other aquatic life and wildlife

These classifications are effective as of March 1, 1998. If a water body is protected for more than one use class, the most stringent water quality criterion will apply (State of Alaska Water Quality Standards 18 AAC 70.040(a)).

All waters within the withdrawal boundaries are protected by use classes (1)(A), (1)(B), and (1)(C) as assigned by the State of Alaska. However, water bodies originating within the Fort Wainwright Yukon Training Area flow into the Chena River, which has been assigned site-specific water quality criteria. The Chena River from its confluence with Chena Slough to the confluence of the Chena River and Tanana River has been classified as (1)(A)(ii), (1)(A)(iii), (1)(A)(iv), (1)(B), and (1)(C) (State of Alaska Water Quality Standards 18 AAC 70.230(e)).

If the natural condition of a water body is demonstrated to be of lower quality than a water quality criterion for the designated use classes and subclasses, and the natural condition will fully protect the designated uses, the natural condition constitutes the applicable water quality criterion (State of Alaska Water Quality Standards 18 AAC 70.235(b)).

Appendix 3.8.C contains water quality criteria for freshwater uses as set by the State of Alaska.

3.8.2.1 Streams

Fort Wainwright Yukon Training Area

Background water quality represents the chemical and biological components of surface waters resulting from natural causes and factors. Limited development and other human-related activities account for the lack of human-induced pollutants and generally excellent water quality of the area streams and lakes (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). Water quality concentrations of specific parameters also indicate the quality of water at the Yukon Training Area is good.

Surface water quality on the Yukon Training Area meets the primary Alaska Drinking Water Standards (18 AAC 80). Only naturally occurring iron concentrations were higher than the secondary standards set by the Alaska Drinking Water Standards (18 AAC 80). (See Appendix 3.8.D).

Chemical Analysis

The pH measurements collected at the Salcha and Chena Rrvers indicate values to be within the limits established by the State's standards (6.5-8.5) as shown

in Appendix 3.8.D. Trends observed in the Chena River showed pH values slightly above neutral during the winter (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). Similar trends have been observed in the smaller water bodies of Redmond Creek, Ninety-eight Creek, and McCoy Creek (south of the Fort Wainwright Yukon Training Area) as shown in Appendix 3.8.D.

Iron is the only naturally occurring element in streams of the withdrawal area that may occasionally exceed recommended water quality levels. Alaska State Drinking Water Secondary Standards recommend less than 0.3 milligrams per liter (mg/l) of iron for waters that are being considered as a drinking water source. The high iron concentration in the lower portion of the Chena River may be attributable to surface water and groundwater drainage from the swampy, muskeg areas of the Yukon Training Area (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a, Anderson 1970).

Dissolved oxygen levels, measured for the Salcha River eight miles above Salchaket, Alaska, range from 9.4 mg/l to 14.2 mg/l. Dissolved oxygen levels measured for the Chena River at North Pole, Alaska, ranged from 5.8 mg/l to 11.7 mg/l. These values are above the State water quality minimum of 4.0 mg/l for dissolved oxygen, which was intended to prevent fish kills. Similar values have been observed in the smaller water bodies of Ninety-eight Creek (which is within the Fort Wainwright Yukon Training Area), Redmond Creek, and McCoy Creek.

Samples collected from the Chena River (Appendix 3.8.D), which does not flow directly through the withdrawal area, indicate that biological oxygen demand (BOD) and chemical oxygen demand (COD) values are low. Due to the similarity between the Chena River and the upland streams of Fort Wainwright Yukon Training Area, BOD and COD values would also be expected to be low in streams of the Yukon Training Area. Most BOD values collected from the Chena River are below 1.0 mg/l and COD values range from 3 mg/l to 46 mg/l.

Phosphate may be a limiting organic nutrient for phytoplankton (photosynthetic organisms of small size that drift on the water) production (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). A study of biological data from the Chena River suggests that primary and secondary productions are low (McCoy 1974). This is reflected by the presence of a large and diverse number of groups of aquatic insects and other benthic invertebrates that are typical of streams high in dissolved oxygen and low in productivity (the overall rate of organic matter production of a body of water). The most common benthic invertebrates are *Chironomidae* (midges), *Plecoptera* (stoneflies), *Ephemeroptera* (mayflies), *Tricoptera* (caddis flies), and *Simuliidae* (blackflies). Aquatic *Acari* (water mites)

were observed but comprise a smaller portion of the benthic fauna population (McCoy 1974).

Sediment Analysis

Suspended sediment and dissolved sediment concentrations are higher in the Tanana River as compared to the smaller streams originating in the uplands of Fort Wainwright Yukon Training Area. This is due to higher discharge rates and contribution of sediment-rich glacial meltwater from the Alaska Range. Near Fairbanks, the average annual (1974-79) load of the Tanana River is 24 million metric tons of suspended sediment and 321,000 metric tons of bedload (larger channel and floodplain material that is rolled, dragged, or skipped along the riverbed) (Burrows et al. 1981). Upstream, near North Pole, Alaska, the average annual load of the Tanana River is 20.7 million metric tons of suspended sediment and 298,000 metric tons of bedload (Burrows et al. 1981). For both sites, bedload is usually 1% to 1.5% of the suspended sediment load.

Sediment loads in the smaller streams of the Yukon Training Area are generally low. The Chena River and other waterbodies originating in the Yukon-Tanana Uplands receive sediment primarily during snowmelt and rainstorm runoff. Annual loads from non-glacial streams of the uplands are inferred to be less than 150 tons per square mile (Anderson 1970). Sediment transport within the Chena River also shows a seasonal variation. Sediment concentrations are much higher for concurrent discharge during spring break-up than for other times of the year. Approximately 50% of the annual load is transported during the period of spring runoff, which is usually in May. Suspended solid concentrations collected at Stuart Creek and the South Fork Chena River within Fort Wainwright Yukon Training Area ranged from 13 mg/l to 42 mg/l (Anderson 1970).

Individual daily suspended solid concentrations of the Tanana River ranged from 58 mg/l in early April to 4,340 mg/l in August then decreased to 160 mg/l in October (Burrows et al. 1981). Particle-size distribution for suspended sediment is similar at Fairbanks and North Pole. Median particle size is generally in the silt range, but at some low water discharges, it is in the very fine sand range. The reasonably defined relation of median particle size of suspended sediment decreasing as discharge increases suggests a watershed source of sediment during snowmelt runoff and within-channel source of sediment during lower runoff periods (Burrows et al. 1981).

Average particle size of bedload of the Tanana River near North Pole is generally in the gravel range, but at some low transport rates, it is in the median sand range. The median bed material particle size measured at North Pole was

in the coarse gravel range. At Fairbanks, bed material particle size ranged from medium gravel to fine sand (Burrows et al. 1981).

Dissolved solids concentrations range from 60 to 484 mg/l within the Tanana Basin. Most surface water within the basin contains less than 200 mg/l of dissolved solids (Anderson 1970).

Fort Greely West and East Training Areas

A limited site-specific study of the water quality of streams flowing through Fort Greely was completed in September of 1990 (U.S. Environmental Hygiene Agency 1990). Water and sediment samples were collected upstream and downstream of Fort Greely. Upstream values give an indication of the background or natural water quality of Fort Greely. Appendix 3.8.D contains the water and sediment chemistries collected upstream for individual streams at Fort Greely. A discussion of downstream values is presented in 4.8.2.

Surface water quality values on Fort Greely meet the primary standards set by the Alaska Drinking Water Standards (18 AAC 80). However, aluminum, iron, and manganese concentrations were higher than the secondary standards set by the Alaska Drinking Water Standards (18 AAC 80). (See Appendix 3.8.D).

Chemical Analysis

The pH measurements collected on Fort Greely ranged from 7.9 to 8.4, which are within the limits established by the State's standards (6.5-8.5) as shown in Appendix 3.8.D.

Iron, a naturally occurring element in streams of Fort Greely, may occasionally exceed the secondary drinking water standard. The Alaska Drinking Water Standards (18 AAC 80) recommend less than 0.3 mg/l of iron for waters that are being considered as a drinking water source. High iron concentrations can be expected in streams that drain swampy areas high in organic matter (Anderson 1970). Iron values collected at streams on Fort Greely are shown in Appendix 3.8.D.

All dissolved oxygen values measured at Fort Greely were within the set State minimum of 4.0 mg/l. Dissolved oxygen values ranged from 9.7 mg/l at the Delta River to 12.1 mg/l at Jarvis Creek.

In general, streams from the Alaska Range are higher in sulfate and magnesium content than other streams in the basin, although these levels are still below the set standards.

Sediment Analysis

The Tanana River receives the bulk of its sediment load from glacial meltwater. The streams draining the Alaska Range, of which the majority originates from glaciers, contribute loads ranging from 150 tons per square mile in the lowlands adjacent to the Tanana River, to several thousand tons per square mile at the termination of glaciers (Anderson 1970).

The average annual suspended sediment yield for the Delta River is 1,200 tons per square mile (Dingman et al. 1971). The Delta River sediment load ranges from 100 to 1,000 mg/l during the open-water season. In-stream sediment samples from the Delta River and other similar streams yielded the following particle size distribution:

clay size - 10-25% of suspended material
silt size - 40-50% of suspended material
sand size - remainder of suspended material

Most of the clay and silt-sized material found at glacial endpoints is rock silt, which is found in layers in the bottom part of most glaciers. Rock silt forms at the glacial bed by rock being ground to fine particles by glacial movement. These particles are transported to receiving waters by melting and freezing cycles at the bed-glacier interface.

Dissolved solid concentrations range from 60 mg/l to 484 mg/l within the Tanana River Basin. Most surface water contains less than 200 mg/l of dissolved solids (Anderson 1970). The primary components are calcium, magnesium, and bicarbonate. Fort Greely water is of the calcium carbonate type and is slightly basic. Typically, higher stream flows have lower dissolved solids concentrations. During low flow periods, the streams containing the highest dissolved solids are those draining mineralized bedrock areas, notably in the Alaska Range (Dingman et al. 1971).

Similar to dissolved solid concentrations, sediment load concentrations change rapidly with changes in stream discharge. Thus, more than 99% of the annual sediment load is transported during the summer and is evenly distributed over this time period (Anderson 1970).

Bedload for the Delta River consists mostly of particles larger than sand size, which move by rolling, bouncing, and suspension near the stream bed. It contains channel and floodplain material with a mixture of gravel particles (averaging about 1.6 inches in diameter), sand and silt. Total basin yield of bedload for the Delta River cannot be estimated (Dingman et al. 1971).

3.8.2.2 Lakes

Fort Wainwright Yukon Training Area

There are a few small lakes and ponds located on Fort Wainwright Yukon Training Area. The smaller water bodies can be dry one to two months out of the year and typically freeze solid during the winter. Iron content in the lakes varies above and below levels found in nearby streams. The degree of hardness of lake water is generally less than the streams (Defense Mapping Agency 1978).

Fort Greely West and East Training Areas

Lakes are abundant on Fort Greely, but information on water quality is scarce. Water samples collected from Bolio, North Twin, South Twin, and Mark Lakes indicated that pH levels were higher than the State's recommended standards of 6.5 to 8.5 as shown in Appendix 3.8.D. All of the lakes have low concentrations of nitrite and nitrate, with Bolio Lake having most of its nitrogen in organic form. Dissolved oxygen concentrations measured at Bolio Lake ranged from 9.8 mg/l to 10.2 mg/l, which adequately meet the State water quality minimum of 4.0 mg/l.

Temperatures in the lakes of Fort Greely would be expected to follow seasonal trends with lows occurring during the winter months and highs occurring in mid- to late-August (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994b). Water temperatures measured at North Twin, South Twin, and Mark Lakes were slightly lower than those measured at Bolio Lake (Appendix 3.8.D).

3.8.3 Ice Bridges

Ice bridges are constructed by the U.S. Army across the Delta River and Jarvis Creek on Fort Greely (Figure 3.8.d). Ice bridges provide overland foot and vehicle access into remote areas of Fort Greely during winter training exercises and offer an important training opportunity for troops.

Ice bridges are artificially-thickened sections of ice constructed at river crossings, usually perpendicular to the river alignment. River sections with slow-flowing water are typically chosen because both the natural thickness of ice and its frequency of formation are greater in reaches with more tranquil flows (Gray and Male 1981). Ice bridge thickness is determined by the amount of traffic expected to travel over the structure.

Ice bridges are often constructed by building a low dike on both sides of the river using light vehicles to windrow the snow. The dikes are iced, or if snow is lacking, logs are used to confine the area into which water is pumped and then allowed to freeze (Gray and Male 1981). Ice bridges are permitted to be

constructed each season in the same location, and each site has a specific amount of water scheduled for use (Figure 3.8.d). Low temperatures allow for ice bridge construction anytime from November to mid-March.

