Environmental Overview and Hydrogeologic Conditions at Umiat, Alaska

By James R. Cowan

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
centimeter (cm)	0.3937	inch
millimeter (mm)	0.03937	inch
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
square kilometer (km^2)	0.3861	square mile
cubic meter per second (m^3/s)	35.31	cubic foot per second
liter per day (L/d)	0.2642	gallon per day
degree Celsius (°C)	°F=1.8 (°C)+32	degree Fahrenheit (°F)

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 the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in this report:

Chemical concentration and water temperature are given only in metric units. Chemical concentration in water is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute mass per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million. Specific conductance is given in microsiemens per centimeter (µS/cm) at 25°C.

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ABSTRACT

Umiat is on the alluvial plain of the Colville River on Alaska's North Slope. The Federal Aviation Administration owns or operates airway support facilities at Umiat and is considering the severity of contamination and the current environmental setting when evaluating options for compliance with environmental regulations at these facilities. Umiat has long cold winters and short cool summers. The local hydrology is controlled by continuous permafrost. The residents of Umiat obtain drinking water from the Colville River. Surface spills and disposal of hazardous materials may affect the quality of the surface water and shallow ground water. The Federal Aviation Administration Umiat facility has no history of flooding. Alternative drinking-water sources may be available but are inadequate to characterize the present quantity or quality of these sources.

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 materials have been spilled or disposed of at the sites, the FAA is conducting environmental studies mandated under 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 sites. This report, the product of compilation, review, and summary of existing hydrologic and geologic data by the U.S. Geological Survey (USGS), in cooperation with the FAA, provides supplemental information for the FAA Umiat facility. Also presented in this report is a description of the history, socioeconomics, and physical setting of the Umiat area.

BACKGROUND

Location

Umiat has an elevation of about 80 m and is in the northern foothills of the Brooks Range on Alaska's North Slope near latitude 69°22' N., and longitude 152°08'W. (fig. 1). The FAA facility is about 280 km southeast of Barrow and about 540 km north-northwest of Fairbanks. Umiat is on the north bank of the Colville River, about 1 km from the river channel. The facility is about 0.5 km south of Seabee Creek and about 2 km upstream from the mouth of Seabee Creek.

