ALASKA GROUND-WATER QUALITY

By R.J. Madison, T.J. McElhone, and Chester Zenone

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DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, *Secretary*

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, *Director*

For additional information:

Chief Hydrologist
U.S. Geological Survey
407 National Center
Reston, VA 22092

For sale by:

U.S. Geological Survey
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FOREWORD

This report contains summary information on ground-water quality in one of the 50 States, Puerto Rico, the Virgin Islands, or the Trust Territories of the Pacific Islands, Saipan, Guam, and American Samoa. The material is extracted from the manuscript of the *1986 National Water Summary*, and with the exception of the illustrations, which will be reproduced in multi-color in the *1986 National Water Summary*, the format and content of this report is identical to the State ground-water-quality descriptions to be published in the *1986 National Water Summary*. Release of this information before formal publication in the *1986 National Water Summary* permits the earliest access by the public.

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ALASKA
Ground-Water Quality

In Alaska (fig. 1), about 70 percent of the population obtains water from ground-water sources. About 104,000 of the 276,000 people using ground water (38 percent) obtain their supply from privately owned systems (U.S. Geological Survey, 1985, p. 129). Most of the ground water in the major withdrawal areas is suitable for drinking and most other purposes. The median concentration of dissolved solids in most areas does not exceed the State's drinking-water standard of 500 mg/L (milligrams per liter) (Alaska Department of Environmental Conservation, 1979). Except for water from bedrock in the Fairbanks area, nitrate (as nitrogen) concentrations are considerably smaller than the drinking-water standard of 10 mg/L (fig. 2). Objectionable iron and hardness concentrations can occur in most areas; however, these conditions can be improved by using relatively inexpensive treatment systems.

Water quality has been degraded in several areas as the result of septic-system effluents or landfill leachates, but the number of persons affected is small. Contamination of the shallow unconsolidated aquifers (fig. 2*A*) by organic contaminants from probable fuel-tank leakage also has been identified at 16 locations. The quality of ground water is naturally impaired in the Fairbanks area, where the concentration of arsenic in water from many wells in bedrock exceeds the State's drinking-water standard of 50 μg/L (micrograms per liter) (fig. 2*B*). Concentrations of arsenic as large as 10,000 μg/L have been reported (Johnson and others, 1978).

Alaska has no hazardous-waste sites on the U.S. Environmental Protection Agency's (1986c,d) National Priorities List. However, at 47 military installations in Alaska a total of 193 waste sites had been identified, as of September 1985, by the U.S. Department of Defense (1986) as potential hazardous-waste sites under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Ninety-two of these sites at 45 military installations (fig. 3) were considered to present a hazard significant enough to warrant response action in accordance with CERCLA. Remedial action at one of these sites has been completed under the program.

The four major sources of potential contamination of aquifers are onsite septic systems, land disposal of wastes, leakage from abandoned fuel tanks, and saltwater intrusion.

WATER QUALITY IN PRINCIPAL AQUIFERS

Aquifers have been mapped in some detail only in parts of the widely separated major population centers—Fairbanks, Juneau, Anchorage, and Kenai-Soldotna (fig. 1*B*). All water-yielding formations in Alaska have been grouped into two principal aquifers (fig. 2*A*)—unconsolidated alluvium and glacial outwash deposits, and bedrock (U.S. Geological Survey, 1985, p. 129–130). The most extensive development and withdrawal of ground water to date (1986) has been at Anchorage, where more than half of the State's population resides. Two other areas of large-scale ground-water use are the Tanana River valley in interior Alaska, which includes the city of Fairbanks, and a petrochemical industrial complex on the Kenai Peninsula. Nearly all ground-water development in Alaska has been in unconsolidated aquifers. About 1 percent of the State's total ground-water withdrawal is from bedrock.

A data base adequate to describe areal variations in the chemical quality of ground water is available for only a few places, such as Juneau, Kenai, Anchorage, and Fairbanks. Few data have been collected for large areas of the State, and outside of these major population centers, most water-quality data are for the unconsolidated aquifers. Most of the sampled water from the unconsolidated aquifers contains less than 400 mg/L dissolved solids (fig. 2*B*) and is considered to be suitable for most uses. Known concentrations of dissolved solids in ground water range from about 25 mg/L in stream-channel alluvium to 6,400 mg/L in shallow wells in some coastal areas. Except in the Fairbanks and Anchorage areas, the bedrock aquifers are virtually undeveloped, and little is known about the quality of the contained water.

