Overview of Environmental and Hydrogeologic Conditions at Farewell, Alaska

By Joseph M. Dorava and James D. Hall

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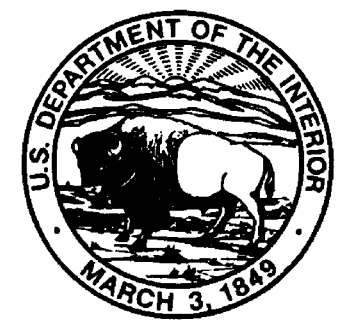

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U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
4230 University Drive, Suite 201
Anchorage, AK 99508-4664

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNIT

Multiply	By	To obtain
millimeter (mm)	0.03937	inch
centimeter (cm)	0.3937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
meter per second (m/s)	3.281	foot per second
cubic meter per second (m^3/s)	35.31	cubic foot per second
cubic meter per second per square kilometer [$(m^3/s)/km^2$]	91.49	cubic foot per second per square mile
degree Celsius (^oC)	$^oF = 1.8 \times {}^oC + 32$	degree Fahrenheit (^oF)

Sea level:

In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality unit used in this report:

mg/L, milligram per liter

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Abstract

The Federal Aviation Administration is making preliminary environmental assessments at most of its present or former facilities in Alaska. The Federal Aviation Administration facility in Farewell lies in the remote interior of Alaska on a broad piedmont north of the Alaska Range. Open wetlands and boreal forests characterize the vegetation. Farewell has a continental climate: summers are short and hot and winters are long and cold. Surface water is abundant in the area. Ground water of unknown quantity and quality is present in aquifers separated by isolated masses of discontinuous permafrost.

