WATER QUALITY

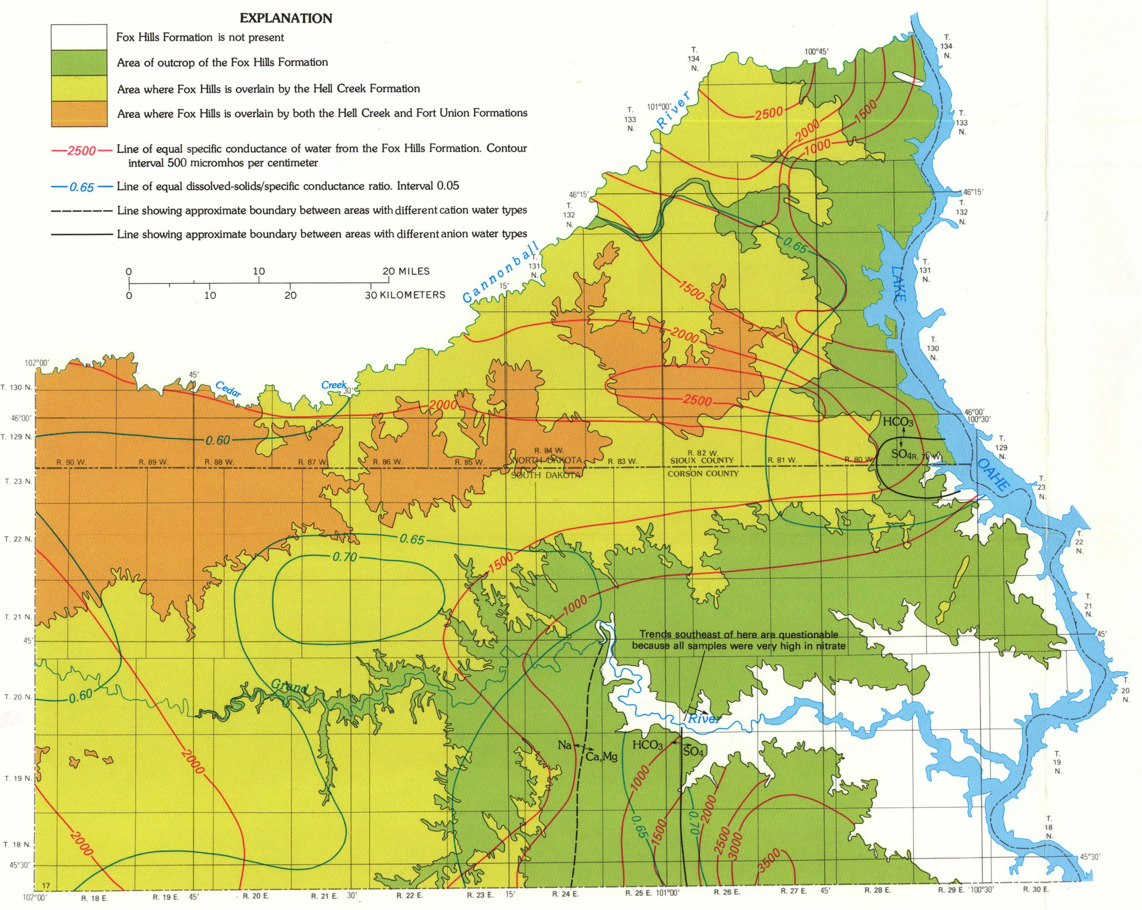

Figure 20.—Map showing specific conductance and geochemical facies in the Fox Hills Formation.