BACKGROUND WATER QUALITY

A graphic summary of selected water-quality variables compiled from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) is presented in figure 2*B*. The summary is based on dissolved-solids, hardness (as calcium carbonate), nitrate (as nitrogen), iron, and arsenic analyses of water samples collected from 1949 to 1976 from the principal aquifers in Alaska. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant in drinking-water supply as established by the U.S. Environmental Protection Agency (1986a, b). The primary maximum contaminant level standards are health related and are legally enforceable. The secondary maximum contaminant level standards apply to esthetic qualities and are recommended guidelines. The primary drinking-water standards include a maximum concentration of 10 mg/L nitrate (as nitrogen) and 50 μg/L arsenic, and the secondary drinking-water standards include maximum concentrations of 500 mg/L dissolved solids and 300 μg/L iron. For these variables, the State drinking-water standards are the same as the national standards.

Unconsolidated Aquifers

Most of the sampled water from the unconsolidated aquifers does not exceed the drinking-water standard. Calcium and magnesium, which contribute to the hardness of water, and bicarbonate are the major dissolved ions. In most of the wells, hardness accounts for 60 to 80 percent of the dissolved-solids concentration. In many communities, wells drilled near the coast yield water of sodium bicarbonate or sodium chloride type.

Iron is present in concentrations that exceed drinking-water standards in a large number of shallow wells in most areas of the State. Concentrations larger than 1,000 μg/L are common (fig. 2*B*). Iron concentrations larger than about 300 μg/L can cause staining of laundry and plumbing fixtures and can impart a taste to the water.

One of the few areas of Alaska where natural ground-water quality could be considered to be unsuitable for some uses is the Copper River basin (Emery and others, 1985). As a general rule, the ground water becomes more mineralized with increasing depth in the upper Copper River basin. Saline springs in the area are the surface manifestation of saline ground water present in the marine sedimentary rocks that underlie much of the glacial-lake deposits (Grantz and others, 1962). Upward movement of water from these older sedimentary rocks has affected the quality of water in the overlying unconsolidated aquifers. Water in the unconsolidated aquifers is characterized by large concentrations of dissolved solids (as much as 10,000 mg/L), sodium, chloride, iron, and manganese.

The summary (fig. 2*B*) shows the variability in chemical quality of the water from unconsolidated aquifers for the major areas of water withdrawal. For many areas of the State, the number of wells having water-quality information is too small to be adequate for statistical inference. For these areas, a general indication of the range in dissolved-solids concentrations in shallow unconsolidated aquifers can be gained from an analysis of stream water-quality data for low-flow (or base-flow) periods. During winter in interior Alaska, the ground is frozen, no surface runoff occurs, and any streamflow is sustained by ground-water discharge.

Dissolved-solids concentration is considered to be a useful index of overall water quality, but available data do not provide representative coverage for winter streamflow in Alaska. However, specific conductance, which is affected by dissolved-solids content, is a characteristic commonly measured in field water-quality determinations. For most natural waters in Alaska, the dissolved-solids concentration ranges from 55 to 65 percent of the specific-conductance value. The following table (Zenone and Anderson, 1978) indicates ranges of specific-conductance values measured during base-flow periods for streams in Alaska, except for the southeastern part of the State, where base flow has not been defined.

Summary of specific-conductance values for base flow of streams in Alaska

[Base-flow period is November 1 to April 30, when surface runoff is small or nonexistent; μS/cm, microsiemens per centimeter at 25 degrees Celsius]

Geographic area (fig. 1*A*)	Range of specific conductance (μS/cm), 1949-76
North Slope	225-350
Kobuk, Nome	150-250
Kuskokwim, Wade Hampton	250-300
Southeast Fairbanks, Upper Yukon, Yukon-Koyukuk	250-400
Bethel	100-240
Dillingham	50-100*
Kenai Peninsula	100-300
Valdez-Copper River	300-500

*Affected by significant volume of lake storage.