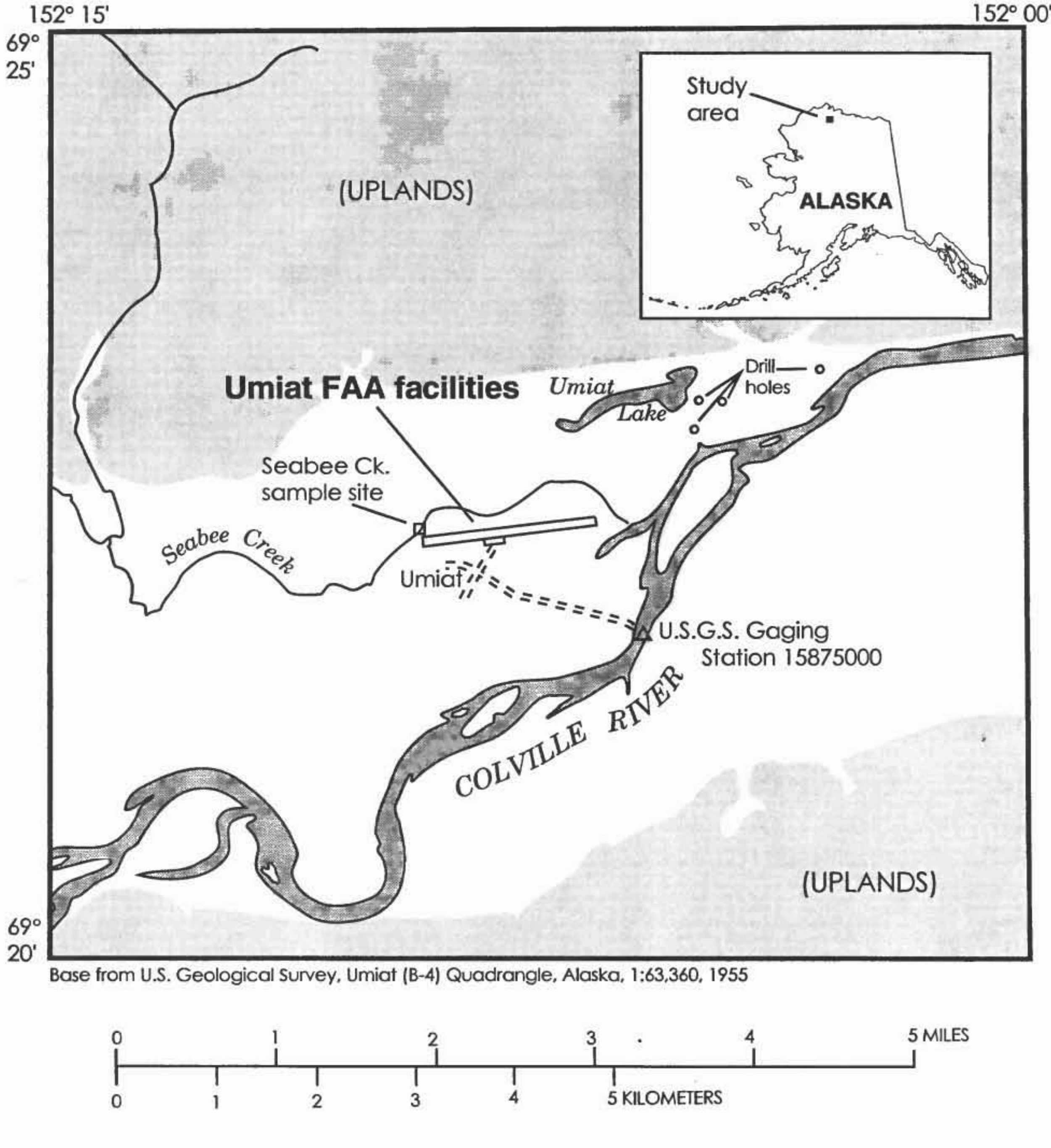

Figure 1. Location of Umiat, Alaska, and Federal Aviation Administration facilities.

History and Socioeconomics

Umiat's location was selected by early Eskimo inhabitants as a place to store river boats, and is named for the Eskimo word for "boats" (Orth, 1967). The Umiat airfield was constructed as a military emergency landing strip during World War II and was operated by the Civil Aeronautics Administration, the predecessor of the FAA (Hart Crowser Earth and Environmental Technologies, 1990). In 1945, the airfield was used by the Department of the Navy as a supply and operations support base for petroleum exploration of the Naval Petroleum Reserve No. 4. In 1953, the U.S. Air Force assumed responsibility for the airfield and operated an Air Weather Service station there. In 1959, the Department of the Navy transferred all Navy property to the FAA. In 1966, the FAA land and facilities were conveyed to the State of Alaska. The FAA Umiat facility now consists only of a contract remote communication outlet (Jacki Holzman, Federal Aviation Administration, written commun., 1995). A detailed account of properties owned, leased, or transferred by the FAA at Umiat and a listing of suspected sources of contamination near these facilities is in the Environmental Compliance Investigation Report (ECIR) of the FAA Umiat facilities prepared by Hart Crowser Earth and Environmental Technologies (1990).

During the 1970's and 1980's, the Umiat airfield was used by the USGS and petroleum companies as a support center for exploration activities on the central North Slope and in the Brooks Range. Umiat airfield continues to serve as an aerial transportation access point to Alaska's North Slope and the Brooks Range. Surface access is restricted to winter-only overland travel. The permanent population of Umiat is three residents, all affiliated with a privately owned service company Umiat Enterprises Inc. (Hart Crowser Earth and Environmental Technologies, 1990; U.S. Army Corps of Engineers, 1993).

