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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HYDROLOGIC INFORMATION FOR LAND-USE PLANNING, BADGER ROAD AREA, FAIRBANKS, ALASKA

By Andrea P. Krumhardt

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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION TABLE

Multiply	by	to obtain
foot (ft)	0.3048	meter (m)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
acre	0.4047	hectare (ha)
gallon per day per foot [(gal/d)/ft]	0.0124	square meter per day (m^2/d)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
micromhos per centimeter at 25°C (µmho/cm)	1.00	microsiemens (µS)

Other abbreviations in this report are:

µg/L (micrograms per liter)
mg/L (milligrams per liter)
mL (milliliters)
FC/100 mL (fecal coliform colony count per 100 mL)

Note: The National Geodetic Vertical Datum of 1929 (NGVD of 1929) is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada. This datum was formerly referred to as Mean Sea Level.

HYDROLOGIC INFORMATION FOR LAND-USE PLANNING, BADGER ROAD AREA, FAIRBANKS, ALASKA

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ABSTRACT

The relatively flat Badger Road area near Fairbanks occupies part of the alluvial plain of the Chena and Tanana Rivers and is underlain by localized areas of permafrost. The water table in the high-transmissivity aquifer that underlies the area is generally shallower than 15 feet, fluctuates seasonally about 2 feet, and slopes northwesterly, the principal direction of ground-water flow. Shallow domestic wells and septic systems, both of which use primarily the upper part of the aquifer, provide water and waste disposal, respectively, for homes in the area. Analyses of water samples from 18 observation wells in undeveloped parts of the study area and from 33 domestic wells, many of which are in subdivisions, indicate that water quality has not been significantly degraded by on-site waste disposal. Three samples had detectable but minor concentrations (less than 3 colonies per 100 milliliters) of fecal coliform bacteria. Concentrations of three contamination indicators (dissolved chloride, dissolved ammonia, and total phosphate) are significantly greater in domestic wells than in observation wells. However, the increase in concentration is generally by a factor less than four and degradation of ground-water quality is not severe.

INTRODUCTION

The Fairbanks North Star Borough and the U.S. Geological Survey have had a cooperative agreement since 1975 to study the geohydrology of the Borough. As part of the study program, this report presents the water-quality and water-level data that were collected in the Badger Road area southeast of Fairbanks (fig. 1) in 1980 and 1981. The Alaska Department of Natural Resources Division of Geological and Geophysical Surveys contributed funding for part of the 1980-81 study effort. The report is intended to aid planners in evaluating the effects of development on ground-water quality.

The alluvial aquifer in the lowland areas surrounding Fairbanks is capable of supplying thousands of gallons of water per minute to properly constructed wells. The water table commonly is less than 15 ft below the land surface. Where municipal waste-disposal facilities are not available, individual septic systems are used. Leach fields are usually placed 10 to 12 ft below the land surface to avoid seasonal frost conditions (Nelson, 1978). Where this situation occurs, the potential for ground-water contamination is high, especially in areas of small lots (.25 acre or less) and shallow wells (20 ft deep or less).

The objectives of this study were: (1) to determine the direction of ground-water flow and seasonal fluctuations of the water table; and (2) to assess the water quality in developed and undeveloped areas. To determine seasonal fluctuation and configuration of the water table, the water levels in 11 U.S. Geological Survey

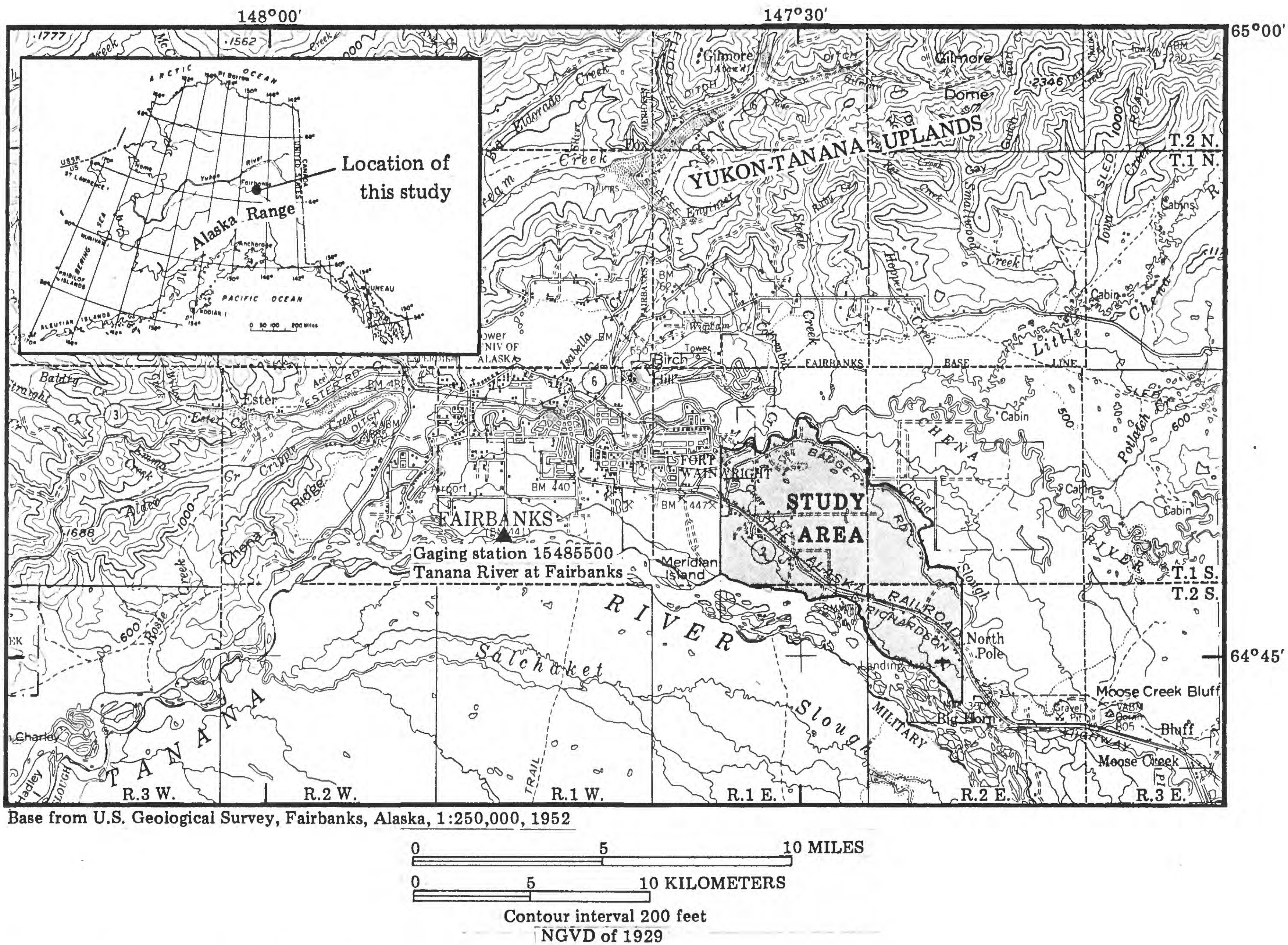


Figure 1.--Location of the Badger Road study area.