In coastal areas of Alaska, the natural ground-water quality can be affected by saltwater intrusion. Coastal aquifers that contain freshwater may be hydraulically connected to the ocean or other saline-water bodies. Under natural conditions, the direction of ground-water flow generally is toward the coast. If pumping lowers the water table or potentiometric surface so that the natural gradient is reversed, saline water will move into the freshwater aquifer. Increases in salinity of the water resulting from pumping stress on the aquifer have occurred at Indian Cove, a small community near Juneau. Six of 18 wells currently in use there produce brackish water having dissolved-solids concentrations larger than 1,000 mg/L (Dearborn, 1985).

In island settings and on offshore bars and spits, fresh ground water generally occurs as an unconfined, lens-shaped body floating on saline ground water. Theoretically, in this situation, there is a 40-foot-thick zone of fresh ground water below sea level for each foot of water-table altitude above sea level (Todd, 1980, p. 496). This situation exists at St. George Island, in the Pribilof Islands in the Bering Sea (Anderson, 1976), and at Fire Island near Anchorage (A.J. Feulner, U.S. Geological Survey, written commun., 1964). Other areas where fresh ground water probably occurs only as thin lenses above salty water are at Unalakleet, Kotzebue, and the coastal fringes of the Yukon and Kuskokwim River deltas in western Alaska.

The role of permafrost in directly imparting a particular type of mineralization to ground water is probably minor. A decrease in the rate of ground-water movement by permafrost provides a longer time for reactions between the water and the enclosing rocks than in regions without permafrost (Williams and van Everdingen, 1973). Chemical reaction rates and saturation concentrations of some constituents also are affected by low water temperatures. Ground water beneath permafrost usually is of nearly constant quality at a particular site, although it may differ in composition from one area to another.

Bedrock Aquifers

Because the bedrock aquifers in most areas of Alaska are undeveloped, very little is known about their water quality. In general, the concentration of dissolved solids in water from bedrock aquifers is larger than that present in the unconsolidated aquifers and the chemical quality is more variable.

One of the areas of more intensive development of bedrock aquifers is in fractured schist of the uplands near Fairbanks. The chemical composition of the water in the schist is extremely variable, and in many instances the presence of large concentrations of several constituents renders the water unsuitable or marginal for domestic use (fig. 2*B*). The hardness of ground water from sampled wells in the Fairbanks area ranges from 17 to 1,000 mg/L, and more than 50 percent of sampled wells have a hardness larger than 300 mg/L (Johnson and others, 1978). Only 7 percent of the sampled wells have a hardness concentration less than 100 mg/L, a level not considered to be objectionable for most uses. Concentrations of iron also are generally large in the Fairbanks area (fig. 2*B*).

Arsenic and nitrate concentrations that exceed the drinking-water standards are common in water from wells completed in the bedrock aquifers near Fairbanks. The primary source of these constituents and the mechanism by which they enter the ground water have not been conclusively demonstrated, but they are considered to be most likely natural (Johnson and others, 1978). For most wells sampled, arsenic concentrations range from 0 to 10,000 μg/L. In most bedrock wells, nitrate concentrations are smaller than 10 mg/L as nitrogen, but water from 21 percent of wells sampled exceeds this value.

EFFECTS OF LAND USE ON WATER QUALITY

In most of Alaska, ground water is an untapped resource that has been virtually unaffected by humans. However, in the major urban areas and in some outlying villages, ground-water quality has been locally degraded, primarily due to seepage from septic systems, landfills, and abandonded fuel-storage tanks. Sites where ground-water contamination has been documented are shown in figure 3.

The rapid growth of population in the Anchorage area has resulted in the construction of many large residential developments outside the city's water- and wastewater-system boundaries. These developments use onsite water sources and wastewater-disposal systems. In many areas, subdivision lots of one-half acre or less are served by individual wells and septic systems. The number of operating septic disposal systems in the greater Anchorage area is about 9,000, or about one for every eight residences. Local contamination of ground water has been caused by septic-system effluent in several areas of Anchorage and Fairbanks. Also, some private water supplies have been contaminated by drainage of surface water into wells that either were improperly constructed or had damaged casing at the ground surface.

