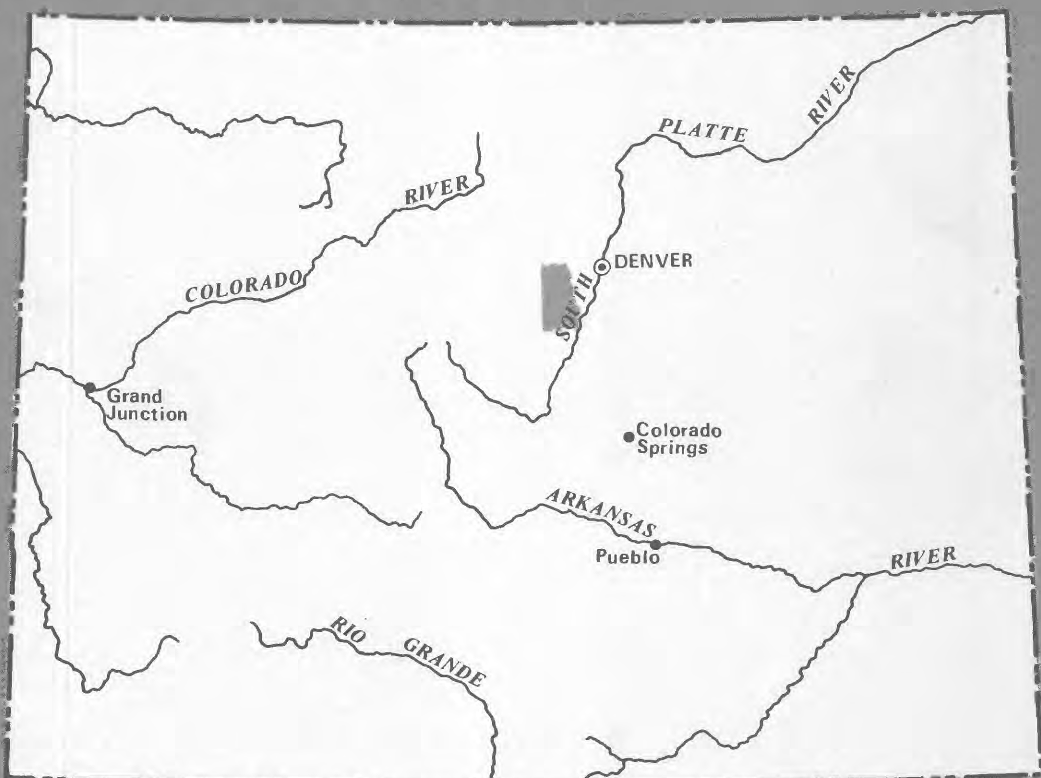
DRINKING-WATER QUALITY AND VARIATIONS IN WATER LEVELS IN THE FRACTURED CRYSTALLINE-ROCK AQUIFER, WEST-CENTRAL JEFFERSON COUNTY, COLORADO

U.S. GEOLOGICAL SURVEY



Water Resources Investigations 79-94

Prepared in cooperation with the
Jefferson County Health Department

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In parts of the area, water for domestic use obtained from the fractured crystalline-rock aquifer contained excessive concentrations of dissolved fluoride, dissolved nitrite plus nitrate, dissolved solids, dissolved iron, dissolved manganese, dissolved zinc, coliform bacteria, gross alpha radiation, and gross beta radiation. Based on water-quality analyses from 26 wells located in small urbanized areas, water from 21 of the wells contained excessive concentrations of one or more constituents.

Water from 11 wells contained concentrations of gross alpha radiation in excess of 15 picocuries per liter, and was estimated to have exceeded the limit in 4 additional wells. Gross beta radiation was estimated to have exceeded 50 picocuries per liter in water from one well.

Local variations in concentrations of 15 chemical constituents, specific conductance, and water temperature were statistically significant. Specific conductance increased significantly only in the vicinity of Indian Hills during 1973-75.

Depths to water in 11 non-pumping wells ranged from 1 to 15 feet annually. The shallowest water levels were recorded in late winter, usually in February. The deepest water levels occurred during the summer and fall. Three-year trends in water-level changes in 6 of the 11 wells indicated a decrease in stored water in the aquifer.

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September 1979

UNITED STATES DEPARTMENT OF THE INTERIOR

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METRIC CONVERSION FACTORS

For those who prefer metric units rather than inch-pound units, conversion factors for units used in this report are listed below:

Multiply inch-pound unit	*By*	*To obtain metric unit*
inch	25.40	millimeter
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
gallon per minute (gal/min)	0.06308	liter per second
mile (mi)	1.609	kilometer

RADIATION UNITS

millirem (mrem).--The quantity of absorbed ionizing radiation that has the same biological effect as 0.001 roentgen of high-voltage X-ray radiation.

picocurie (pCi).--The unit of radioactivity equal to 2.22 disintegrations per minute of any radioactive nuclide.

dose equivalent.--The product of the absorbed dose from ionizing radiation and factors related to biological effectiveness due to type of radiation and its distribution in the body. The units are expressed in rems.

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Carl J. Johnson, Jefferson County Health Department

ABSTRACT

In parts of the area, water for domestic use obtained from the fractured crystalline-rock aquifer contained excessive concentrations of major chemicals, coliform bacteria, trace elements, or radiochemicals. Based on water-quality analyses from 26 wells located in small urbanized areas, water from 21 of the wells contained excessive concentrations of one or more constituents.

The mandatory drinking-water standard of 2 milligrams per liter for dissolved fluoride was exceeded in water from two wells; the maximum concentration was 3.9 milligrams per liter. Two wells yielded water containing dissolved nitrite plus nitrate in concentrations greater than the mandatory drinking-water standard of 10 milligrams per liter as nitrogen; the maximum concentration was 18 milligrams per liter. Dissolved solids exceeded the recommended drinking-water standard of 500 milligrams per liter in water from one well. The recommended drinking-water standard of 300 micrograms per liter for dissolved iron was exceeded in water from six wells and the recommended drinking-water standard of 50 micrograms per liter for dissolved manganese was exceeded in water from eight wells. Two wells yielded water containing dissolved zinc in concentrations greater than the recommended drinking-water standard of 5,000 micrograms per liter.

Concentrations of coliform bacteria exceeded 1 per 100 milliliters in water from four wells. The maximum concentration of coliform bacteria was 42 per 100 milliliters of water.

Water from 11 wells contained concentrations of gross alpha radiation in excess of 15 picocuries per liter; gross alpha radiation in water from 4 additional wells was estimated to have exceeded 15 picocuries per liter. Gross beta radiation was estimated to have exceeded 50 picocuries per liter in water from one well. Water from one well contained excessive concentrations of both gross alpha and gross beta radiation.

Local variations in concentrations of 15 chemical constituents, specific conductance, and water temperature were statistically significant. Specific conductance increased significantly during 1973-75 only in the vicinity of Indian Hills.

Depths to water in 11 wells equipped with temporary pumps ranged from 1 to 15 feet annually. The shallowest water levels were recorded in late winter, usually in February. The deepest water levels occurred during the summer and fall, but the month varied from year to year for a given well and differed between wells. Three-year trends in water-level changes in 6 of the 11 wells indicated a decrease in stored water in the aquifer.

INTRODUCTION

Increasing residential development and the resulting increase in the number of wells drilled for domestic water supplies and in the number of individual waste-treatment systems installed to dispose of domestic wastes is causing significant changes in the hydrology of the fractured crystalline-rock aquifer in west-central Jefferson County (fig. 1). In 1971, the U.S. Geological Survey began a 6-year, two-phase investigation of west-central Jefferson County to determine the effects of the increased development on the quality and quantity of water in the fractured crystalline-rock aquifer.

The first phase of the investigation, done in cooperation with the Jefferson County Planning Commission and the Colorado Geological Survey, was conducted to determine water availability, general water quality, and factors controlling water quality. Results of the first phase of the investigation (Hofstra and Hall, 1975*a* and 1975*b*) showed that disposal of domestic wastes is causing degradation of ground-water quality and that radiochemicals in the water may be a health hazard.

In 1975, the U.S. Geological Survey, in cooperation with the Jefferson County Health Department, began the second phase of the investigation. The objectives of this phase of the investigation were to determine: (1) The chemical and bacterial quality of water in the fractured crystalline-rock aquifer, (2) concentrations of trace elements and radiochemicals in ground water, (3) seasonal variations in ground-water quality, (4) the presence or absence of degradation in chemical quality during a 2-year period in extensively developed areas, (5) the pattern and extent of fluctuation in water levels, (6) the effects on water quality of residential wastewater-treatment systems, and (7) the similarities and differences of various types of residential wastewater-treatment systems. This report presents results of all aspects of the second phase of the investigation with the exception of the results pertaining to residential wastewater-treatment systems, which will be presented in a subsequent report.

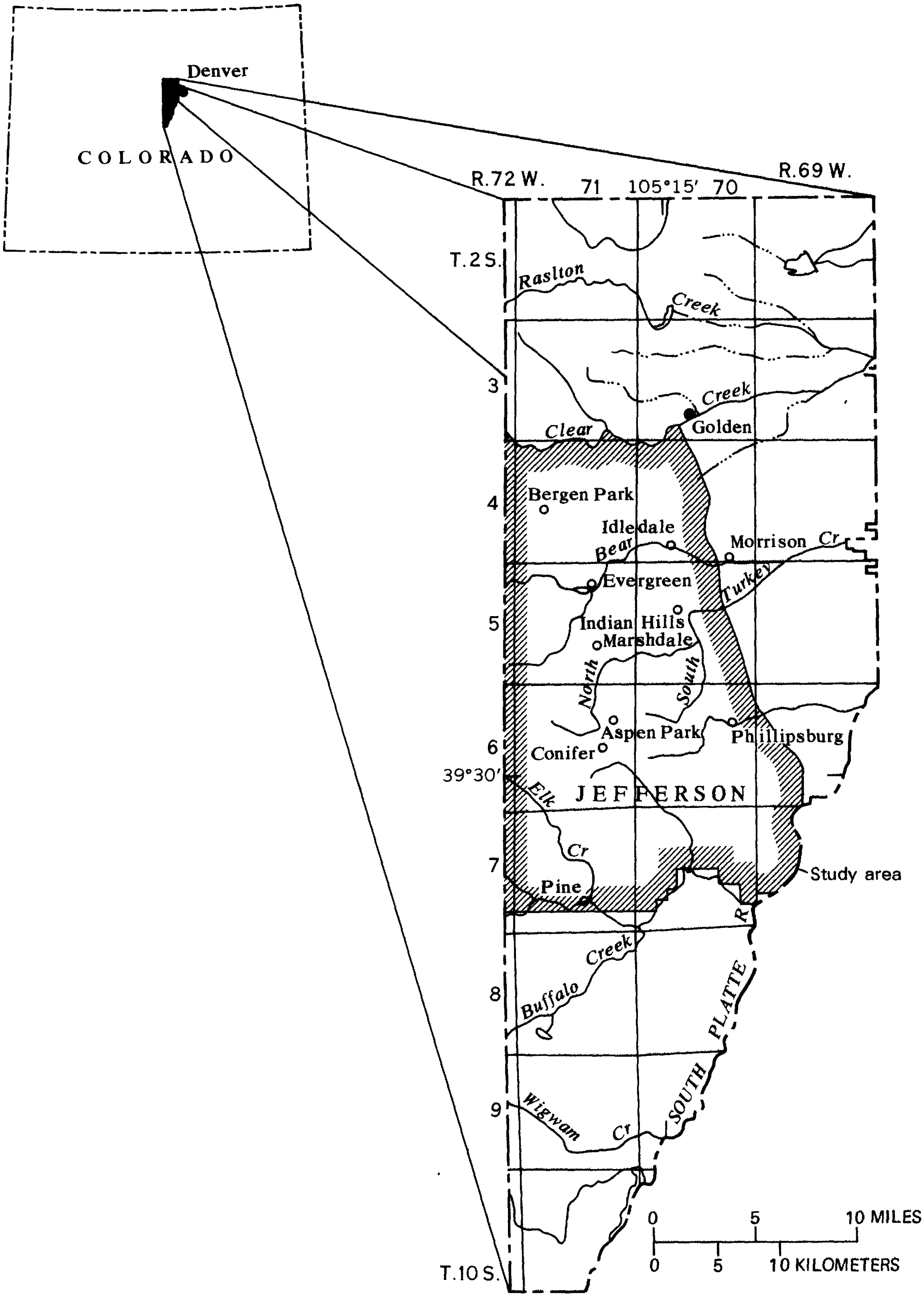

Figure 1.--Location of study area.

Approach

Data for this investigation were collected from 173 wells, most of which are located in the central part of the study area between Evergreen and Conifer (fig. 1). Eleven of these wells are owned by the U.S. Government and were drilled only for the purposes of collecting samples for water-quality analyses and obtaining water-level measurements; the rest of the wells are privately owned.

To determine the general chemical and bacterial quality and concentrations of trace elements and radiochemicals in the water, samples for chemical, bacterial, and radiochemical analyses were collected at 26 wells--the 11 governmentally owned wells and 15 privately owned wells (fig. 2). The 11 governmentally owned wells were sampled three additional times to determine the seasonal variation in water quality. The wells were arbitrarily numbered and these numbers (fig. 2) are used in this report when referring to the wells. The governmentally owned wells have consecutive numbers from 1 through 11 and the 15 privately owned wells have numbers between 100 and 500.

Water-quality determinations were made using methods described in reports by Brown and others (1970), Goerlitz and Brown (1972), Slack and others (1973), Wood (1976), and the American Public Health Association (1975). Measurements of specific conductance and water temperature were made at the well sites, bacterial determinations were made in field-laboratory vehicles, detergent concentrations were determined at the laboratory of the Jefferson County Health Department, and all remaining analyses were done at laboratories of the U.S. Geological Survey. The results of the analyses were compared with mandatory (primary) standards established by the Colorado Department of Health (1977) for constituents in domestic water supplies obtained from ground water and with recommended (secondary) standards established by the U.S. Environmental Protection Agency (1977) for constituents in public water supplies to determine the suitability of the water for drinking.

Specific conductance was measured during the summers of 1973 and 1975 at the 11 governmentally owned wells and at 147 additional wells, all located within 0.25 mi of the governmentally owned wells. The specific-conductance data were analyzed statistically to determine if the general water quality had deteriorated during the 2-year interval.

Water levels were measured monthly in the 11 governmentally owned wells for 34 months during 1973-76 to determine seasonal variations and annual trends. Additional water-level measurements were made in February 1977 at 8 of the 11 wells.

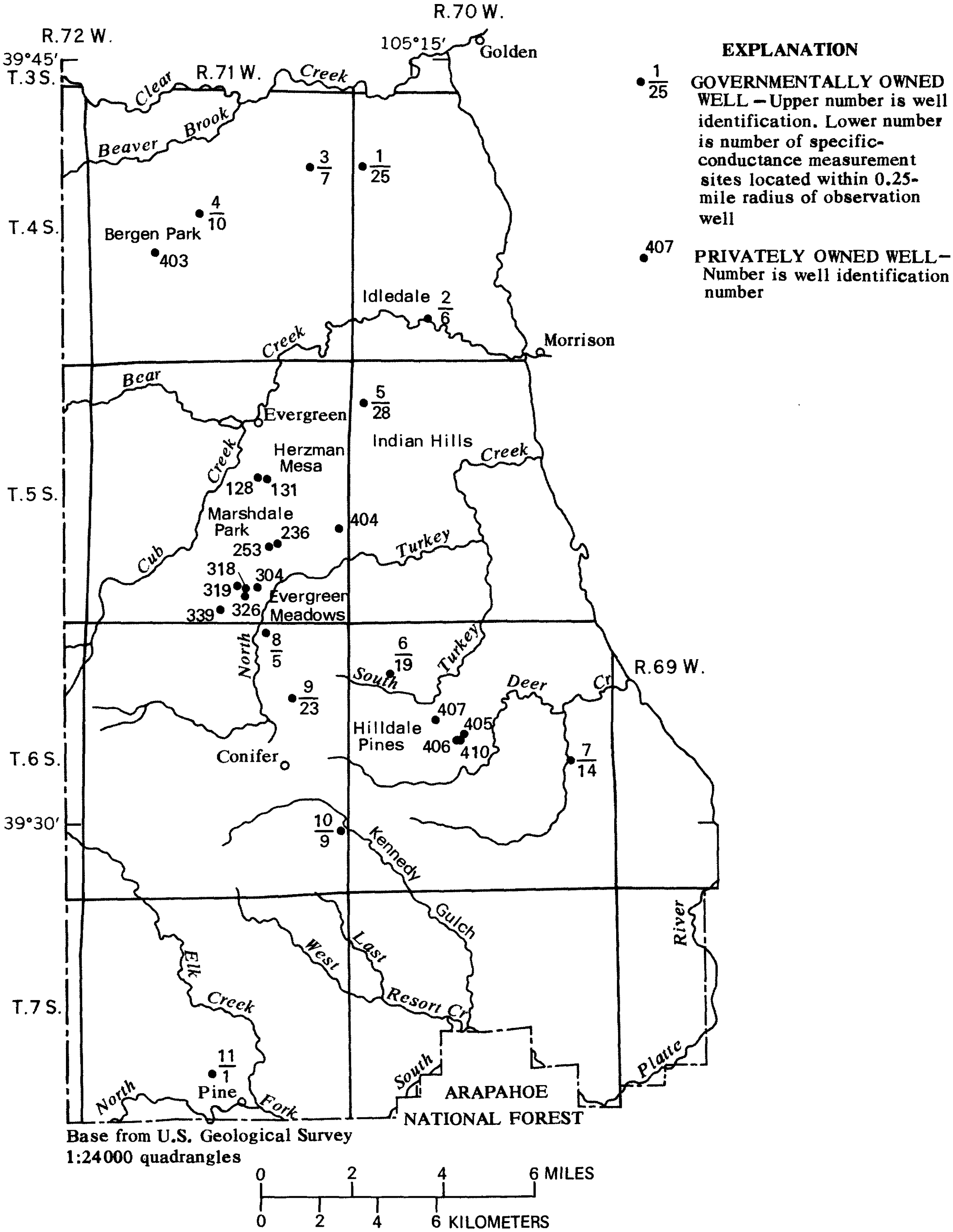

Figure 2.--Location of wells where samples for water-quality analyses were collected.