observation wells and 6 U.S. Army Corps of Engineers observation wells were measured monthly during 1980 and 1981. One additional observation well could not be used for water level measurements, but was sampled for chemical analyses. To assess the water quality of the area, samples were collected once from privately owned wells and quarterly for 1 year from 16 of the 18 observation wells. The observation wells have no alternative use and are never pumped except to collect samples. Water-quality determinations included concentrations of fecal-coliform bacteria, nitrate, chloride, ammonia, phosphorus, sulfate, iron, hardness, and arsenic.

SETTING

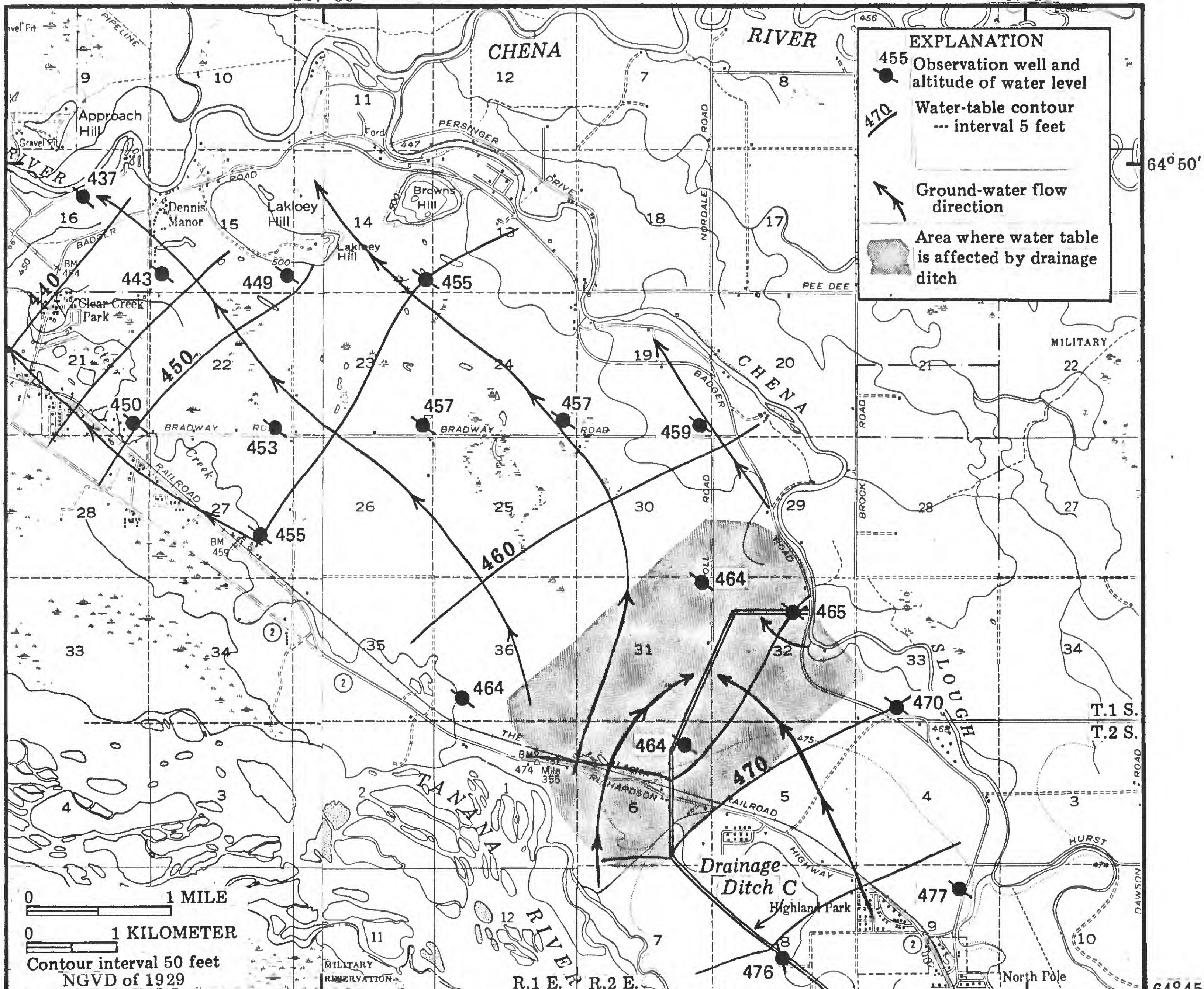
The study area, southeast of Fairbanks, is bounded by the Chena River and Chena Slough on the north and east and by the Tanana River on the south. These drainageways occupy the northern part of the broad lowland between the Alaska Range to the south and the Yukon-Tanana uplands to the north (fig. 1). The study area is not served by water and sewer utilities.

The Badger Road area is relatively flat and slopes from east to west at approximately 5 ft/mi. Local depressions such as sloughs, swales, and ponds are common. Two prominent bedrock hills, Lakloey Hill and Browns Hill, are exposed in the north-central part of the study area. Except for these bedrock hills, which are composed of basalt and schist, the area is underlain by alternating layers and lenses of sand and gravel overlain by as much as 15 ft of gray silt. This alluvium is commonly unfrozen, but locally may be perennially frozen from 3 to 275 ft. The frozen alluvium generally has a low ice content (Péwé and others, 1976). The total thickness of the alluvium has never been determined except in one area where a thickness of 800 ft was reported (Barnes, 1961). The slough and swale deposits consist of silt, silty sand, and organic materials, and locally are perennially frozen. There is not a continuous layer of frozen material throughout the study area, but rather an irregular pattern of thawed and perennially frozen sediments.