Ground water has been contaminated locally in the Anchorage area by the disposal of solid waste directly into lakes that are connected hydraulically to the ground-water system, or by surface disposal in landfills where the water table is shallow (Zenone and others, 1975). Shallow ground water beneath the Merrill Field landfill in Anchorage and the old Greater Anchorage Area Borough landfill (closed since 1977), where near-surface materials are saturated, is severely contaminated by leachate produced within the refuse. Leachate at these two sites is characterized by large concentrations of organic carbon, iron, and manganese, combined with concen-

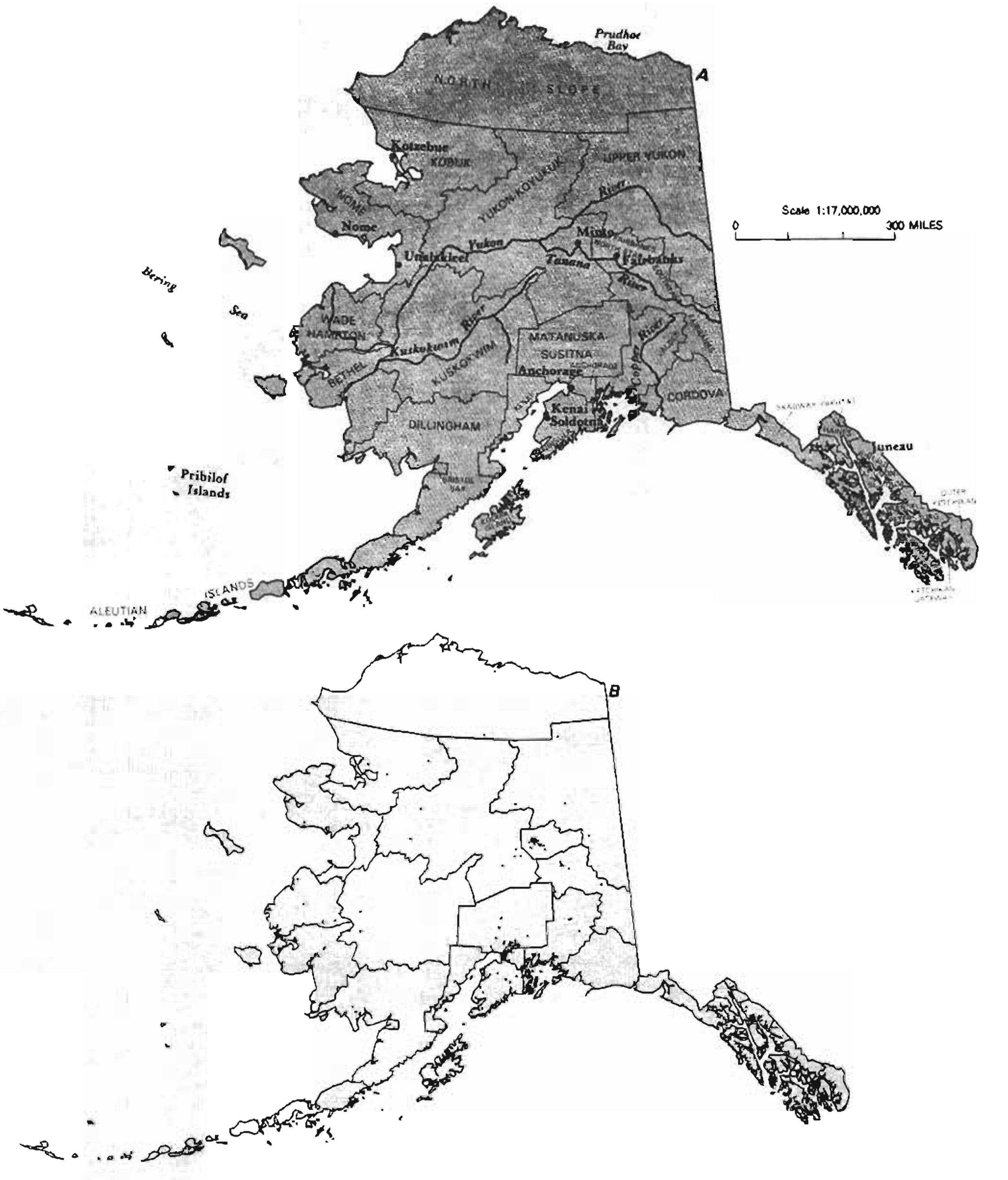

Figure 1. Selected geographic features and 1985 population distribution in Alaska. *A*, Geographic areas, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted to the 1985 U.S. Bureau of the Census data for county populations.)