Acknowledgments

Appreciation is extended to personnel of the Jefferson County Health Department who assisted throughout this investigation. Particularly involved with the planning, sampling, and analytical phases of the investigation were Daniel Tipton, Richard Bell, William Dorrance, and Edward Nickum. Appreciation also is extended to the landowners who permitted the collection of water samples from their wells and the installation of observation wells on their property.

DRINKING-WATER QUALITY

General Indicators

Concentrations of dissolved solids, dissolved magnesium, dissolved sulfate, dissolved fluoride, dissolved chloride, dissolved nitrite plus nitrate, and detergents, and the presence of coliform and fecal-coliform bacteria were used as general indicators of drinking-water quality. Results of the analyses made during the investigation for these indicators are summarized in table 1.

Dissolved Solids

Concentrations of dissolved solids greater than 500 mg/L (milligrams per liter) may impart an unpleasant taste to the water and may not quench thirst as well as water containing concentrations less than 500 mg/L (McKee and Wolf, 1971). Water from well 2 (fig. 2) contained dissolved solids in excess of the recommended standard of 500 mg/L. As concentrations of dissolved solids increase, concentrations of constituents such as chloride, magnesium, and sulfate generally increase. Concentrations of constituents such as fluoride and nitrite plus nitrate, detergents, and bacteria are not well correlated with dissolved-solids concentrations. Concentrations of these constituents may or may not increase as dissolved solids increase.

Magnesium

Excessive concentrations of magnesium may have a laxative effect on new users of the water and may impart an unpleasant taste to the water (McKee and Wolf, 1971). No wells yielded water containing magnesium in excess of the former recommended standard of 125 mg/L.

Sulfate

Excessive concentrations of sulfate may have a laxative effect on new users of the water and may impart an unpleasant taste to the water (McKee and Wolf, 1971). No wells yielded water containing sulfate in excess of the recommended standard of 250 mg/L.

Table 1.--*Concentrations of general water-quality indicators in water from 26 wells completed in the fractured crystalline-rock aquifer*

Indicator	Chemical concentrations, in milligrams per liter; bacterial concentrations, in number of bacteria per 100 milliliters of water				Number of wells where water contained constituents in excess of indicated standard
	Minimum	Mean[1]	Maximum	Standard[2]	
Dissolved solids----------	103	195.1	528	[3]500	1
Magnesium----------------	2.2	8.4	33	[4]125	0
Sulfate------------------	2.3	16.6	90	[3]250	0
Fluoride-----------------	.1	.66	3.9	[5]2.0	2
Chloride-----------------	.8	9.9	47	[3]250	0
Nitrite plus nitrate as nitrogen.	.01	2.4	18	[5]10	2
Detergents[6]--------------	.0	.01	.4	[3].5	0
Coliform bacteria---------	0	1.0	42	([7])	[7]4
Fecal-coliform bacteria--	0	0	0	([7])	0

[1]Where more than one analysis for a substance was made, the average concentration was used in the calculation of the mean concentration.

[2]Water-quality standards for all indicators except bacteria are for total concentrations (dissolved plus suspended). Only dissolved concentrations were determined. Total concentrations may be equal to or greater than the dissolved concentrations. The U.S. Geological Survey considers all material passing through a 0.45-micrometer filter to be dissolved.

[3]Recommended standard of the U.S. Environmental Protection Agency (1977).

[4]Formerly a recommended standard of the Colorado Department of Health (1967).

[5]Mandatory standard of the Colorado Department of Health (1977). Standard for fluoride based on mean-annual maximum-daily air temperature at Evergreen, Colo.--61.0°F or 16.1°C (U.S. Weather Bureau, 1961-66; U.S. Environmental Data Service, 1966-73). Standard for nitrite plus nitrate based on standard for nitrate (10 mg/L as nitrogen).

[6]Methylene blue active substances (MBAS).

[7]No standard for bacteria in a single sample. However, because of potential health hazards, the presence of any bacteria, especially fecal-coliform bacteria, is considered to be a problem by public-health officials. Disinfection of the water supply is generally recommended or required.

Fluoride

While fluoride in drinking water may reduce the incidence of dental caries (cavities), excessive concentrations may cause mottling of teeth, especially in children (McKee and Wolf, 1971). The mandatory standard of 2.0 mg/L for drinking water is based on the air temperature at Evergreen and is related to the amount of water a person drinks. The assumption is that the warmer the climate, the more water a person would normally drink. Water from wells 5 and 11 (fig. 2) contained fluoride in excess of the mandatory standard of 2.0 mg/L.

Chloride and Nitrate

Both chloride and nitrate occur naturally in ground water in the study area, but natural concentrations are not large. Because of the composition of the aquifers and land use in the study area, significant concentrations of chloride and nitrate in ground water indicate contamination from human and animal wastes. Both chloride and nitrogen-containing compounds are concentrated in human and animal wastes. Chloride is chemically stable and generally remains in a soluble form in ground water. The nitrogen in the wastes is converted to nitrate in the presence of oxygen and certain bacteria. Infiltrating wastewater is considered a major source of nitrate in ground-water supplies (Goldberg, 1971).

In addition to being an indicator of contamination, concentrations of chloride exceeding the recommended standard of 250 mg/L for drinking water may impart a salty taste to the water (McKee and Wolf, 1971). No wells yielded water containing chloride in excess of the recommended standard. Concentrations of nitrate exceeding the mandatory standard of 10 mg/L for drinking water may cause methemoglobinemia (blue-baby disease) in newborn infants who drink the water or breast-fed babies whose mothers drink the water (McKee and Wolf, 1971). Although the mandatory standard of 10 mg/L (table 1) is for nitrate only, both nitrite and nitrate, reported as nitrite plus nitrate, were determined because both can cause the same health problems. Nitrite concentrations were determined for the complete analyses and generally were small compared with nitrate concentrations. Water from wells 2 and 4 contained more than 10 mg/L of nitrite plus nitrate as nitrogen. Concentrations equaling or exceeding 4 mg/L are an indication of probable contamination and signal the need for a more detailed investigation to determine the source and prevention of the contamination. Water from wells 1, 7, 9, and 253 (fig. 2) contained concentrations that equaled or exceeded 4 mg/L.

Detergents

The presence of detergents (methylene-blue active substances or MBAS) in ground water is a positive indication of contamination from domestic wastes as detergents do not occur naturally in water. Excessive concentrations of detergents may cause water to foam and impart an unpleasant taste to the water (McKee and Wolf, 1971). No wells yielded water containing detergents in excess of the recommended standard of 0.5 mg/L.

Bacteria

Two or more coliform bacteria per 100 mL (milliliters) were present in water from wells 2, 6, and 404 (fig. 2). The observed number of bacteria per 100 mL of water ranged from 0 to 42. While the presence of coliform bacteria does not necessarily indicate a health hazard, their presence is an indication of possible pollution and the possible presence of fecal-coliform bacteria and pathogenic viruses and other pathogenic organisms. No fecal-coliform bacteria occurred in water from the 26 wells sampled during this investigation. However, in a previous investigation of Jefferson County (Hofstra and Hall, 1975*b*), fecal-coliform bacteria occurred in water from 11 of 561 wells completed in the fractured crystalline-rock aquifer, and in Park County, fecal-coliform bacteria were found in water from 2 of 60 wells completed in the fractured crystalline-rock aquifer (Klein and others, 1978).

Trace Elements

During this investigation, concentrations of the following trace elements were determined: Aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, mercury, molybdenum, selenium, and zinc (table 2). While minor amounts of certain trace elements are required for good health, excessive amounts of any trace element may be a health hazard. For the purpose of this discussion, the trace elements are divided into two groups based on relative potential health hazard. The first group to be discussed is those trace elements that may occur in well water in concentrations that would constitute a health hazard (Colorado Department of Health, 1977). The second group to be discussed includes those trace elements for which the drinking-water standards (U.S. Environmental Protection Agency, 1977) are principally based on taste and esthetic considerations or have no standard established.

The range of concentrations determined during this investigation for the first group of trace elements, arsenic (0 to 1 μg/L, microgram per liter), barium (0 to 200 μg/L), cadmium (0 to 2 μg/L), lead (0 to 15 μg/L), mercury (0 to 0.4 μg/L), and selenium (2 to 4 μg/L), were all less than the mandatory standards for drinking water. Therefore, none of these trace elements constitute a health hazard in the well water that was sampled.

The range of concentrations determined during this investigation for the second group of trace elements, aluminum (0 to 30 μg/L), copper (0 to 180 μg/L), and molybdenum (0 to 58 μg/L) was either less than the recommended standards for drinking-water or was relatively insignificant for those trace elements for which standards have not been established. Therefore, these trace elements do not constitute either an esthetic or a health hazard in the well water that was sampled.

Table 2.--*Concentrations of dissolved trace elements in water from 26 wells completed in the fractured crystalline-rock aquifer*

Trace element	Concentrations, in micrograms per liter			Number of wells sampled	Standard[1], in micrograms per liter	Number of wells where water contained trace elements in excess of indicated standard
	Minimum	Mean	Maximum			
Aluminum-----	0	10.9	30	11	------	-
Arsenic------	0	.1	1	17	[2]50	0
Barium-------	0	40	200	23	[2]1,000	0
Cadmium------	0	.5	2	26	[2]10	0
Copper-------	0	19	180	16	[3]1,000	0
Iron---------	0	[4]320	8,600	26	[3]300	6
Lead---------	0	4.8	15	26	[2]50	0
Manganese----	0	[4]60	1,900	26	[3]50	8
Mercury------	.0	.05	.4	26	[2]2	0
Molybdenum---	0	8.1	58	16	------	-
Selenium-----	2	2.6	4	11	[2]10	0
Zinc---------	0	1,900	21,000	26	[3]5,000	2

[1]Water-quality standards are for total concentrations (dissolved plus suspended). Only dissolved concentrations were determined. Total concentrations may be equal to or greater than the dissolved concentrations. The U.S. Geological Survey considers all material passing through a 0.45-micrometer filter to be dissolved.

[2]Mandatory standard of Colorado Department of Health (1977).

[3]Recommended standard of U.S. Environmental Protection Agency (1977).

[4]Where more than one determination for an element was made for a well, the average value was used in the calculation of the mean concentrations.

Dissolved-iron concentrations ranged from 0 to 8,600 µg/L. Water from wells 2, 5, 6, 11, 253, and 304 (fig. 2) contained iron in excess of the recommended standard of 300 µg/L. Dissolved-manganese concentrations ranged from 0 to 1,900 µg/L. Water from wells 2, 4, 5, 6, 7, 11, 304, and 506 (fig. 2) contained manganese in excess of the recommended standard of 50 µg/L. Water from wells 2, 5, 6, 11, and 304 contained both iron and manganese in excess of the recommended standards.

As little as 120 µg/L of iron or 50 µg/L of manganese may impart a metallic taste to the water and to beverages, such as tea and coffee. Both iron and manganese tend to precipitate as hydroxides and will stain laundry and household porcelain fixtures. The maximum concentrations of both iron and manganese determined in this investigation are not considered to be a health hazard.

Dissolved-zinc concentrations ranged from 0 to 21,000 µg/L. Water from wells 405 and 406 (fig. 2) contained zinc in excess of the recommended standard of 5,000 µg/L. Concentrations greater than 5,000 µg/L will impart a metallic taste to the water, but the maximum concentrations determined in this investigation are not considered to be a health hazard. Excessive zinc concentrations may result from corrosion of galvanized plumbing parts (Klusman and Edwards, 1977). The governmentally owned wells installed for this investigation contained no galvanized metal parts; the largest zinc concentration in water from these wells was 60 µg/L.

Radiochemicals

Standards for radiochemical radiation in drinking water established by the Colorado Department of Health (1977) are summarized in table 3. Radiochemical analyses for the 11 governmentally owned wells are listed in table 4 and for the 15 privately owned wells in table 5.

Table 3.--*Standards for radiochemical radiation in drinking water*

[After Colorado Department of Health, 1977]

Type of radiation	Standard
Gross alpha particles (including radium-226 but excluding radon and uranium)[1].	15 pCi/L.
Radium-226 + radium-228[2]	5 pCi/L.
Gross beta particles + photons (from manmade radionuclides, excluding tritium and strontium-90)[3,4].	4 mrem per year to total body or internal organ.
Strontium-90	8 pCi/L.

[1]When gross alpha radiation exceeds 10 pCi/L in a water supply, it must be analyzed for radium-226.

[2]If the concentration of radium-226 exceeds 3 pCi/L in a water supply, it must be analyzed for radium-228.

[3]If two or more radionuclides are present, the sum of their annual dose-equivalent to the total body or to any internal organ shall not exceed 4 mrem per year. Dose-equivalents shall be based on an assumed drinking-water intake of 2 liters per day.

[4]If the gross beta radiation exceeds 50 pCi/L in a water supply, it must be analyzed to identify the major radioactive constituents and the appropriate body and internal organ dose-equivalents must be calculated.

Table 4.--*Radiochemical analyses of water from the 11 governmentally owned wells completed in the fractured crystalline-rock aquifer*

[pCi/L=picocurie per liter]

Well no.	Gross alpha radiation[1] (pCi/L as natural uranium)			Dissolved uranium (pCi/L)	Dissolved radium-226[2] (pCi/L)	Gross beta radiation[1] (pCi/L as cesium-137)			Dissolved potassium-40[2] (pCi/L)
	Total	Dissolved[3]	Suspended[3]			Total	Dissolved	Suspended	
1--	10	8	1.9	-------	0.4	9.7	7.3	2.4	3.3
2--	32	27	5.7	-------	.8	20	9.6	10	2.6
3--	<1.4	1.2	<.2	-------	---	3.6	3.2	.4	1.9
4--	12	8	4.1	-------	.1	9.8	4.6	5.2	2.5
5--	37	30	6.5	-------	.4	13.8	6.7	7.1	1.8
6--	5.8	4.6	1.2	-------	.8	5.0	3.0	2.0	2.9
[4]7--	128	46	82	-------	1.3	73	19	54	3.5
8--	<9	<.9	8	-------	---	10	1.5	8.5	1.3
9--	13	12	1.0	-------	.3	7.5	4.0	3.5	1.8
10--	26	10	16	-------	.1	19	4.5	14	1.6
11--	29	4.7	24	-------	.2	21	1.8	19	.8
Mean--	32.5	16.7	15.8	-------	0.5	17.5	5.9	11.5	2.2
Number of samples	9	9	9		9	11	11	11	11

[1]Samples collected in December 1973.
[2]Samples collected in May 1975.
[3]Values were converted from micrograms of natural uranium per liter to picocuries per liter by multiplying by 0.68 (Thatcher and others, 1977, p. 88).
[4]Dissolved strontium-90 less than 0.1 pCi/L in May 1975.