HYDROLOGY

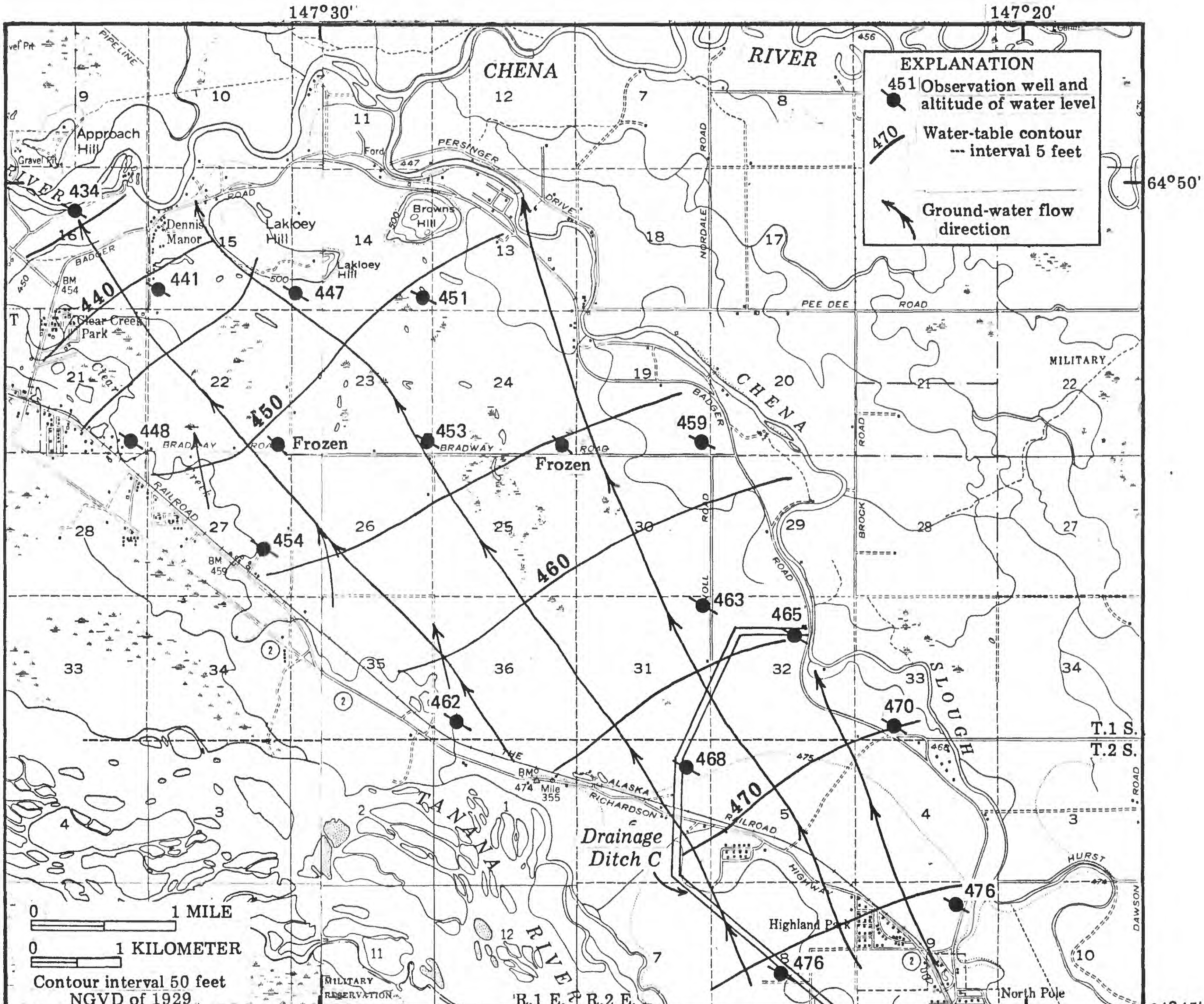
The Badger Road area is underlain by part of an extensive aquifer that underlies the Tanana River valley (Nelson, 1978). Pumping tests have demonstrated the productivity of this aquifer--several wells developed in the aquifer produce more than 1,000 gal/min--but have not provided much data useful in determining the transmissivity (a measure of the capacity of an aquifer to transmit water) of the aquifer. Cederstrom (1963, p. 45) summarized the transmissivity of the alluvial aquifer near Fort Wainwright, located 1 mi west of the Badger Road area, as being on the order of "...several hundred thousand gallons per day per foot." This is a relatively high value of transmissivity.

The primary source of recharge to the aquifer in the Badger Road area is the Tanana River. Recharge from Chena River and Chena Slough is probably negligible. Areal recharge by direct infiltration of precipitation probably is less than areal discharge by evapotranspiration and is also negligible. The water table slopes in a northwesterly direction at approximately 4 ft/mi until it intersects the Chena River and Chena Slough (figs. 2 and 3). Representative flow lines, drawn at right angles to the water-table contours, indicate the general direction of ground-water



Base from U.S. Geological Survey, Fairbanks, Alaska, 1:63,360, 1955

Figure 2.--Locations of observation wells and water-table configuration for high water-table conditions, July 10, 1980.



Base from U.S. Geological Survey, Fairbanks, Alaska, 1:63,360, 1955

Figure 3.--Locations of observation wells and water-table configuration for low water-table conditions, January 8, 1981. Two of the observation wells were frozen and could not be measured.

movement. The flow direction appears to be generally constant throughout the year. Drainage ditch "C" creates a local depression in the water table during average and high-water conditions (fig. 2). This ditch was designed to intercept water seeping under the Tanana River levee and divert the water into Chena Slough. When the ditch is unable to drain ground water due either to ice blockage or to a drop in the water table below the ditch level, the water-table configuration is unaffected by the ditch (fig. 3).

The water table is relatively flat and shallow, but local topographic relief makes a significant difference in the depth to water. The depth of the water table below land surface ranged from less than 1 ft to 16 ft. Seasonal water-level fluctuations in individual wells ranged from less than 1 ft to about 3.5 ft and averaged about 2 ft. The altitude of the water table fluctuates synchronously with stage of the Tanana River. Synchronous fluctuations indicate that the Tanana River is a boundary stream that controls the altitude of the water table at the stream-aquifer interface. The water-table fluctuations are attenuated with increasing distance from the Tanana River (fig. 4a and 4b vs. 4e), especially near discharge boundaries (fig. 4c and 4d vs. 4e) such as Chena Slough and drainage ditch C. The most common causes of a rise in river stage are runoff from melting snow and ice in the spring (breakup), snowmelt from the Alaska Range during the hot summer months, and heavy summer and autumn rainfall in the Yukon-Tanana Uplands. However, the water table can also rise locally during the winter months when drainageways (such as the Chena River flood-control ditches) clog with ice. When ground water is unable to flow into the drainageway, the water table rises above the top of the stream ice. Then ground water seeps out as an overflow and freezes to form "icings". This cycle can continue throughout the winter and may cause icings extensive enough to inundate homes, roads, and septic systems near the drainageway.