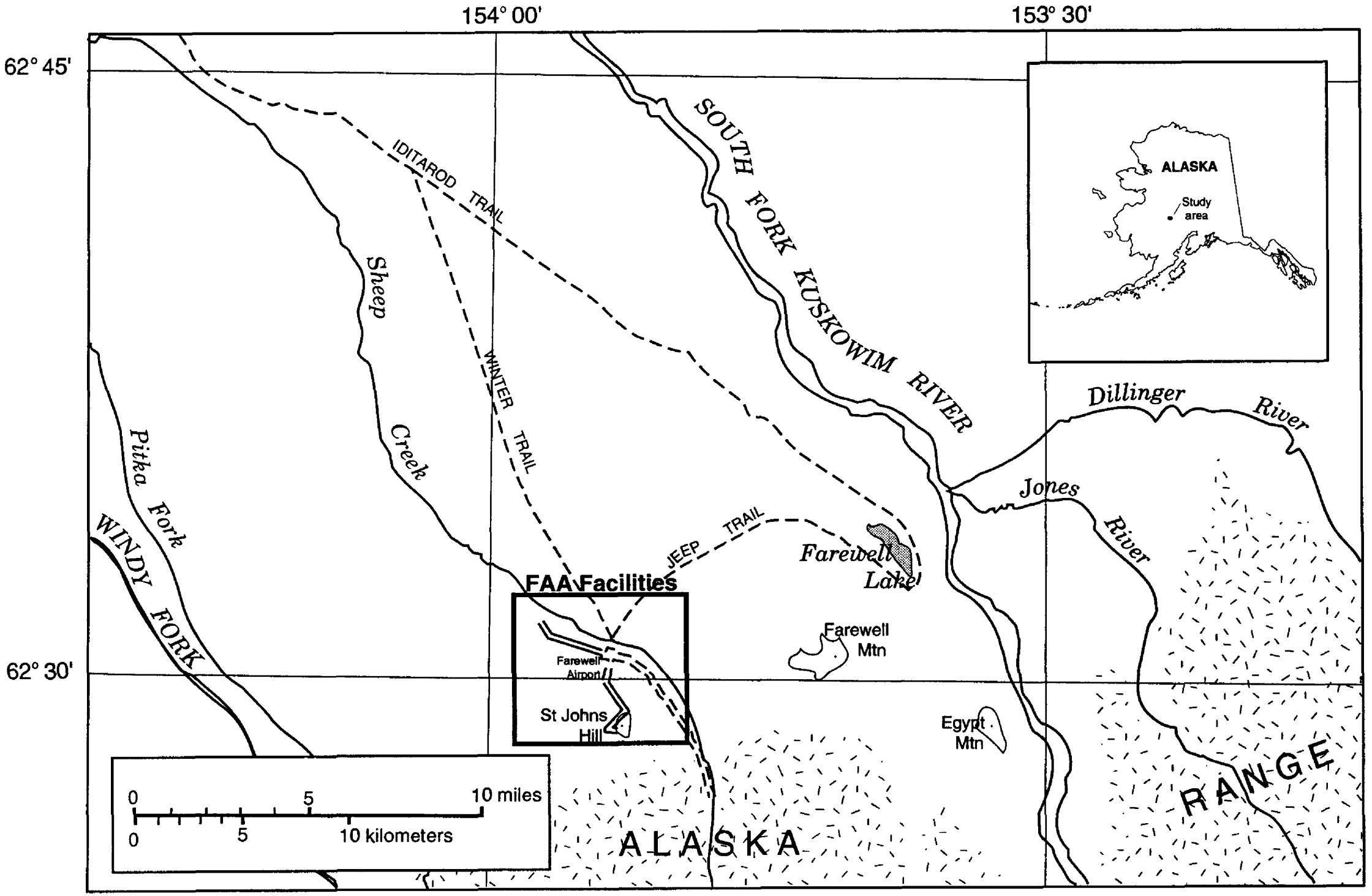
INTRODUCTION

The Federal Aviation Administration (FAA) owns and (or) operates airway support and navigational facilities throughout Alaska. At many of these sites, fuels and potentially hazardous materials such as solvents, polychlorinated biphenyls, and pesticides may have been used and (or) disposed of. To determine if environmentally hazardous substances have been spilled or disposed of at any of these sites, the FAA is conducting environmental studies mandated by the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act. To complete these more comprehensive environmental studies, the FAA requires information on the hydrology and geology of areas surrounding the facilities. This report is the product of compilation, review, and summary of existing hydrologic and geologic data by the U.S. Geological Survey, in cooperation with the FAA, and provides such information for the FAA facility and nearby areas at Farewell, Alaska. Also presented in this report is a brief description of the history and physical setting of the region surrounding Farewell.

BACKGROUND

Location

Farewell is in southwest interior Alaska at lat 62°30'N., long 153°53'W. (fig. 1), about 350 km northwest of Anchorage. The Farewell FAA facility is at an elevation of 468 m (National Oceanic and Atmospheric Administration, 1993) and is on the south bank of Sheep Creek, about 10 km west of Farewell Mountain. Access to the FAA facility is by air only. An unimproved tractor trail leading to Farewell Landing, 80 km to the northwest is no longer used.



Base from U.S. Geological Survey, McGrath, Alaska, 1:250,000, 1958

Figure 1. Location of Farewell, Alaska, and Federal Aviation Administration Facilities.

History

The FAA facility at Farewell (fig. 2) was built in 1942 as a part of the World War II defense buildup in Alaska. It presently consists of two gravel airstrips, an operating remote communications outlet, and additional support buildings (Ecology and Environment, 1992; National Oceanic and Atmospheric Administration, 1993). Although the FAA facility is currently not maintained, it still serves as an emergency landing site (National Oceanic and Atmospheric Administration, 1993). A detailed list of FAA owned and operated facilities in Farewell can be found in a report by Ecology and Environment, Inc. (1992). The only year-round residents in this remote area operate Farewell Lodge, located approximately 15 km east of the FAA facility.