Table 5.--*Radiochemical analyses of water from the 15 privately owned wells completed in the fractured crystalline-rock aquifer*

[pCi/L=picocurie per liter]

Well no.	Gross alpha radiation (pCi/L as natural uranium)			Dis-solved uranium[1] (pCi/L)	Dis-solved radium-226 (pCi/L)	Gross beta radiation (pCi/L as cesium-137)			Dis-solved potas-sium-40 (pCi/L)
	Total	Dis-solved[1]	Sus-pended			Total	Dis-solved	Sus-pended	
128--	-----	60	------	----	---	-----	8.1	------	---
	-----	50	------	2.2	0.2	-----	13	------	0.8
131--	-----	12	------	----	---	-----	8.6	------	---
	-----	17	------	12	.4	-----	13	------	1.4
236--	-----	65	------	33	1.1	-----	9.3	------	1.0
253--	-----	19	------	19	.2	-----	5.4	------	.9
304--	-----	4.8	------	----	---	-----	3.2	------	---
	-----	4.4	------	.9	.1	-----	3.2	------	.7
318--	-----	68	------	20	.3	-----	13	------	.9
319--	-----	33	------	----	---	-----	5.5	------	---
	-----	33	------	12	.1	-----	10	------	.7
326--	-----	12	------	----	---	-----	5.6	------	---
	-----	8.8	------	4.4	.1	-----	5.6	------	.6
339--	-----	9.5	------	----	---	-----	4.9	------	---
	-----	8.2	------	3.3	.2	-----	2.4	------	.6
403--	-----	5.9	------	2.1	.1	-----	6.1	------	2.8
404--	-----	18	------	----	---	-----	3.6	------	1.7
405--	-----	65	------	12	.4	-----	7.8	------	.6
406--	-----	45	------	12	.9	-----	11	------	1.4
407--	-----	8.8	------	2.4	.1	-----	3.5	------	.6
410--	-----	143	------	58	.8	-----	28	------	1.0
Mean--	-----	33	------	15.2	0.4	-----	8.5	------	1.0
Number of samples		21		14	14		21		15

[1]Values were converted from micrograms of natural uranium per liter to picocuries per liter by multiplying by 0.68 (Thatcher and others, 1977, p. 88).

Radiation standards for drinking water do not provide absolute protection to individuals consuming the water; the standards are established to keep the increased health risks at an acceptable level. The health risks expected from concentrations of radiation less than the standards are small increases in rates of cancer incidence and genetic alterations. The standard of 15 pCi/L (picocuries per liter) for gross alpha radiation was established based on the amount of radiation that could be expected from radium-226. Radium-226, which occurs naturally, is concentrated in the body predominantly in bones and bone marrow.

Total gross alpha radiation (dissolved plus suspended) ranged from about 1.4 to 128 pCi/L in water from the 11 governmentally owned wells (table 4). Water from wells 2, 5, 7, 10, and 11 (fig. 2) contained gross alpha radiation concentrations in excess of 15 pCi/L (uncorrected for radon and uranium). The mean value for dissolved gross alpha radiation was 16.7 pCi/L and for suspended gross alpha radiation it was 15.8 pCi/L, a ratio of about 1:1.

Dissolved gross alpha radiation ranged from 4.4 to 143 pCi/L in water from 15 privately owned wells (table 5). Suspended gross alpha radiation was not determined, but could have been present in significant amounts if the same ratio (about 1:1) of dissolved to suspended gross alpha radiation applies as was determined for the 11 governmentally owned wells. Water from wells 128, 236, 318, 319, 405, 406, and 410 contained dissolved gross alpha radiation in excess of 15 pCi/L (excluding radon but subtracting dissolved uranium). Water from wells 131, 253, 404, and 407 may have contained gross alpha radiation in excess of the radiation limit if the unmeasured suspended gross alpha radiation were in proportion to the approximate 1:1 ratio mentioned above and if the radon and suspended uranium (and dissolved uranium in the case of well 404) concentrations were negligible.

Dissolved radium-226 radiation, a component of the dissolved gross alpha radiation, ranged from 0.1 to 1.3 pCi/L in water from 23 wells (tables 4 and 5). The radiation standard for radium-226, 5 pCi/L, also includes radiation from radium-228 (table 3), but the State regulations do not require radium-228 to be determined unless radium-226 radiation levels exceed 3 pCi/L. Because radiation from radium-228 was not determined during the study, it is not known if the standard of 5 pCi/L was exceeded. In most water supplies, however, the radiation of radium-226 exceeds the radiation of radium-228 (U.S. Environmental Protection Agency, 1976, p. 139). Therefore, it is unlikely that water from any of the 23 wells contained dissolved-radium radiation in excess of 5 pCi/L.

Total gross beta radiation as cesium-137 (dissolved and suspended) ranged from 3.6 to 73 pCi/L in water from the 11 governmentally owned wells (table 4). The mean value for dissolved gross beta radiation was 5.9 pCi/L and for suspended gross beta radiation it was 11.5 pCi/L, a ratio of about 1:2. Water from well 7 contained total gross beta radiation in excess of 50 pCi/L. If the ratio of dissolved to unmeasured suspended gross beta radiation was in the 1:2 proportion as observed in water from the governmentally owned wells, water from well 410 may also have gross beta radiation greater than 50 pCi/L.

The three most restrictive radionuclides that produce beta radiation are lead-210, radium-228, and strontium-90. Concentrations of lead-210 and radium-228 were not determined in this study, but need to be determined for any well in this area with excessive (more than 50 pCi/L) gross beta radiation, because municipal water supplies in the area may have as much as 3.9 pCi/L of lead-210 in finished water (North Table Mountain Water District, Golden, Colo., written commun., 1978).

Strontium-90 is a manmade beta-particle-emitting radioisotope and, therefore, should not be found in the ground water in the study area. One analysis was made for strontium-90 (well 7) and, as expected, the strontium-90 radiation was less than 0.1 pCi/L. Potassium-40, another beta-particle-emitting radioisotope was determined by calculation from potassium concentrations. The radiation from potassium-40 was calculated to have ranged from 0.6 to 3.5 pCi/L. Such concentrations are insignificant as a radiation hazard in water supplies.

Although it is unlikely to occur in the water supplies sampled, 15 pCi/L of gross alpha radiation could result in a dose equivalent to the consumer of as much as 8 mrem/yr (millirem per year)--twice the allowable dose assuming the gross alpha radiation to be due to uranium (National Research Council, 1977, p. 867). This would result in an annual estimated increased risk of death of 4 chances in 1 million from leukemia, bone cancer, and soft-tissue cancers (conservative estimate, U.S. Environmental Protection Agency, 1977, p. 132). Moreover, for all generations, a somewhat higher rate of birth defects and ill health related to chromosomal abnormalities could be expected. Water from well 7 had more than eight times the 15-pCi/L limit for dissolved gross alpha radioactivity alone (without correction for radon or suspended uranium), and had more than the 50-pCi/L limit for gross beta radioactivity. The gross alpha activity alone could represent a dosage of as much as 102 mrem/yr to persons consuming the water. While this is less than background radiation, it could result in an annual estimated increased risk of death of 51 chances in 1 million per year, and a similar excess of birth defects expressed over several generations. In addition, persons using water with this much radioactivity would experience a similar increase (about 50 per 1 million per year) of nonfatal cancers, and a somewhat larger increase in ill health related to changes in the mutation rate (National Academy of Sciences and National Academy of Engineering, 1972).

Based on the data available, the presence of particulates (suspended matter) in the water can more than double the gross alpha and gross beta radiation. Because particulates are commonly present in the water, especially during the spring, installation of a filter located in the water-supply system before it enters the home would remove the particulates and decrease the amount of radiation in the water being consumed.

Areal Distribution of Excessive Constituent Concentrations in Water Used for Drinking

Water from 7 of the 11 governmentally owned wells and from 14 of the 15 privately owned wells contained excessive concentrations of major chemicals, bacteria, trace elements, or radiation (table 6). Wells that yielded water containing excessive concentrations of dissolved solids, dissolved fluoride, or dissolved nitrite plus nitrate are located either in the northern one-fourth or along the southern edge of the study area (fig. 3).

Wells that yielded water containing excessive concentrations of coliform bacteria are generally located in the central part of the study area (fig. 4). However, coliform bacteria in ground water generally do not travel far before they die (Romero, 1970) and, therefore, their presence represents local contamination rather than widespread contamination (Hofstra and Hall, 1975a).

Wells that yielded water containing excessive concentrations of iron, manganese, or zinc are located throughout the study area (fig. 5). As discussed earlier, excessive zinc concentrations may be the result of corrosion of galvanized plumbing. However, eliminating well 405 (fig. 5) does not change the areal distribution of wells that yielded water containing excessive concentrations of trace elements.

Wells that yielded water containing excessive gross alpha radiation are located south of Bear Creek (fig. 6). Wells that yielded water containing excessive gross beta radiation are located in the southeastern part of the study area (fig. 6).

WATER-QUALITY VARIATIONS

Local Variations

Because environmental conditions such as geology, hydrology, and land use vary for each well site, the quality of water from all wells would not be expected to be the same. The data in tables 1, 2, 4, 5, 7, and 8 and in the Water-Quality Data section (tables 9, 10, and 11) indicate that there is considerable variation in water quality between different wells. For example, the nitrite plus nitrate as nitrogen concentrations in December 1973 ranged from 0.03 to 18 mg/L for the 11 governmentally owned wells (table 7). The mean value (table 8) was 4.37 mg/L. Although nitrite plus nitrate concentrations may be increased by effluent from leach fields, variation also is evident for constituents of the water such as silica, hardness, and radiochemical concentrations that are not likely to be influenced by man's activities but instead may be controlled by variations in mineralogy for the fractured crystalline-rock aquifer. Concentrations of trace elements also vary considerably between wells.

Table 6.--*Wells where water contained excessive concentrations of major chemicals, bacteria, trace elements, and radiochemicals*

[e=estimated]

Well no.	Major chemicals: Dissolved solids	Major chemicals: Dissolved fluoride	Major chemicals: Dissolved nitrite plus nitrate	Bacteria: Coliform bacteria	Trace elements: Dissolved iron	Trace elements: Dissolved manganese	Trace elements: Dissolved zinc	Radiochemicals: Total gross-alpha radiation	Radiochemicals: Total gross-beta radiation
GOVERNMENTALLY OWNED WELLS									
1	---	---	---	---	---	---	---	---	---
2	X	---	X	X	X	X	---	X	---
3	---	---	---	---	---	---	---	---	---
4	---	---	X	---	---	X	---	---	---
5	---	X	---	---	X	X	---	X	---
6	---	---	---	X	X	X	---	---	---
7	---	---	---	---	---	X	---	X	X
8	---	---	---	---	---	---	---	---	---
9	---	---	---	---	---	---	---	---	---
10	---	---	---	---	---	---	---	X	---
11	---	X	---	---	X	X	---	X	---
PRIVATELY OWNED WELLS									
128	---	---	---	---	---	---	---	X	---
131	---	---	---	---	---	---	---	Xe	---
236	---	---	---	---	---	---	---	X	---
253	---	---	---	---	X	---	---	Xe	---
304	---	---	---	---	X	X	---	---	---
318	---	---	---	---	---	---	---	X	---
319	---	---	---	---	---	---	---	X	---
326	---	---	---	---	---	---	---	---	---
339	---	---	---	X	---	---	---	---	---
403	---	---	---	---	---	---	---	---	---
404	---	---	---	X	---	---	---	Xe	---
405	---	---	---	---	---	---	X	X	---
406	---	---	---	---	---	X	X	X	---
407	---	---	---	---	---	---	---	Xe	---
410	---	---	---	---	---	---	---	X	Xe

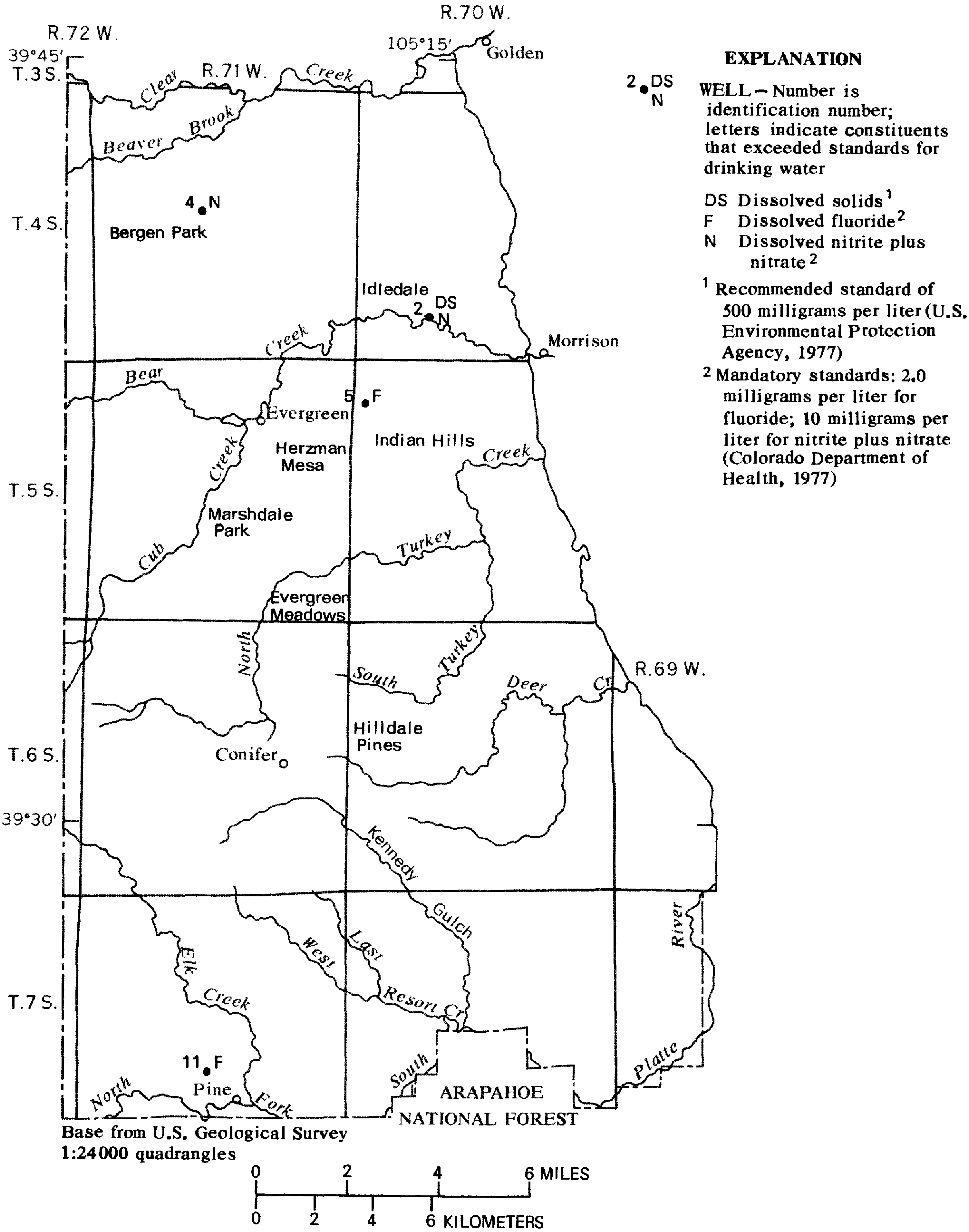

Figure 3.--Location of wells where water contained concentrations of dissolved solids, dissolved fluoride, or dissolved nitrite plus nitrate in excess of drinking-water standards.

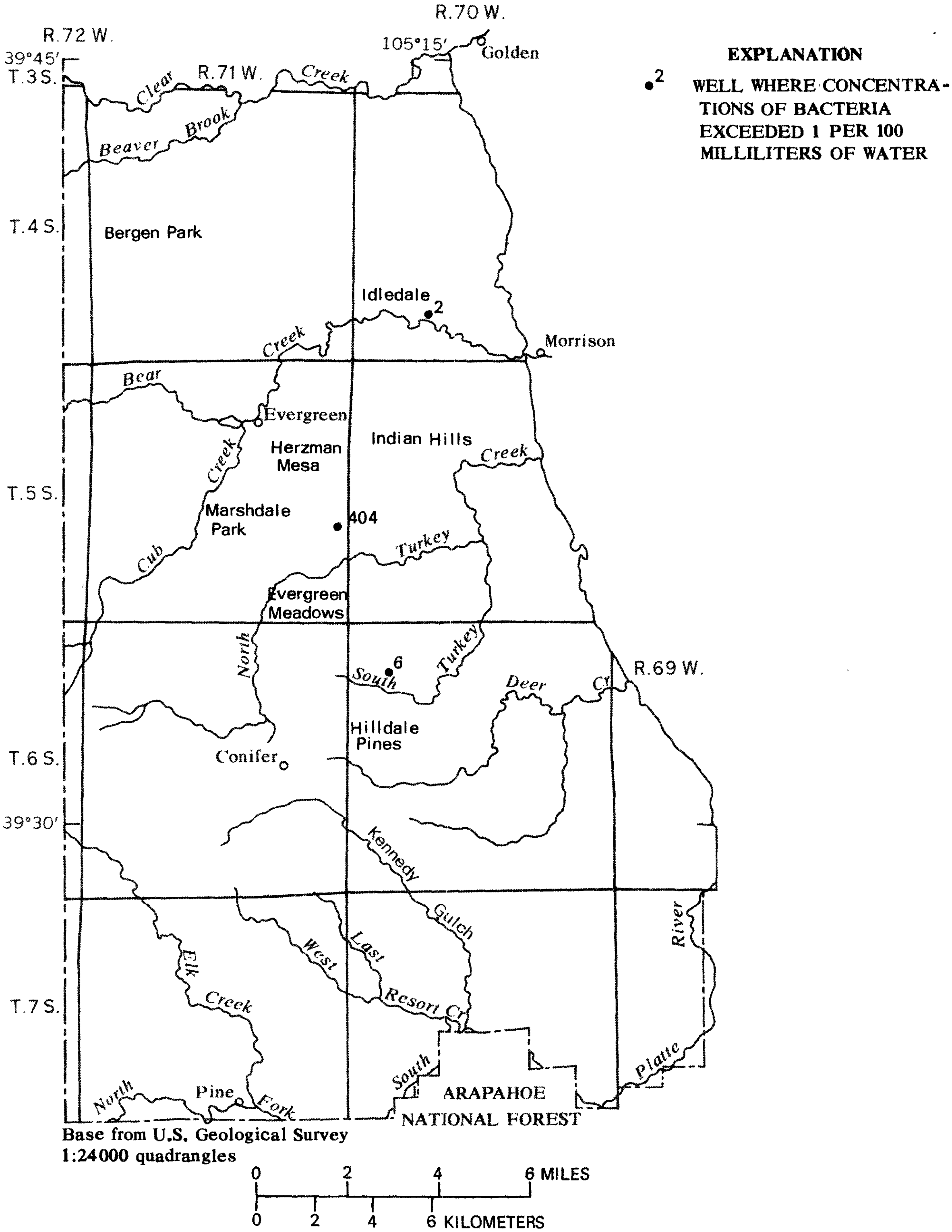

Figure 4.--Location of wells where water contained excessive concentrations of coliform bacteria.