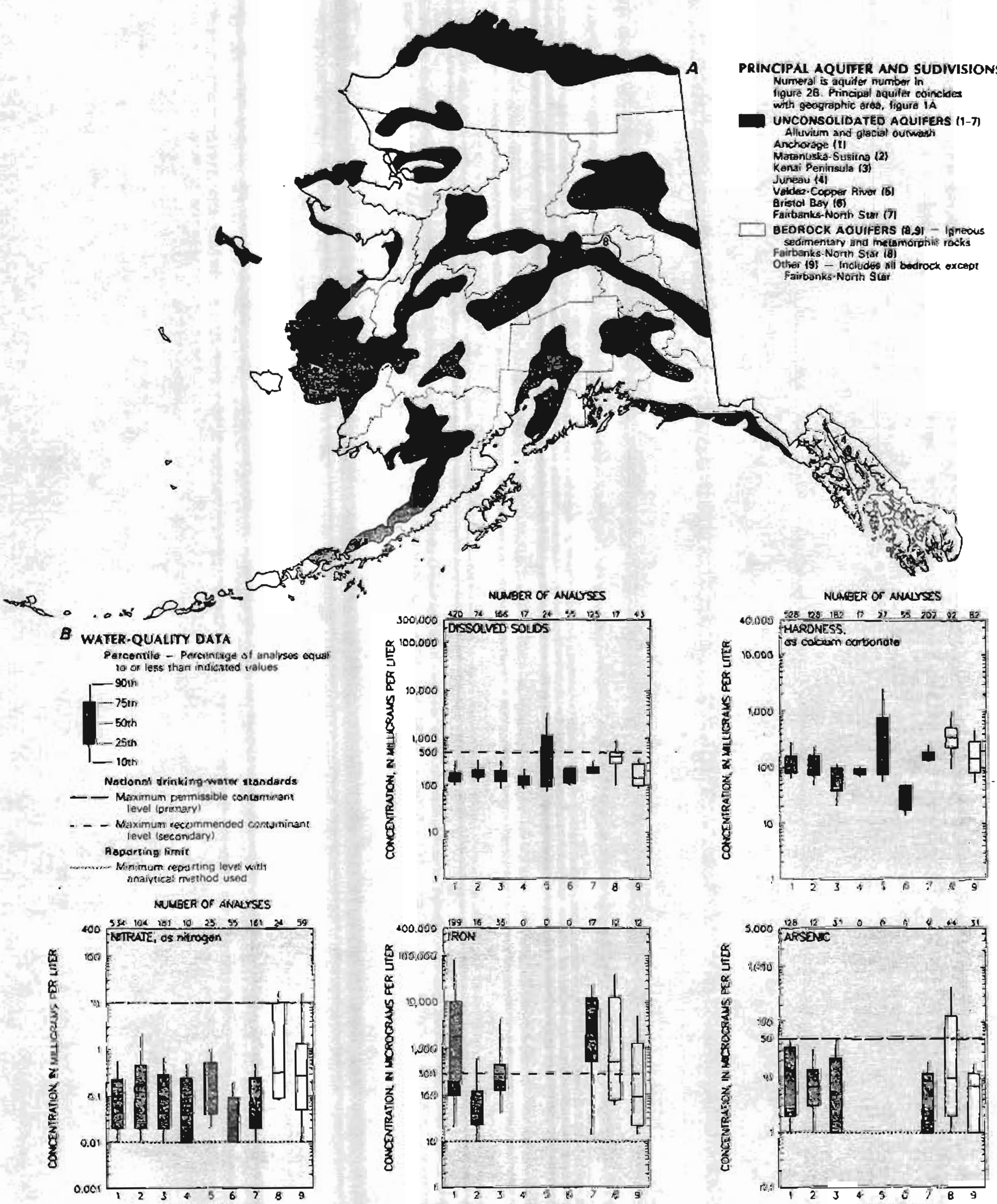

Figure 2. Principal aquifers and related water-quality data in Alaska. *A*, Principal aquifers. *B*, Selected water-quality constituents and properties, as of 1949-85. (Sources: *A*, U.S. Geological Survey, 1985. *B*, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