PHYSICAL SETTING

Climate

Umiat is in the arctic climate zone, which is characterized by long cold winters and short cool summers (Hartman and Johnson, 1978). The diurnal temperature range is moderate, and precipitation is low. The area is subject to occasional strong winds. The mean annual temperature is about -12°C. Monthly temperatures range from a July mean maximum of about 18°C to a February mean minimum of about -36°C. Mean annual precipitation is about 140 mm, and mean annual snowfall is about 860 mm. August is normally the month having the greatest rainfall, and snowfall is typically greatest in October (Leslie, 1989). Mean monthly and annual temperature, precipitation, and snowfall are summarized in table 1.

Table 1. Mean monthly and annual temperature, precipitation, and snowfall for the period 1948–87, Federal Aviation Administration Umiat facility

[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	-24.3	-26.8	-22.9	-13.7	-1.3	12.5	18.1	14.2	4.9	-7.8	-17.1	-24.7	-7.4
	(Record maximum 29.4 °C, July, 1951)												
Mean minimum	-33.6	-35.8	-33.1	-25.8	-10.0	2.2	5.5	3.2	-3.1	-15.8	-26.1	-33.6	-17.2
	(Record minimum -54.4 °C, February, 1987)												
Mean	-28.9	-31.3	-28.1	-19.7	-5.5	7.3	11.8	8.7	0.9	-11.8	-21.6	-29.2	-12.3
Precipitation, in millimeters of moisture													
	9	4	4	5	3	20	17	27	13	15	10	9	Total 136
Snowfall, in millimeters													
	112	58	66	58	36	10	0	5	76	208	114	114	Total 857

Vegetation

Uplands near Umiat are in the moist tundra ecosystem, which is characterized by a vegetative cover dominated by cottongrass tussocks and sedges in association with dwarf shrubs (Viereck and Little, 1972). Ridgetops tend to be barren of vegetation. The alluvial plain of the Colville River is in a shrub thicket ecosystem that has sedge and cottongrass mats and woody and herbaceous plants. Isolated stands of tall willow brush occur in nearby gullies. Both ecosystems are extremely productive during the short growing season (Joint Federal-State Land Use Planning Commission for Alaska, 1973).

Geology

Bedrock in the Umiat area consists of about 7,900 m of sedimentary strata unconformably overlying a metamorphic basement complex of Middle Devonian age (Gryc, 1988). The upper 4,400 m of the geologic section consists of folded deltaic sands, shales, and conglomerates of Cretaceous age. The folded Cretaceous strata are expressed as and exposed in reverse-faulted east-trending linear ridges and valleys that characterize the topography of the northern foothills of the Brooks Range. Sands and shales of Late Cretaceous age outcrop on the surrounding ridgetops.

The shallow geology at the FAA Umiat facility consists of unconsolidated alluvial terrace deposits of Pleistocene and Holocene age (Collins, 1958). The stratigraphy of these surficial deposits is characterized by interbedded gravel, sand, and silt. The thickness of the alluvial section, as measured in exploration oil wells and other drill holes near Umiat, ranges from about 10 to 30 m (Williams, 1970).

Soils at the FAA Umiat facility are classified as inceptisols, a soil order including somewhat immature soils that exhibit only minor modification of the parent material. Most permafrostbearing soils are classified as inceptisols (Rieger and others, 1979). The source of the soil at the FAA Umiat facility is the alluvial deposits in the Colville River Valley and adjacent terraces (Furbush and Summerfield, 1970). River terrace soil is generally alkaline and poorly drained with a sandy and silty texture. The organic surface mat ranges in thickness from about 8 to 25 cm (Furbush and Summerfield, 1970). Constantly saturated during the summer, the seasonally thawed active layer is about the same thickness as the organic mat. Disturbance of the organic surface mat can induce settling and erosion as a result of differential warming and thawing of the underlying permafrost.

Similar soil on the neighboring uplands has an organic surface mat as much as 40 cm thick. During summer, the permafrost table is within the surface mat (Furbush and Summerfield, 1970). Relatively level areas are characterized by the presence of polygonal ground. Steep slopes and barren ridgetops have well-drained sandy soil, and the active layer is as much as 130 cm thick. Islands in and natural levees along the Colville River exhibit well-drained, stratified, sandy and silty soil where soil is preserved.