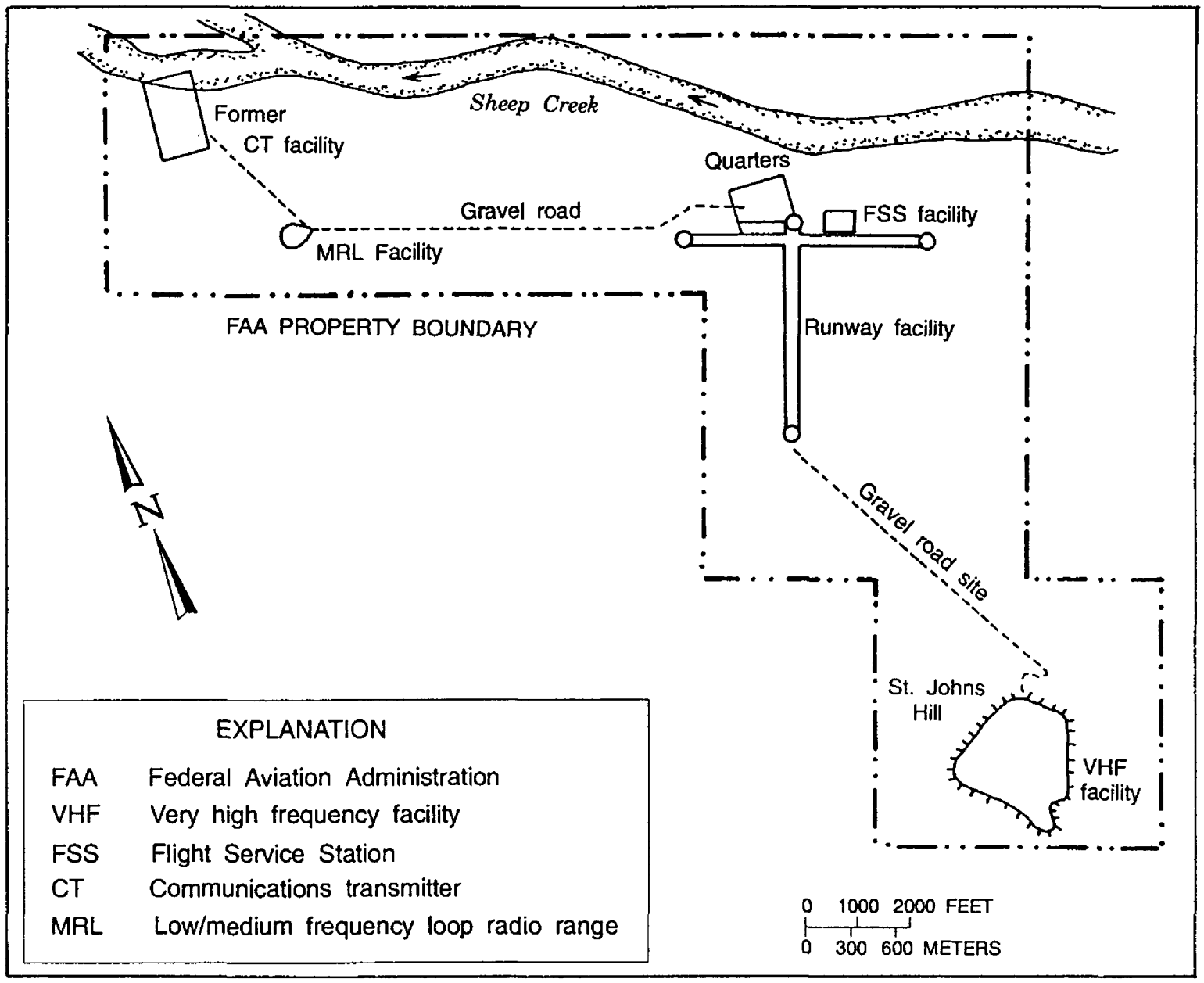


Figure 2. Location of Federal Aviation Administration Facilities at Farewell, Alaska. (Modified from Ecology and Environment, Inc., 1992.)