Appendix 3.8.E lists various permits required for the construction of ice bridges by the State of Alaska. New applications for permits must be submitted when the existing permits expire. For any proposed activity that significantly deviates from the approved permit, the Army must notify each agency involved to obtain written approval prior to commencement of the activity.

3.8.4 National Wild and Scenic Rivers System

The National Wild and Scenic Rivers System was established by Congress in 1968 through the Wild and Scenic Rivers Act (Public Law 90-542). The Act declared that the established national policy of developing some rivers with dams and other construction needed to be complimented by a policy of protecting other rivers having outstanding natural, cultural, scenic, and recreational values in their free-flowing condition for the enjoyment of present and future generations (National Park Service 1999).

No streams within the withdrawal areas have been designated as wild and scenic. However, the upper reaches of the Delta River, all of the Tangle Lakes (approximately 50 miles south of the southern boundary of Fort Greely), and the Tangle River were designated as part of the National Wild and Scenic River System by the Alaska National Interest Lands Conservation Act in 1980. There are 26 rivers in Alaska that are part of this system and the Bureau of Land Management manages six of them (Bureau of Land Management 1999).

Tangle Lakes, Tangle River and the Delta River were recognized for their outstanding scenery and natural and cultural values and classified either wild, scenic or recreational. A *wild* river is free of impoundments, generally inaccessible except by trail, and has exceptionally clean waters. *Scenic* classifications apply to sections that are free of impoundments, have shorelines that are largely undeveloped but are accessible by roads. *Recreational* segments are accessible by road and may have some development along their shorelines (Bureau of Land Management 1999). The Delta River is classified as wild and scenic beginning at the Lower Tangle Lakes area to Milepost 212 on the Richardson Highway. From Milepost 212 to a point one-half mile north of Black Rapids, the Delta River is classified as recreational (Butorac, pers. com. 1998). The designation terminates approximately 15 miles south of the southern boundary of Fort Greely.

3.9 GROUNDWATER

3.9.1 Groundwater Occurrence

Fort Wainwright Yukon Training Area

In general, groundwater exists in large supply on the Fort Wainwright Yukon Training Area. Local groundwater conditions are controlled by topography, water-bearing characteristics of the source, and the distribution of permafrost. Based on these conditions, three distinct groundwater source areas exist on the Yukon Training Area: the Tanana-Chena Rivers floodplain, creek valley bottoms, and upland hills (Figure 3.9.a). On a regional basis, groundwater migrates in a northwestward direction in a flow direction similar to the Tanana and Chena Rivers. Table 3.9.a lists the quantity, source, depth, quality, and development potential of groundwater within the Yukon Training Area.

The Tanana-Chena Rivers floodplain, located in the northwest portion of the Yukon Training Area, is relatively flat and is underlain by fine-to-coarse grained material with a moderate distribution of permafrost. The floodplain is the best source of groundwater in the area. The aquifer is composed of alternating layers and lenses of alluvial silt, sand, and gravel and is very permeable. As a result, this area is subject to rapid recharge rates from the Tanana and Chena Rivers, and from surface and underground flow from the uplands and surrounding mountains. A majority of recharge to the groundwater reservoir underlying the Yukon Training Area occurs in this region. Generally, the occurrence of groundwater is controlled by permafrost. Groundwater within the floodplain is an excellent source for development due to large supply, favorable drilling conditions, and shallow water table (Defense Mapping Agency 1978).

The next best source areas of groundwater, by volume, are creek valley bottoms located throughout the central portion of the Fort Wainwright Yukon Training Area. Unfrozen gravel located just above the bedrock, and the bedrock itself, comprise a majority of the water-bearing aquifer. High organic material content and the presence of permafrost in the valley bottoms prevents infiltration of surface water. As a result, groundwater recharge rates are low. Artesian springs are also present on the edges of valley floors where percolating groundwater is confined by permafrost located on lower slopes.

The upland hills located on Fort Wainwright Yukon Training Area are a very poor source of groundwater. The lack of groundwater storage is attributed to high topographic relief and the well-drained, unfrozen silts. Fractures and joints of underlying bedrock are a possible source of groundwater within the area. Generally, water yield is low and recharge rates are slow. Permafrost is absent on south-facing slopes and in the areas of higher relief. Perched water tables

can be found along fracture zones or above permafrost on north-facing slopes and at the base of hillslopes (Defense Mapping Agency 1978).

Fort Greely West Training Area

Field specific groundwater data for the West Training Area do not exist due to the remoteness of the area. As a result, aquifer characteristics and groundwater occurrence, recharge, and discharge are inferred from the following characteristics of the East Training Area groundwater system. The portions of the West Training Area with the greatest groundwater potential are the floodplain alluvium along the Little Delta River, Delta Creek, and the broad alluvial fans extending along the north flanks of the Alaska Range (shown in Figure 3.9.b). Groundwater potential is greatest in these areas due to the extensive saturated thickness and abundant recharge of the unconsolidated alluvial deposits. In general, groundwater potential decreases with distance from the alluvial deposits. Well yields have been estimated to be greater than 50 gallons per minute for wells located in glacial moraines, and less than 50 gallons per minute for wells located in bedrock (Anderson 1970). Similar to the Fort Greely East Training Area, aquifers are recharged from surface streams. Small amounts of infiltration of precipitation may also contribute to aquifer recharge.

Fort Greely East Training Area

It is suspected that the alluvial aquifer system underlying the Fort Greely East Training Area may be composed of several aquifers separated by leaky confining layers even though data supporting this hypothesis are lacking. As a result, this system is classified as a single aquifer with varying local confinement. Silty sediments and glacial till may be the source of local confinement. The aquifer is unconfined near Clearwater Creek, which is east of the East Training Area, and near the Tanana River, 18 miles upstream from the Gerstle River, which is also east of the East Training Area. Well logs within the Fort Greely area indicate that permafrost does not generally extend into the saturated zone and usually does not act as a confining layer. Stratification due to lenticular deposits of silt, sand, and gravel with boulders causes permeability within the alluvial sequence to range widely. The presence of silty sediments in many areas may cause some sections of the aquifer to have low transmissivity values (the ability of the aquifer to transmit water). Overall, a large alluvium thickness and the presence of sand and gravel lenses results in a high transmissivity for the alluvial aquifer. Well yields in the Fort Greely East Training Area are as high as 1,500 gallons per minute (Wilcox 1980). Figure 3.9.b shows the location of groundwater within the Fort Greely East Training Area.

The alluvial aquifer system underlying the East Training Area is recharged by losing streams along all of its boundaries and by infiltration of precipitation.

Jarvis Creek and the Delta River are perched above the aquifer and lose water to it through their streambeds. Further north, the Tanana River also contributes to groundwater recharge through its streambed. To the east, the Gerstle River has a losing reach where the river flows onto an alluvial fan. Also, several small creeks draining the north face of the Alaska Range commonly lose all their flow to the ground near the apex of the alluvial apron located in the southeastern section of the East Training Area. During rainstorms and spring snowmelt period, flow within these streams can be observed further down channel. In general, the volume of groundwater recharge from this area is directly related to the amount of surface flow (Wilcox 1980).

In the northern, western, and eastern portions of the East Training Area, water is discharged from the alluvial aquifer system to the surface water system. Clearwater Creek and Clearwater Lake are almost entirely spring fed. This is supported by the fact that these areas are unfrozen during the winter months because of the inflow of relatively warm groundwater. The swampy areas along the Tanana River to the north of the East Training Area receive spring flow. Springs are also present near the mouth of the Delta River. The year-round groundwater discharge rate in the East Training Area is estimated to exceed 1,200 cubic feet per second not including the unmeasured seepage rates to the Tanana River (Wilcox 1980).

In general, the water table moves closer to the land surface the further it is distanced from the Alaska Range. The water table is more than 400 feet below the land surface near the front of the Alaska Range, 150 to 200 feet near Fort Greely, 50 to 100 feet near the City of Delta Junction and less than 10 feet near Clearwater Creek, Clearwater Lake, and Big Delta (Wilcox 1980). The water table near the East Training Area slopes northward at gradients between one foot and 25 feet per mile. This level can also fluctuate in response to seasonal recharge to the aquifer from river and stream channel losses and from precipitation. Seasonal fluctuation is on the order of 20 to 60 feet. Data from a well having a continuous four-year record, located in the northern portion of the East Training Area, indicate that water levels are lowest in late May or early June. River ice typically breaks up in April or May, and recharge from surface water begins. In response, the groundwater level rises until it reaches a peak in October. At this time, the rivers freeze and recharge ceases. The groundwater level recedes until May or June, when recharge begins again. The water table also indicates that groundwater recharged by the Delta River and Jarvis Creek flows northeast toward Clearwater Lake. Groundwater recharged by the Tanana River, the Gerstle River, and the small creeks draining the north face of the Alaska Range flows toward the springs near Clearwater Creek. In general, the

groundwater flows in a northeasterly direction and may flow in a more northerly direction in winter (Wilcox 1980).

3.9.2 Groundwater Quality

In general, the chemical quality of groundwater reflects its geologic environment. Groundwater quality on the Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas is divided into three general areas based on geologic regime. The first set of wells drilled along the boundaries of the Tanana Basin, including the southern portion of Fort Greely along the northern flanks of the Alaska Range and the uplands of the Yukon Training Area, is typically high in magnesium bicarbonate or magnesium sulfate. Wells drilled in crystalline rock may have concentrations of magnesium and nitrate higher than the limit recommended by the Alaska Drinking Water Standards (18 AAC 80) as listed in Appendix 3.9. The second group of wells is located in the alluvial valleys of Fort Greely. Water is low in iron and exhibits moderate hardness values. Groundwater quality in this area is similar to the streams that flow across the alluvial fans. This area is the largest source of good quality water within the Tanana River Basin. The final set of wells, located in the organic-rich sediments of floodplains, terraces, and valley fills, including the uplands of the Yukon Training Area, is low in sulfate and moderate to high in hardness and iron. Chloride and fluoride concentrations are low throughout the withdrawal areas. Overall, groundwater temperatures stay relatively constant; values are less than 40°F and usually range from 32°F to 34°F (Anderson 1970).

Fort Wainwright Yukon Training Area

No groundwater monitoring wells have been drilled on the Fort Wainwright Yukon Training Area including the Stuart Creek Impact Area. As a result, an estimate of naturally occurring groundwater quality on the Yukon Training Area must be made based on information from groundwater wells in the surrounding area (Figure 3.9.a).

Appendix 3.9 contains measured values for various groundwater quality parameters collected at specific sites near the Yukon Training Area. The Alaska Drinking Water Standards (18 AAC 80) are also listed for comparison.

The only water quality parameter with measured values above the set standard is iron. Well G-14 had the lowest value of 7.11 milligrams per liter (mg/l) and well G-16 had the highest value of 25.0 mg/l. The secondary drinking water standard for iron is 0.3 mg/l. Most municipal water supplies require treatment for iron removal prior to use in the Fairbanks area (Defense Mapping Agency 1978). Sodium values ranged from 5.2 mg/l to 15.0 mg/l, well below the standard of 250 mg/l. The concentrations of sulfate, chloride, fluoride, and nitrate were also

well below their set standards. Well G-16 had the highest dissolved solids reading of 429.0 mg/l and well G-14 had a low concentration of 135 mg/l. The dissolved solids standard is 500 mg/l.

Fort Greely West and East Training Areas
Human inhabitation of Fort Greely is sparse. As a result, few wells have been drilled on the installation and groundwater quality data are limited to areas in the immediate vicinity of the Fort Greely Main Post. A majority of the available groundwater quality data date from the early 1950s through the 1970s. The most recent values available are from 1990, and were collected in the Main Post area (Appendix 3.9). These data provide a reasonable estimate of the region's natural groundwater quality. It should be noted that some groundwater wells within the Main Post area were drilled in response to specific spills or hazardous materials operations. Figure 3.9.b shows the location of groundwater wells in the Fort Greely vicinity. Groundwater monitoring wells have not been drilled on the Fort Greely West or East Training Areas. Thus, no groundwater quality data are available for the Impact Areas.

According to limited available data, Fort Greely groundwater quality is good. All of the water quality parameters measured were below the concentrations recommended by the Alaska Drinking Water Standards (18 AAC 80) as listed in Appendix 3.9. Measured pH values were within the acceptable range of 6.5 to 8.5 standard units. Sodium values ranged from 5.1 mg/l at Donnelly Flats to 3.2 mg/l at Black Rapids. Both values were far below the established standard of 250 mg/l. Sulfate, chloride, fluoride, nitrate, and iron values are also well below the set standards. The lowest dissolved solid value of 153 mg/l was recorded at well G-13 and the highest value of 225 mg/l was recorded at well G-10. All of these values were below the standard.