HYDROLOGY

The regional hydrology of the Umiat area is affected by the presence of continuous permafrost which extends from the base of the active layer to a depth of about 240 m (Williams, 1970). Permafrost, sediments that remain at or below freezing temperatures for 2 consecutive years or more, impedes water movement on and beneath the land surface and isolates surface water and very shallow ground water from the deep ground-water system. Infiltration of surface water and communication between aquifers might occur in taliks (thawed zones) beneath deep lakes, rivers, and river pools (McCarthy, 1994).

Surface discharge during the spring thaw in late May and early June consists mostly of sheet runoff because snow meltwater is unable to infiltrate the still-frozen surficial sediments. During this short period, river and stream discharge represents more than half of the total annual flow (Sloan, 1987). Although typically decreasing, streamflow normally continues in rivers and major streams throughout the summer. During summer, the thin active layer (the surficial thaw layer) remains saturated and acts as a shallow unconfined aquifer. Low hydraulic conductivity of the active layer soils, low hydraulic gradients in flat-lying areas, and shallow thaw depth significantly impede ground-water flow (Dingman and others, 1980). In areas of low topographic relief, surface flow is often restricted to local systems of thawed ice-wedge cracks formed in the thin active layer (McCarthy, 1994). In these areas, surface water is often confined to lakes, ponds, and soil cracks within the local drainage area.

In September, with the onset of winter, river and stream discharge significantly decreases as surface waters begin to freeze. Flow in streams and the largest rivers is at or near zero by late winter when surface-water bodies have frozen to a depth of about 2 m (Sloan, 1987). Lakes, ponds, and river pools deeper than 2 m may retain water beneath the ice layer throughout the winter.

Ground water may be found during the winter in taliks beneath river channels and lakes that are deeper than 2 m. Aquifers within taliks may remain unfrozen during the winter because of heat transfer from the surface-water body to the underlying sediments (Sloan, 1987) or because of hydrothermal or hydrochemical gradients in the aqueous phase (Nelson and Munter, 1990). Recharge is predominantly from an overlying water body or, less commonly, from intrapermafrost or subpermafrost ground water. Shallow aquifers, when recharged by rivers, may be acceptable drinking-water sources (Sloan, 1987). However, ground water in shallow aquifers recharged by lakes and small streams may retain the high organic content of the surface waters and might not be suitable for human consumption. Ground water in deeper aquifers within and below the thick permafrost interval is often brackish and generally is not a suitable drinking-water source.

Surface Water

The FAA Umiat facilities are about 1 km north of the Colville River, the dominant surface-water feature in the area. The largest river in arctic Alaska, the Colville River flows northeast from Umiat for about 30 km where it turns north and discharges into the Beaufort Sea about 170 km downstream from the facility. The river flows through braided channels that are bounded by low lake-dotted terraces that separate the river channels from the surrounding uplands. Other surface-water features in the area are tributary streams, lakes, ponds, and springs.

There is no long-term continuous streamflow record for the Colville River. In April 1978, zero flow was observed at USGS streamflow-gaging station 15875000 at Umiat (U.S. Geological Survey, 1979). The river's instantaneous discharge was previously measured about 1.6 km downstream from Umiat on 3 days in 1953. The streamflow at that location was recorded as zero in April and about 180 m^3/s in July and 370 m^3/s in September (U.S. Geological Survey, 1958). Instantaneous discharge was estimated to be about 70 m^3/s near the same location in August 1977 (U.S. Geological Survey, 1978). However, the river has been reported to have perennial flow during other years (Black and Barksdale, 1948). USGS streamflow-gaging station 15880000, which is on the Colville River about 140 km downstream from Umiat, was continuously operational for 114 days during the summer of 1977 (U.S. Geological Survey, 1978). The mean daily discharge for the 114-day record was about 1,020 m^3/s. Drainage basin area for USGS streamflow-gaging station 15880000 is about 53,540 km^2. However, the data for station 15880000 are too limited to allow their meaningful extrapolation to the Umiat area where the Colville River's drainage area is about 35,800 km^2 (U.S. Geological Survey, 1989). Other streamflow data in arctic Alaska are too limited spatially and temporally to allow derivation of meaningful average and minimum streamflow estimates by regression analysis (T.P. Brabets, U.S. Geological Survey, oral commun., 1995). Therefore, estimated average annual discharge and low-flow discharge were not determined for the Colville River at Umiat.