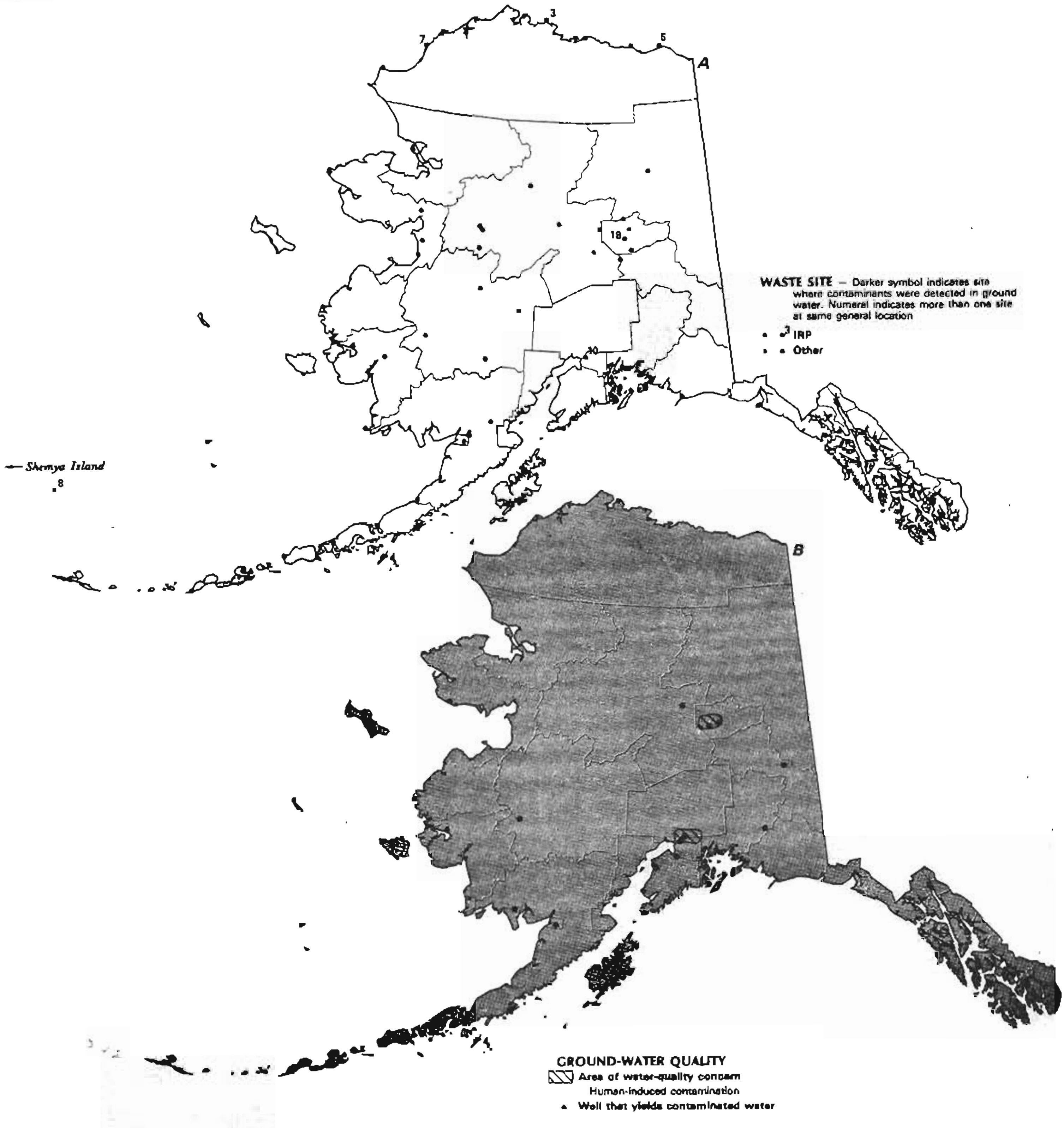

Figure 3. Selected waste sites and ground-water-quality information in Alaska. *A*, Department of Defense Installation Restoration Program (IRP) sites, as of 1985. *B*, Areas of human-induced contamination and distribution of wells that yield contaminated water, as of 1986. *C*, Municipal landfills, as of 1986. (Sources: *A*, U.S. Department of Defense, 1986. *B*, Alaska Department of Environmental Conservation files, 1986. *C*, Henry Friedman, Alaska Department of Environmental Conservation, oral commun., July 1986.)