3.10 WETLANDS

Wetlands are lands transitional between terrestrial and deepwater habitats where the water table usually is at or near the land surface or the land is covered by shallow water (Cowardian et al. 1979). Wetlands are sociologically, ecologically, and economically valuable in Alaska. These areas provide resources for people in rural Alaskan villages to survive. Wetlands also serve as wildlife habitat areas for large mammals and especially migrating birds. Additionally, Alaskan wetlands sustain some of the richest commercial, sport, and subsistence fisheries.

Wetlands have important hydrologic and water quality functions including flow regulation, erosion control, sediment retention, nutrient uptake, and contaminant

removal. Wetland formation is influenced by local climate, basin morphometry, the ratio of watershed area to wetland volume, and the material properties of peats and their underlying mineral substrates (Bedford and Ford 1987). Alaskan wetlands are unique, as compared to wetlands found in the contiguous United States, due to the influence of high-latitude phenomena such as glaciers, permafrost, and aufeis (massive winter icings that occur in river valleys). These features determine wetland volume and areal distribution and the rate and time of water released.

Knowledge of the areal extent of wetlands in the withdrawal area is limited. The most descriptive wetland data that exist for the Fort Wainwright and Fort Greely area were developed by the U.S. Fish and Wildlife Service as part of the National Wetlands Inventory (NWI) program in 1992. This program identified wetlands using stereoscopic analysis of high altitude aerial photographs. Wetlands were identified based on vegetation, visible hydrology, and geography in accordance with Classification of Wetlands and Deepwater Habitats of the United States (Cowardian et al. 1979). These photographs represent the natural conditions occurring during the year in which they were taken. There is also a margin of error that exists when using aerial photographs for identification and mapping purposes. Some small wetlands and those obscured by dense forest cover may not be included in this inventory. The NWI program did not complete wetland delineation for the entire withdrawal areas.

Figures 3.10.a and 3.10.b show the location of wetlands and the extent of the NWI delineation on the withdrawal areas of the Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. Wetlands are categorized by the U.S. Fish and Wildlife Service wetland classification system. This system places ecologically similar habitats into a hierarchal system based on dominant plants or substrates (as shown in Appendix 3.10) This system was designed to be used by Federal and State agencies for the inventory and mapping of wetland surveys. For purposes of this classification, wetlands must have one or more of the following attributes: at least periodically, the land supports predominantly hydrophytes; the substrate is predominantly undrained hydric soil; and the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardian et al. 1979).

To compensate for the lack of detail associated with the NWI, U.S. Army Alaska (USARAK) has contracted with the U.S. Army Corps of Engineers Waterways Experiment Station (WES) and Cold Region Research Engineering Laboratory (CRREL) to delineate wetlands on Fort Wainwright and Fort Greely. Both projects will include digitization of all wetland boundaries. In addition, USARAK

is developing a classification system based on hydrogeomorphic characteristics of vegetative communities and will include a description of values and functions of wetlands on Fort Wainwright and Fort Greely. Wetland management recommendations will also be included.

Fort Wainwright Yukon Training Area

The majority of Fort Wainwright Yukon Training Area (72%) is classified as upland. Shrub wetlands can be found scattered throughout the Yukon Training Area. These wetlands are associated with slightly higher relief on the edges of marshes and in poorly-drained basins and depressions with cold, waterlogged soils typically located along or near stream corridors. A thick layer of peat over a mottled gray silt or silt loam with a water table a few inches from the surface is characteristic of the area. Depth to permafrost is often less than 30 inches. These wetlands are classified by the U.S. Fish and Wildlife Service as saturated palustrine scrub-shrub or forested systems. Approximately 14% of the Fort Wainwright Yukon Training Area is covered by this wetland type. Wetlands located in the South Fork Chena River Lowlands on the Stuart Creek Impact Area are similar to those found on the training areas. A large wetland cluster is located in the lowlands of the Chena River floodplain and the French-Moose Creek area. Appendix 3.10 contains the areal extent and individual wetland types identified on the Training Area.

Fort Greely West and East Training Areas

Shrub wetland is the dominant wetland variety found on Fort Greely. Little Delta Training Area, located in the northwest portion of Fort Greely West Training Area, is predominantly covered by scrub-shrub or forested palustrine wetland systems. Approximately 13% (of the area surveyed) of Fort Greely is covered by these types of wetlands. A small northern portion of the Lakes Impact Area was surveyed for wetlands. This area contains saturated palustrine scrub-shrub wetland systems. Even though approximately half of the Impact Area (54%) was not inventoried, it is likely that this type of wetland is dominant throughout the Training Area. Wetlands located along Delta and Little Delta Rivers and Jarvis Creek are riverine systems having unconsolidated bottoms. Very few wetlands other than those along Jarvis Creek are found on the Fort Greely East Training Area. Appendix 3.10 contains the areal extent and individual wetland types identified at Fort Greely.

3.11 VEGETATION

In 1980, a hierarchial land classification system was developed through the U.S. Department of Agriculture to describe and manage lands on a regional to local

scale. The term "ecoregion" was used to describe continuous geographical areas defined by climate and vegetation. An ecoregion is characterized by landform, soil, flora, fauna, and ecological climax. This classification based on ecosystems is now accepted and used by several federal agencies to manage lands in terms of biodiversity. The following general description of the withdrawn lands is from the hierarchial land classification (Bailey 1995, McNab and Avers 1994).

Table 3.11.a Ecoregion Hierarchial Land Classification System.

ECOREGION	FORT WAINWRIGHT YUKON TRAINING AREA	FORT GREELY WEST AND EAST TRAINING AREAS
DOMAIN	**POLAR** - low temperatures, severe winters, small amounts of precipitation mainly in summer.	**POLAR** - low temperatures, severe winters, small amounts of precipitation mainly in summer.
DIVISION	**SUBARCTIC** - cold snowy forest climate - boreal subarctic type, open lichen woodlands, taiga.	**SUBARCTIC** - cold snowy forest climate - boreal subarctic type, open lichen woodlands, taiga.
PROVINCE	**UPPER YUKON TAIGA-MEADOW** Vegetation complex, forests of white spruce, paper birch, quaking aspen covering most lower slopes on south and south-facing slopes in north. Black spruce at higher elevations on all north-facing slopes in south, on all but steep south-facing slopes in north and on lower slopes with impeded soil drainage throughout area. Above black spruce forest, land is either barren or alpine meadow (tundra) characterized by sedges and mosses on poorly-drained sites and low growing shrubs on drier sites.	**ALASKA RANGE HUMID TAIGA-TUNDRA-MEADOW** Dense bottom-land stands of white spruce and cottonwood on floodplains, black spruce in poorly-drained areas up to 1,000ft (300m), upland spruce-hardwood forests of white spruce, birch, aspen, and poplar, with undergrowth of moss, fern, grass, and berry to timberline at about 2,500-3,500ft (800-1,100m).
SECTION	**UPPER YUKON HIGHLANDS** - See description above.	**ALASKA MOUNTAINS** - substantial portion of area barren of vegetation. In vegetated areas, alpine and moist tundra communities of prostrate plants are predominant. Riparian spruce-hardwood forests infrequently occur at low elevations.

Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas are part of the Polar Domain and Subarctic Division. Areas within the Polar Domain have low temperatures, severe winters, and small amounts of precipitation occurring mainly in summer. The Subarctic Division further describes the areas as having cold, snowy, forest climates of the boreal Subarctic type and open lichen woodlands called taiga.

The Subarctic Division encompassing the withdrawal lands is further divided into Provinces and then into Sections. The Fort Wainwright Yukon Training Area lies within the Upper Yukon Taiga-Meadow Province, Upper Yukon Highlands Section (Bailey 1995, McNab and Avers 1994). These are lands of complex vegetation with forests of white spruce *(Picea glauca)*, paper birch *(Betula papyrifera)*, and quaking aspen *(Populus tremuloides)*, dominating well-drained areas on lower and south-facing slopes. Black spruce (*Picea mariana*) is found where permafrost is present at higher elevations and on north-facing slopes. Black spruce is also found on lower slopes with impeded drainage. Above the black spruce tree line, areas are barren or alpine meadow (tundra) characterized by sedges and mosses in poorly-drained sites and low growing shrubs on drier sites (McNab and Avers 1994).

Fort Greely West and East Training Areas lie within the Alaska Range Humid Taiga-Tundra-Meadow Province and Alaska Mountains Section. The Province is characterized by dense bottomland stands of white spruce and cottonwood (*Populus sp.*) on floodplains and forests similar to those described for Fort Wainwright Yukon Training Area, with black spruce found on higher elevation north-facing slopes and in lower, poorly-drained areas. White spruce forests and spruce/hardwood forests are found on lower, well-drained slopes and south-facing slopes with an understory of low shrubs, forbs, grass, ferns, and moss. Barren areas are common in the Alaska Mountain Section. Portions of the withdrawal lands are barren at higher elevations, but vegetation associated with alpine and moist tundras are also present (Racine et al. 1997, Bailey 1995, McNab and Avers 1994). At lower elevations within the Section, riparian spruce-hardwood forests infrequently occur.

Viereck et al. (1992) has classified vegetation in Alaska into a five level system. Level I lists the general categories: forest (dense growth of trees), scrub (stunted trees or shrubs), and herbaceous vegetation (forbs, graminoids, mosses and lichens). This level is subsequently divided to Level 5 where associated plant species are listed. Most vegetation descriptions for the withdrawn lands use Viereck's classification system. The vegetation description in this section is an overview of information gathered from several reports of vegetation patterns on the withdrawal lands and is based on Viereck's classification system.

Vegetation patterns of the withdrawal lands are determined by a number of natural influences including climate, topography, glaciation, flooding, depth of water table, permafrost, and fire. These areas are covered by forest, grassland, shrubs and/or scrub, bogs, fens, and alpine tundra (Racine et al. 1997). Mountainous areas create their own climates, influencing vegetation. Vegetation patterns change from the lowland areas to the high tundra. These vegetation types change according to slope, aspect, elevation, and permafrost. Bailey (1995) termed these vegetation pattern changes within mountainous areas "Vertical Vegetative Zonation". Throughout the Interior, interrelationships among the different elements creates complex patterns of vegetation.

The withdrawal lands contain pure stands of spruce or hardwoods to forests of mixed spruce/hardwood. The lowland black spruce/hardwood forest found on each post is the most common forest type in interior Alaska (U.S. Dept. of the Army Hdqtrs 1979 and 1980). In wet areas with permafrost, black spruce is dominant. Lowland black spruce is found in flat valley bottoms, lake sides, bog margins, and muskegs where drainage is poor.

Stands of white spruce are found mainly in areas of well-drained soils where permafrost is absent. White spruce/balsam poplar (*Populus balsamifera*) stands are found in floodplains, low river terraces, and south-facing slopes (Jorgenson et al. 1996, U.S. Dept. of the Army 1979 and 1980). White spruce is also found mixed with paper birch on high ridges and with quaking aspen at lower elevations. Quaking aspen is a fast growing tree common on south slopes, well-drained benches, and creek bottoms throughout interior Alaska to an elevation of 3000 feet. Tamarack (*Larix laricina)* is also found with white and black spruce in riverine areas and occasionally with paper birch (Jorgenson et al. 1996, Racine et al. 1997).

The withdrawal lands also contain areas of tundra (alpine and moist), barren lands, wetlands, and low and tall shrubs. Moist tundra is found in small scattered areas on the Fort Wainwright Yukon Training Area. Moist tundra, also called foothills tundra, occurs from about 2,500 to 3,500 feet on the Yukon Training Area. Vegetation in alpine and moist tundra consist of low, dwarf or procumbent shrubs, sedges, and grasses (U.S. Dept. of the Army Hdqtrs 1979). Fort Greely West Training Area has small areas of moist tundra in the northwest and southeast and alpine tundra in the west and south. Alpine tundra occurs above treeline at approximately 3,500 to 4,000 feet.

Barren lands are glaciers, snowfields, and bare exposed rock in river gravel bars and in mountainous areas (U.S. Dept. of the Army Hdqtrs 1980, Jorgenson et al. 1996). The Fort Wainwright Yukon Training Area contains river barrens

consisting of stream channels and silt, sand, and gravel bars (Racine et al. 1997). Barren areas on Fort Greely West Training Area occur in the south at MacArthur and Patton Mountains, the Molybdenum Rim, and Trident Glacier.