The hydrograph showing discharge at USGS streamflow-gaging station 15910000 on the Sagavanirktok River near Sagwon (fig. 2) illustrates the characteristic seasonal streamflow pattern of arctic rivers and streams. The station is approximately 140 km east of Umiat, and has a drainage area of about 5,700 km^2. There is no measurable discharge between early November and mid-May. Streamflow generally peaks in June and then declines, with periodic rainstorm peak flows, until freezeup in November.

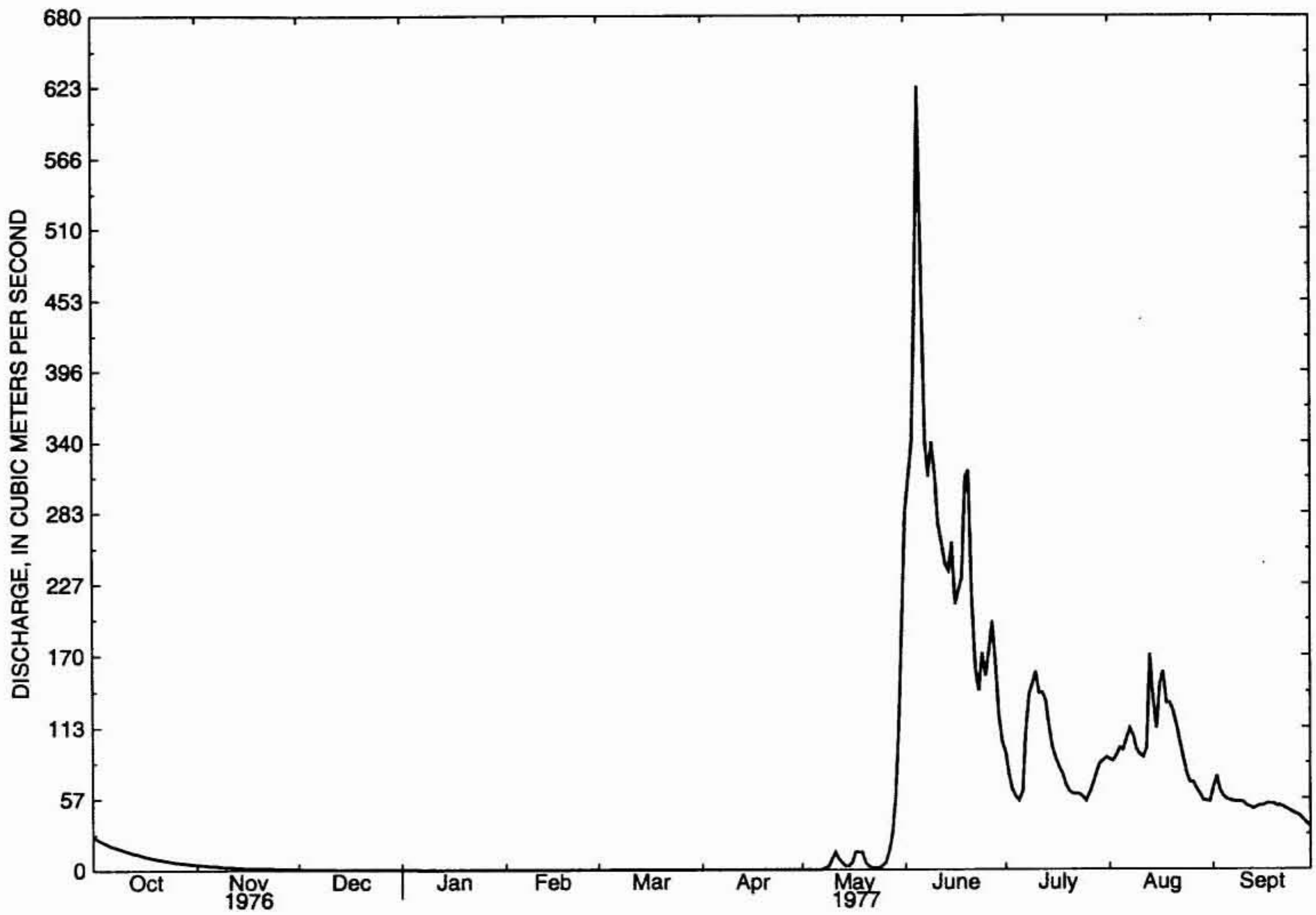

Figure 2. Hydrograph showing discharge at Sagavanirktok River near Sagwon, Alaska

The quality of the Colville River water, sampled near Umiat in July 1953, at a discharge of 184 m^3/s, was reported to be excellent (Williams, 1970). The results of the 1953 analysis are listed in table 2, as are the results of the analyses of Colville River water samples collected at or near Umiat in 1969, 1975, 1977, and 1978 (U.S. Geological Survey, 1958, 1971, 1976, 1978, 1979).

Seabee Creek, the largest tributary of the Colville River near Umiat, and many of the shallow cutoff lakes on the river terraces bordering the river are reported to freeze to their beds during the winter and are potential water sources only during the summer. Seabee Creek was sampled in conjunction with other water-quality investigations in the area. The analytical results are included in this report to provide background water-quality information for the Umiat area. Analyses of water-quality samples collected from Seabee Creek at the road crossing immediately west of the Umiat airstrip in 1983, 1984, and 1990, indicated the presence of two inorganic chemicals (iron and manganese) at concentrations possibly exceeding 1995 