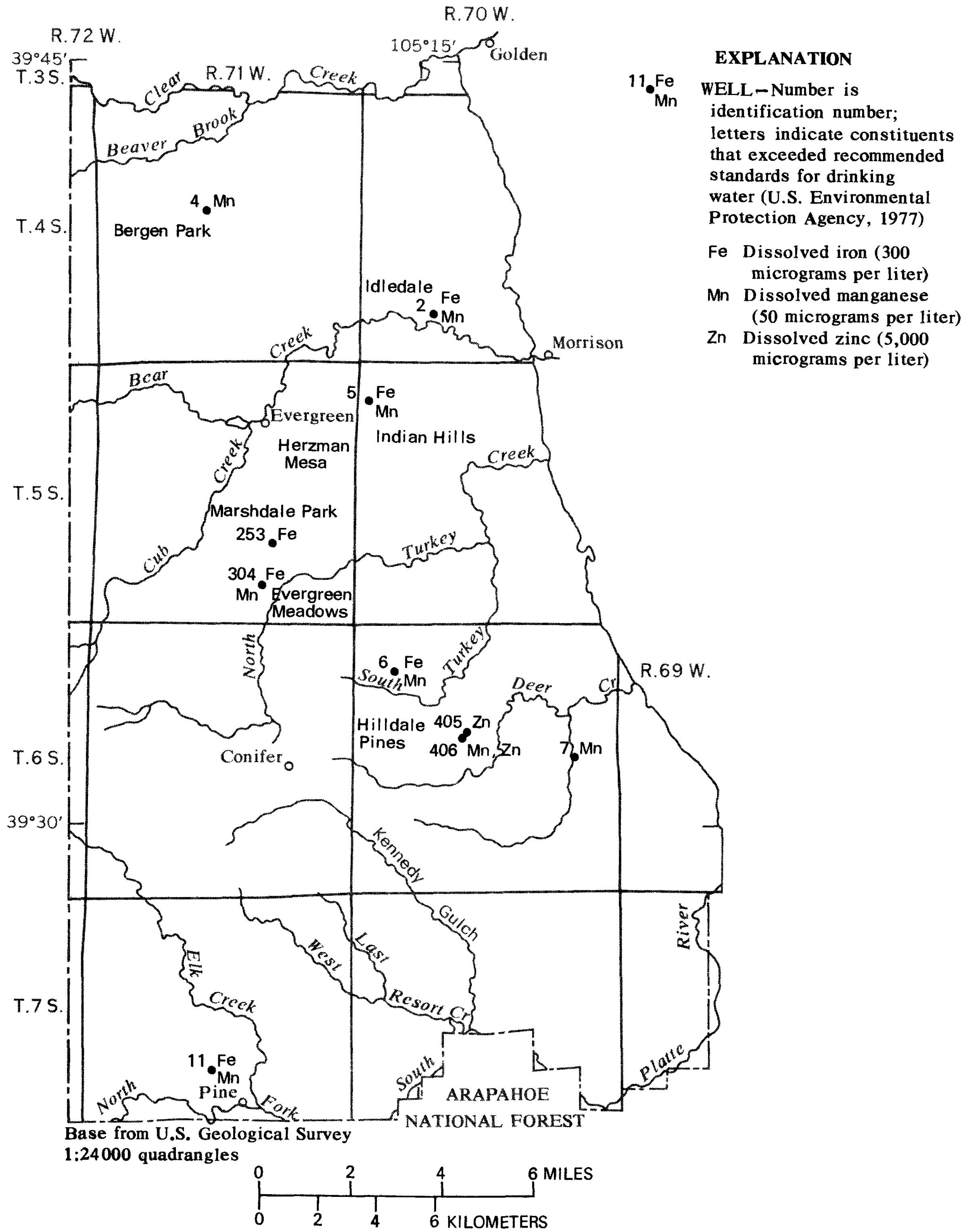

Figure 5.--Location of wells where water contained concentrations of dissolved iron, dissolved manganese, or dissolved zinc in excess of drinking-water standards.

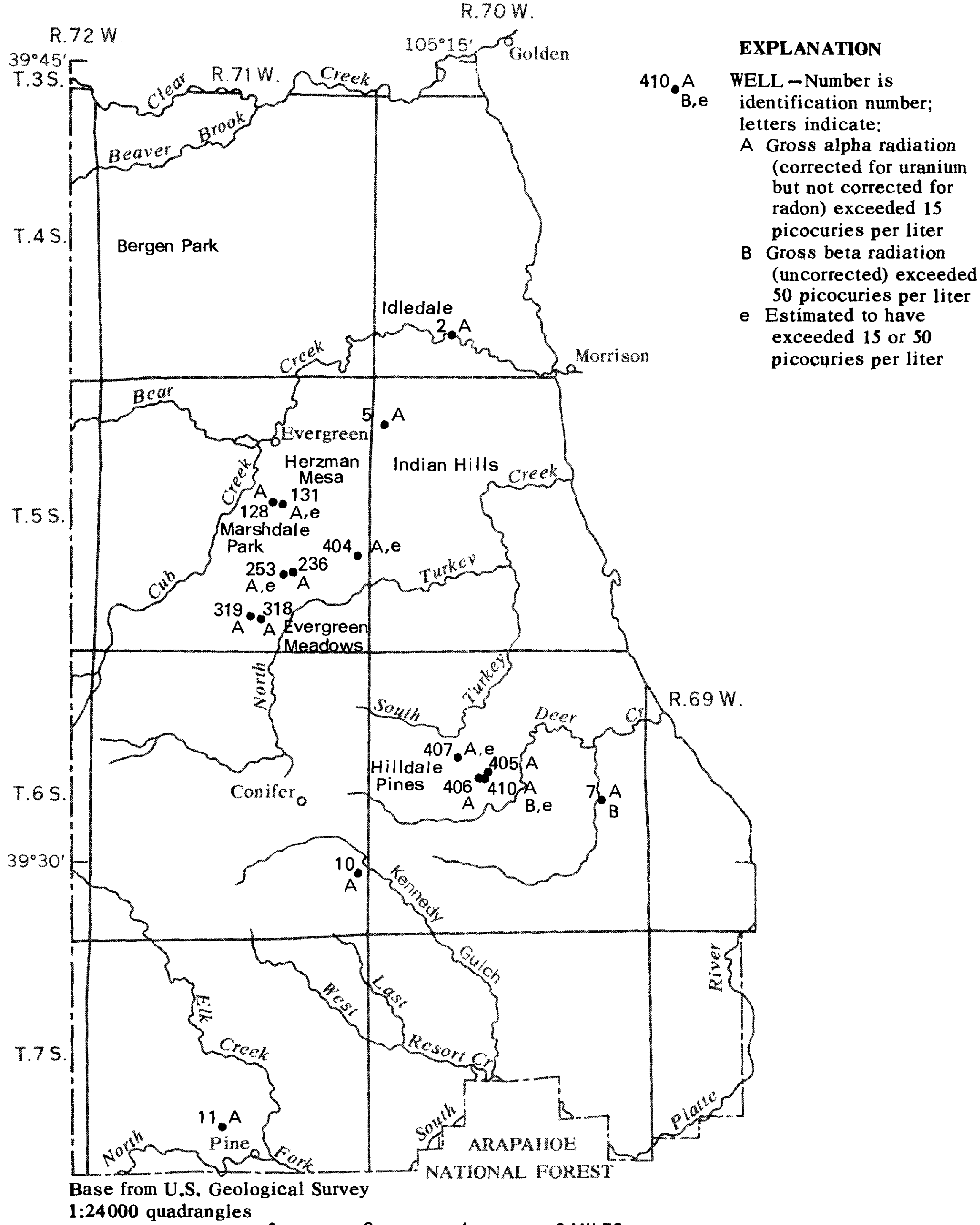

Figure 6.--Location of wells where water contained excessive concentrations of gross alpha and gross beta radiation.

Table 7.--*Local and seasonal variations in concentrations of nitrite plus nitrate as nitrogen in water from the 11 governmentally owned wells completed in the fractured crystalline-rock aquifer*

Well number	Concentration, in milligrams per liter			
	December 1973	May 1975	September 1975	December 1975
1----------	5.1	6.3	4.9	5.0
2----------	18	13	14	18
3----------	3.6	3.6	3.2	2.8
4----------	12	9.3	7.9	8.8
5----------	.03	.11	.11	.06
6----------	2.0	.78	.17	.62
7----------	1.2	3.1	4.1	3.8
8----------	2.1	2.1	1.9	1.9
9----------	3.9	4.5	3.9	4.4
10----------	.03	.06	.11	.15
11----------	.15	.03	.01	.03

A significant difference (1 percent level of significance) between wells or local variation was determined for all constituents except dissolved iron and dissolved manganese (table 8). Dissolved iron and manganese concentrations were not significantly different between wells because the variation with time for individual wells was so large. This variation could be due to problems of sample collection or analysis, or unknown environmental factors.

Seasonal Variations

Just as environmental conditions at two wells may not be identical, conditions at a particular well may not be the same for each sampling period. As seasons change, variables such as land use, surface temperatures, ground cover, and recharge rates also change. The quality of water in the well may eventually reflect these changing conditions. The seasonal sampling of the 11 governmentally owned wells was designed to determine if the water quality in the fractured crystalline-rock aquifer changes significantly with time.

Table 8.--*Seasonal variations in concentrations of chemical constituents and values of physical properties in water from the 11 governmentally owned wells completed in the fractured crystalline-rock aquifer*

Water-quality parameter	Mean concentration or value					Results of statistical tests	
	December 1973	May 1975	September 1975	December 1975	Combined data	Significant trend between wells[1]	Significant trend between sampling times[1]
CHEMICAL CONSTITUENT (MILLIGRAMS PER LITER)							
Alkalinity (as calcium carbonate)--	125.5	130.8	133.3	133.4	130.5	Yes	No
Bicarbonate------------------------	153.1	159.4	162.3	161.3	159.0	Yes	No
Calcium, dissolved-----------------	43.7	43.7	44.8	46.2	44.6	Yes	No
Chloride, dissolved----------------	13.6	16.4	15.5	15.9	15.3	Yes	No
Dissolved solids-------------------	227.1	229.1	231.3	233.9	230.3	Yes	No
Fluoride, dissolved----------------	.81	.88	.89	.86	.86	Yes	No
Hardness (as calcium carbonate)-----	157	155	165	164	160	Yes	No
Iron, dissolved (micrograms per liter).	180	360	290	910	440	No	No
Magnesium, dissolved---------------	11.3	11.1	12.7	11.4	11.6	Yes	Yes
Manganese, dissolved (micrograms per liter).	220	80	50	50	100	No	No
Nitrite plus nitrate as nitrogen, dissolved.	4.4	3.9	3.7	4.1	4.0	Yes	No
Noncarbonate hardness (as calcium carbonate).	31.2	25.9	31.9	31.5	30.1	Yes	No
Orthophosphorus, dissolved---------	.027	.015	.018	.004	.016	Yes	Yes
Potassium, dissolved---------------	2.62	2.88	2.69	2.56	2.69	Yes	No
Silica (as silicon dioxide)---------	16.5	16.2	15.9	16.4	16.3	Yes	No
Sodium, dissolved------------------	14.2	15.6	15.7	16.0	15.4	Yes	No
Sulfate, dissolved-----------------	27.0	25.9	26.7	25.7	26.3	Yes	No
Specific conductance, in micromhos per centimeter at 25 degrees Celsius.	370.6	374.1	389.0	390.2	381.0	Yes	No
Water temperature, in degrees Celsius-	8.0	8.7	8.7	7.7	8.3	Yes	Yes

[1]Significantly different at the 1-percent level by analysis of variance.

Major chemical constituents, specific conductance, and temperature were analyzed for water samples collected from the wells, and calculated mean concentrations or values for each sampling period are given in table 8. Differences in these means between sample-collection times were not statistically significant except for dissolved magnesium, dissolved phosphate, and temperature. The orthophosphate concentrations are small and are at the limit of detection by the laboratory procedure and, as such, cannot be considered to reflect a difference due to sampling time. The small seasonal difference of temperature is understandable, considering that water temperatures become more constant with increasing depth from the surface of the land. The seasonal difference of magnesium is unexpected in view of the lack of significant variation for the majority of chemical constituents, and remains unexplained.

In general, the water quality in the fractured crystalline-rock aquifer in the vicinity of the sampled wells did not change significantly from December 1973 to December 1975. If the concentrations of the more abundant dissolved constituents remain constant through the seasons, it is also reasonable to assume that the concentrations of trace constituents remain constant from season to season.

Two-Year Trend in General Water Quality

The specific conductance of water from wells within 0.25 mi of the 11 governmentally owned wells was measured twice: During the summers of 1973 and 1975. (See Water-Quality Data section, table 10.) Specific conductance is related to dissolved solids and thus can be related to possible ground-water degradation from waste-treatment systems (Hofstra and Hall, 1975*b*). A statistical test[1] was made to determine if the specific conductance had increased during the 2 years from mid-1973 to mid-1975. In the vicinity of well 5, located in Indian Hills, the specific conductance was found to be significantly greater[2] in 1975 than in 1973. The Indian Hills area has been undergoing considerable growth and the aquifer has been used both as a source of water supply and as a sink for disposal of wastewater from septic tanks and absorption fields.

Statistical tests of data from the vicinity of 8 of the remaining 10 governmentally owned wells indicated no significant increase in specific conductance in the 2-year period. Insufficient data were available for statistical analysis for data from the vicinity of wells 8 and 11. Based on tests using the combined data of all 11 areas, it was determined that specific conductance for the entire area had not increased significantly after 2 years.

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[1]The test was a one-tailed paired-design t-test with a significance level of 10 percent.

[2]The level of significance was less than 0.5 percent.

FLUCTUATIONS IN WATER LEVELS

Water levels in wells 1 through 11 were measured monthly from September 1973 through June 1976, and 10 miscellaneous measurements were made between July 1976 and February 1977. The measurements were usually made during the first week of each month.

A graph of monthly precipitation at Evergreen, Colo., and hydrographs showing water-level measurements in the 11 wells are presented in figure 7. The water-level fluctuations are unique for each well. Water levels in wells 2 and 11 were almost constant throughout the year, while water levels in wells 1 and 3 fluctuated as much as 15 ft during a year. The amount of annual water-level fluctuation in a given well commonly is not consistent from year to year. The amount and pattern of precipitation does not appear to have a direct effect on the water levels from month to month.

There is an indication of a long-term relationship between precipitation and water levels. Precipitation at Evergreen was greater than average early in 1973 and again in the middle of 1975 and water levels were high in most of the wells in early 1974 and in the middle of 1976, about a year after the periods of greater than average precipitation had occurred. However, several more years of records would be required to determine if there is a 1-year lag period between precipitation and water-level response in the fractured crystalline-rock aquifer.

Short-term responses of water levels to precipitation from individual storms such as was reported for a shallow well completed in the fractured crystalline-rock aquifer (Hofstra and Hall, 1975*a*, fig. 13) cannot be determined when water levels are measured monthly. However, the installation of automatically recording precipitation and water-level gages at the well sites would provide data needed to determine if water levels rapidly respond to precipitation.