Wetland areas are comprised of scrub bogs, bog meadows, lowland low scrub containing sedges *(Carex spp.)*, tussock meadows, and lowland moist meadows with bluejoint reedgrass *(Calamagrostis canadensis)* and sedges. Willows (*Salix spp.)* and forbs may be present. Lowland areas also contain coniferous and deciduous forests (Jorgenson et al. 1996). On Fort Wainwright Yukon Training Area, wetlands are found in low lying areas and floodplains of all creeks. The northwest corner of the Yukon Training Area is part of the Chena River floodplain. Extensive wetlands are found on Fort Greely. See Chapter 3.10 for more detailed account of wetlands.

Transitional zones or ecotones commonly occur on the withdrawal lands. Low and tall shrub vegetation types form ecotones between forests and barren areas or tundra at high elevations, and forests and barren areas at lower elevations. They are usually found along floodplains or just above treeline. Species within low or tall shrub ecotones are alder (*Alnus sp.*), willow, cottonwood, birch, mountain ash (*Sorbus sp.*), and low growing white spruce with minimal ground cover. Subalpine areas contain grasses, mosses, dwarf shrubs, and lichens (Racine et al. 1997).

3.11.1 Ecological Land Classification

A further description of the withdrawal lands is needed to understand the complex vegetative compositions of the areas. U.S. Army Cold Regions Research and Engineering Laboratory contracted ABR, Environmental Research and Services Inc., to produce Ecological Land Classification maps for Fort Wainwright in 1996. ABR is working to complete maps for Fort Greely. The maps delineate Ecodistricts, Ecosubdistricts, and Ecosites.

Ecodistricts are physiographic units within a climatic region that influence moisture availability and exposure to radiant solar energy and have similar geology, geomorphology, and hydrology. Names of ecodistricts are based on prominent geographic features and broad physiographic land forms. Ecosubdistricts are smaller physiographic regions having distinct, repeating associations of vegetation, soils, permafrost characteristics, waterbodies, and fauna. The Fort Wainwright Yukon Training Area lies within the White Mountains Ecodistrict. There are four Ecosubdistricts within Fort Wainwright Yukon Training Area. They are the Chena-Salcha Highlands, French-Moose Creek Lowlands, Chena Floodplain, and South Fork Chena Lowlands. These areas are defined in Table 3.11.b and shown in Figure 3.11.a (Jorgenson et al. 1996).

Table 3.11.b Ecosubdistricts of Fort Wainwright Yukon Training Area.

Chena Salcha Highlands - Mountainous area of weathered bedrock in alpine areas. Permafrost is present on northern and lower slopes and absent on southern slopes. White spruce-birch-aspen forests on south slopes, black spruce forests on north slopes, riverine willows in drainages, and alpine tundra on high exposed ridges are common.

French-Moose Creek Lowlands - Rounded hills and mountains with low marshy land, collapse-scar and flat bogs present. Area generally above Tanana floodplain, but has numerous small streams originating in highlands. Permafrost nearly continuous: absent in collapse-scar bogs, thaw ponds, and ridges of well-drained sand dunes. Black spruce and birch forests, shrub-tussock meadows, sedge-moss bogs, and aquatic vegetation in shallow thaw ponds are common.

Chena Floodplain - Meandering stretch of lower Chena River with active and inactive floodplains. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow, and alder tall shrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.

South Fork Chena Lowlands - Valley bottoms with active and inactive floodplain areas. Permafrost continuous, except under larger streams. Vegetation is dominated by black spruce, and birch forests, low shrubland, and tussock tundra. White spruce-balsam poplar forests are found along floodplains.

Ecosites are subgroups representing vegetation types or successional stages within a uniform soil and geomorphic class. The Fort Wainwright Yukon Training Area has 32 ecosites and descriptions of these are listed in Table 3.11.c (Jorgenson et al. 1996). Many of the ecosites described for Fort Wainwright Yukon Training Area apply to Fort Greely West and East Training Areas.

Within each of the ecosites listed in Table 3.11.c are vegetative communities. The Ecological Land Classification Report (Jorgenson et al. 1996) contains a table of the vegetative communities that were combined to create each of the ecosites.

Five forest ecosites dominate the landscape on Fort Wainwright Yukon Training Area covering over 75,000 acres. Four of the ecosites are upland forest: mixed (17,575 acres), south-facing broadleaf (17,559 acres), needleleaf (14,652 acres), and south-facing mixed (13,250 acres), and one is a lowland needleleaf forest (11,919 acres). Riverine barrens, and wet and moist meadows encompass the least amount of area.

The ecosite map of Fort Wainwright Yukon Training Area has been divided into four separate maps. The northwest portion of the Training Area is shown in

Figure 3.11.b, the northeast, Figure 3.11.c, the southwest, Figure 3.11.d, and the southeast in Figure 3.11.e.

Table 3.11.c Ecological Land Classifications for Fort Wainwright Yukon Training Area.

ECOSITE	DESCRIPTION
RIVERINE BARRENS	Unvegetated to partially vegetated (<30% cover) river-bars that are frequently flooded.
RIVER	Lower perennial river, both glacial or non-glacial.
RIVERINE BROADLEAF FOREST	Open or closed early-mid successional forests, with balsam poplar, paper birch, and aspen. Inactive flooding regime. Organic layer undeveloped.
RIVERINE MIXED FOREST	Typically mid-successional, closed white spruce-balsam poplar forest. Soils are riverine cover deposits. Inactive flooding regime.
RIVERINE TALL SCRUB	Dense stands of willow and alder, early successional plants on riverine silts that are regularly flooded.
RIVERINE WET MEADOW	Sedge wet meadows found in recently abandoned sloughs and channels. Organic horizons of sedge peat vary from shallow to moderate over riverine silts.
RIVERINE COMPLEX	Common on meander floodplains. Individual meanders may contain entire successional sequence. Vegetation includes scattered open to closed spruce stands, shrub stands and sedge-shrub areas.
LAKES OR PONDS	Lacustrine environments that may contain submerged vegetation. Lakes may be oxbows along rivers, bedrock controlled or thaw basins.
LOWLAND NEEDLELEAF FOREST	Open to closed forest of black spruce is common. White spruce and tamarack also occur. Terrain usually abandoned cover deposit or lowland retransported deposit. Organics moderate to thick. Permafrost generally present.
LOWLAND BROADLEAF FOREST	Most commonly characterized by a closed forest of paper birch. Also found are open and closed forests on lowland retransported deposits, and open to closed mixed broadleaf forests on lowland eolian deposits.
LOWLAND MIXED FOREST	Closed spruce-paper birch forest is dominant type. Other types are open to closed spruce-paper birch-quaking aspen forests on better drained lowland loess and closed spruce-paper birch forests on lowland eolian complex. Most types are unfrozen.

Table 3.11.c Ecological Land Classifications for Fort Wainwright Yukon Training Area.

ECOSITE	DESCRIPTION
LOWLAND TALL SCRUB	Broadleaf woodland-shrub woodland (post fire) and closed tall shrub resulting from recent disturbance on abandoned-floodplain cover deposits. Typically organic layer is thin and permafrost is absent.
LOWLAND LOW SCRUB	Dominant communities are shrub birch-*Ericaceous* shrub on abandoned-floodplain cover deposits. Open, low mixed shrub-sedge tussock meadow also occur on cover deposits and recently burned shrub types. Scattered trees, particularly black spruce and tamarack may be present. Soils generally organic, saturated and frozen. Tussock patches and burned areas have variable organic development and permafrost.
LOWLAND MOIST MEADOW	Bluejoint reedgrass and sedges are dominant. Typically circular features associated with streams, recently abandoned drainages or old sand dunes. Scattered shrubs, usually willows, and forbs may be present. Soils are well-drained mineral or organic mineral, mesic and permafrost free.
LOWLAND EOLIAN COMPLEX	A mosaic of terrain unit types (lowland eolian deposits, lowland retransported deposits, organic bogs, and isolated sand dunes) that support a mixture of paper birch, black spruce, low shrub, mesic graminoid and wet tussock meadows, and bog vegetation types. Black spruce most common on frozen soil that vary from open to woodland densities. Small thermokarst ponds, sphagnum bogs, and tussock meadows also occur. Deciduous trees restricted to patchy areas of better drainage.
LOWLAND SLOPE DRAINAGE COMPLEX	Repeating associations of communities on variable lowland terrain (lowland eolian deposits, abandoned cover deposits, and lowland retransported deposits). Open spruce stands interrupted by linear features, such as abandoned channels and water tracks, which are populated by alder and paper birch on toe slopes and low shrubs and graminoids on the flats.
LOWLAND ABANDONED CHANNEL COMPLEX	Occurs on shallow, gravelly soils. Plant communities are open black spruce-tamarack forest, open and closed low shrub and sedge wet meadows.
SCRUB BOG	Lowland mixed conifer woodland types growing on organic deposits. Organic terrain includes lowland eolian complex, veneer bog and flat bog.

Table 3.11.c Ecological Land Classifications for Fort Wainwright Yukon Training Area.

ECOSITE	DESCRIPTION
BOG MEADOW	Open low willow-graminoid shrub bog, lowland sedge-moss bog meadow, and lowland sedge-herb bog meadow communities (including in-filling lakes) growing on saturated, organic deposits veneer bogs, shore bogs and collapse scar bogs.
UPLAND NEEDLELEAF FOREST	Open and closed black spruce and mixed spruce forests occurring on moderate to well-drained residual bedrock soils, upland retransported soils, and upland loess deposits on north, east and west-facing slopes. Permafrost may be present particularly on north-facing and lower slopes.
UPLAND BROADLEAF FOREST	Woodland to closed paper birch forests on moderate to well drained residual bedrock, upland retransported and upland loess deposits on north, east and west-facing slopes. Organic horizons shallow and permafrost absent. Woodland stands usually occur with dense tall scrub as an early successional stage after fire or other disturbance.
UPLAND MIXED FOREST	Open to closed spruce-paper birch forests on moderate to well drained residual bedrock, upland retransported and upland loess deposits on north, east and west-facing slopes. Organic horizons shallow, permafrost absent or discontinuous. Many stands are mid-successional communities that will eventually be replaced by closed spruce forest.
UPLAND NEEDLELEAF FOREST (SOUTH-FACING)	South-facing slopes populated by white spruce and mixed spruce forests. Residual bedrock or upland retransported soils. Drainage good and permafrost absent. Open black spruce forest can occur on lower south slopes where drainage may be impaired or soil temperatures low.
UPLAND BROADLEAF FOREST (SOUTH-FACING)	Open to closed quaking aspen and paper birch-quaking aspen forests. Residual bedrock, upland retransported or upland loess deposits. Drainage good, permafrost absent. May be maintained by fire or be mid-successional with white spruce in understory.
UPLAND MIXED FOREST (SOUTH-FACING)	Closed spruce-paper birch-quaking aspen forests on residual bedrock soils, upland retransported deposits or upland loess deposits. Drainage good and permafrost absent. Commonly are mid-successional forests that will be replaced by spruce stands.
UPLAND TALL SCRUB	Dense, tall scrub thickets of alder and willow usually a result from disturbance but may also occur at headwaters of small drainages. Understory often solely alder leaf litter. Permafrost absent, soils residual bedrock and upland loess deposits.

Table 3.11.c Ecological Land Classifications for Fort Wainwright Yukon Training Area.

ECOSITE	DESCRIPTION
UPLAND LOW SCRUB	Open and closed shrub birch communities, post-fire scrub patches and dry midgrass-shrub. Shrub birch and early successional scrub occur on residual bedrock soils, upland loess and upland retransported soils. Organic layer thickness thin to moderate. Midgrass-shrub is restricted to dry, steep, south-facing bluffs.
UPLAND SLOPE DRAINAGE COMPLEX	Successive drainages produce an alternating pattern of tall shrub, deciduous forest and spruce forest on upland retransported and residual bedrock soils.
SUBALPINE FOREST	Found at elevational limit of tree growth. Permafrost is usually present. Forest is mature, but trees (white and black spruce, and rarely, paper birch) are small and scattered. Grades into dwarf tree scrub as growing conditions become more severe.
SUBALPINE SCRUB	Rare in study area. Tall shrubs, usually willow and glandular birch, form closed communities on residual bedrock soil or weathered bedrock at or just below treeline. Permafrost common.
ALPINE SCRUB	Occurs above upper limit of tree growth on weathered bedrock or a thin layer of residual bedrock soil. Vegetation may be discontinuous due to rocky soils and outcroppings. Plants low growing. Dwarf shrubs and lichens provide most of cover at higher sites, low shrubs dominate just above treeline and in protected areas.
HUMAN MODIFIED	Barren or partially vegetated areas that have been excavated or filled.