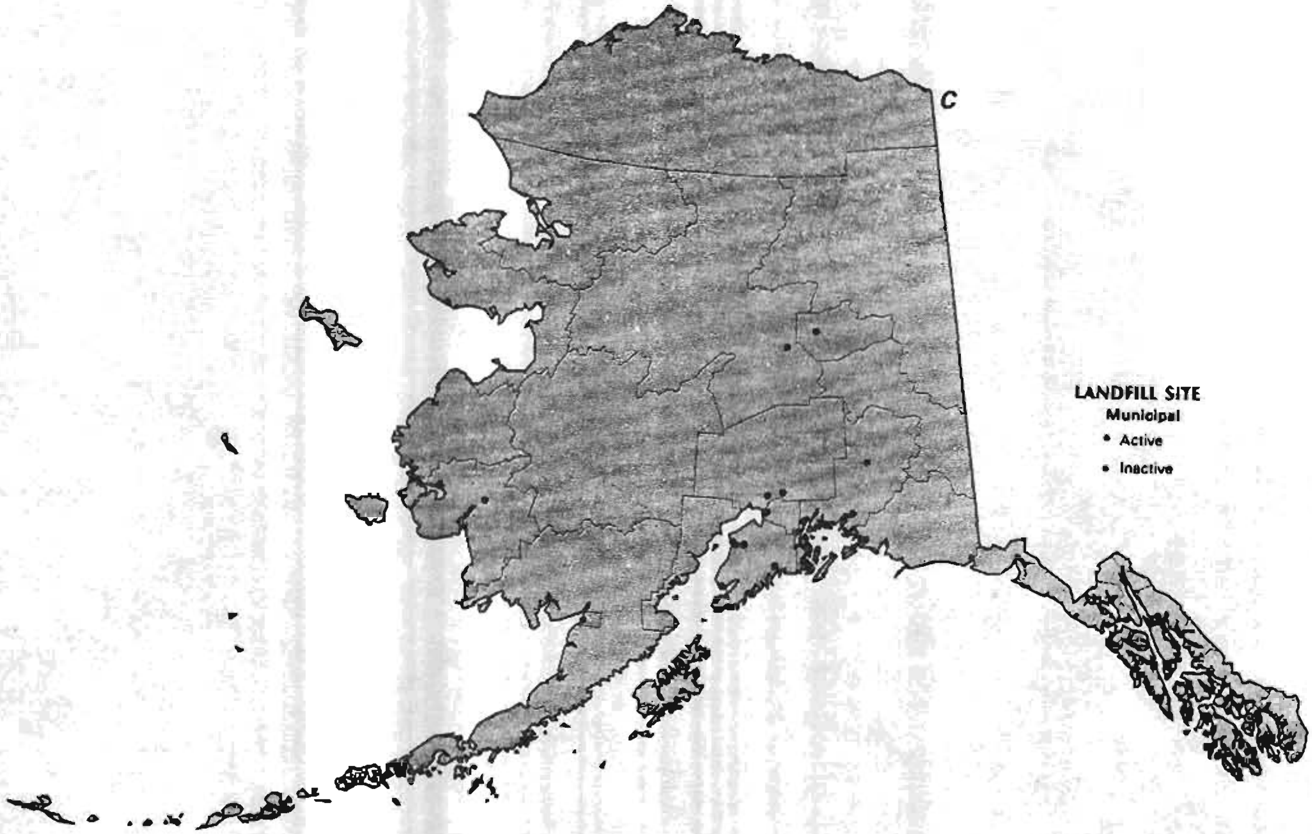

Figure 3.—Continued.