Climate

Farewell has a continental climate typical of interior Alaska. Conditions include significant diurnal and annual temperature variations as well as low precipitation, limited cloud cover, and low humidity (Hartman and Johnson, 1984). For the period 1942 to 1976, weather records were kept by FAA personnel at Farewell (Leslie, 1989). During this period, the mean annual temperature was -3.7 °C, the mean maximum July temperature was 17.9 °C, and the mean minimum December temperature was -24.4 °C. Mean annual precipitation is about 420 mm and the mean annual snowfall is about 1,470 mm. The mean annual and monthly temperature, precipitation, and snowfall are summarized in table 1.

Vegetation

The vegetation near Farewell includes both open wetlands and boreal forest (Selkregg, 1976). Open wetland areas contain stands of black spruce, tamarack, paper birch, and willows, as well as sedges and grasses (Selkregg, 1976; Viereck and Little, 1972). The boreal forest is located primarily on upland areas and consists of white and black spruce, interspersed with balsam poplar, paper birch, and aspen. The area north of the airport is primarily boreal forest, while the area to the south is primarily open wetland.

GEOLOGY

Physiography

The FAA facility at Farewell lies on a piedmont in the Tanana-Kuskokwim Lowlands, which is a broad depression north of the Alaska Range (Wahrhaftig, 1965). The piedmont is an extension of the foothills of the Alaska Range, which begin less than 5 km to the south of the FAA facility. In this area, the mountains of the Alaska Range are oriented in a northeast-to-southwest direction. A major geologic feature in the area is the Farewell Fault, a right-lateral strike-slip fault which is part of the Denali Fault system. This fault can be identified less than 30 km south of the FAA facility by a sudden northwest shift of all significant water courses (Mamet and Plafker, 1982).

Bedrock Geology

Bedrock exposures near Farewell consist of metamorphosed turbidite sandstone, limestone, shale, chert and greenstone (Bundtzen and Gilbert, 1983; Bundtzen and others, 1982; Reed and Nelson, 1980; Sloan and others, 1979). Also present are plutonic and volcanic rocks as well as extensive layers of continental clastic sediments such as coal, shale, mudstone, sandstone, and conglomerate (Bundtzen and Gilbert, 1983; Bundtzen and others, 1982; Reed and Nelson, 1980). Bedrock near Sheep Creek and the FAA facility is overlain by unconsolidated glacial and fluvial sediments (Kline and Bundtzen, 1986). Bedrock in the nearby Alaska Range is intruded by dikes and granitic plutons, and is locally metamorphosed (Mamet and Plafker, 1982).

Bedrock exposures along the Farewell Fault indicate about 45 m of movement since early in the Devonian Period; evidence also suggests that the fault has been active since the beginning of the Quaternary Era or the Holocene Epoch (Marti Miller, U.S. Geological Survey, oral commun., 1995). The Farewell Fault is considered active and constitutes a potential hazard to the FAA facility at Farewell.

Table 1. Mean monthly temperature, precipitation, and snowfall for the period 1942 to 1976, Farewell, Alaska

[Modified from Leslie (1989); °C, degree Celsius; mm, millimeter]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature (°C)													
Mean maximum	-12.8	-10.4	-5.8	2.1	10.2	16.5	17.9	15.2	9.8	-0.2	-7.7	-13.3	1.8
	(Record maximum 30.0 °C, June 1969)												
Mean minimum	-24.3	-22.5	-18.7	-9.4	-0.6	5.1	7.3	5.8	0.7	-9.6	-18.7	-24.4	-9.1
	(Record minimum -51.7 °C, December 1946)												
Mean	-18.6	-16.5	-12.2	-3.7	4.8	10.8	12.6	10.5	5.2	-4.9	-13.2	-18.8	-3.7
Precipitation (mm of moisture)	11.7	13.0	10.2	13.7	24.6	64.5	89.9	99.6	46.5	20.8	15.5	12.7	422.9
Snowfall (mm)	157.5	205.7	147.3	188.0	48.3	2.5	0.0	0.0	45.7	279.4	218.4	177.8	1468.1

Hopkins and others (1955) confirm the existence of one well drilled for the Civil Aeronautics Administration at the site presently known as the Farewell FAA facility. The well is about 110 m deep and did not reach bedrock.The driller's log for this well could not be located (Louise Flynn, Ecology and Environment, oral commun., 1995).