In 1995, a floristic survey of Fort Wainwright was conducted. The study provided a baseline inventory of the existing flora (Racine et al. 1997). A complete floristic survey of Fort Greely has not been conducted, but many of the plant species found on Fort Wainwright occur on Fort Greely. Floristic surveys have been conducted on Fort Greely in areas east of the Delta River. Two plants have been identified on Fort Greely that have not been found on Fort Wainwright. They are *Bupleurum americanum* and *Elaeagnus communtata.* For a complete list of plants found on Fort Wainwright and Fort Greely see Appendix 3.11.

No Federal or State listed endangered or threatened plant species are listed by the Alaska Natural Heritage Program as occurring within or near the withdrawal lands. Five plants listed as rare or major range extensions were found on Fort Wainwright during the 1995 survey. Detailed information on the findings can be

reviewed in Chapter 3.14 Threatened or Endangered Species and Species of Concern.

3.11.2 Timber Management

The Military Lands Withdrawal Act (Public Law 99-606) identified the Secretary of the Interior and Secretary of the Army as managers of the withdrawn lands. U.S. Army Alaska is required under the Sikes Act (Public Law 105-85) to complete and implement Integrated Natural Resources Management Plans for Fort Wainwright and Fort Greely.

The Sikes Act also mandates management of forest resources. The Integrated Natural Resources Management Plans are five year planning documents that have identified management needs for the installations. One of the goals of the plans is to implement Forest Ecosystem Management Plans. U.S. Army Alaska plans to implement a ten year project, in 1999, to inventory forest resources on Fort Wainwright and Fort Greely.

The Military Lands Withdrawal Act authorizes the Secretary of the Interior, through the Bureau of Land Management, (after consultation with the Secretary of the military department concerned) to develop a plan for the management of the withdrawal lands. The Bureau of Land Management and Army wrote Resource Management Plans for Fort Wainwright and Fort Greely (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a,b). The management plans include provisions necessary for proper management and protection of resources and values of such areas. Forest management is covered under these plans.

Sales of forest products are the responsibility of the Bureau of Land Management (BLM). Sales of forest products will require additional National Environmental Policy Act (NEPA) review and documentation, requires military concurrence, and compliance with Federal Regulation, Sales of Forest Products (43 CFR 5400). Authorization for non-military free use of timber is also the responsibility of the BLM and requires a permit pursuant to Federal Regulation, Free Use of Timber (43 CFR 5510), and military concurrence.

3.12 WILDLIFE

The Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas support a large diversity of wildlife. Wildlife populations on the withdrawal lands are managed by the Alaska Department of Fish and Game. Past management emphasis has been directed toward big game populations.

Habitat for some of these species has been identified and protected on the withdrawal lands. Little information is available on habitat availability for small game, non-game species, and migratory birds. Most habitat important for these species has not been identified for management or protection on the withdrawal lands. Species known to occur on the posts are listed in Appendix 3.12.

The Alaska Department of Fish and Game organizes its Game Management Areas into units and subunits. The withdrawn lands are within Alaska Department of Fish and Game, Game Management Unit (GMU) 20, and lie within three Game Management Subunits. The Fort Wainwright Yukon Training Area is within GMU 20B, Fort Greely West Training Area, west of the Delta River, is within GMU 20A, and lands east of the Delta River including Fort Greely East Training Area are within GMU 20D (Figure 3.12.a).

The Alaska Department of Fish and Game has categorized wildlife species in its Alaska Hunting Regulations 1997-1998. The following categories of big game, small game, and furbearing species are listed according to these regulations.

Big game species on both posts include: black bear *(Ursus americanus)*, grizzly bear *(Ursus arctos)*, moose *(Alces alces)*, wolf *(Canis lupus)*, and wolverine *(Gulo gulo)*. Fort Greely also has Dall sheep *(Ovis dalli)*, caribou *(Rangifer tarandus)*, and bison *(Bison bison)* (ADF&G 1998).

Small game species on the withdrawal lands include: willow ptarmigan *(Lagopus lagopus)*, rock ptarmigan *(Lagopus mutus)* and white-tailed ptarmigan *(Lagopus leucurus)*, ruffed grouse *(Bonasa umbellus)*, spruce grouse *(Dendragopus canadensis)* and sharp-tailed grouse *(Pedioecetes phasianellus)* , and snowshoe hare *(Lepus americanus)* (ADF&G 1998, U.S. Dept. of the Army Hdqtrs 1979 and 1980).

State listed furbearing animals found on the withdrawal lands include: coyote *(Canis latrans)*, red fox *(Vulpes vulpes)*, lynx *(Lynx canadensis)*, beaver *(Castor canadensis)*, land otter *(Lutra canadensis)*, marten *(Martes americana)*, mink *(Mustela vison)*, short-tailed weasel *(Mustela erminea)*, muskrat *(Ondatra zibethicus)*, hoary marmot *(Marmota caligata)*, northern flying squirrel *(Glaucomys sabrinus)*, Arctic ground squirrel *(Spermophilus parryii)* and red squirrel *(Tamiasciurus hudsonicus)*.

Unclassified game species found on the withdrawal lands include four species of shrew *(Sorex* sp.*)*, the deer mouse *(Peromyscus maniculatus)*, meadow jumping mouse *(Zapus hudsonicus)* and porcupine *(Erethizon dorsatum)* (ADF&G 1998).

Non-game mammal species found on the posts include five species of vole *(Microtus* sp. and *Clethrionomys* sp.*)*, northern bog lemmings *(Synaptomys borealis)*, and the little brown bat *(Myotis lucifugus)*. One amphibian, the wood frog *(Rana sylvestris),* is common.

The withdrawal lands provide a diversity of habitats for many species of birds. Some of the most common non-game birds found are: alder flycatcher *(Empidonax alnorum)*, American kestrel *(Falco sparverius*), northern hawk owl *(Surnia ulula*), great horned owl *(Bubo virginianus*), yellow-rumped warbler *(Dendroica coronata)*, orange-crowned warbler *(Vermivora celata)*, common redpoll *(Acanthis flammea*), and hoary redpoll *(Carduelis hornemanni)* (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). Waterfowl are numerous in the Chena floodplain area of Fort Wainwright Yukon Training Area and throughout the wetland areas on Fort Greely.

3.12.1 High Use Areas and Sensitive Habitats

Several documents have identified high use areas and sensitive habitats for wildlife species on the withdrawal lands. The Final Environmental Impact Statement for the withdrawal of Fort Wainwright Yukon Training Area (U.S. Dept. of the Army 1979) identified moose concentration areas and waterfowl habitat areas (Figure 3.12.b). The Final Environmental Impact Statement for the withdrawal of Fort Greely West and East Training Areas (U.S. Dept. of the Army Hdqtrs 1980) identified a grizzly bear high spring use area and grizzly bear range, and the bison calving area, and summer and winter range.

A Cooperative Agreement for the Management of Fish and Wildlife Resources on Army Lands in Alaska (U.S. Army Alaska Hdqtrs 1979) established protection of sensitive habitats for bison, moose, and caribou. The cooperative agreement was revised in 1986 and identified changes in the bison and caribou sensitive habitat boundaries. A sandhill crane roosting area was also designated through the 1986 agreement.

The Resource Management Plan for Fort Greely (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a) designated sensitive grizzly bear and Dall sheep habitats. The sensitive grizzly bear range has been corrected, and is shown as the high use grizzly bear range with only riparian and ridge habitat identified as sensitive in Figure 3.12.c. The Dall sheep habitat was the same habitat identified in the Final Environmental Impact Statement (U.S. Dept. of the Army Hdqtrs 1980).

Consultation with the Alaska Department of Fish and Game (ADF&G) for this Legislative Environmental Impact Statement has culminated in identification of

boundary changes for sensitive species on Fort Greely. Caribou, moose, grizzly bear, Dall sheep, and bison sensitive habitats and sensitive time periods have been updated. An additional sandhill crane roosting area was also identified. This information and the documents listed above were used to delineate habitats on maps shown in this chapter.

3.12.2 Big Game Species

Hunting big game species on the withdrawal lands is an important recreational activity. The following summaries for six big game species gives general information on harvest numbers, population estimates, and habitat use.

Black Bear - Black bear are found throughout the withdrawal lands but most hunting occurs in the Fort Wainwright Yukon Training Area. Bears are usually harvested by using bait stations in the spring. Data for 1997 shows that 11 bears were taken in the Fort Wainwright Yukon Training Area during the spring, while none were harvested in the fall. Fifty-three hunters registered for the spring hunt on Fort Wainwright Yukon Training Area and only five hunters registered for Fort Greely. No bears were taken during the spring hunt on Fort Greely and only one was harvested in September (Reidsma, pers com. 1998). No habitat on the withdrawn lands has been identified as sensitive for black bears by the Alaska Department of Fish and Game (Dale, pers. com. 1998). Population estimates are not available for black bears inhabiting the withdrawn lands.

Grizzly Bear - Grizzly bears are found throughout Fort Wainwright Yukon Training Area and Fort Greely. Harvest reports for Fort Wainwright state that zero to three bears are taken annually. Approximately five bears are harvested annually from the Fort Greely West Training Area. No habitat within Fort Wainwright Yukon Training Area is considered sensitive by the Alaska Department of Fish and Game (ADF&G) for grizzly bears (Reynolds, per. comm. 1998).

The 1980 Final Environmental Impact Statement for the withdrawal renewal of Fort Greely identified an "intensive spring use area" located in the southeast portion of the West Training Area within the bison calving and summer range. The Bureau of Land Management identified sensitive habitat within the Fort Greely West Training Area. The habitat lies between the Little Delta River (west) and Delta Creek (east) and the southern post boundary, north to Dinosaur Ridge (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a). The habitat information identified in these documents has been reviewed by ADF&G, and current sensitive grizzly bear habitat on Fort Greely has been identified (Figure 3.12.c).

Grizzly bears still use the intensive spring use area. The ridge habitat between the Little Delta River, Delta Creek, south to the post boundary, and north to Dinosaur Ridge, and riparian areas along the East Fork of the Little Delta River, Delta Creek, and a portion of Buchanan Creek are important feeding areas. Sensitive periods for bears in these areas are from 1 May - 31 May, and 1 September - 30 September. The southern portion of Fort Greely West Training Area has been identified as a cub rearing and breeding area with the sensitive period from 1 May - 20 June. The grizzly bear range identified in the 1980 Final EIS, and shown in Figure 3.12.c, is not listed as sensitive.

Moose - Moose are found throughout the withdrawal lands. The Final Environmental Impact Statement (U.S. Dept. of the Army Hdqtrs 1979) for the withdrawal of Fort Wainwright Yukon Training Area identified moose concentration areas. These include Moose Creek and the Chena floodplain in the northwest, Hunts and Horner Creeks in the north, the South Fork Chena River drainage and Beaver Creek in the northeast, Ninety-eight Mile Creek in the southeast, and the Little Salcha River drainage as it enters the southern boundary for Fort Wainwright Yukon Training Area (Figure 3.12.b).

The cooperative agreement (U.S. Army Alaska Hdqtrs 1979) for management of wildlife at Fort Greely identified the East Training Area as seasonal moose range. The Final Environmental Impact Statement (U.S. Dept. of the Army Hdqtrs 1980) also identified spring, summer, fall, and winter concentration areas. Consultation with Alaska Department of Fish and Game (ADF&G), in 1997 and 1999, further defined boundaries for concentration areas. These include additional fall, winter, and spring concentration areas. Habitat shown in Figure 3.12.d is considered sensitive. Minimum disturbance periods are 15 May - 10 June for calving, and 10 September - 20 October for fall rut.

Population estimates for the Fort Wainwright Yukon Training Area are unknown, but the Tanana Flats of Fort Wainwright is the largest known moose calving area in interior Alaska (Nakata Planning Group 1987). The 1995 fall population estimate for moose on Fort Greely was 700 to 1,100 animals. In the southern portion of the East Training Area, moose numbers appear to be slowly increasing (Dubois, pers. com. 1997). In 1997, 37 moose were taken within Fort Wainwright Yukon Training Area, and 38 moose were harvested on Fort Greely (Von Rueden and Bruce 1997). Game Management Unit 20 has the State's largest moose harvest.

Dall Sheep - Dall sheep are found on the Fort Greely West Training Area (Figure 3.12.e). The Molybdenum Ridge within the southern portion of the West Training Area was identified as a sheep concentration area. The Dall sheep

range was also shown to extend onto the West Training Area in the extreme southwest corner and again in the south, within the Delta Creek/Trident Glacier area (U.S. Dept. of the Army Hdqtrs 1980).