U.S. Environmental Protection Agency secondary maximum contaminant levels (C.E. Sloan and Richard Emanuel, U.S. Geological Survey, written commun.,1983; Pollen, 1986; Brunett and others, 1991). Field and laboratory analytical results are summarized in table 3. Only those constituents detected in the analyses are listed.

Table 2. Summary of Colville River water-quality analyses from U.S. Geological Survey sample sites at and near Umiat for 1953, 1969, 1975, 1977, and 1978

[---, not analyzed; m^3/s, cubic meter per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; <, less than]

Property or constituent	7/28/53	4/30/69	5/1/69	4/19/75	8/5/77	4/25/78
Field data						
Instantaneous discharge (m^3/s)	184	---	---	---	70.8 est.	0.0
Temperature (°C)	---	0.4	0.3	---	18.5	0.0
pH (units)	6.8	7.6	8.0	6.9	7.2	7.2
Specific conductance (µS/cm)	109	637	283	238	124	285
Dissolved oxygen (mg/L)	---	---	---	3.6	---	1.8
Analytical data (mg/L)						
Silica	1.9	8.0	5.2	3.3	---	4.6
Iron (filtered)	---	---		---	---	0.03
Iron (unfiltered)			0.23			
Calcium	13.0	83.0	36.0	---	---	36.0
Magnesium	1.8	27.0	12.0	---	---	13.0
Hardness (calcium, magnesium)	52	318	140	110	---	140
Sodium	1.5	13.0	5.5	3.9	---	4.4
Potassium	0.5	1.8	1.3	1.1	---	1.0
Carbonate	---	---	---	---	0.0	0.0
Bicarbonate	53	382	152	---	59	130
Sulfate	10	38	26	23	---	40
Chloride	0.5	0.0	0.0	1.0	---	1.4
Fluoride	---	0.1	0.1	---	---	0.0
Nitrate as nitrite	0.3	0.0	2.2	---	---	---
Nitrite plus nitrate as nitrogen	---	---	---	0.55	---	0.45
Ortho. phosphorus as phosphorus	---	---	---	0.01	---	0.01
Total dissolved solids (sum)	59	359	164	---	---	167
Color (platinum-cobalt units)	---	10	5	0	<5	---
Turbidity (JTU)	---	---	---	2	---	---
Total organic carbon	---	---	---	4.2	---	3.2