GROUND-WATER QUALITY

A main concern of homeowners, planners, and developers in the Badger Road area is the quality of ground water. Water samples collected from domestic wells and observation wells were analyzed for the constituents and properties shown in table 1. Samples were analyzed for arsenic because arsenic contamination is common in wells in the uplands north of the study area and the extent of the contamination is unknown. None of the samples from the Badger Road area, however, contained more than 50 µg/L of arsenic (table 2), the drinking-water limit established by the U.S. Environmental Protection Agency (1976).

Even water that appears clean and odor free can contain contaminants. The Alaska Department of Environmental Conservation (1979) requires that drinking water contain fewer than 1 FC/100 mL of water. Water samples from 3 of the 49 wells sampled contained detectable fecal coliform bacteria. Although this is a small number of wells, it represents about 6 percent of the sampled wells and indicates that further monitoring and testing are warranted. Only one of the three samples contained more than 1 FC/100 mL, and the owner of the well attributed the problem to a malfunctioning septic system.

Fecal coliform bacteria in themselves are not harmful, but their presence is an indicator that pathogens (any disease-causing agents) may be present. Diseases linked to contamination from septic systems include infectious hepatitis, typhoid fever, dysentery, and other gastrointestinal illnesses (Scalf and others, 1977).

Table 1. -- Constituents and properties of water analyzed in this study.

Constituent or property	Reason for analysis
Fecal coliform bacteria (FC/100 mL)	Presence indicates bacterial contamination by fecal materials; State limit for drinking water is "less than 1 FC/100 mL" for private wells.
Arsenic (µg/L)	Health hazard; natural arsenic common in wells in uplands, north of the study area. State drinking-water limit is 50 µg/L.
Chloride (mg/L)	Values significantly greater than the normal range of those in undeveloped areas commonly indicate degradation of ground-water quality by septic-system effluent.
Nitrate (mg/L as nitrogen)	Same reason as for chloride analysis; also, concentrations greater than 15 mg/L may be a health hazard to infants.
Ammonia (mg/L)	Same reason as for chloride analysis.
Phosphorous (mg/L)	Same reason as for chloride analysis.
Sulfate (mg/L)	Same reason as for chloride analysis.
Iron (mg/L)	Concentrations greater than about 0.3 mg/L cause staining of plumbing fixtures, laundry, etc.
Hardness (mg/L as $CaCO_3$)	Water having hardness greater than about 100 mg/L generally requires softening.
pH (units)	Corrosiveness of water and ability of water to keep iron in solution increase with decreasing pH (below about 6).
Specific conductance (µmho/cm at 25°C)	An approximate indicator of dissolved solids.

The following factors in installation of a septic system are important in reducing the likelihood of bacterial contamination of wells: (1) type of materials into which the seepage pit will discharge; (2) separation between the water table and point of septic-tank effluent discharge; (3) direction of ground-water flow; and (4) depth of nearby wells. In general, materials such as sand and silty sand are effective in filtering out bacteria. Gravels are less suitable for waste disposal because the coarse material does not filter as well, there is less adsorption, and the ground-water flow rates are much faster than through fine-grained materials. Septic-tank effluent discharged into areas underlain by permafrost will eventually be diverted to the ground surface.

State of Alaska (1973) regulations require that septic systems be buried no closer than 4 ft to the seasonally high water table and that they be at least 100 ft from a well. Complying with these regulations is difficult in the Badger Road areas where individual building lots are small and the water table is shallow. Although there may be enough room on one particular lot to satisfy the 100-foot separation regulation, distance to neighboring wells and septic systems must also be considered. Additionally, many homeowners bury their septic systems 10 to 12 ft below the surface to avoid seasonal frost conditions (Nelson, 1978). In many areas, this places the system below or at the water table, thereby increasing the chances of contaminations of wells.

Table 2. -- Water-quality data for Badger Road area, 1980-81

[Asterisk, *, denotes observation well (see figure 5 for well location)]