U.S. Army Alaska and the Alaska Department of Fish and Game conducted a study of Dall sheep movements on and near Fort Greely (Spiers and Heimer 1990). Researchers identified five subpopulations totaling 150 sheep on Fort Greely West Training Area in winter and 100 in summer. The Dall sheep are found in the southwestern portion of the West Training Area in the mountainous areas at elevations above 3,000 feet. These areas include MacArthur Mountain, Patton Mountain, and the Molybdenum Ridge. Three winter and three summer ranges were identified. Two of the winter ranges lie within the summer ranges. A separate winter range is the Molybdenum Ridge. The current sensitive habitat areas, identified by ADF&G in 1997, are shown in Figure 3.12.e.

The Dall sheep ranges on Fort Greely are the northern extension of distribution for the five subpopulations. Although migration routes were not observed, researchers inferred that one route is between the Molybdenum Ridge and Hayes Glacier and the southern portion of Whistler Creek, both located south of the post boundary (Spiers and Heimer 1990).

Fort Greely and Fort Richardson, Alaska, are the only military posts in the world with Dall sheep. Fort Greely is the only post open for hunting Dall sheep, according to Spiers and Heimer (1990). Although hunting is allowed, few sheep are taken on Fort Greely and the annual harvest is near zero.

Caribou - The Fortymile Caribou Herd historically ranged over 85,000 square miles including Fort Wainwright and Fort Greely. The herd was estimated at 568,000 animals in the 1920s, but in 1995 the population was approximately 22,000 (U.S. Dept. of the Interior 1995). Today few caribou are seen on Fort Wainwright Yukon Training Area, and those found on Fort Greely are part of the Delta Creek Herd.

The Delta Creek Caribou Herd is estimated at 4,600 animals that range over 3,000 square miles encompassing Fort Greely. Portions of the West Training Area have been designated as sensitive pre-calving, calving, and post-calving habitat. Consultation with Alaska Department of Fish and Game in 1997 identified recent habitat boundaries and these areas are restricted for military use during 15 May - 31 May when there are concentrations of caribou present. Sensitive winter habitat for the herd was identified by the ADF&G in 1999 (Figure 3.12.f).

Caribou hunting is allowed on Fort Wainwright Yukon Training Area, but no caribou have been harvested since 1995. Hunting is also allowed on Fort Greely, but few caribou are taken since most of the herd has moved west, off the post, by hunting season (Dale pers. com. 1997).

Bison - Twenty-three bison were transplanted in 1928, from the National Bison Range in Montana to the vicinity of Big Delta-Delta Junction Area. The Delta Bison Herd once ranged over an area from the hills north of the Tanana River south to the Alaska Range, east to Healy Lake and as far west as the Little Delta River (ADF&G 1993, U.S. Dept. of the Army Hdqtrs 1980).

The 1979 cooperative agreement designated areas on the Fort Greely West Training Area as important bison calving and summer range. The agreement also listed a portion of Fort Greely West Training Area and all of Fort Greely East Training Area as important late summer and early winter range. The 1986 cooperative agreement identified bison calving and summer range within the West Training Area, with minimal disturbance dates of 1 May - 31 August, if large numbers of animals are present. The agreement did not identify the East Training Area habitat. (Figure 3.12.g).

Consultation with the ADF&G for this LEIS identified current bison range that includes sensitive calving areas around Buffalo Dome and the Texas Range. The sensitive period for bison in these areas is mid-February to early September. The fall/winter migration route was also identified, which includes the entire East Training Area and a small area of the extreme West Training Area.

The herd normally uses the floodplain of the Delta River mainly on Fort Greely, starting mid-February to March with calving occurring from late April to early June. Bison summer range is along the floodplain and adjacent uplands between Black Rapids Glacier and the mouth of the Delta River. These areas are used until August or September. Bison also use an area on Fort Greely, west of the Delta River, that burned in 1990 (ADF&G 1993).

During the months of July, August, and September, bison migrate from the floodplain of the Delta River to the Delta Junction Bison Range east of the Delta River and then to the Delta Agricultural Project farms north of the East Training Area. The bison migrate through the Fort Greely East Training Area (Figure 3.12.g. The animals winter on the farmlands and the Delta Junction Bison Range. A map of these areas is in the Delta Bison Management Plan (ADF&G 1993) and also identified in Figure 3.12.g.

The Alaska Department of Fish and Game has a pre-calving herd size objective of 360 animals with 430-440 animals before the hunting season. Hunting is the main management practice to maintain the size and composition of the herd (ADF&G 1993).

Wolf - Information is not available on wolf populations on and near Fort Wainwright Yukon Training Area and Fort Greely. The Alaska Department of Fish and Game is monitoring wolves throughout GMU 20A which includes Fort Greely, to determine the number of wolf packs in the area and relationships between wolves and moose. Wolves are hunted on the withdrawal lands.

Wolverine - Wolverines are hunted on the withdrawal lands but no information is available on wolverine populations on Fort Wainwright Yukon Training Area and Fort Greely.

3.12.3 Sandhill Crane

The 1986 cooperative agreement identified an area along the Delta River on the Fort Greely West Training Area as important for migrating sandhill cranes (Figure 3.12.h). The area provides necessary roosting habitat. This habitat has a minimal disturbance period of 25 April - 15 May and 1 September - 30 September when cranes are present.

Consultation with Alaska Department of Fish and Game for this Legislative Environmental Impact Statement resulted in the identification of an additional sandhill crane roosting area that encompasses land within the Fort Greely West Training Area. This habitat lies in the northwestern portion of the Training Area. It is the Delta Creek wash that parallels Delta Creek (Figure 3.12.h). The Delta Creek Assault Landing Strip is located within this habitat. Restricted activity dates are 25 April - 15 May and 1 September - 30 September when cranes are present.

3.12.4 Migratory Birds

Breeding Bird Surveys have been conducted on Fort Wainwright Yukon Training Area since 1982. No Breeding Bird Surveys have been conducted on Fort Greely. Swan surveys have been conducted on Fort Greely since 1978. Migratory species have been identified on the withdrawal lands and a list of species can be found in Appendix 3.12.

Two major migration routes extend through the Northern Interior Region of Alaska. Fort Wainwright Yukon Training Area lies within one major migration route with two million waterfowl and 12,000 raptors migrating in the spring (April 10-May 20), and five million waterfowl and 23,000 raptors migrating in the fall

(August 1-October 10). The other route encompasses a portion of Fort Greely. Two million waterfowl and 25,000 raptors follow this route in the spring, and nine million waterfowl and 48,000 raptors follow it in the fall. Information was not given for other migratory species (USAF 1995).

3.13 FISHERIES

The Fort Wainwright Yukon Training Area and Fort Greely West Training Area are within the Alaska Department of Fish and Game, Sport Fish Division, Fairbanks Management Area for fisheries. The Fort Greely East Training Area is within the Delta Junction Management Area.

3.13.1 Fish Stocking

Most ponds or lakes on the withdrawal lands are too shallow to support year round fish populations due to complete freezing or lack of oxygen in winter. The Alaska Department of Fish and Game, Fairbanks Office, stocks lakes on the withdrawn lands through the Statewide Stocking Plan (ADF&G 1997). One lake on Fort Wainwright Yukon Training Area and sixteen lakes on Fort Greely West Training Area are stocked (Figures 3.13.a and 3.13.b). Table 3.13.a and Table 3.13.b list the location, species stocked, life-stage, year stocking will occur, and number of fish stocked.

Table 3.13.a Fish Stocking for Fort Wainwright Yukon Training Area (1998-2002).

Location	Species	Size	1998	1999	2000	2001	2002
Manchu Lake	Arctic Char	Fingerling	0	8,600	0	8,600	0
Manchu Lake	Rainbow Trout	Fingerling	0	8,600	0	8,600	0

Table 3.13.b Fish Stocking for Fort Greely West Training Area (1998-2002).

Location	Species	Size	1998	1999	2000	2001	2002
Koole Lake	Rainbow	Fingerling	16,000	16,000	16,000	16,000	16,000
Bolio Lake	Rainbow	Catchable	1,500	2,500	2,500	2,500	2,500
Mark Lake	Rainbow	Fingerling	0	3,600	0	3,600	0
Mark Lake	Coho	Fingerling	3,600	0	3,600	0	3,600

Table 3.13.b Fish Stocking for Fort Greely West Training Area (1998-2002).

Location	Species	Size	1998	1999	2000	2001	2002
Weasel Lake	Rainbow	Fingerling	1,600	0	1,600	0	1,600
Bullwinkle Lake	Rainbow	Fingerling	0	800	0	800	0
Chet Lake	Rainbow	Fingerling	0	1,600	0	1,600	0
Chet Lake	Lake Trout	Fingerling	800	0	800	0	800
Ghost Lake	Rainbow	Fingerling	0	1,000	0	1,000	0
Ghost Lake	Lake Trout	Fingerling	1,000	0	1,000	0	1,000
South Twin Lake	Rainbow	Fingerling	4,000	4,000	4,000	4,000	4,000
Rockhound Lake	Rainbow	Fingerling	0	600	0	600	0
No Mercy Lake	Rainbow	Fingerling	0	600	0	600	0
Nickel Lake	Rainbow	Fingerling	0	1,000	0	1,000	0
Nickel Lake	Grayling	Fingerling	0	250	0	250	0
Nickel Lake	Lake Trout	Fingerling	500	0	500	0	500
North Twin Lake	Rainbow	Fingerling	2,000	2,000	2,000	2,000	2,000
North Twin Lake	Lake Trout	Fingerling	2,000	0	2,000	0	2,000
Doc Lake	Rainbow	Fingerling	0	500	0	500	0
Luke Lake	Grayling	Fingerling	0	400	0	400	0
J Lake	Grayling	Fingerling	0	750	0	750	0
J Lake	Coho	Fingerling	3,000	0	3,000	0	3,000
Sheefish Lake	Grayling	Fingerling	0	400	0	400	0

Table 3.13.b Fish Stocking for Fort Greely West Training Area (1998-2002).

Location	Species	Size	1998	1999	2000	2001	2002
Sheefish Lake	Arctic Char	Fingerling	0	800	0	800	0

3.13.2 Wild Fisheries

On Fort Wainwright Yukon Training Area, the Chena and Salcha River drainages support Arctic grayling *(Thymallus arcticus*), chinook salmon *(Oncorhynchus tshawytscha*), chum salmon (*O. keta*), sheefish (*Stenodus leucichthys nelma*), humpback whitefish (*Coregonus pidschian*), round whitefish (*Prosopium cylindraceum*), Arctic lamprey (*Lampetra japonica*), least cisco (*Coregonus sardinella*), burbot (*Lota lota*), longnose sucker (*Catostomus catostomus*), northern pike (*Esox lucius*), sculpin (*Cottus cognatus*), and lake chub *(Couesius plumbeus).*

Stuart Creek, Globe Creek, and Beaver Creek support Arctic grayling and round whitefish. Ninety-eight Creek contains several species of fish including chinook and chum salmon. Other waterways on the post contain several species of fish mentioned above but do not contain anadromous species.

The South Fork of the Chena River, the Little Salcha River, and Ninety-eight Creek on the Fort Wainwright Yukon Training Area are listed as anadromous (migrate from sea to rivers to breed) waterways by the State of Alaska (Viavant, pers. com 1998).

Horseshoe Lake, located in the northwest corner of the Yukon Training Area, supports a native population of northern pike (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994b). Manchu Lake, located near the posts western boundary, is stocked by Alaska Department of Fish and Game.

Fort Greely West Training Area is bordered by Buchanan Creek on the southwest and the Little Delta River to the west and northwest. The East Fork of the Little Delta River and Delta Creek flow through the western portion of the West Training Area. Jarvis Creek flows through the East Training Area with Granite Creek boarding its eastern boundary. These waters are glacier fed and flow from the north slope of the Alaska Range, north to the Tanana River. They are generally silt laden and do not support large fish populations. A few clear streams on the post provide summer habitat for grayling. Naturally occurring populations of lake chub, northern pike, sculpin, and longnose sucker are found

in lakes on the post (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a).

No anadromous fish species are found in the waters on Fort Greely. The Little Delta River and Delta Creek are listed by the State of Alaska as anadromous streams but chum, chinook, and coho *(Oncorhynchus kisutch)* salmon are not reported in the installation area (Parker, pers. com. 1998).

A list of fish species recorded for the posts is provided in Appendix 3.12.

3.14 THREATENED OR ENDANGERED SPECIES (State and Federal) AND SPECIES OF CONCERN (State)

3.14.1 Vegetation

No Federal or State listed threatened or endangered plant species have been listed as occurring within the area of Fort Wainwright or Fort Greely and no species have been found on the withdrawal lands (ANHP website ADF&G 1998, Sousa, pers. com. 1998).