Table 3. Summary of Seabee Creek water-quality analyses near Umiat for 1983, 1984, and 1990

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ---, not analyzed; <, less than; >, greater than; ND, not detected]

Property or constituent	Sloan and Emanuel[1] 8/16/83	Pollen[2] 7/16/84	Brunett and others[3] 5/27/90
Field data			
Temperature (°C)	19.0	16.7	8.0
pH (units)	7.2	7.2	6.6
Specific conductance (µS/cm)	50	70	50
Dissolved oxygen (mg/L)	---	9.8	---
Alkalinity (mg/L as calcium carbonate)	20	35	18
Analytical data (mg/L)			
Chloride	6.6	1.0	1.4
Nitrate as nitrite as nitrogen	---	---	5.6
Sulfate	10.3	---	15.1
Iron	0.738	0.891	0.065
Manganese	---	---	0.054
Chromium	<0.003	0.002	ND
Calcium	9.3	9.4	7.2
Total Petroleum Hydrocarbon (TPH)	---	---	ND on 5/27/90 0.33 on 7/31/90
Biological Oxygen Demand (BOD)	>2	<6	---
Chemical Oxygen Demand (COD)	36	56	---
Color, true, (color units)	60	60	---
Oil and grease	0.0	<5	---

[1]C.E. Sloan and Richard Emanuel, U.S. Geological Survey, written commun., 1983.
[2]Pollen, 1986.
[3]Brunett and others, 1991.

In areas lacking effective surface drainage, lake waters tend to retain and concentrate organic matter during the summer. Deeper lakes such as Umiat Lake, which is 2 km northeast of the FAA Umiat facility, retain water beneath the ice throughout the winter, but water quality deteriorates as freezing further concentrates dissolved solids and organic compounds in the remaining water column (Williams, 1970).

Icings were observed on the Colville River near Umiat during an aerial reconnaissance in early May 1969 (C.E. Sloan, U.S. Geological Survey, written commun., 1969). Icings, known also as aufeis, are masses of ice formed by the breakout, overflow, and subsequent freezing of sheets of emergent surface water and ground water (Sloan and others, 1976). Icings can divert surface-water flow and cause flooding and erosion during periods of rapid warming (R.L. Burrows, U.S. Geological Survey, oral commun., 1995). However, the FAA facility is about 1 km from the Colville River channel and probably at no significant risk of flooding or erosion caused by river icings. The FAA Umiat facility is on an inactive flood plain unit not currently subject to inundation by streams (Mortensen and Cannon, 1982). The U.S. Army Corps of Engineers (1993) documents no record of floods or flood insurance studies for the Umiat area. The draft ECRI prepared by Hart Crowser Earth and Environmental Technologies (1990) also documents no flood history at the facility. Lack of flooding was also confirmed by the National Weather Service (Paul Meyer, National Weather Service, oral commun., 1995). Because there is no history of flooding at the FAA Umiat facility, a flood frequency analysis was not undertaken.

Ground Water

The permafrost in the Umiat area extends from the base of the active layer to a depth of about 240 m (Williams, 1970). In areas of continuous permafrost, ground water is usually restricted to two environments. The first is unfrozen alluvium and bedrock aquifers beneath and adjacent to water bodies deeper than 2 m. The second is bedrock aquifers beneath the permafrost zone (McCarthy, 1994). Bedrock aquifers within and below the permafrost interval are characterized by increasing concentrations of salinity and dissolved solids with depth. Ground water from these aquifers is probably not a potable water supply (Williams, 1970).