Fluctuations in water level for most of the wells follow a predictable trend. The water levels decline in the fall and winter months, usually reaching a maximum depth during February. The time of maximum depth to water during the year represents the minimum amount of stored ground water. By graphically joining the water-level values for successive Februarys, a year-to-year trend of the minimum amount of water in storage for a given well can be estimated. The water in storage was decreasing for wells 1, 3, 4, 5, 7, and 10, not changing in wells 2, 6, 8, and 11, and increasing in well 9 (fig. 8).

The difference between the highest and the lowest water levels for a given year would be proportional to the annual recharge to the aquifer. The highest water levels tend to occur during the spring to late summer but specific occurrence varies from year to year for a given well and from well to well. Therefore, to estimate the peak of a hydrograph, monthly measurements would have to be made for about 6 months. The trend of a curve joining the peak water levels for a given well appears to parallel the trend for the minimum values (fig. 8).

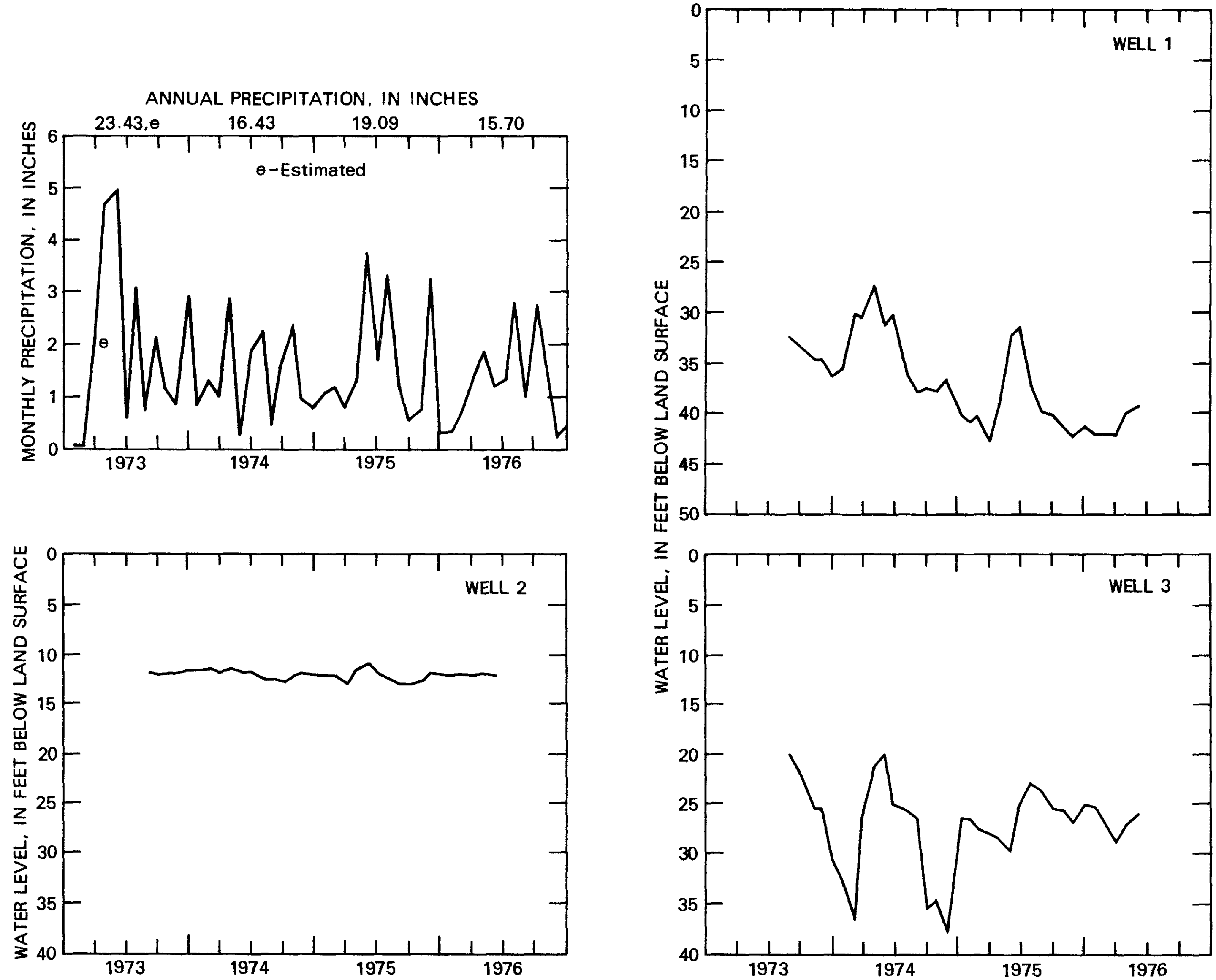

Figure 7.--Monthly and annual precipitation at Evergreen, Colo., and monthly depths to water in the 11 governmentally owned wells, 1973-76. (Precipitation data from U.S. Environmental Data Service, 1973-76)

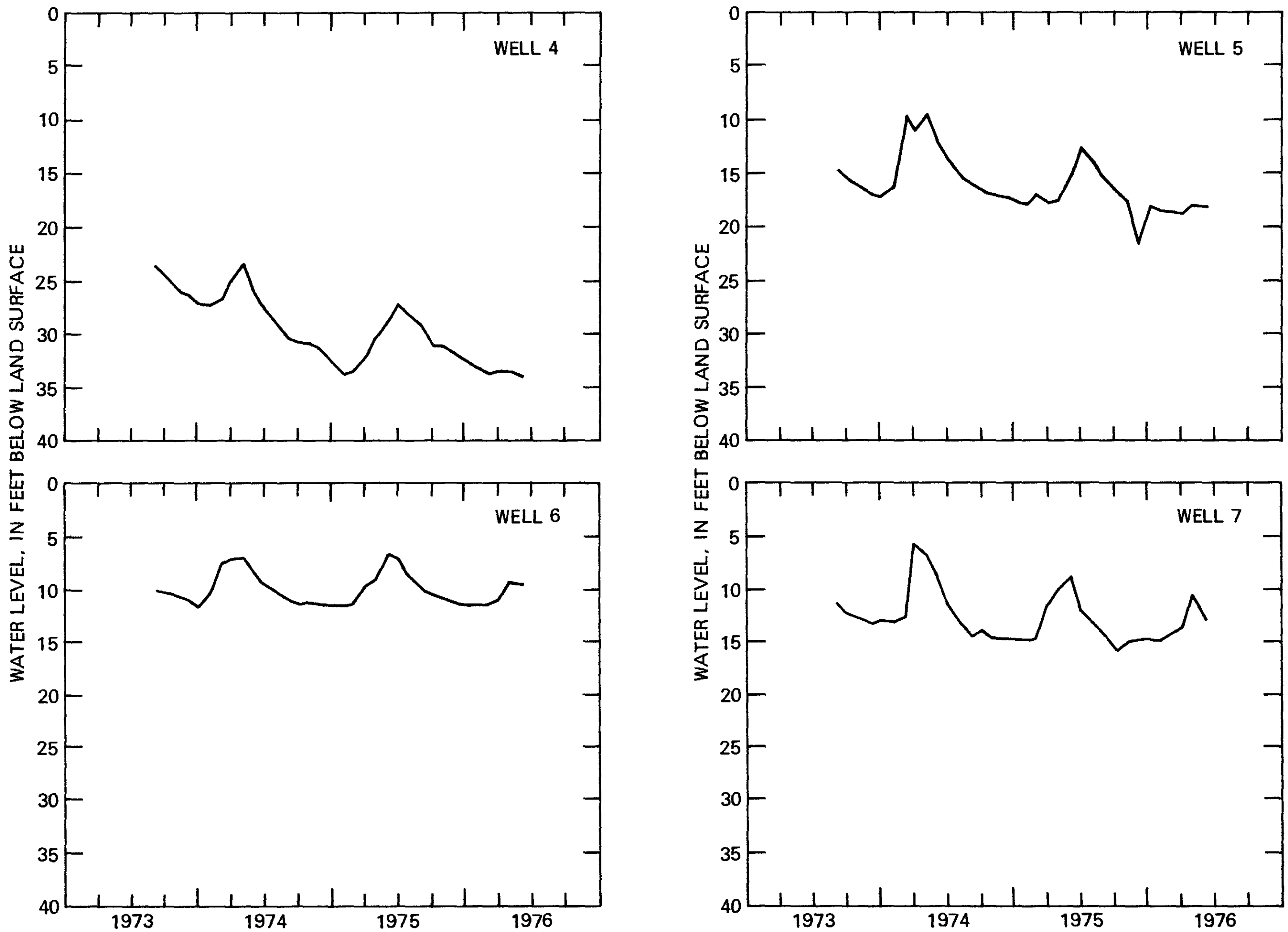

Figure 7.--Monthly and annual precipitation at Evergreen, Colo., and monthly depths to water in the 11 governmentally owned wells, 1973-76--Continued.

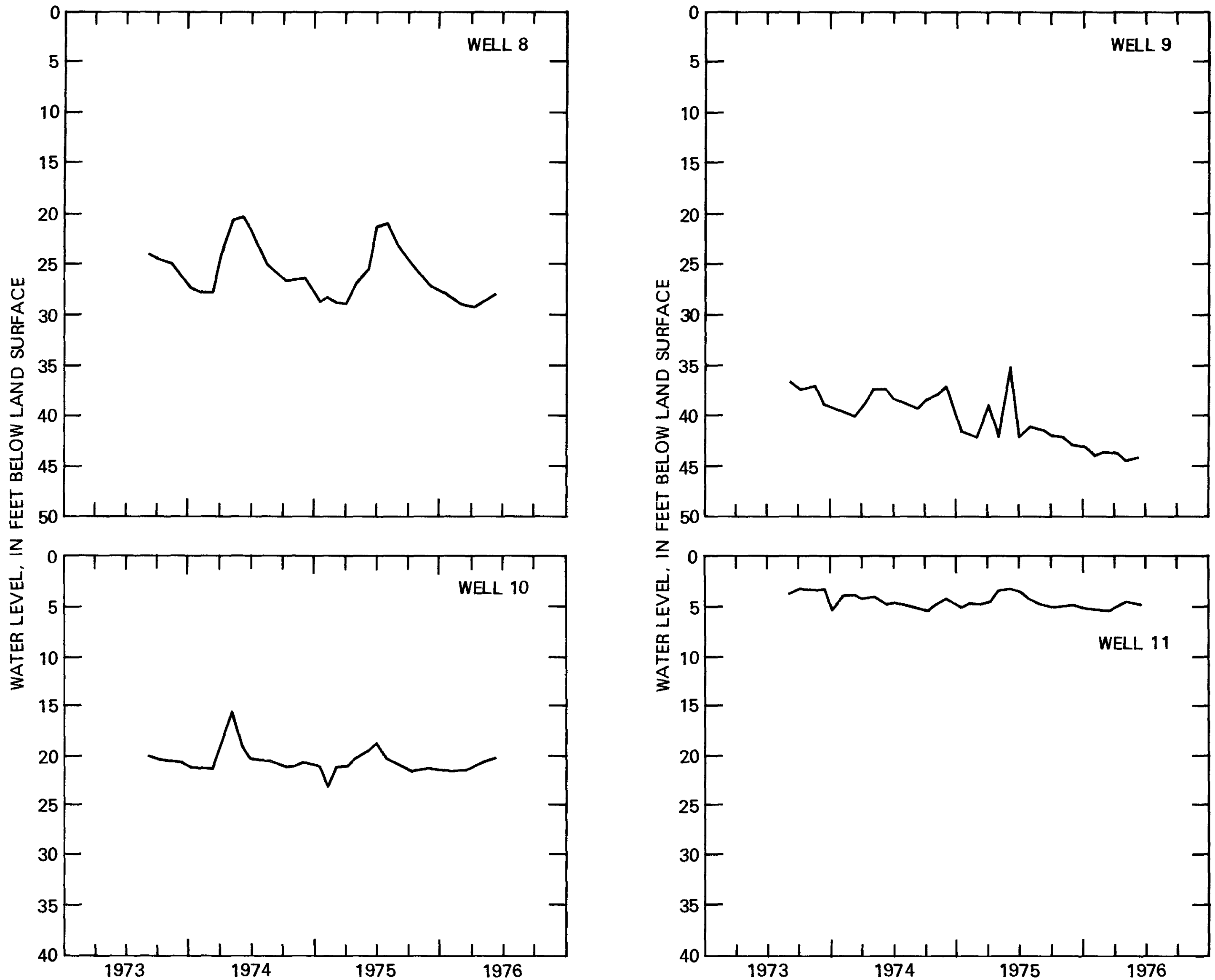

Figure 7.--Monthly and annual precipitation at Evergreen, Colo., and monthly depths to water in the 11 governmentally owned wells, 1973-76--Continued.

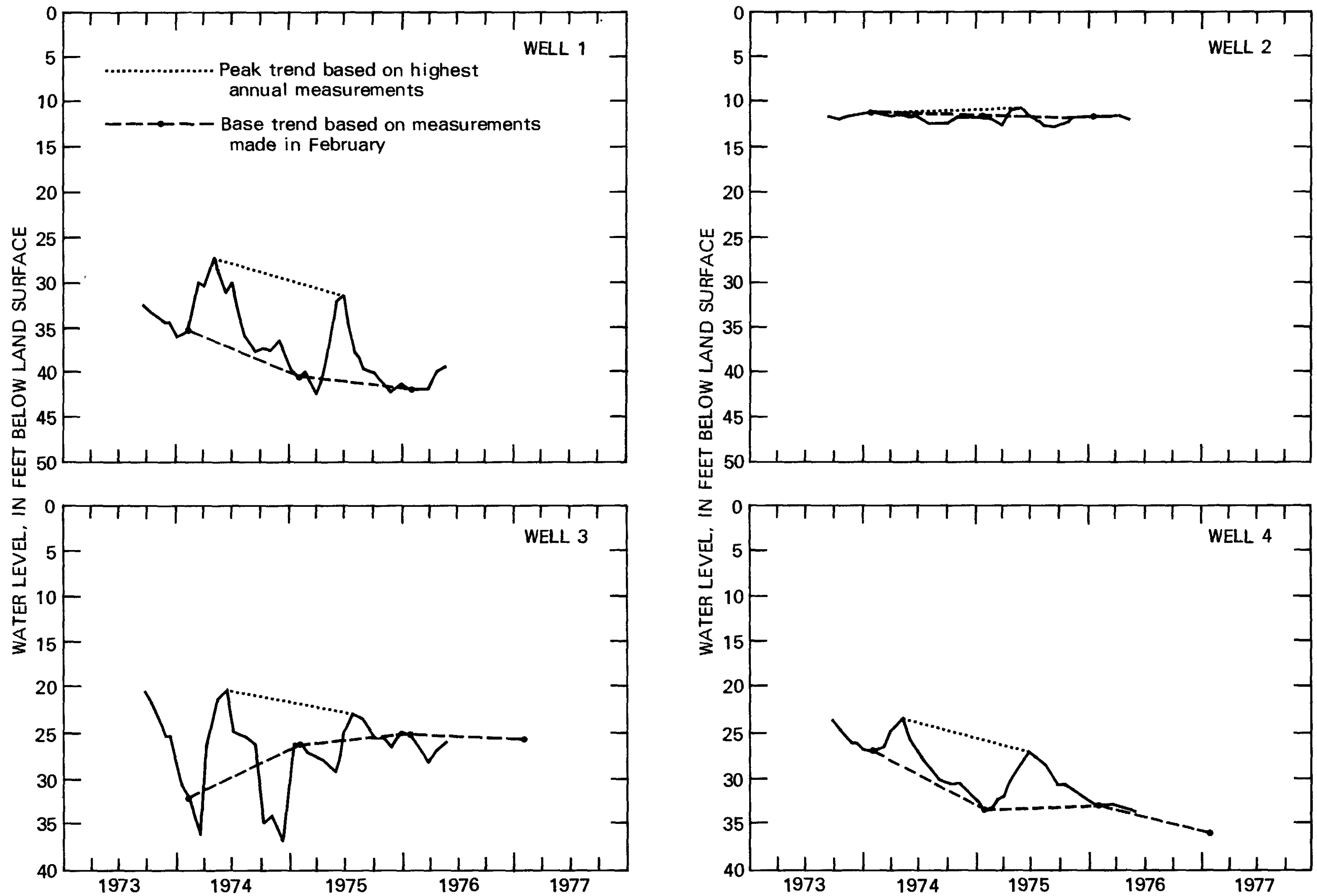

Figure 8.--Water-level trends in the 11 governmentally owned wells, 1973-77.