Surficial Geology

Surficial deposits near the FAA facility at Farewell consist primarily of glacial outwash and alluvium. The FAA facility is located on a combination of glacial outwash and terrace alluvium deposits. Glacial outwash deposits include sand and gravels found in flood plains of braided rivers, outwash plains, fans, aprons and terraces. Terrace alluvium is usually composed of well-sorted alluvial sand and gravel deposited in alluvial plains that are later incised to form benches. These deposits generally tend to be well drained unless affected by permafrost (Bundtzen and others, 1982).

The primary soil mapped by Rieger and others (1979) near Farewell, covering about 75 percent of the area, consists of a coarse mottled gray silt loam or sandy loam which drains poorly because it is commonly perennially frozen below a depth of 25 to 50 cm. A second deposit, which covers about 10 percent of the area and is found primarily on moraines, consists of a well-drained, sandy gravel overlying layers of very gravelly sand with cobblestones (Rieger and others, 1979). A third surficial deposit, which also covers about 10 percent of the area and is found primarily on stream terraces, consists of well-drained, gray sand and silt sediments of alluvial origin overlying shallow loose sand, gravel, and cobblestones (Rieger and others, 1979).

Permafrost in this area of Alaska is generally found in isolated or discontinuous masses (Ferrians, 1965). A report by Bundtzen and others (1982) along with regional and statewide data provided by Ferrians (1965) indicates that permafrost may be found in the local surficial deposits near Farewell. It begins at a relatively shallow depth and extends to an approximate maximum depth of less than 200 m (Ferrians, 1965; Rieger and others, 1979; Selkregg, 1976). Hopkins and others (1955) report that permafrost at Farewell was found at depths of less than 1 m, extending to a depth of about 4 m.

HYDROLOGY

The relief found in the nearby Alaska Range provides the drainage which contributes to the general southeast-to-northwest flow of the tributaries to the Kuskokwim River. Sheep Creek, a major tributary to the Pitka Fork of the Kuskokwim River, flows within 0.1 km of the FAA facility at Farewell (fig. 2). The South and Windy Forks of the Kuskokwim River are the largest rivers in the area and are located approximately 15 km to the northeast and 15 km to the southwest respectively from the FAA facility (fig. 1). In addition, the area is covered by numerous fresh-water lakes and tributary streams. Low wetland vegetation is ubiquitous throughout the area indicating that soils are saturated at or near the ground surface (Selkregg, 1976). Ground water is likely obtainable from the underlying unconsolidated sediments and bedrock.

Surface Water

Approximately 70 percent of the 423 mm of annual precipitation falls during the summer (table 1). Summer rainstorms cause significant increases in stream discharge. Streams also obtain significant quantities of water from snow melting in the nearby Alaska Range.

Streamflow and water-quality data were collected by the Alaska Division of Geological and Geophysical Surveys during reconnaissance hydrologic surveys of streams in the area (Ireland and Collazzi, 1985a; 1985b). Stream and basin characteristics for the Dillinger and Jones Rivers (fig. 1) are shown in table 2. Discharge was measured and water samples collected near the South Fork of the Kuskokwim River, 15 to 20 km northeast of the FAA facility at Farewell. Dissolved solids were estimated from specific conductance measurements (Ireland and Collazzi, 1985a). The Dillinger and the Jones Rivers are similar to Sheep Creek in origin, size, and location.