Location	Site no.	Sampling date	Well depth (ft)	Water level (below land surface) (ft)	Fecal coliform bacteria (FC/100 mL)	Specific conductance (µmho/cm at 25°C)	Temperature (°C)	pH (units)	Hardness (as $CaCO_3$) (mg/L)
T.1 S., R.1 E., Sec. 13	4	03/10/81	35		0	500	8.0	7.1	210
	5	03/11/81	27	10.6	0	475	3.5	7.1	200
	6	03/11/81		6.55	0	500	4.5	7.3	110
	7-1	03/25/81			0	375	2.0	7.4	150
	7-2	03/25/81	20		0	325	10.0	7.3	150
	8	04/07/81			2	312	5.0	7.1	120
	9	04/07/81			0	300	2.0	7.0	130
	10	04/07/81			0	450	10.5	7.1	180
	11	04/09/81			0	290	5.0	6.8	140
	12	04/08/81			1	300	4.5	6.8	130
	13	04/09/81		7.12	0	350	5.0	6.8	160
	14	04/09/81	12		0	425	2.5	7.0	140
	15	04/15/81			0	338	7.0	7.0	
T.1 S., R.1 E., Sec. 14	3*	08/13/80	11	6.68	0	340	2.0	6.8	130
		10/29/80	11	7.06	0	330	2.0	7.0	130
		04/21/81	11	7.74	0	300	1.5	7.0	130
		07/07/81	11	6.74	0	312	2.0	7.2	130
	4*	08/12/80	6	1.00	0	450	3.0	7.0	150
		10/28/80	6	1.23	0	400	3.5	6.8	170
		07/14/81	6	1.26	0	400	3.0	6.8	170
	5	03/09/81			0	725	9.0	6.4	
	6	03/09/81			0	600	2.0	7.1	240
T.1 S., R.1 E., Sec. 15	1*	08/07/80	10	4.34	0	290	5.0	7.1	130
		10/28/80	10	5.09	0	310	1.5	6.8	140
		04/21/81	10	5.54	0	320	1.0	7.2	140
		07/07/81	10	4.48	0	350	1.0	7.3	140
	3	01/17/80	60	13.65	0	312	6.0	6.6	130
T.1 S., R.1 E., Sec. 16	4*	08/07/80	20	14.75	0	369	2.0	6.9	170
		10/28/80	20	16.39	0	380	2.5	7.0	180
		04/21/81	20	15.90	0	338	2.5	7.3	170
		07/08/81	20	12.66	0	395	1.0	7.0	180
T.1 S., R.1 E., Sec. 21	3-1	02/08/80	99		0	370	10.0	7.3	
	3-2	01/22/80	97		0	340	15.0	6.8	170
	3-3	01/22/80	95	8.85	0	325	4.0	6.9	170
	4-2	02/06/80			0	380	4.5	6.7	170
	5	01/29/80	110	9.01	0	575	12.0	6.8	270
	6	01/31/80	40	9.50	0	342	5.0	6.8	170
	7	02/08/80			0	450	5.0	7.0	190
	8-1	02/08/80			0	378	1.5	6.7	160
	8-2	04/01/80			0	370	8.0	6.8	160
	9	01/30/80			0	338	4.5	6.4	170
	10*	07/31/80	10	4.15	0	500	3.5	7.0	220
		10/29/80	10	5.41	0	580	2.5	7.2	260
		04/22/81	10	5.70	0	438	3.0	7.4	210
		07/08/81	10	4.50	0	510	5.0	7.5	260
T.1 S., R.1 E., Sec. 22	3*	07/31/80	6	1.22	0	310	4.5	6.4	140
		10/29/80	6	2.61	0	290	2.0	7.0	150
		07/08/81	6	1.29	0	320	3.0	6.7	150
T.1 S., R.1 E., Sec. 23	1*	08/12/80	8	3.16	0	360	9.0	7.0	150
		10/29/80	8	3.16	0	340	2.5	7.0	150
		04/22/81	8	3.93	0	345	2.0	6.8	160
		07/08/81	8	0.87	0	388	5.0	6.8	170
T.1 S., R.1 E., Sec. 24	1*	08/12/80	10	2.92	0	420	2.0	7.0	140
		10/29/80	10	3.50	0	340	1.0	7.2	160
		07/08/81	10	2.67	1	328	3.5	8.2	170
T.1 S., R.1 E., Sec. 27	2*	08/07/80	20	3.09	0	360	4.0	7.0	160
		11/06/80	20	5.81	0	380	4.5	7.0	180
		04/23/81	20	4.29	0	360	3.0	7.2	180
		07/09/81	20	2.96	0	350	2.0	7.4	180
T.1 S., R.1 E., Sec. 36	1*	07/30/80	14	5.08	0	340	4.5	7.3	160
		11/06/80	14	7.29	0	245	3.5	8.3	180
		04/23/81	14	7.11	0	390	2.0	7.4	180
		07/09/81	14	9.66	0	300	3.0	8.4	180
T.1 S., R.2 E., Sec. 19	2	01/17/80			0	350	6.0	6.8	170
	3	03/25/80	28		0	390	3.0	7.0	170
	4	03/25/80	30		0	343	6.0	7.0	
	5	03/25/80	14		0	500	8.0	7.0	210
	6	03/27/80	25		0	353	12.0	7.3	
	7	03/27/80	27		0	421	7.0	7.0	
	8	04/01/80			0	398	6.0	6.8	170
	9*	08/12/80	10	6.16	0	360	8.0	7.6	150
		10/30/80	10	6.50	0	410	4.0	7.2	170
		04/21/81	10	6.45	0	340	3.0	7.6	170
		07/07/81	10	6.08	0	338	5.0	7.6	180
T.1 S., R.2 E., Sec. 31	1*	07/30/80	10	5.14	0	430	3.5	7.0	180
		10/30/80	10	5.88	0	400	1.5	6.8	190
		04/21/81	10	6.18	0	390	2.0	7.2	190
		07/07/81	10	5.27	0	400	2.0	7.2	190
T.1 S., R.2 E., Sec. 33	1*	07/30/80	15	8.24	0	600	2.5	7.0	270
		10/30/80	15	8.79	0	700	1.5	6.8	340
		04/22/81	15	8.77	0	600	2.0	7.0	310
		07/14/81	15	8.11	0	562	1.5	7.0	320
T.2 S., R.2 E., Sec. 6	3*	08/07/80	19	5.58	0	320	4.0	7.2	140
		11/06/80	19	6.39	0	430	3.5	7.4	160
		04/28/81	19	5.56	0	280	4.0	7.4	160
		07/09/81	19	5.47	0	300	3.0	7.3	160
	4*	08/07/80	19	6.53	0	410	1.5	7.2	200
		11/07/80	19	5.93	0	410	0.5	7.2	210
		04/23/81	19	4.64	0	400	1.0	7.3	210
		07/09/81	19	6.84	0	400	1.0	7.2	290
T.2 S., R.2 E., Sec. 9	4*	07/30/80	17	8.76	0	420	3.0	7.0	180
		10/30/80	17	9.30	0	380	1.5	7.1	180
		04/28/81	17	9.18	0	375	1.5	7.3	180
		07/14/81	17	8.52	0	375	2.0	7.4	180