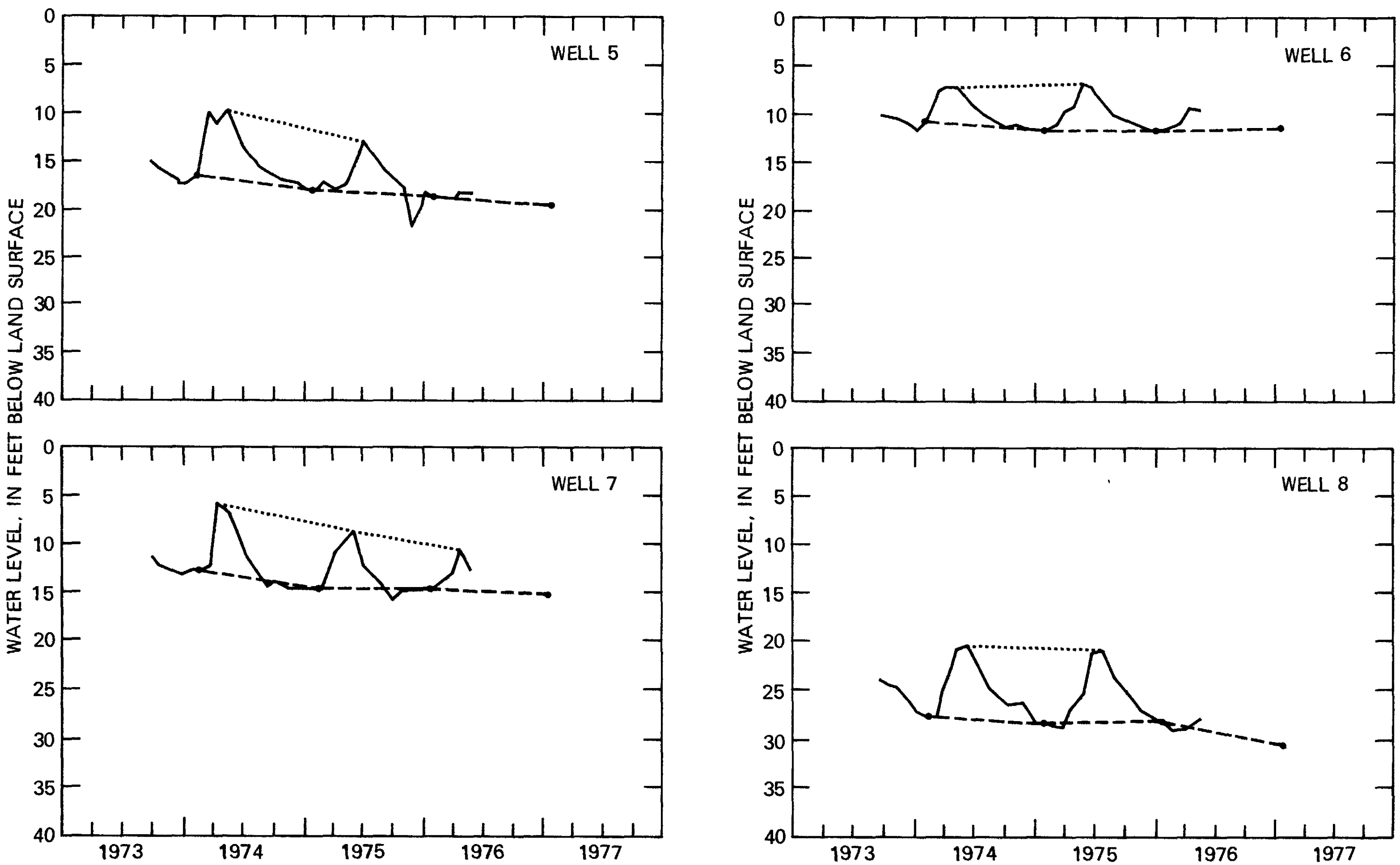

Figure 8.--Water-level trends in the 11 governmentally owned wells, 1973-77--Continued.

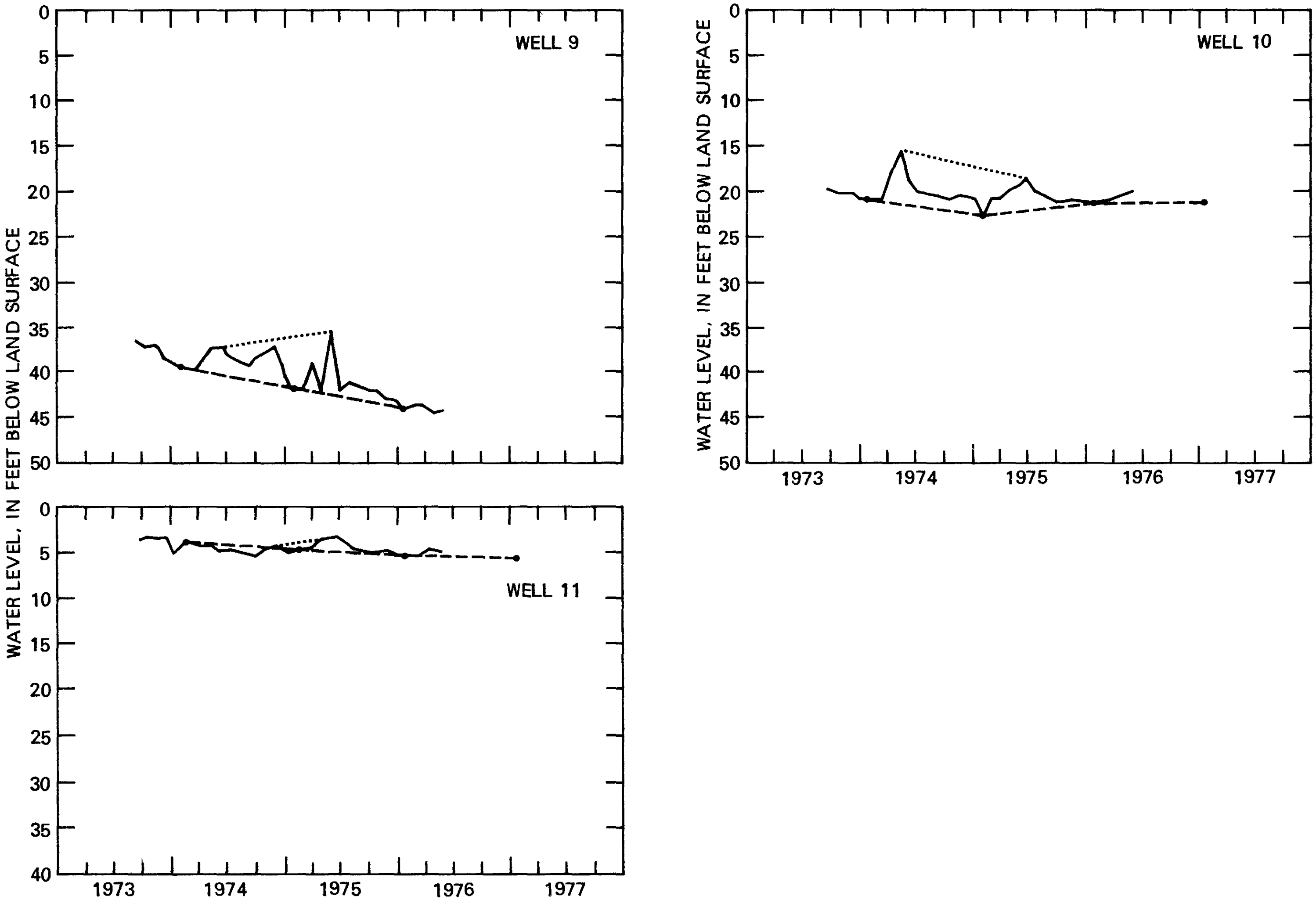

Figure 8.--Water-level trends in the 11 governmentally owned wells, 1973-77--Continued.

In future years, the U.S. Geological Survey, in cooperation with the Colorado State Engineer, will measure the depth to water during February in eight of the wells. This water-level monitoring program will provide information on year-to-year trends in available water in the fractured crystalline-rock aquifer and perhaps establish a relationship with annual precipitation.

SUMMARY

The quality of water from the fractured crystalline-rock aquifer generally is acceptable for drinking on the basis of current Federal and State standards even though water from 21 of the 26 wells contained excessive concentrations of major chemicals, bacteria, trace elements, or radiochemicals. Excessive concentrations of dissolved solids, dissolved iron, dissolved manganese, and dissolved zinc that occurred in water from 10 wells constitute nuisances to the users rather than health hazards.

Although water from three wells contained excessive concentrations of coliform bacteria, no fecal-coliform bacteria, which are associated with pathogenic viruses and organisms, were present in the water. The excessive concentrations of dissolved fluoride and dissolved nitrite plus nitrate that occurred in water from four wells were not significantly greater than their mandatory standards.

While the use of water meeting radiation standards for drinking water does not provide absolute protection to individuals consuming the water, this practice keeps the increased health risks at a more acceptable level. Although excessive radiation occurred or may have occurred in water from 16 wells, the increases in health risks from drinking the water are relatively small. However, additional analyses to identify the sources of radiation are warranted. The presence of particulates in the water can more than double the gross alpha and gross beta radiation. Because particulates are commonly present in the water, especially during the spring, installation of a filter located in the water-supply system before it enters the home would remove the particulates and decrease the amount of radiation in the water being consumed.

Wells that yielded water containing excessive concentrations of dissolved solids, dissolved fluoride, or dissolved nitrite plus nitrate are located either in the northern one-fourth or along the southern edge of the study area. Wells that yielded water containing excessive concentrations of coliform bacteria are generally located in the central part of the study area. Wells that yielded water containing excessive concentrations of trace elements are located throughout the study area. Wells that yielded water containing excessive gross alpha radiation are located south of Bear Creek; those containing excessive gross beta radiation are located in the southeastern part of the study area.

Major chemical concentrations, specific conductance, and water temperature vary statistically between wells. There is also variation at a given well for different sampling times. However, these seasonal trends are not the same from well to well (no areawide trend) and probably are not the same from year to year for a given well. A seasonal trend was determined for water temperature and possibly for magnesium and phosphate.

The specific conductance in ground water around well 5 located in Indian Hills significantly increased from 1973 to 1975. For the area as a whole there was not a significant change.

Depths to water in the measured wells fluctuated annually from 1 to 15 ft. They reflected seasonal precipitation patterns, possibly with a 1-year lag time. The greatest depth to water was most often in February; whereas, the shallowest depth to water was variable, occurring during the spring, summer, or autumn months. Annual measurements in February of depth to water could be sufficient for surveillance of long-term trends of available water in the aquifer.

For the 3 years of record, there was an apparent decrease in available water in storage in the vicinity of 6 of the 11 wells that were monitored. This apparent decrease in storage is thought to be a short-term trend reflecting climatological and land-use factors, but further surveillance will be necessary to verify this hypothesis.

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WATER-QUALITY DATA

Table 9.--*Water-quality analyses for the 11 governmentally*

FT=feet; GAL/MIN=gallon per minute; MG/L=milligrams per liter; MICROMHOS=
100 ML=colonies per 100 milliliters; UG/L=micrograms per liter; PC/L=

LOCAL IDENTIFIER	WELL NUM-BER	U.S. GEOLOGICAL SURVEY IDENTIFICATION NUMBER	AQUIFER[1]	DATE OF SAMPLE (Y-M-D)	TIME	TOTAL DEPTH OF WELL (FT)	WELL YIELD (GAL/MIN)
SC00407007BDCA	1	394309105160800	400PCMBC	73-12-06	1015	230	0.20
			400PCMBC	75-05-15	0950	230	--
			400PCMBC	75-09-18	1030	230	--
			400PCMBC	75-12-03	1015	230	--
SC00407032AABC	2	393958105143200	400PCMBC	73-12-07	1130	100	.50
			400PCMBC	75-05-15	1500	100	--
			400PCMBC	75-09-19	0915	100	--
			400PCMBC	75-12-03	1515	100	--
SC00407112CBBA	3	394301105173300	400PCMBC	73-12-06	1400	110	6.4
			400PCMBC	75-05-15	1050	110	--
			400PCMBC	75-09-18	1200	110	--
			400PCMBC	75-12-03	1130	110	--
SC00407116DBBB	4	394205105202400	400PCMBC	73-12-05	1300	160	1.0
			400PCMBC	75-05-15	1250	160	--
			400PCMBC	75-09-18	1330	160	--
			400PCMBC	75-12-03	1230	160	--
SC00507006CDDC	5	393821105161000	400PCMBC	73-12-11	1200	180	.20
			400PCMBC	75-05-15	1400	180	--
			400PCMBC	75-09-18	1445	180	--
			400PCMBC	75-12-04	0945	180	--
SC00607007AAAA	6	393301105153100	400PCMBC	73-12-12	1015	70	6.8
			400PCMBC	75-05-16	0900	70	--
			400PCMBC	75-09-19	1200	70	--
			400PCMBC	75-12-04	1230	70	--
SC00607013CCCD	7	393121105110400	400PCMBC	73-12-10	1330	160	.40
			400PCMBC	75-05-16	0800	60	--
			400PCMBC	75-09-19	1315	60	--
			400PCMBC	75-12-04	1100	60	--
SC00607102BBDC	8	393350105184300	400PCMBC	73-12-11	1500	140	.40
			400PCMBC	75-05-16	1300	140	--
			400PCMBC	75-09-19	1030	140	--
			400PCMBC	75-12-03	1400	140	--
SC00607111DACA	9	393232105180200	400PCMBC	73-12-13	1100	120	3.4
			400PCMBC	75-05-16	1130	120	--
			400PCMBC	75-09-19	1100	120	--
			400PCMBC	75-12-04	1400	120	--
SC00607125DAAA	10	392958105164600	400PCMBC	73-12-12	1400	220	.10
			400PCMBC	75-05-16	1400	220	--
			400PCMBC	75-09-19	1400	220	--
			400PCMBC	75-12-04	1500	220	--
SC00707121DDAC	11	392511105200600	400PCMBC	73-12-13	1600	220	.70
			400PCMBC	75-05-16	1500	220	--
			400PCMBC	75-09-19	1500	220	--
			400PCMBC	75-12-04	1615	220	--

owned wells completed in the fractured crystalline-rock aquifer

micromhos per centimeter at 25° Celsius; DEG C=degrees Celsius; COL. PER picocuries per liter.

DIS-SOLVED SILICA (SIO2) (MG/L)	SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CAR-BONATE (CO3) (MG/L)	ALKA-LINITY AS CACO3 (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)
15	62	12	7.6	4.4	195	0	160	20	14
15	61	12	8.0	4.4	202	--	166	22	17
15	61	13	8.0	4.2	195	--	160	19	18
14	62	13	8.6	4.5	207	--	170	19	17
18	78	31	40	3.7	287	0	235	51	41
12	78	29	48	3.4	323	--	265	46	44
12	83	33	48	3.0	349	--	286	49	43
16	91	29	50	3.0	347	--	285	46	42
22	14	3.0	7.0	2.7	27	0	22	15	12
22	16	3.1	8.1	3.2	25	--	21	16	19
21	14	3.2	7.4	2.5	26	--	21	15	13
22	15	3.0	7.3	2.7	19	--	16	19	16
22	87	14	11	3.1	209	0	171	33	36
20	89	14	13	3.3	234	--	192	30	45
20	83	14	13	3.0	224	--	184	27	45
21	85	12	12	2.3	199	--	163	28	47
15	36	18	10	2.0	213	0	175	12	2.1
16	38	20	11	2.4	232	--	190	11	3.0
16	38	23	11	1.7	234	--	192	11	1.7
17	39	21	11	1.8	236	--	194	9.5	.8
24	17	3.6	6.6	1.4	56	0	46	10	7.7
16	23	4.6	8.8	2.9	88	--	72	5.2	9.5
15	24	5.9	10	3.3	108	--	89	4.9	8.1
21	32	6.5	15	2.5	137	--	112	2.5	15
16	49	9.5	8.6	5.4	186	0	153	19	7.7
12	46	8.3	8.1	4.7	163	--	134	19	11
15	53	11	8.0	5.7	173	--	142	20	12
15	51	9.7	8.1	5.5	182	--	149	20	10
33	15	2.5	11	1.6	38	0	31	14	14
30	14	2.2	11	1.7	32	--	26	15	15
30	14	2.6	11	1.4	29	--	24	16	14
30	15	2.7	9.9	1.4	33	--	27	16	12
16	39	14	6.4	1.6	159	0	130	9.5	11
15	40	15	6.6	2.4	169	--	139	11	12
13	43	19	7.5	2.3	186	--	153	10	11
15	43	14	6.4	1.9	162	--	133	9.2	11
11	36	14	15	2.1	186	0	153	27	1.5
9.1	29	12	16	2.2	155	--	127	32	2.8
6.8	32	13	16	1.7	147	--	121	32	1.4
2.3	28	12	15	1.7	136	--	112	33	1.5
12	48	2.5	33	.8	128	0	105	86	2.4
11	47	2.2	33	1.1	130	--	107	78	2.3
9.8	48	2.4	33	.8	114	--	94	90	3.0
7.6	47	2.5	33	.9	116	--	95	81	2.5