During the 1995 floristic survey of Fort Wainwright, several populations of three plants listed as imperiled in the State or rare by the Alaska Natural Heritage Program were located. Two plant species were found that are considered major range extensions of more than 90 miles. The Nature Conservancy has created a "Ranking System", assigning each taxon a global (G) and a state (S) ranking from one (critically imperiled) to five (demonstrably secure), based on several factors such as abundance, range, degree of threat, existing protection, and the number of occurrences. The rare plants with their appropriate global and state listing and those plants with major range extensions are listed in Table 3.14.a. The global and state ranking system definitions are found below the table. The land-type where the populations were found is also listed.

Table 3.14.a Plants Found in the Fort Wainwright Yukon Training Area During Floristic Survey (1995) that are Major Range Extensions or Rare and Being Tracked by Alaska Natural Heritage Program.

PLANT SPECIES	GLOBAL[1] AND STATE[2] RANKING	NOTES	LAND TYPE
Water plantain *(Alisma triviale)* is a semi-aquatic species that is imperiled in the state with approximately 6-20 occurrences or few remaining individuals or acres. This species is disjunct by over 100 miles from its main range. It may become more common as more aquatic sites within Alaska are surveyed.	G5S2	Rare - Major Range Extension	Lowland
Crawford's sedge *(Carex crawfordii)* is found at dry sites and roadsides. It is slowly being found in more areas in Alaska and may be more common than first thought. At present it can be considered state imperiled, rare, or uncommon.	G5S2S3	Rare - Tracked	Lowland
English sundew *(Drosera anglica)* was found in the northwest corner of Fort Wainwright Yukon Training Area near a lake. Due to this extreme distance from the nearest population, researchers believe populations will be located between the two disjunct populations and the species will probably be found more common than presently thought.	None	Major Range Extension	Lowland
Bog addersmouth orchid *(Hammarbya paludosa)* is a bog orchid that has a very discontinuous distribution and has never been reported as common. The populations found in the Fort Wainwright Yukon Training Area are located in the southwest corner of the post. Several additional populations have been located in interior and southern Alaska.	None	Major Range Extension	Lowland
Northern kittenstails *(Synthyris borealis)* is not uncommon but has a limited range. It is found in moist alpine sites in interior Alaska.	G3G4 S3S4	Rare - Tracked	Alpine

[1] Global Rankings:

G1: Critically imperiled globally (typically 5 or fewer occurrences, or very few remaining individuals or acres).
G2: Imperiled globally (typically 6-20 occurrences, or few remaining individuals or acres).
G3: Either very rare and local throughout its range or found locally in a restricted range (typically 21-100 occurrences).
G4: Apparently secure globally.
G5: Demonstrably secure globally.
G#Q#: Taxonomically questionable.
G#T#: Global rank of species and global rank of the described variety or subspecies.
G#G#: Global rank of species uncertain; best described as a range between the two ranks.

[2] State Rankings

S1: Critically imperiled in state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state (typically 5 or fewer occurrences, or very few remaining individuals or acres)
S2: Imperiled in state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state (typically 6 to 20 occurrences, or few remaining individuals or acres)
S3: Rare or uncommon in the state (typically 21-100 occurrences).
S4: Apparently secure in state, with many occurrences.
S5: Demonstrably secure in state, with many occurrences.
SR#: Reported from the state, but not yet verified.
SP: Occurring in nearby state or province; not yet reported in state, but probably will be encountered with further inventory.
S#S# State rank of species uncertain; best described as a range between the two ranks.
MRE: Major Range Extension - Considered to be significant range extensions of more than 150 km (90mi) based on maps of Hulten (1968).
T: Tracked in the Alaska Natural Heritage Program's Biological Conservation Database.

3.14.2 Wildlife

Pursuant to Section 7 of the Endangered Species Act of 1973, U.S. Army Alaska completed informal consultation with the U.S. Fish and Wildlife Service (USFWS) concerning the withdrawal renewal of Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. Based on the project description and the fact that no new Impact Areas are proposed, the U.S. Fish and Wildlife Service concluded that the land withdrawal renewal is not likely to adversely impact listed species (Sousa, pers. com. 1998). The informal consultation response letter from the U.S. Fish and Wildlife Service (USFWS) is in Appendix 3.14.

The USFWS now places species into four categories; endangered, threatened, proposed, and candidate. In the past, the USFWS had a category for species that could be imperiled but required further studies to determine if they warranted being proposed for listing. The list was termed "Category 2" and later "species of concern". The Service no longer keeps a list of these species but now has a cooperative agreement with The Nature Conservancy's Natural Heritage Program. The program evaluates all native species and assigns global, national, and state ranks to each species. The USFWS reviews the list and recommends additions, deletions, and changes in ranking according to recent research findings (Donaldson, pers. com. 1998).

The U.S. Fish and Wildlife Service has listed one federally endangered species, the American peregrine falcon *(Falco peregrinus anatum*), and one federally delisted species, the Arctic peregrine falcon *(Falco peregrinus tundrius*) as occurring within the area of Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. Although the American peregrine falcon is listed as endangered, it is no longer considered in danger of extinction by the USFWS. On August 25, 1998, the Secretary of the Interior proposed delisting the American peregrine falcon. The USFWS is presently working on the final ruling which could result in delisting in 1999 (Donaldson pers. com. 1998). The Arctic peregrine falcon was removed from the federal listing on October 5, 1994, but the species will be monitored for a minimum of five years from the time of delisting. At any time during the remaining period, the falcon could be emergency listed if surveys indicate a reversal in recovery (Sousa, pers. com. 1998).

The American peregrine falcon nests in interior Alaska in forested areas. Although no nests have been identified on the withdrawal lands, suitable nesting habitat may exist and falcons do migrate through the areas. The Arctic peregrine falcon nests in the tundra areas of northern and western Alaska and may also migrate through the withdrawal lands (Sousa, pers. com. 1998, ADF&G et al. 1994).

The Army will consult with the USFWS and follow all regulatory management recommendations listed in the *Peregrine Falcon Recovery Plan - Alaska Population* (USFWS 1982) if an American peregrine falcon nest is found on military land. The Integrated Natural Resources Management Plans for Fort Wainwright and Fort Greely will also contain management guidelines.

Confirmed sightings of American peregrine falcons at Fort Wainwright and Fort Greely have occurred. It is not known if these were migrating birds, singles or pairs. American peregrine falcons are known to nest along the Tanana River and Salcha River north of Fort Greely. Suitable nesting habitat may exist along the bluffs of the Little Delta River on the western boundary of Fort Greely West Training Area (U.S. Dept. of the Interior and U.S. Dept. of Defense 1994a).

Habitat requirements for falcons are divided into four categories: nesting, feeding, migration, and wintering. Nesting in interior Alaska mainly occurs on cliffs and rarely in trees (two records). In interior Alaska, falcons feed in open areas that include rivers and muskegs, and they have been seen aerial hunting high above the tree canopies. In tundra regions, they prefer the marshy, boggy, or wet tundra over dry tundra. Exact migration habitat requirements have not been documented, but migrating falcons need an abundant prey source and

roosting areas (trees, poles, buildings). Peregrine falcons do not winter in Alaska (USFWS 1982).

The U.S. Forest Service (USFS) lists the trumpeter swan *(Cygnus buccinator)* and American osprey *(Pandion haliaetus carolinensis*) as sensitive species. The U.S. Forest Service lists species as sensitive when concerned about viability. Species are listed when populations and/or habitats have been reduced, restricted, or are vulnerable to resource development, or the species require special management to maintain viable populations (ANHP website USFS 1998).

Trumpeter swans have not been found on the Fort Wainwright Yukon Training Area but are known to nest on the Tanana Flats and within Fort Greely West Training Area (Bruce, pers. com. 1998). Trumpeter swans require wetlands with dense vegetation for nesting. In Alaska they create nests of horsetail and sedges (Bellrose 1980), and feed on a variety of marsh and aquatic plants.

Osprey nests are found in snags and living trees near waters with abundant fish populations (Harrison 1979, Udvardy 1988). Osprey have been identified on each post.

Four passerines listed as "species of concern" by the State of Alaska have been confirmed on the withdrawal lands. They are the olive-sided flycatcher (*Contopus borealis*), gray-cheeked thrush (*Catharus minimus*), Townsends warbler (*Dendroica townsendii*), and blackpoll warbler (*Dendroica striata*). A species of concern listing was generated to bring attention to the needs of vulnerable species before they require more extreme and costly management actions. Alaska Department of Fish and Game created the new category in 1993. Attention should be given to protecting habitats (ANHP website ADF&G 1998).

These migratory birds nest mainly in the coniferous forests of Alaska. The olive-sided flycatcher is also found in open woodlands, forest burns, boreal bogs, and muskegs. The grey-cheeked thrush nests in conifers and dense stands of alder or willow (Harrison 1979, Udvardy 1988).

The osprey, swan, sandhill crane, and four passerines are protected under the Migratory Bird Treaty Act (16 U.S.C. 703-721), (MBTA). The Act specifically addresses the "taking" of migratory birds. The definition of taking includes disturbance and habitat destruction.

Table 3.14.b Species Listed as Endangered, Threatened, Species of Concern or Sensitive.

SPECIES	USFWS	STATE	USFS	FORT WAINWRIGHT	FORT GREELY
American peregrine falcon	E	ASC	----	X	X
Arctic peregrine falcon	D	ASC	----	----	----
olive-sided flycatcher	----	ASC	----	X	X
gray-cheeked thrush	----	ASC	----	X	X
Townsend's warbler	----	ASC	----	X	----
Blackpoll warbler	----	ASC	----	X	X
Osprey	----	----	S	X	X
Trumpeter Swan	----	----	S	X	X

E=Endangered ASC=Alaska Species of Concern X=Confirmed Sightings
D=Delisted S=Sensitive

Partners in Flight is an organization with members from Federal and State agencies, non-governmental conservation organizations, academia, and private industry. The organization was developed to promote wise land management practices for the preservation of landbirds. The program has evaluated species using several parameters and developed a list showing species likelihood of extinction in the near future. The birds are grouped into three categories by priority: highest, high, and moderate. The Boreal Partners in Flight Working Group has compiled a list of species for Alaska. Table 3.14.c lists the Alaska species and if they have been identified on the withdrawal lands. The Alaska list does not have birds grouped by priority, but several of the species are also on the national list and their rankings are listed below in Table 3.14.c.

There are no legal habitat management requirements for the species listed, but conserving habitat will help ensure their survival. For a list of species found on the withdrawal lands see Appendix 3.12.

Table 3.14.c Species Listed By Boreal Partners in Flight (--Rankings not available).

SPECIES	RANKING	FORT WAINWRIGHT	FORT GREELY
Arctic warbler	----	X	X
Black swift	High Priority	----	----

Table 3.14.c Species Listed By Boreal Partners in Flight (--Rankings not available).

SPECIES	RANKING	FORT WAINWRIGHT	FORT GREELY
Blackpoll warbler	----	X	X
Blue grouse	----	----	----
Bohemian waxwing	----	X	X
Boreal owl	----	X	X
Chestnut-backed chickadee	----	----	----
Golden-crowned kinglet	----	X	X
Gray-cheeked thrush	----	X	X
Gyrfalcon	----	X	X
Hammond's flycatcher	----	----	----
MacGillivray's warbler	----	----	----
McKay's bunting	High Priority	----	----
Northern shrike	----	X	X
Northern goshawk	----	X	X
Northwestern crow	----	----	----
Olive-sided flycatcher	Moderate Priority	X	----
Pacific slope flycatcher	----	----	----
Red-breasted sapsucker	----	----	----
Rufous hummingbird	Moderate Priority	X	X
Rusty blackbird	----	X	X
Siberian tit (Gray-headed chickadee)	----	X	X
Smith's longspur	High Priority	X	X
Townsend's warbler	----	X	----
Varied thrush	----	X	X
Vaux's swift	----	----	----
Western screech owl	----	----	----
Western wood-pewee	Moderate Priority	X	X
White-tailed ptarmigan	----	X	X

3.15 FIRE MANAGEMENT

The Military Lands Withdrawal Act states that the secretary of the military department managing the withdrawn lands shall take necessary precautions to prevent and suppress brush and range fires resulting from military activity, occurring within and outside the lands withdrawn, and may seek assistance from the Bureau of Land Management to suppress the fires. The law requires the Secretary of the Interior and the Secretary of the Army to enter into a Memorandum of Understanding for fire management on military lands. Under the Memorandum, the Bureau of Land Management shall provide assistance in suppression of fires and the Department of the Army may transfer funds to the Bureau as compensation. The duration of the Memorandum is the same as the land withdrawal period. A Memorandum of Understanding was signed by the Bureau of Land Management and U.S. Army Alaska (BLM and USARAK 1995).