Alkalinity (as $CaCO_3$) (mg/L)	Dissolved sulfate (mg/L)	Dissolved chloride (mg/L)	Dissolved nitrate ($NO_2 + NO_3$) as N (mg/L)	Total nitrate ($NO_2 + NO_3$) as N (mg/L)	Total ammonia as NH_4 (mg/L)	Dissolved phosphorus as P (mg/L)	Total phosphorus (ortho) as P (mg/L)	Total arsenic (µg/L)	Total iron (mg/L)
215	0.5	35.0		0.00	0.45		0.00	6.0	8.1
210	0.4	26.0		0.00	0.31		0.00	10.0	5.9
243	0.5	24.0		0.00	0.28		0.00	9.0	7.7
169	4.0	20.0		0.00	0.47		0.10	5.0	7.1
169	3.7	19.0		0.00	0.44		0.10	7.0	8.1
157	18.0	5.2		0.01	0.40		0.28	13.0	13.1
134	17.0	1.2		0.00	0.24		0.07	2.0	4.2
197	2.8	34.0		0.00	0.62		0.12	11.0	10.0
139	17.0	5.4		0.00	0.32		0.13	2.0	3.2
134	14.0	2.3		0.02	0.39		0.13	3.0	4.2
154	14.0	10.0		0.00	0.39		0.14	6.0	4.3
162	10.0	30.0		0.01	1.0		0.10	5.0	7.7
159	2.4	3.7		0.00	0.16		0.12	6.0	
153	8.4	1.7	0.09			0.09		10.0	8.8
157								11.0	9.0
141	13.0	1.4		0.00	0.33		0.09	13.0	8.6
148	15.0	1.8		0.01	0.23		0.10	12.0	9.0
197	4.4	1.1	0.03			0.23		24.0	31.0
251			0.00					27.0	53.0
207	15.0	1.5		0.54	0.08		0.10	44.0	56.0
412	0.7			0.00	0.02		0.00	7.0	
369	0.5	19.0		0.00	0.31		0.00	2.0	12.0
143	12.0	9.1	0.01			0.03		23.0	24.0
138								16.0	9.8
141	13.0	9.3		0.00	0.27		0.03	18.0	10.0
141	12.0	11.0		0.01	0.26		0.00	16.0	9.7
139	12.0	1.7	0.01			0.10		7.0	8.8
172	20.0	4.6	0.19			0.03		9.0	6.4
180								9.0	6.8
157	21.0	4.4		0.00	0.25		0.05	8.0	5.1
159	33.0	4.4		0.02	0.23		0.03	10.0	5.7
156	24.0	3.5	0.70			0.07		4.0	
148	26.0	3.1	0.21			0.05		3.0	0.55
148	23.0	3.5	0.01			0.04		7.0	1.6
164	22.0	6.7	0.70			0.02		2.0	1.3
254	9.8	22.0	0.08			0.00		3.0	8.0
164	23.0	15.0	0.03			0.01		7.0	4.4
205	14.0	9.7	0.59			0.01		4.0	6.7
180	23.0	5.1	0.17			0.02		7.0	0.74
156	22.0	4.7	0.36			0.02		3.0	0.38
164	22.0	5.2	0.04			0.01		6.0	
244	7.2	2.6	0.07			0.08		8.0	9.6
320								10.0	8.6
221	2.0	1.8		0.01	0.86		0.01	10.0	6.3
259	2.4	2.7		0.09	1.1		0.00	8.0	9.5
156	4.8	1.1	0.61			0.03		7.0	4.6
154								12.0	5.6
159	7.5	2.1		0.00	0.07		0.00	9.0	5.4
180	8.3	1.2	0.00			0.01		6.0	3.8
166								6.0	4.4
167	3.9	1.1		0.01	0.12		0.00	7.0	4.2
195	7.1	1.3		0.00	0.13		0.00	5.0	3.5
164								8.0	17.0
190								10.0	15.0
166	13.0	9.0		0.01	0.28		0.00	6.0	12.0
156	21.0	1.1	0.04			0.01		3.0	0.52
174								11.0	14.0
175	22.0	0.9		0.18	0.11		0.01	7.0	2.6
172	20.0	1.2		0.13	0.03		0.00	3.0	0.39
156	26.0	2.6	0.07			0.03		7.0	6.3
111			0.00					10.0	15.0
164	25.0	2.1		0.01	0.10		0.02	5.0	4.8
139	29.0	2.4		0.02	0.09		0.00	4.0	2.1
172	11.0	2.2	0.04			0.03		12.0	4.8
180	12.0	1.9	0.28			0.01		1.0	0.20
172	5.0	2.6	0.06			0.01		5.0	
238	7.7	5.9	0.08			0.01		4.0	0.46
172	11.0	2.1	2.0			0.01		1.0	
200	5.6	4.3	1.5			0.01		0.0	
197	4.6	5.4	0.02			0.03		5.0	2.1
165	1.3	1.8	0.00			0.00		5.0	3.6
194								6.0	11.0
174	1.2	1.2		0.01	0.04		0.01	4.0	0.90
177	1.8	1.5		0.00	0.04		0.01	3.0	1.4
205	1.8	0.03	0.16			0.03		4.0	1.8
202								5.0	1.6
200	1.6			0.05	0.07		0.11	2.0	1.5
195	5.8			0.00	0.03		0.01	3.0	3.2
279	31.0	5.1	0.03			0.03		2.0	0.48
308								2.0	0.68
284	32.0	6.6		0.01	0.08		0.00	2.0	1.0
259	39.0	5.1		0.01	0.07		0.03	2.0	3.2
115	30.0	1.5	0.25			0.00		8.0	3.2
143								13.0	4.1
130	33.0	1.0		0.14	0.08		0.01	1.0	0.80
127	36.0	1.4		0.02	0.07		0.00	8.0	1.6
197	0.9	1.1	0.26			0.01		22.0	57
216								3.0	0.89
202	1.1	0.7		0.01	0.09		0.04	1.0	0.07
180	2.7	1.7		0.00	0.11		0.00	10.0	73
177	29.0	4.9	2.1			0.01		10.0	4.7
164								11.0	3.7
157	31.0	2.8		0.00	0.21		0.00	5.0	2.6
162	37.0	3.5		0.00	0.13		0.03	7.0	2.2