Table 9.--*Water-quality analyses for the 11 governmentally owned*

WELL NUMBER	AQUIFER[1]	DISSOLVED FLUORIDE (F) (MG/L)	DISSOLVED NITRITE (N) (MG/L)	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L)	DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	SPECIFIC CONDUCTANCE (MICROMHOS)
1	400PCMBC	0.1	--	5.1	.02	254	200	44	432
	400PCMBC	.2	--	6.3	.01	267	200	36	440
	400PCMBC	.3	0.01	4.9	.01	256	210	46	445
	400PCMBC	.2	.00	5.0	.00	263	210	39	455
2	400PCMBC	.4	--	18	.03	485	320	87	785
	400PCMBC	.2	--	13	.01	478	310	49	795
	400PCMBC	.2	.00	14	.02	505	340	57	780
	400PCMBC	.3	.00	18	.00	528	350	62	850
3	400PCMBC	.1	--	3.6	.03	105	47	25	153
	400PCMBC	.1	--	3.6	.02	116	53	32	165
	400PCMBC	.2	.01	3.2	.01	103	48	27	155
	400PCMBC	.4	.00	2.8	.00	107	50	34	163
4	400PCMBC	.3	--	12	.04	363	280	100	589
	400PCMBC	.2	--	9.3	.02	371	280	88	575
	400PCMBC	.3	.01	7.9	.02	351	270	81	630
	400PCMBC	.2	.00	8.8	.00	345	260	98	575
5	400PCMBC	2.0	--	.03	.02	206	160	0	353
	400PCMBC	2.5	--	.11	.01	219	180	0	385
	400PCMBC	2.4	.00	.11	.01	221	190	0	400
	400PCMBC	2.3	.01	.06	.01	219	180	0	400
6	400PCMBC	.1	--	2.0	.03	107	57	11	157
	400PCMBC	.2	--	.78	.01	120	76	4	210
	400PCMBC	.2	.01	.17	.02	127	84	0	225
	400PCMBC	.2	.01	.62	.01	174	110	0	300
7	400PCMBC	.2	--	1.2	.02	213	160	9	359
	400PCMBC	.2	--	3.1	.01	204	150	15	340
	400PCMBC	.2	.00	4.1	.02	228	180	36	385
	400PCMBC	.2	.01	3.8	.01	226	170	18	390
8	400PCMBC	.1	--	2.1	.04	119	48	17	160
	400PCMBC	.2	--	2.1	.05	114	44	18	160
	400PCMBC	.2	.00	1.9	.05	112	46	22	160
	400PCMBC	.2	.00	1.9	.01	112	49	22	155
9	400PCMBC	.3	--	3.9	.03	194	160	25	339
	400PCMBC	.4	--	4.5	.01	206	160	23	335
	400PCMBC	.5	.00	3.9	.01	215	190	33	375
	400PCMBC	.5	.01	4.4	.00	200	170	32	345
10	400PCMBC	1.6	--	.03	.02	200	150	0	339
	400PCMBC	1.6	--	.06	.01	182	120	0	305
	400PCMBC	1.9	.01	.11	.01	178	130	13	320
	400PCMBC	1.6	.00	.15	.00	163	120	8	285
11	400PCMBC	3.7	--	.15	.02	252	130	25	411
	400PCMBC	3.9	--	.03	.01	243	130	20	405
	400PCMBC	3.4	.00	.01	.02	248	130	36	404
	400PCMBC	3.4	.01	.03	.00	236	130	33	375

wells completed in the fractured crystalline-rock aquifer--Continued

PH (UNITS)	TEMPER-ATURE (DEG C)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM (COL. PER 100 ML)	METHY-LENE BLUE ACTIVE SUB-STANCE (MG/L)	DIS-SOLVED ALUM-INUM (AL) (UG/L)	DIS-SOLVED ARSENIC (AS) (UG/L)	DIS-SOLVED BARIUM (BA) (UG/L)	DIS-SOLVED CAD-MIUM (CD) (UG/L)	DIS-SOLVED COPPER (CU) (UG/L)
7.7	8.5	<1	<1	.0	0	--	--	--	--
--	9.5	<1	<1	.0	--	0	0	0	5
--	9.5	<1	<1	.0	--	--	--	--	--
--	8.5	<1	<1	.0	--	--	--	--	--
7.7	11.0	5	<1	.4	0	--	--	--	--
--	11.0	<1	<1	.0	--	0	0	1	2
--	12.0	<1	<1	.0	--	--	--	--	--
--	10.5	<1	<1	.0	--	--	--	--	--
6.4	7.5	<1	<1	.1	0	--	--	--	--
--	8.0	<1	<1	.0	--	0	0	0	0
--	7.0	<1	<1	.0	--	--	--	--	--
--	7.5	<1	<1	.0	--	--	--	--	--
7.3	6.5	<1	<1	.0	0	--	--	--	--
--	8.0	<1	<1	.0	--	0	0	1	3
--	7.0	<1	<1	.0	--	--	--	--	--
--	7.0	<1	<1	.0	--	--	--	--	--
7.5	9.5	<1	<1	.0	20	--	--	--	--
--	9.5	<1	<1	.0	--	0	0	0	0
--	9.0	<1	<1	.0	--	--	--	--	--
--	9.0	<1	<1	.0	--	--	--	--	--
6.5	8.5	5	<1	.0	30	--	--	--	--
--	8.0	19	<1	.0	--	0	0	0	0
--	8.5	42	<1	.0	--	--	--	--	--
--	8.0	24	<1		--	--	--	--	--
7.4	8.0	<1	<1	.0	10	--	--	--	--
--	9.5	<1	<1	.0	--	0	0	0	1
--	8.5	<1	<1	.0	--	--	--	--	--
--	7.5	<1	<1	.0	--	--	--	--	--
6.1	7.0	<1	<1	.0	20	--	--	--	--
--	7.5	<1	<1		--	1	0	0	1
--	7.5	<1	<1	.0	--	--	--	--	--
--	7.0	<1	<1		--	--	--	--	--
7.3	6.5	<1	<1	.0	10	--	--	--	--
--	7.0	<1	<1	.0	--	0	0	0	1
--	7.5	<1	<1	.0	--	--	--	--	--
--	6.0	<1	<1	.0	--	--	--	--	--
7.8	5.5	<1	<1	.0	10	--	--	--	--
--	7.0	<1	<1	.0	--	0	0	0	0
--	7.5	<1	<1	.0	--	--	--	--	--
--	5.5	<1	<1	.0	--	--	--	--	--
7.8	10.0	<1	<1	.0	20	--	--	--	--
--	10.5	<1	<1	.0	--	1	0	0	0
--	12.0	<1	<1	.0	--	--	--	--	--
--	10.0	<1	<1	.0	--	--	--	--	--

Table 9.--*Water-quality analyses for the 11 governmentally owned*

WELL NUMBER	DATE OF SAMPLE	DISSOLVED IRON (FE) (UG/L)	DISSOLVED LEAD (PB) (UG/L)	DISSOLVED MANGANESE (MN) (UG/L)	DISSOLVED MERCURY (HG) (UG/L)	DISSOLVED MOLYBDENUM (MO) (UG/L)	DISSOLVED SELENIUM (SE) (UG/L)
1	73-12-06	10	--	0	--	--	2
	75-05-15	40	15	20	.2	2	--
	75-09-18	20	--	0	--	--	--
	75-12-03	30	--	0	--	--	--
2	73-12-07	70	--	90	--	--	2
	75-05-15	320	2	140	.0	3	--
	75-09-19	20	--	150	--	--	--
	75-12-03	130	--	110	--	--	--
3	73-12-06	10	--	20	--	--	2
	75-05-15	10	2	5	.4	0	--
	75-09-18	40	--	0	--	--	--
	75-12-03	50	--	0	--	--	--
4	73-12-05	30	--	80	--	--	2
	75-05-15	20	1	5	.1	2	--
	75-09-18	30	--	0	--	--	--
	75-12-03	30	--	10	--	--	--
5	73-12-11	1400	--	1900	--	--	4
	75-05-15	60	0	130	.4	4	--
	75-09-18	290	--	90	--	--	--
	75-12-04	320	--	80	--	--	--
6	73-12-12	120	--	50	--	--	4
	75-05-16	2600	1	400	.0	5	--
	75-09-19	1700	--	230	--	--	--
	75-12-04	8600	--	210	--	--	--
7	73-12-10	140	--	110	--	--	4
	75-05-16	60	1	40	.0	1	--
	75-09-19	10	--	10	--	--	--
	75-12-04	30	--	20	--	--	--
8	73-12-11	30	--	33	--	--	3
	75-05-16	40	1	10	.0	0	--
	75-09-19	30	--	10	--	--	--
	75-12-03	50	--	10	--	--	--
9	73-12-13	10	--	17	--	--	2
	75-05-16	50	1	10	.0	2	--
	75-09-19	10	--	0	--	--	--
	75-12-04	30	--	10	--	--	--
10	73-12-12	70	--	33	--	--	2
	75-05-16	250	1	30	.2	9	--
	75-09-19	110	--	30	--	--	--
	75-12-04	150	--	50	--	--	--
11	73-12-13	90	--	100	--	--	2
	75-05-16	550	0	80	.0	58	--
	75-09-19	920	--	50	--	--	--
	75-12-04	550	--	80	--	--	--

wells completed in the fractured crystalline-rock aquifer--Continued

DIS-SOLVED ZINC (ZN) (UG/L)	DIS-SOLVED GROSS ALPHA AS U-NAT. (UG/L)	SUS-PENDED GROSS ALPHA AS U-NAT. (UG/L)	DIS-SOLVED GROSS BETA AS CS-137 (PC/L)	SUS-PENDED GROSS BETA AS CS-137 (PC/L)	DIS-SOLVED RA-226 (RADON METHOD) (PC/L)	DIS-SOLVED STRON-TIUM 90 (PC/L)	DIS-SOLVED POTAS-SIUM 40 (PC/L)
--	12	2.8	7.3	2.4	--	--	--
50	--	--	--	--	.39	--	3.3
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	39	8.4	9.6	10	--	--	--
20	--	--	--	--	.79	--	2.6
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	1.7	<.4	3.2	.4	--	--	--
20	--	--	--	--	--	--	1.9
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	12	6.1	4.6	5.2	--	--	--
40	--	--	--	--	.13	--	2.5
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	44	9.5	6.7	7.1	--	--	--
0	--	--	--	--	.35	--	1.8
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	6.8	1.7	3.0	2.0	--	--	--
20	--	--	--	--	.77	--	2.9
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	67	120	19	54	--	--	--
6	--	--	--	--	1.3	<.1	3.5
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	<1.3	12	1.5	8.5	--	--	--
40	--	--	--	--	--	--	1.3
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	17	1.5	4.0	3.5	--	--	--
60	--	--	--	--	.34	--	1.8
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	15	24	4.5	14	--	--	--
8	--	--	--	--	.09	--	1.6
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	6.9	36	1.8	19	--	--	--
20	--	--	--	--	.19	--	.80
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--

Table 10.--*Water-quality analyses for the 15 privately owned wells completed in the fractured crystalline-rock aquifer*

FT=feet; GAL/MIN=gallons per minute; MG/L=milligrams per liter; MICROMHOS=micromhos per centimeter at 25°Clesius; COL. PER 100 ML=colonies per 100 milliliters; UG/L=micrograms per liter; PC/L=picocuries per liter

LOCAL IDENTIFIER	WELL NUMBER	U.S. GEOLOGICAL SURVEY IDENTIFICATION NUMBER	AQUIFER[1]	DATE OF SAMPLE (Y-M-D)	TOTAL DEPTH OF WELL (FT)	WELL YIELD (GAL/MIN)	DIS-SOLVED SILICA (SIO2) (MG/L)	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)
SC00407120ACBB	403	394127105212900	400PCMBC	75-11-18	203	2.5	21	39	6.3	9.2
SC00507114CBCB	128	393653105185100	400PCMBC	75-10-08	240	.50	14	44	7.6	15
			400PCMBC	76-09-27	240 --	--	--	--	--	--
SC00507114CBDB	131	393652105184000	400PCMBC	75-10-29	178	.50	12	69	12	17
			400PCMBC	76-09-28	78 --	--	--	--	--	--
SC00507124DDBA	404	393554105164900	400PCMBC	76-07-14	360	2.5	22	30	6.9	13
SC00507126BADB2	236	393535105182500	400PCMBC	75-11-06	325 --	--	--	--	--	--
			400PCMBC	76-07-14	325	--	27	27	5.0	8.7
SC00507126BBDA	243	393532105183700	400PCMBC	75-11-11	152	1.3	23	50	9.3	13
SC00507134AAAD2	304	393443105185400	400PCMBC	75-10-22	--	--	18	21	5.4	10
			400PCMBC	75-09-27	--	--	--	--	--	--
SC00507134ABAD	318	393442105191200	400PCMBC	75-11-05	--	7.0	14	32	6.9	17
SC00507134ABBC	319	393444105192400	400PCMBC	75-10-21	--	--	17	35	7.8	12
			400PCMBC	76-09-27	--	--	--	--	--	--
SC00507134ACAB2	326	393435105191200	400PCMBC	75-10-14	180	3.0	21	22	5.0	10
			400PCMBC	75-09-27	180	--	--	--	--	--
SC00507134CBBD	339	393419105195100	400PCMBC	73-03-09	280 --	--	--	--	--	--
			400PCMBC	75-11-12	280	1.0	26	24	4.5	10
			400PCMBC	76-09-27	280 --	--	--	--	--	--
SC00607016ADCA	405	393150105133300	400PCMBC	76-07-13	440	2.2	30	18	2.6	12
SC00607016ADCC	406	393144105134000	400PCMBC	76-08-10	480	1.2	19	31	4.3	12
SC00607016BBAA	407	393207105141700	400PCMBC	75-11-05	153	2.0	24	18	4.0	12
SC00607016DABB	410	393143105133700	400PCMBC	76-08-10	420	2.0	21	42	4.0	9.8

Table 10.--*Water-quality analyses for the 15 privately owned wells completed in the fractured crystalline-rock aquifer*--Continued

WELL NUMBER	DATE OF SAMPLE	DIS-SOLVED POTAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	CAR-BON-ATE (CO3) (MG/L)	ALKA-LINITY AS CACO3 (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	DIS-SOLVED NITRITE (N) (MG/L)	DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L)	DIS-SOLVED SOLIDS (SUM of CONSTI-TUENTS) (MG/L)	HARD-NESS (CA,MG) (MG/L)	NON-CAR-BONATE HARD-NESS (MG/L)
403	75-11-18	3.9	152	--	125	15	2.8	0.3	0.00	0.83	177	120	0
128	75-10-08	1.4	203	--	167	11	2.8	.2	.00	.48	201	140	0
	76-09-27	1.1	--	--	--	--	--	--	--	--	--	--	--
131	75-10-29	1.9	243	--	199	13	21	1.0	.01	3.8	286	220	23
	76-09-28	1.9	--	--	--	--	--	--	--	--	--	--	--
404	76-07-14	2.3	154	--	126	6.9	5.7	.3	.00	.56	167	100	0
236	75-11-06	--	--	--	--	--	--	--	.00	.61	--	--	--
	76-07-14	1.3	128	--	105	5.2	2.3	.3	.00	.62	144	88	0
243	75-11-11	1.0	142	--	116	13	30	.3	.01	7.9	250	160	47
304	75-10-22	1.0	114	--	94	7.0	2.3	.4	.00	.08	124	75	0
	76-09-27	1.0	--	--	--	--	--	--	--	--	--	--	--
318	75-11-05	1.1	160	--	131	4.7	2.0	1.7	.00	.01	159	110	0
319	75-10-21	1.0	169	--	139	2.3	1.3	.7	.00	.01	161	120	0
	76-09-27	1.0	--	--	--	--	--	--	--	--	--	--	--
326	75-10-14	.8	92	--	75	14	5.8	.5	.00	.67	131	76	0
	76-09-27	.8	--	--	--	--	--	--	--	--	--	--	--
339	73-03-09	.9	--	--	--	--	2.0	--	--	.46	--	--	--
	75-11-12	.8	108	--	89	5.5	2.3	.3	.00	.59	131	78	0
	76-09-27	.8	--	--	--	--	--	--	--	--	--	--	--
405	76-07-13	.8	100	--	82	3.7	.8	.2	.00	.20	124	56	0
406	76-08-10	1.9	120	0	98	30	4.6	.3	.49	3.9	201	95	0
407	75-11-05	.7	94	--	77	4.3	1.7	.7	.00	.05	114	62	0
410	76-08-10	1.4	158	0	130	6.9	1.6	.5	.00	.45	170	120	0

Table 10.--*Water-quality analyses for the 15 privately owned wells completed in the fractured crystalline-rock aquifer*--Continued