Table 2. Streamflow and water-quality characteristics of the Dillinger and Jones Rivers near the South Fork of the Kuskokwim River

[Data from Ireland and Collazzi (1985a); km^2, square kilometer; m^3/s, cubic meter per second; $(m^3/s)/km^2$, cubic meter per second per square kilometer; m/s, meter per second; mg/L, milligram per liter]

Stream	Date	Drainage area (km^2)	Discharge (m^3/s)	Unit runoff [$(m^3/s)/km^2$]	Mean velocity (m/s)	Hardness (mg/L)	pH	Dissolved solids[1] (mg/L)
Dillinger River	June 1981	228	5.98	0.03	0.46	248	8.40	185
	April 1982	228	2.35	.01	.27	320	7.65	339
Jones River	June 1981	224	3.57	.02	1.43	252	8.25	167
	April 1982	224	2.32	.01	.79	250	7.85	285

[1]Estimated from reported measurements of specific conductance (Ireland and Collazzi, 1985a) by applying Parks and Madison (1985) base information for the southwest sub-region of Alaska.

More than 50 lakes can be found within a 25-km radius of Farewell. Most lakes in the area were likely formed by glaciers or from subsidence of land surface as permafrost melted. Most lakes are not connected to the primary surface-water drainage system of the area (Kline and Bundtzen, 1986), and are likely fed by a combination of ground-water flow and precipitation.

Despite an abundance of streams and lakes near Farewell, hydrologic data are sparse. Previous studies were focused on or close to McGrath—the nearest center of population—about 100 km northwest of Farewell. These studies provide little data on the quantity and quality of surface water near the FAA facility at Farewell.

Ground Water

Data regarding the quantity and quality of ground water at the Farewell FAA facility are sparse. Hopkins and others (1955) confirm the existence of one well drilled for the Civil Aeronautics Administration (CAA). In 1942, the water level of this well was about 103 m below land surface. No recent data for this well could be found.

The CAA well at Farewell confirms the existence of an aquifer, but provides little significant data. The continuous flow maintained in the Dillinger and Jones Rivers also indicates the presence of an aquifer. Water-surface elevations of lakes may indicate the elevation of the local water table. At Farewell, lake elevations indicate a northwesterly slope to the water table. Permafrost may impede the flow of ground water. More precise descriptions of local ground-water conditions and the ground-water/surface-water interactions would require additional collection and interpretation of field data.

Floods and Hydrologic Hazards

No flood has been recorded at the Farewell FAA facility. Flooding in the Tanana-Kuskokwim Lowland near Farewell is caused by spring snow melt, by ice jams on rivers, and by heavy local rainfall (Selkregg, 1976). Because the FAA facility at Farewell is located near Sheep Creek (fig. 2), back-water flooding from downstream ice jams or flash floods caused by release of upstream ice jams may be a hazard to the site. Rainfall floods could also cause Sheep Creek to overtop its banks near Farewell. To identify flood hazards at Farewell, further investigation is needed.

Drinking Water Sources

Ground water has been the principal source of drinking water for the Farewell FAA facility (Ecology and Environment, Inc., 1992). At least one well is present at the FAA facility in Farewell, but a driller's log for this well was not available (Louise Flynn, Ecology and Environment, oral commun., 1995). No other wells were identified near Farewell. At the FAA facility, Sheep Creek may be used as an alternative source of drinking water. Numerous fresh-water lakes near Farewell may contain potable water; however, larger lakes in the Farewell area are primarily used for recreation and transportation and are too far from the FAA facility (fig.1) to be utilized as an alternative source of drinking water. Treatment of any surficial source of drinking water would likely be necessary. Undiscovered aquifers, if present, could be used as an alternative source of drinking water.

SUMMARY

The FAA facility at Farewell is located on the northwest Alaska Range piedmont of interior Alaska, approximately 100 km southeast of McGrath. These lowlands are composed of glacial sediments and alluvial sand and gravel. The area is characterized by numerous shallow lakes, ponds, and streams and is surrounded by open wetland and forest vegetation. Regionally, the direction of ground-water flow is to the northwest toward the Kuskokwim River. Flooding is a potential hazard at the FAA facility and may be caused by ice jams or rainfall. Alternative drinking-water sources may be available from local surface-water bodies and undiscovered aquifers; however, little data are available to determine the quantity or quality of these potential sources.

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