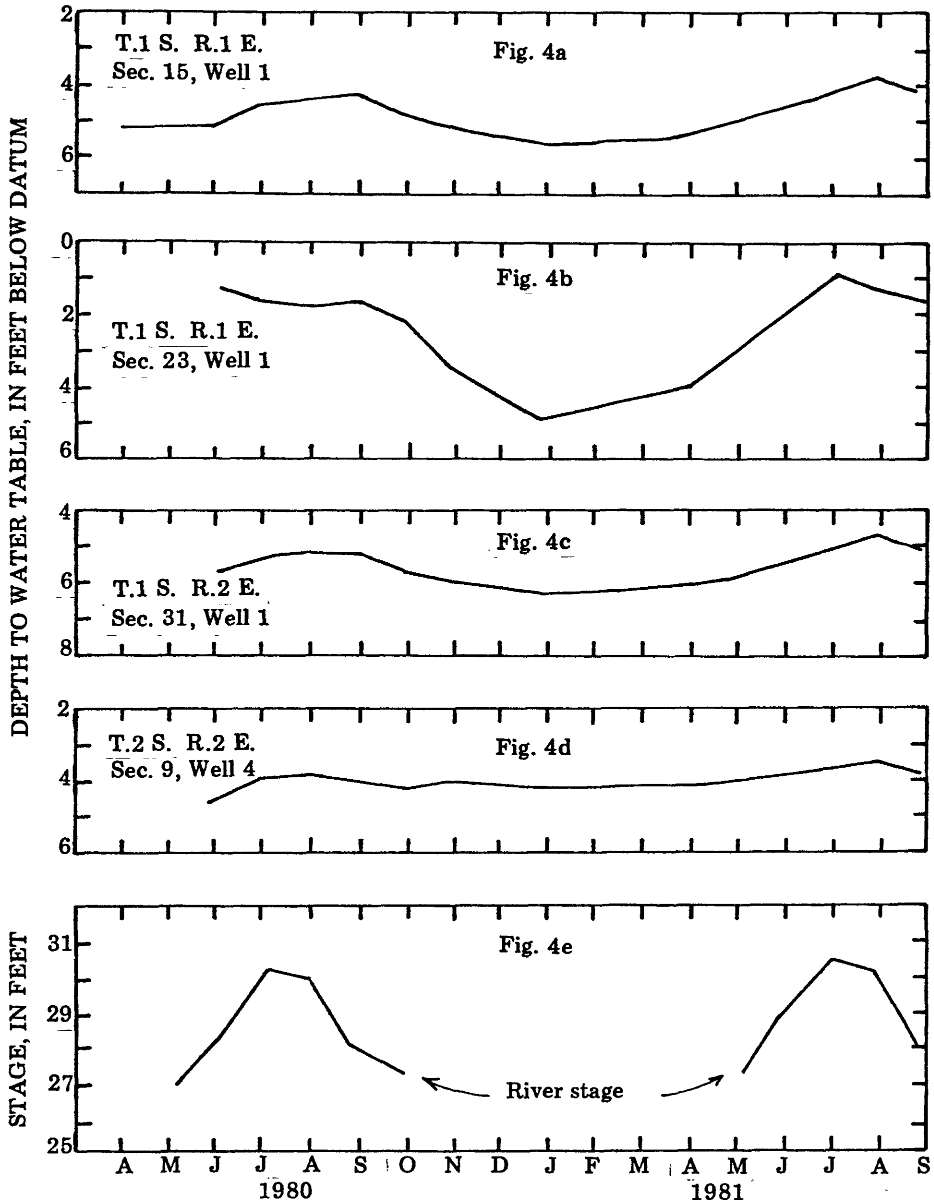


Figure 4.--Hydrographs showing synchronous fluctuations of the water table and the stage of the Tanana River. River is frozen from October to May. (See figure 5 for well locations.)

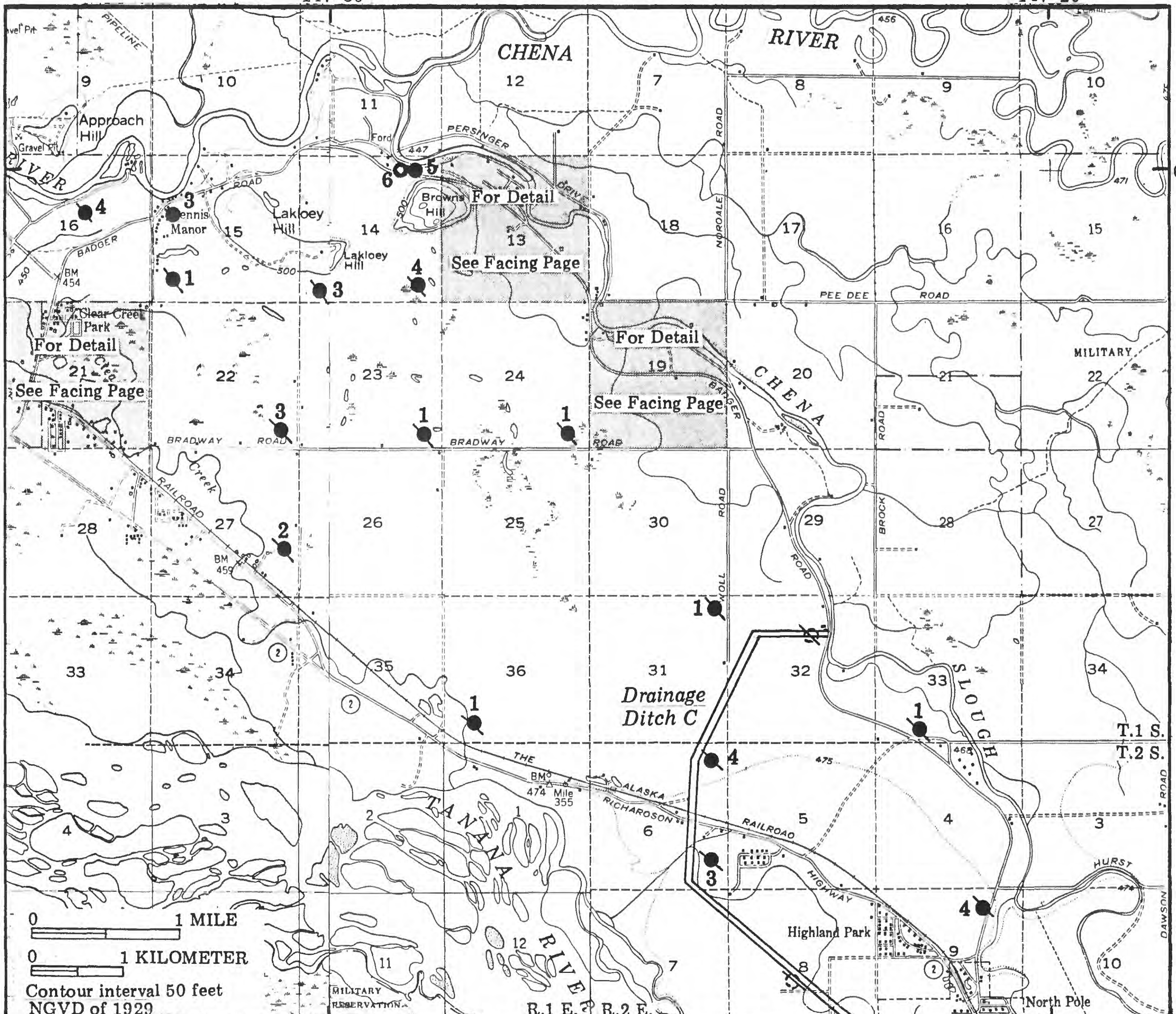
Septic-tank effluents travel in the direction of ground-water flow. Therefore, a private well located upgradient (southeast) from a septic system has little chance of becoming contaminated from that system. Properly constructed wells that withdraw water from depths greater than 100 ft below the water table are also less likely to be contaminated than are shallow wells. However, no water samples have been collected from deep wells, and the quality of water from deep parts of the aquifer is unknown.

Nitrate, chloride, phosphorus, and, to a lesser extent, ammonia and sulfate are commonly considered to be "contamination indicators" because they are present in septic-tank effluent. If ground-water samples from a residential area contain these constituents in concentrations greater than the normal range of concentrations for the aquifer, then septic-system effluent is a possible cause of the degradation of ground-water quality. The mean concentrations and standard deviations of the contamination indicators were compared using a two-population "t" test to determine whether the concentration of any constituent is significantly greater in domestic wells than in observation wells. At the 5 percent confidence level the concentrations of dissolved nitrite + nitrate, total nitrite + nitrate, dissolved orthophosphate, and dissolved sulfate in domestic wells were not significantly different from the same concentrations in observation wells. However, there are statistically significant differences in concentrations of dissolved ammonia, dissolved chloride, and total phosphate in domestic-well samples compared to the same concentrations in observation wells (table 3). The higher concentrations of all three constituents are in the domestic wells in developed areas rather than the observation wells in undeveloped areas. Wells that yield water containing more than 10 mg/L of chloride are shown on figure 5. Whether or not these higher chloride concentrations are significant precursors to contamination problems can only be determined by future monitoring to determine the temporal trends of concentrations. The present concentrations of all contamination indicators except fecal coliform do not exceed the drinking-water standards (U.S. Environmental Protection Agency, 1976).