WELL NUMBER	DATE OF SAMPLE	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	IMME-DIATE COLI-FORM[2] (COL. PER 100 ML)	FECAL COLI-FORM[2] (COL. PER 100 ML)	METHY-LENE BLUE ACTIVE SUB-STANCE[2] (MG/L)	DIS-SOLVED ARSENIC (AS) (UG/L)	DIS-SOLVED BARIUM (BA) (UG/L)	DIS-SOLVED CAD-MIUM (CD) (UG/L)	DIS-SOLVED COPPER (CU) (UG/L)	DIS-SOLVED IRON (FE) (UG/L)	DIS-SOLVED LEAD (PB) (UG/L)	DIS-SOLVED MAN-GANESE (MN) (UG/L)
403	75-11-18	260	--	[3]<1	[3]<1	[8]0.0	--	100	1	--	0	6	0
128	75-10-08	350	--	<1	<1	.0	0	<200	1	--	80	11	10
	76-09-27	340	--	--	--	--	--	--	--	--	--	--	--
131	75-10-29	525	--	[4]<1	[4]<1	.0	--	200	1	--	70	6	10
	76-09-28	500	--	--	--	--	--	--	--	--	--	--	--
404	76-07-14	260	--	2	<1	.0	0	--	1	60	120	14	30
236	75-11-06	215	--	<1	<1	.0	--	--	--	--	--	--	--
	76-07-14	220	--	[5]<1	[5]<1	--	0	--	1	5	90	4	10
243	75-11-11	425	--	<1	<1	.0	--	100	0	--	2500	3	20
304	75-10-22	200	--	<1	<1	.0	--	100	0	--	370	2	210
	76-09-27	180	--	--	--	--							
318	75-11-05	260	--	<1	<1	.0	--	100	0	--	30	1	30
319	75-10-21	260	--	<1	<1	.0	--	0	0	--	10	8	10
	76-09-27	250	--	--	--	--	--	--	--	--	--	--	--
326	75-10-14	195	--	<1	<1	.0	--	0	1	--	40	2	10
	76-09-27	220	--	--	--	--	--	--	--	--	--	--	--
339	73-03-09	194	--	<1	<1	--	--	--	--	--	--	--	--
	75-11-12	175	--	1	<1	.0	--	0	0	--	40	5	10
	76-09-27	200	--	--	--	--	--	--	--	--	--	--	--
405	76-07-13	160	--	<1	<1	.0	0	--	2	1	120	12	0
406	76-08-10	285	6.2	<1	<1	.0	0	0	1	38	40	11	120
407	75-11-05	155	--	<1	<1	.0	--	100	1	--	20	0	20
410	76-08-10	256	7.2	<1	<1	.0	0	0	2	180	30	14	60

Table 10.--*Water-quality analyses for the 15 privately owned wells completed in the fractured crystalline-rock aquifer*--Continued

WELL NUMBER	DATE OF SAMPLE	DIS-SOLVED MERCURY (HG) (UG/L)	DIS-SOLVED MOLYB-DENUM (MO) (UG/L)	DIS-SOLVED ZINC (ZN) (UG/L)	DIS-SOLVED GROSS ALPHA AS U-NAT. (UG/L)	DIS-SOLVED GROSS BETA AS CS-137 (PC/L)	DIS-SOLVED POTAS-SIUM 40 (PC/L)	DIS-SOLVED RA-226 (RADON METHOD) (PC/L)	DIS-SOLVED URANIUM (U) (UG/L)
403	75-11-18	0.0	--	340	8.7	6.1	2.8	0.06	3.1
128	75-10-08	.0	--	2500	88	8.1	--	--	--
	76-09-27	--	--	--	74	13	.80	.24	33
131	75-10-29	.0	--	2300	18	8.6	--	--	--
	76-09-28	--	--	--	25	13	1.4	.38	17
404	76-07-14	.0	3	1400	26	3.6	1.7	--	--
236	75-11-06	--	--	--	--	--	--	--	--
	76-07-14	.0	5	840	96	9.3	1.0	1.1	49
243	75-11-11	.0	--	2600	28	5.4	.90	.18	28
304	75-10-22	.0	--	1500	7.0	3.2	--	--	--
	76-09-27	--	--	--	6.5	3.2	.70	.14	1.3
318	75-11-05	.0	--	210	100	13	.90	.34	29
319	75-10-21	.0	--	400	48	5.5	--	--	--
	76-09-27	--	--	--	49	10	.70	.12	17
326	75-10-14	.0	--	2800	18	5.6	--	--	--
	76-09-27	--	--	--	13	5.6	.60	.09	6.4
339	73-03-09	--	--	--	--	--	--	--	--
	75-11-12	.0	--	1700	14	4.9	--	--	--
	76-09-27	--	--	--	12	2.4	.60	.16	4.9
405	76-07-13	.0	4	5300	96	7.8	.60	.36	17
406	76-08-10	.0	13	21000	66	11	1.4	.90	18
407	75-11-05	.0	--	2300	13	3.5	.60	.06	3.5
410	76-08-10	.0	19	2700	210	28	1.0	.78	86

[1]400 PCMBC=Precambrian Erathem.

[2]Analyses of samples collected during 1975 and 1976 were made at the laboratory of the Jefferson County Health Department using standard methods (American Public Health Association, 1975); analysis of the sample collected in 1973 was made at a laboratory of the U.S. Geological Survey.

[3]These samples collected on Nov. 12, 1975.

[4]These samples collected on Nov. 13, 1975.

[5]These samples collected on about July 20, 1976.

Table 11.--*Specific-conductance data for wells completed in fractured crystalline-rock and unconsolidated-rock aquifers near the 11 governmentally owned wells*

[MICROMHOS=micromhos per centimeter at 25°Celsius]

LOCAL IDENTIFIER	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)
		WELLS NEAR WELL 1		
SC00407007BCBD-----	73-08-24	365	75-07-11	350
SC00407007BCCB-----	73-08-24	305	75-07-10	300
SC00407007BCDB-----	73-08-24	330	75-07-10	320
SC00407007BCDC-----	73-08-24	355	75-07-22	335
SC00407007BDBB-----	73-08-25	375	--------	---
SC00407007BDBD-----	73-08-24	390	75-07-09	405
SC00407007BDCA1----	73-08-23	485	75-07-09	495
SC00407007BDCA2----	73-08-23	430	75-07-09	440
SC00407007BDCD1----	73-08-24	495	75-07-11	520
SC00407007BDCD2----	73-08-24	460	75-07-22	460
SC00407007BDDA[1]----	73-08-24	420	75-07-10	375
SC00407007BDDD1----	73-08-24	560	75-07-09	670
SC00407007BDDD2----	--------	---	75-07-09	780
SC00407007CAAC-----	73-08-24	300	75-07-10	280
SC00407007CABA-----	73-08-25	480	75-07-11	490
SC00407007CABB-----	73-08-24	545	75-07-10	500
SC00407007CABD-----	73-08-24	610	75-07-01	710
SC00407007CACA-----	73-08-24	540	75-07-11	440
SC00407007CACB-----	73-08-24	710	75-07-01	650
SC00407007CADC-----	73-08-24	380	75-07-01	380
SC00407007CBAD-----	73-08-24	405	75-07-01	400
SC00407007CBBB-----	73-08-24	240	75-07-10	230
SC00407007CBCA-----	73-08-24	270	--------	---
SC00407007CBDA1----	73-08-24	440	75-07-10	420
SC00407007CBDA2----	73-08-24	520	75-07-01	495
		WELLS NEAR WELL 2		
SC00407029DACA-----	73-08026	335	--------	---
SC00407029DCAA-----	73-08-26	380	75-07-03	380
SC00407029DDBB-----	--------	---	75-07-02	500
SC00407032AAAB[1]----	73-08-26	440	75-07-22	445
SC00407032ABAD-----	--------	---	75-07-14	710
SC00407032ABCB-----	73-08-26	700	75-07-26	530

Table 11.--*Specific-conductance data for wells completed in fractured crystalline-rock and unconsolidated-rock aquifers near the 11 governmentally owned wells*--Continued

LOCAL IDENTIFIER	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)
		WELLS NEAR WELL 3		
SC00407111ADDD-----	73-08-23	560	75-07-01	745
SC00407111DBDC-----	73-08-23	400	75-07-01	340
SC00407112CACB-----	73-08-24	300	--------	---
SC00407112CBAC-----	73-08-25	275	75-07-10	280
SC00407112CBCA-----	73-08-24	320	75-07-10	280
SC00407112CBCD-----	73-08-24	230	75-07-10	220
SC00407112CBDB-----	73-08-24	260	75-07-01	260
		WELLS NEAR WELL 4		
SC00407116ACCC-----	73-08-21	545	75-07-09	580
SC00407116CBAC-----	73-08-21	410	75-07-10	370
SC00407116CDAC-----	73-08-21	480	75-07-10	500
SC00407116CDAD-----	73-08-22	645	--------	---
SC00407116CDCB-----	73-08-22	630	75-07-09	620
SC00407116DBAA-----	73-08-21	650	75-07-11	690
SC00407116DBBD-----	73-08-21	345	75-07-22	325
SC00407116DBDD-----	73-08-22	565	75-07-10	490
SC00407116DBCB-----	73-08-22	540	75-07-09	520
SC00407116DCCC-----	73-08-22	670	--------	---
		WELLS NEAR WELL 5		
SC00507006CCAB-----	73-08-17	290	75-07-14	360
SC00507006CDAA-----	73-08-17	395	75-07-03	400
SC00507006CDAB-----	--------	---	75-06-26	430
SC00507006CDAD-----	--------	---	75-07-03	800
SC00507006CDCC-----	73-08-17	360	--------	---
SC00507006DADA-----	73-08-21	305	75-06-26	470
SC00507006DCAD-----	73-08-17	300	75-07-08	320
SC00507006DCBB-----	73-08-17	260	75-06-26	270
SC00507006DCBC1----	73-08-17	360	--------	---
SC00507006DCBC2----	73-08-17	370	75-06-25	490
SC00507006DCBC3----	73-08-17	360	75-06-26	460
SC00507006DCBD-----	73-08-17	430	75-07-03	540
SC00507006DCDB-----	73-08-17	275	75-07-03	300
SC00507006DCDC-----	73-08-17	255	75-07-08	365
SC00507007ABCB-----	73-08-21	525	75-06-26	525

Table 11.--*Specific-conductance data for wells completed in fractured crystalline-rock and unconsolidated-rock aquifers near the 11 governmentally owned wells*--Continued

LOCAL IDENTIFIER	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)
		WELLS NEAR WELL 5--Continued		
SC00507007ABCC-----	73-08-17	290	75-06-26	300
SC00507007ABCD-----	73-08-17	345	75-06-26	365
SC00507007BAAC-----	73-08-17	330	75-06-26	340
SC00507007BABD-----	73-08-21	350	75-07-08	225
SC00507007BACA-----	73-08-21	360	--------	---
SC00507007BADA-----	73-08-21	465	75-07-08	500
SC00507007BBAC-----	73-08-17	360	--------	---
SC00507007BBBC-----	--------	---	75-07-02	380
SC00507007BBCA-----	73-08-17	500	75-07-02	480
SC00507007BBCB-----	--------	---	75-07-02	425
SC00507007BBCD-----	73-08-17	320	75-06-26	350
SC00507007BBDD-----	73-08-17	415	75-06-26	575
SC00507007BDAB[1]----	73-08-17	265	75-06-25	370
		WELLS NEAR WELL 6		
SC00607005CCCB-----	73-08-14	115	75-07-07	100
SC00607006DCAA-----	73-08-14	235	75-07-07	280
SC00607006DDBC-----	73-08-15	225	75-07-08	480
SC00607006DDBD-----	73-08-15	240	75-07-11	240
SC00607006DDDD-----	73-08-16	175	75-07-10	160
SC00607007AAAA1[1]---	73-08-15	120	75-07-07	120
SC00607007AAAA2----	73-08-15	195	75-07-22	205
SC00607007AABB-----	73-08-16	225	75-07-07	220
SC00607007AACC-----	--------	---	75-07-03	220
SC00607007ABAD-----	73-08-15	260	75-07-07	260
SC00607007ACAA-----	73-08-14	305	75-07-03	320
SC00607007ADBA-----	73-08-15	225	75-07-07	230
SC00607008BBBB-----	73-08-16	135	75-07-07	115
SC00607008BBBC-----	73-08-15	350	75-07-03	380
SC00607008BBCB-----	73-08-16	260	75-07-07	225
SC00607008BBCC-----	73-08-14	370	75-07-03	425
SC00607008BBDB1----	73-08-14	650	75-07-03	510
SC00607008BBDB2----	73-08-14	355	75-07-22	280
SC00607008BBDB3----	73-08-14	275	75-07-11	300

Table 11.--*Specific-conductance data for wells completed in fractured crystalline-rock and unconsolidated-rock aquifers near the 11 governmentally owned wells*--Continued

LOCAL IDENTIFIER	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)
		WELLS NEAR WELL 7		
SC00607013CBCC[1]----	--------	---	75-07-02	220
SC00607013CCBB-----	--------	---	75-06-26	265
SC00607013CCBD-----	73-08-14	250	75-07-03	250
SC00607013CCCC1----	73-08-14	340	75-07-02	360
SC00607013CCCC2----	--------	---	75-07-22	305
SC00607023AACA-----	73-08-14	285	75-07-22	390
SC00607023ABAA[1]----	73-08-14	310	75-07-02	210
SC00607024BABA[1]----	73-08-14	150	75-06-26	160
SC00607024BBBB[1]----	73-08-14	300	75-06-26	260
SC00607024BBBD1[1]---	73-08-14	225	75-07-02	200
SC00607024BBBD2----	--------	---	75-07-02	280
SC00607024BCBB[1]----	73-08-14	280	--------	---
SC00607024CBCA1[1]---	73-08-14	230	--------	---
SC00607024CBCA2[1]---	73-08-14	240	75-07-03	150
		WELLS NEAR WELL 8		
SC00507135CCAA-----	73-08-16	150	75-07-07	140
SC00607102BBDB-----	--------	---	75-07-07	260
SC00607102BBDC-----	73-06-22	360	75-07-08	370
SC00607102BCAB-----	--------	---	75-07-08	235
SC00607102BCDB-----	--------	---	75-07-10	210
		WELLS NEAR WELL 9		
SC00607111ADCC-----	73-08-16	470	75-07-07	550
SC99596111DAAA[1]----	73-08-16	145	--------	---
SC00607111DAAB-----	73-08-16	185	75-07-10	100
SC00607111DABB-----	73-08-16	185	75-07-07	180
SC00607111DABC-----	73-08-15	590	75-07-07	580
SC00607111DABD-----	73-08-15	250	75-07-07	265
SC00607111DACB-----	73-08-15	235	75-07-10	215
SC00607111DADD-----	73-08-16	255	75-07-07	240
SC00607111DBAB-----	73-08-16	250	75-07-08	250
SC00607111DBBD-----	73-08-16	360	75-07-08	320
SC00607111DBCB-----	73-08-16	275	75-07-08	270
SC00607111DBDA1----	73-08-15	340	75-07-07	305
SC00607111DBDA2----	73-08-15	335	75-07-11	360
SC00607111DBDA3----	73-08-15	410	75-07-07	425
SC00607111DBDA4----	73-08-15	380	75-07-07	400

Table 11.--*Specific-conductance data for wells completed in fractured crystalline-rock and unconsolidated-rock aquifers near the 11 governmentally owned wells*--Continued

LOCAL IDENTIFIER	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)	DATE OF MEASUREMENT (Y-M-D)	SPECIFIC CONDUCTANCE (MICROMHOS)
		WELLS NEAR WELL 9--Continued		
SC00607111DBDB-----	73-08-15	400	75-07-11	350
SC00607111DBDD-----	73-08-16	330	75-07-08	340
SC00607111DCBB-----	73-08-16	215	75-07-11	305
SC00607111DCCA-----	73-08-16	145	75-07-10	140
SC00607111DDBC1----	73-08-16	175	75-07-11	170
SC00607111DDBC2----	73-08-16	200	75-07-11	210
SC00607112CBAB[1]----	73-08-16	260	--------	---
SC00607112CBCB-----	73-08-16	245	75-07-10	290
		WELLS NEAR WELL 10		
SC00607030BBDD-----	73-08-13	245	75-07-11	260
SC00607030BCAD-----	73-08-13	280	75-07-11	260
SC00607030CBAC-----	73-04-10	310	--------	---
SC00607030CCAA[1]----	73-08-13	310	75-07-08	195
SC00607125ACAC-----	73-08-13	265	--------	---
SC00607125ACDA-----	73-08-13	320	75-07-11	315
SC00607125ACDC-----	73-08-13	315	75-07-09	390
SC00607125ADBB-----	73-08-13	300	75-07-09	280
SC00607125CCDB-----	--------	---	75-07-11	450
		WELL NEAR WELL 11		
SC00707121CABA[1]----	73-08-13	215	75-07-09	205

[1]Unconsolidated-rock aquifer.

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