Various documents establish management for fire protection and suppression on the withdrawal lands. U.S. Army Alaska and the Alaska Fire Service of the Bureau of Land Management have entered into two Interservice Support Agreements (Dept. of the Interior and USARAK 1995, USARAK and DOI 1995). The agreements establish that the Army shall provide the Alaska Fire Service with use of certain buildings, utilities, land, training services, air support, and other support services in exchange for fire protection services. Under the agreement the Alaska Fire Service is responsible for all fire detection and suppression on withdrawal lands.

The Alaska Fire Service has a Reciprocal Fire Protection Agreement (Dept. of the Interior and State of Alaska 1998a) with the State of Alaska, Department of Natural Resources, Division of Forestry. Under this agreement the agencies implement a coordinated fire suppression effort within the State of Alaska, identifying "Protection Areas" (pre-determined areas within the State) where each agency has agreed to provide wildland fire suppression on State and Department of the Interior lands, regardless of ownership. The agencies agree to provide fire protection services on Protection Responsibility Lands (lands designated for wildland fire protection due to Alaska Fire Service or Division of Forestry legal mandates).

This Reciprocal Fire Protection Agreement states that the Alaska Fire Service, through various agreements with the military, is responsible for wildland fire suppression on military lands administered by U.S. Army Alaska and the 11th Air Force. The lands include withdrawal properties on Fort Wainwright and Fort Greely.

The agreement defines general guidelines for the Alaska Fire Service and the Division of Forestry to negotiate an Annual Operating Agreement (Dept. of the Interior and State of Alaska 1998b), establishing standard operating procedures and providing detailed guidance for implementing the Reciprocal Agreement. The latest Operating Agreement was finalized June 15, 1998. Through the Reciprocal Fire Protection Agreement and the Annual Operating Agreement, the Division of Forestry has agreed to provide detection and initial attack suppression services upon request, and subject to available forces, for Fort Greely West and East Training Areas, which lie within the Division of Forestry Protection Area. "No Entry Areas" are excluded. The request to the Division of Forestry will be made by the Military Fire Chief or the Alaska Fire Service, Military Fire Management Officer.

In 1980 the Alaska Land Use Council, now called the Alaska Interagency Fire Management Council, authorized the creation of Alaska Interagency Fire Management Plans. The Council was formed by a provision in the Alaska National Interest Lands Conservation Act. Interagency Fire Management Plans were prepared for 13 geographic areas in the state. The plan for the Upper Yukon-Tanana Planning Area (BLM 1984) covers Fort Wainwright and Fort Greely. U.S. Army Alaska is a cooperative land manager under the plan.

The Alaska Wildland Fire Management Plan (BLM 1998) contains common elements from the approved 13 plans. The plan was written to coordinate fire related land use objectives, through cooperative planning, in the most cost effective manner. The plan designates wildland fire protection areas. Under the plan, land managers are allowed to establish fire management options according to their land use objectives and constraints. The plan is reviewed yearly and any revisions to fire management by land managers are made during the review. Changes in fire protection options can be made between 30 September and 31 March.

The Alaska Fire Management Plan establishes four fire protection options. Land managers may select among these options, based on evaluation of their individual legal mandates, policies, regulations, resource management objectives, and local conditions (BLM 1996). The fire protection status options are:

Critical Protection - Lands receive maximum detection coverage and are highest priorities for attack response. Immediate and aggressive initial attack is provided. Land owners/managers are notified of the situation as soon as possible. These areas receive priority over adjacent lands and resources in the event of escaped fires.

Full Protection - Areas receive maximum detection coverage and immediate and aggressive initial attack response. If initial attack is successful or the fire is otherwise controlled within the first burning period, special agency notification is not required. If the fire escapes and requires additional suppression, affected land owners/managers are notified to develop further fire suppression strategies.

Modified Protection - A level of protection is provided between Full and Limited. A high degree of protection is provided during critical burn periods, decreasing as risk to higher protection areas is diminished. These areas receive maximum detection coverage. Initial attack action is based on potential for damage, constraints on affected land, and/or discussions with the land owner/manager. If there is no initial attack, the land owner/manager is apprised of the situation daily and unmanned fires are monitored.

Limited Protection - Areas where the values at risk do not warrant the expense of suppression and are areas where natural fire is important to ecosystem sustainability. Fires within these areas receive routine detection effort. Attack response is based on the need to keep the fire within Limited protection areas and the need to protect Critical sites. Land owners/managers are immediately notified and unmanned fires are monitored.

Two fire protection status categories have been developed for Army lands in Alaska. **Unplanned** areas are lands which have not been given an official designation but receive protection equal to that given lands in Full Protection. The Alaska Fire Service has responsibility for initial response in these areas (Jandt, pers. com. 1998). The second category is **Restricted Areas or Hot Zones** and includes Impact Areas and other places where no "on the ground" fire fighting can be accomplished due to danger of unexploded ordnance (Figures 3.15.a and 3.15.b). High Hazard Impact Areas are managed as Hot Zones with Limited protection. One Small Arms Range that extends onto withdrawal lands on Fort Yukon Training Area is also listed as a Hot Zone. These areas can be suppressed through backburning and aerial-dropped retardants (BLM 1996).

U.S. Army Alaska has established fire protection boundaries for the Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. (Figures 3.15.a and 3.15.b). In 1998, U.S. Army Alaska changed the fire protection status for the eastern portion of Fort Wainwright Yukon Training Area from Modified to Limited in response to the State of Alaska's change in fire management status for lands adjoining the Training Area.

3.15.1 Fire History

The Alaska Fire Service retains incident reports for fires on the withdrawn lands. Data from the reports were used to create maps and tables of fires occurring on Fort Wainwright Yukon Training Area and Fort Greely West and East Training Areas. The maps show most fires greater than 1,000 acres between 1954 and 1992 inclusive and fires greater than 100 acres between 1993 and 1996 inclusive (Figures 3.15.c and 3.15.d). Mapping information for 11 fires was not available. Fires less than 100 acres have occurred on the withdrawn lands, but data are only available from 1986-1997. Information on these fires, and those fires 100 acres or greater, will be presented separately for Fort Wainwright Yukon Training Area and Fort Greely.

In 1998, a lightning-caused fire began on Fort Greely West Training Area and spread to State land. The fire is shown in Figure 3.15.d but data were not added to tables 3.15.c and 3.15.d. The fire burned 23,476 acres within the West Training area.

The two major causes of fires on the withdrawal lands are incendiary devices and lightning. A total of 95 incendiary fires and 13 lightning fires have been recorded since 1954. Nineteen of the incendiary fires and six of the lightning fires were 100 acres or greater. Information on the cause of five fires that were greater than 100 acres was not available. Other causes of fire on the withdrawal lands are, field burning, exhaust, recreation, trash burning, and warming fires. Only 13 acres have burned as a result of these causes.

Fort Wainwright Yukon Training Area

Eleven fires, 100 acres or more, occurred on Fort Wainwright Yukon Training Area from 1959-1997. Nine fires, totaling 7,208.40 acres were caused by incendiary devices within the Stuart Creek Impact Area and Buffer Zone. Two fires occurred in the northern portion of the Training Area. The fire in 1959 (#50) totalled 5,872.03 acres and the cause is not known. This fire moved beyond the Fort Wainwright Yukon Training Area boundary onto State land. A lightning caused fire in 1987 (#B078) covered 10,960 acres and was contained within the Training Area.

Table 3.15.a Fires 100 Acres or Greater Occurring from 1959 - 1997 on Fort Wainwright Yukon Training Area. (* Fires not shown on map)

FIRE NUMBER	YEAR	CAUSE	ACRES
B262*	1997	INCENDIARY	940.00
A454*	1992	INCENDIARY	200.00

Table 3.15.a Fires 100 Acres or Greater Occurring from 1959 - 1997 on Fort Wainwright Yukon Training Area. (* Fires not shown on map)

FIRE NUMBER	YEAR	CAUSE	ACRES
B508	1991	INCENDIARY	220.00
B323*	1991	INCENDIARY	100.00
B306	1991	INCENDIARY	1,000.00
A128	1990	INCENDIARY	880.00
A083*	1986	INCENDIARY	200.00
8505	1980	INCENDIARY	1,769.91
8505	1980	INCENDIARY	1,898.49
B078	1987	LIGHTNING	10,960.00
50	1959	UNKNOWN	5,872.03
TOTAL ACRES BURNED			**24,040.43**

Table 3.15.b Number of Fires by Cause on Fort Wainwright Yukon Training Area (1959-1997).

CAUSE OF FIRE	NUMBER OF FIRES BY CAUSE	TOTAL ACRES BURNED	PERCENT TOTAL ACRES BURNED
INCENDIARY	37	3,929.80	26%
LIGHTNING	5	11,002.50	74%
FIELD BURNING	0	0	INSIGNIFICANT
EXHAUST	0	0	INSIGNIFICANT
RECREATION	0	0	INSIGNIFICANT
TRASH BURN	1	7.0	INSIGNIFICANT
UNKNOWN	0	0	INSIGNIFICANT
WARMING FIRE	1	3.0	INSIGNIFICANT
INFORMATION NOT AVAILABLE	1	5,872.03	NOT ADDED IN
TOTAL	44	20,814.33	100%

Fort Greely West and East Training Areas

Nineteen fires, 100 acres or more, occurred on Fort Greely from 1954-1997. Two were in the East Training Area and occurred in 1954 (#111) and 1987

(#B023). The cause of the fire in 1954 was not available and the fire in 1987 was caused by incendiary devices. The remaining 17 fires were within the West Training Area. Five of the fires were caused by lightning, ten by incendiary devices, and causal information on four is not available.

Table 3.15.c Fires 100 Acres or Greater Occurring From 1954 - 1997 on Fort Greely. (* Fires not shown on map)

FIRE NUMBER	YEAR	CAUSE	ACRES
A145	1996	INCENDIARY	14,200.00
A321	1996	INCENDIARY	66,560.00
A416	1996	INCENDIARY	2,000.00
A034	1992	INCENDIARY	1,410.00
A035	1992	INCENDIARY	960.00
A132	1990	INCENDIARY	22,762.22
B001*	1989	INCENDIARY	150.00
B002*	1987	INCENDIARY	100.00
B023	1987	INCENDIARY	43,500.00
612002	1986	INCENDIARY	174.00
B320*	1997	LIGHTNING	2,500.00
B265*	1993	LIGHTNING	300.00
B266*	1993	LIGHTNING	895.00
A009*	1990	LIGHTNING	100.00
A310	1990	LIGHTNING	21,760.00
8476	1981	UNKNOWN	20,418.74
8656	1971	UNKNOWN	15,209.41
45	1956	UNKNOWN	12,049.41
111	1954	UNKNOWN	16,185.78
TOTAL ACRES BURNED			**241,234.56**

Table 3.15.d Total Number of Fires by Cause on Fort Greely (1954-1997).

CAUSE OF FIRE	NUMBER OF FIRES BY CAUSE	TOTAL ACRES BURNED	PERCENT TOTAL ACRES BURNED
INCENDIARY	58	154,099.80	86%
LIGHTNING	8	25,619.60	14%
FIELD BURNING	1	1.5	INSIGNIFICANT
EXHAUST	1	0.6	INSIGNIFICANT
RECREATION	1	0.1	INSIGNIFICANT
TRASH BURN	1	0.5	INSIGNIFICANT
UNKNOWN	1	0.1	INSIGNIFICANT
WARMING FIRE	1	0.1	INSIGNIFICANT
INFORMATION NOT AVAILABLE	4	63,863.34	NOT ADDED IN
TOTAL	**72**	**243,585.64**	**100%**

3.15.2 Prescribed Burns

U.S. Army Alaska, in cooperation with the Alaska Fire Service, conducts prescribed burns on the withdrawal lands to improve wildlife habitat, decrease potential for ignitions and fire escape from live firing, and to increase military Training Areas. Five controlled burns are scheduled for the 1999 season, four in the Fort Wainwright Yukon Training Area and one in the Fort Greely West Training Area. For a complete description of the proposed burns, see the Alaska Fire Service Proposed Prescribed Burning Projects Report (1998) which can be obtained from the Alaska Fire Service, Fort Wainwright. Table 3.15.e lists the fires, acres, and proposed schedule.

Table 3.15.e Prescribed Burn Projects (1998).

Withdrawal Renewal Lands	Acres	Proposed Schedule
Fort Wainwright Grouse Project	5	Not Scheduled
Fort Wainwright Stuart Creek Basin	2,300	May-July 1999
Fort Wainwright Stuart Creek Perimeter	2,000	May-July 1999
Fort Wainwright Stuart Creek Camera Site 1	2,650	May-July 1999
Fort Greely Oklahoma Range	10,000	Not Scheduled