Table 3. -- Comparison of mean values of contamination indicators between domestic wells (developed areas) and observation wells (undeveloped areas).

Constituent	Total number of samples	Range of values (mg/L)	Mean values (mg/L): Domestic wells	Mean values (mg/L): Observation wells	t test: Degrees of freedom	t test: t value
Dissolved ammonia	31	.02-1.1	0.387	0.187	29	2.48
Dissolved chloride	48	.03-35.	10.61	3.00	46	2.88
Total phosphorous	31	0.00-0.28	0.086	0.025	29	2.88

Concentrations of iron consistently exceed the drinking-water limit of 0.3 mg/L. Water from most wells causes iron staining on plumbing fixtures and has an unpleasant taste and (or) odor. Hardness of ground water in samples taken from the Badger Road area ranged from 110 to 340 mg/L. Water having less than 100 mg/L of hardness is generally acceptable for domestic use. At concentrations greater than 200 mg/L, homeowners commonly soften the water using a domestic water softener.



Base from U.S. Geological Survey, Fairbanks, Alaska, 1:63,360, 1955

Figure 5---See facing page.

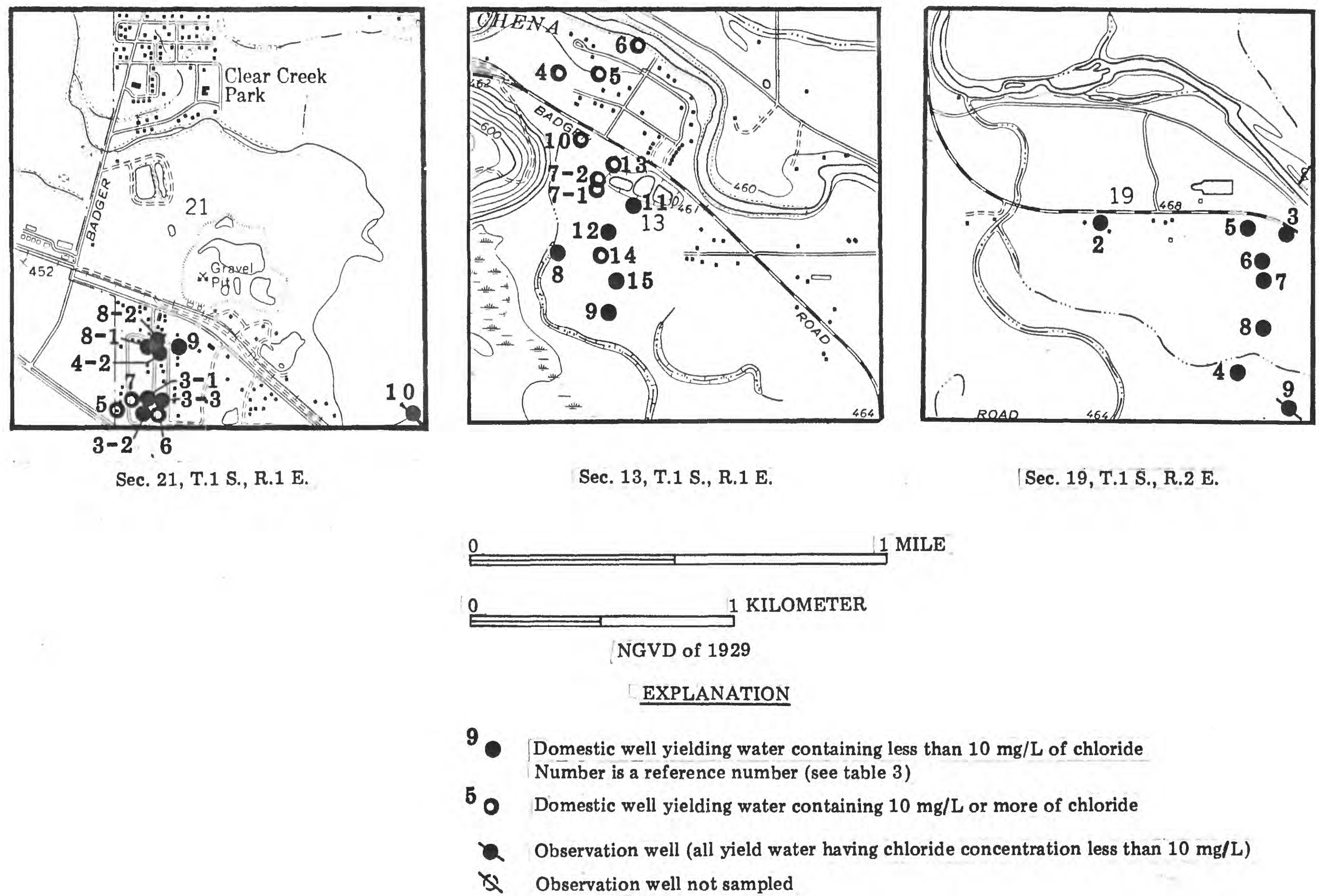


Figure 5.--Locations of wells. Wells are differentiated on the basis of chloride concentration.

Specific conductance ranged from 245 to 700 µmho/cm, and pH ranged from to 6.4 to 8.4 units. These value ranges indicate moderately hard water within a pH range that does not cause the water to be very corrosive. Table 2 lists values for all samples collected as part of the study, and locations of the sampled wells are shown in figure 5.

SUMMARY

The following is a summary of hydrologic conditions in the Badger Road as interpreted from data collected during the 1980-81 study period.

1. The water table slopes northwesterly at approximately 4 ft/mi.
2. Ground water generally flows in a northwesterly direction.
3. The depth to water in wells ranged from less than 1 ft to 16 ft.
4. Fluctuations of the water table are caused by changing stage in the Tanana River. The difference between the highest and lowest water levels measured in the 18 observation wells averaged 2 ft.
5. The presence of fecal coliform bacteria was noted in 3 of 49 wells. Only one of the samples exceeded the Alaska Department of Environmental Conservation recommended limit of 1 FC/100 mL.
6. In samples analyzed for iron, hardness, arsenic, nitrate, chloride, phosphorus, and sulfate, only iron was found in concentrations exceeding Environmental Protection Agency maximum recommended limits for domestic water supplies. However, values for contamination indicators, such as ammonia and chloride, were higher in domestic wells (developed areas) than in observation wells (undeveloped areas).

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