Several drill holes, located about 2.5 km northeast of the FAA Umiat facility between Umiat Lake and the Colville River (fig. 1), penetrated unfrozen sand and gravel zones within the river valley alluvium (Williams, 1970). Freshwater was reported in unfrozen terrace deposits in one of the holes in a 1.5-m-thick gravel interval at a depth of about 4 m. Yield and water quality were not determined, but thickness and lithologies of the alluvial deposits penetrated by the borings indicate that ground water may be available from unfrozen alluvium beneath the river. Smaller quantities may be available from unfrozen alluvium beneath the deeper lakes and from local unfrozen zones in the terrace alluvium near the river (Williams, 1970). The water table in the unfrozen river valley alluvial aquifers probably varies with seasonal river discharge.

Nelson and Munter (1990) describe taliks beneath deep river pools of braided arctic rivers as a series of unfrozen alluvium galleries separated by permafrost barriers beneath areas of shallow riffles. Geological and geophysical research conducted in the Kuparuk River about 150 km northeast of Umiat indicated that riverbed sediments beneath shallow riffle areas are frozen to the stream bottom during winter, effectively isolating each talik and its overlying pool and preventing recharge during much of the winter. Recharge occurs only if the talik is pumped and results in rapid dewatering of the river pool.

Unfrozen aquifers in taliks beneath lakes deeper than 2 m probably have lower recharge rates and poorer water quality than do aquifers beneath the Colville River (Williams, 1970). Like subriver taliks, each sublake talik is an isolated system with recharge occurring only if the aquifer is pumped (Nelson and Munter, 1990). As with subriver taliks, pumping of sublake taliks will result in dewatering of the overlying lake. Recharge rate is inhibited by the low permeability of lake-bottom sediments and organic mats and of the surrounding permafrost. Consequently, pumped aquifers beneath lakes are unlikely to recharge as quickly as those in communication with river water. The quality of water in sublake aquifers is probably unsuitable for drinking-water supplies because of the high concentration of organic constituents.

In the absence of subsurface data, the ground-water system at the FAA Umiat facility is difficult to define. However, because ground-water-flow direction tends to conform to topography, the ground-water-flow direction at the FAA Umiat facility is probably southeasterly toward the Colville River. Because of the low relief of the area, the ground-water-flow velocity may be very slow. Except for the shallow alluvial aquifers in close proximity to, and possibly in communication with, the Colville River, ground-water movement is probably restricted to the thawed active zone during the summer. Consequently, there is probably little risk of long-range migration or of deep infiltration of ground water that may be contaminated by surface spills. The ultimate receptor of surface-water runoff and of shallow ground-water discharge near the FAA facility is the Colville River.

DRINKING WATER

Present Drinking-Water Supplies

No public water-supply system exists in Umiat. Drinking water is obtained from the Colville River, hauled to the Umiat Lodge, and chlorinated prior to use. The U.S. Geological Survey (1986) estimated that the per-capita domestic use of surface-water by rural residents of Alaska is about 38 L/d. Umiat Enterprises, Inc., the local service company that operates Umiat Lodge, reported that visitors and FAA employees, when not staying at the lodge, sometimes camp near the river and also use the Colville River as a drinking-water source (Umiat Enterprises, Inc., oral commun., 1995). The company, in compliance with State of Alaska regulations, submits river-water samples to a privately owned laboratory in Fairbanks for water-quality analyses.

Alternative Drinking-Water Sources

Although adequate data are not available to characterize the quantity and quality of alternative drinking water sources at the FAA facility, several potential sources may be available. The Colville River has been an abundant perennial source of drinking water for the small number of residents and visitors at Umiat and probably will remain so. Deepened lakes or excavated pits may be used to store surface water or ground water for year-round use. Wells drawing ground water from shallow unfrozen aquifers in the alluvial sediments of the river valley may yield water of sufficient quantity and quality to supply the drinking-water needs of the local population. However, further exploration would be required to confirm the availability of ground water. During the winter, snow and ice may also serve as sources of drinking water if effective heating and treatment methods are available.

SUMMARY

Umiat's remote location makes it dependent upon aerial transportation. Overland travel is restricted to winter only. Continuous permafrost controls the local hydrogeologic system. Because no public water-distribution system exists, residents and visitors use the Colville River as a drinking-water supply. Alternative drinking-water sources may be available but data are not adequate to characterize the quantity and quality of these sources.

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