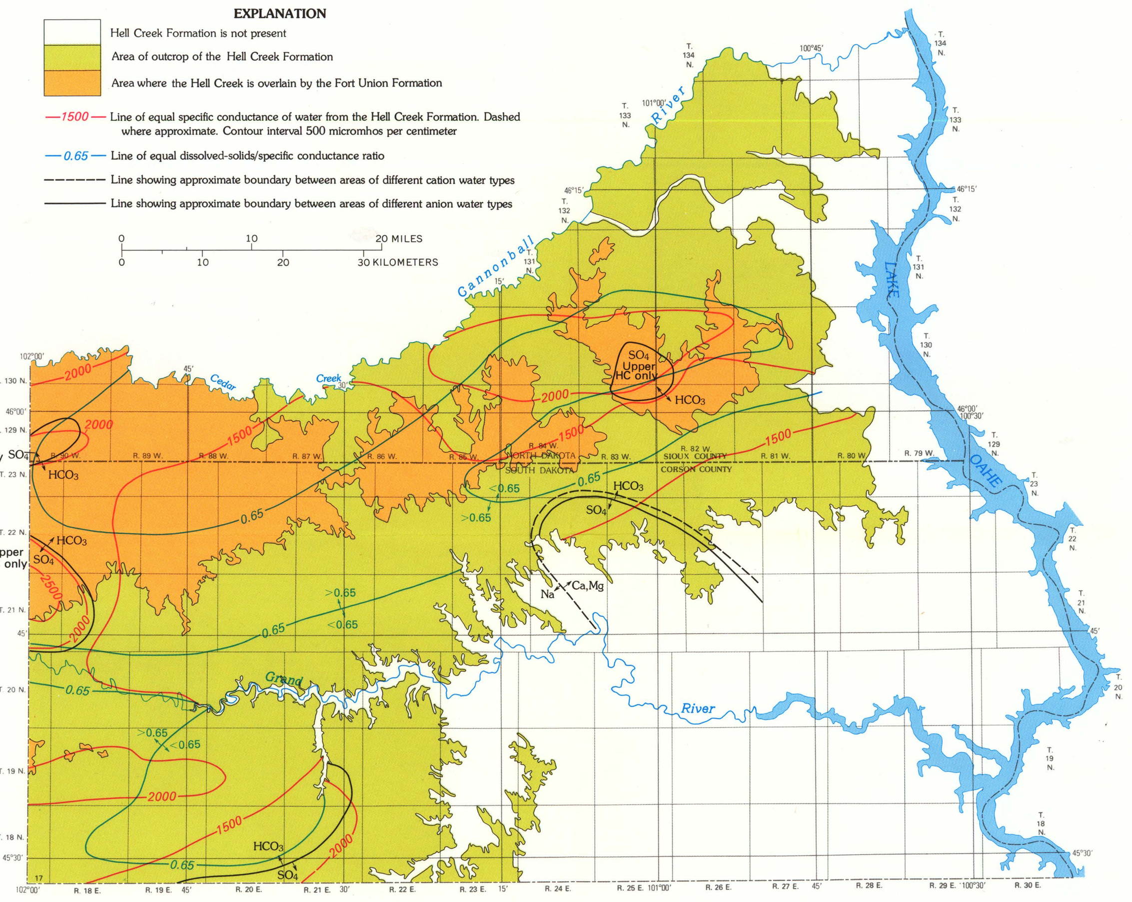

Figure 21.—Map showing specific conductance and geochemical facies in the Hell Creek Formation.

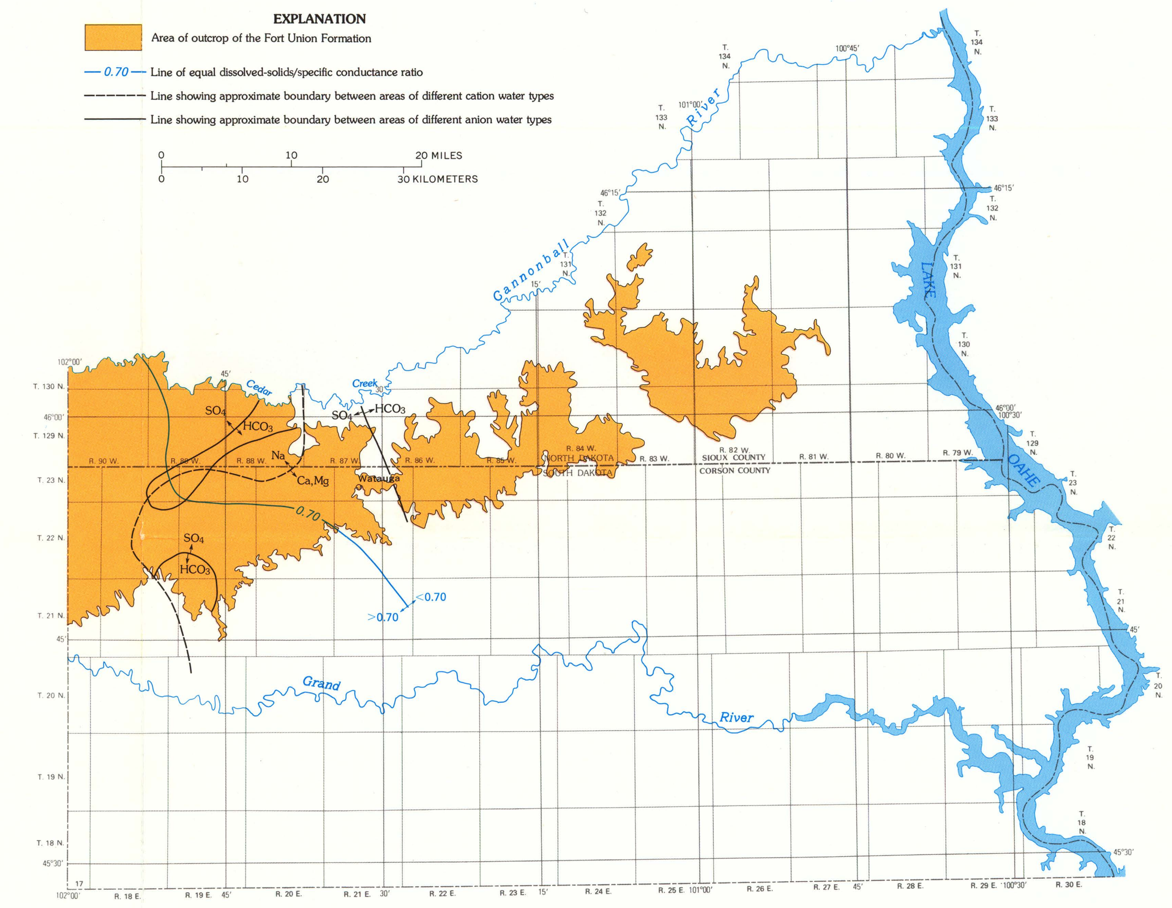

Figure 22.—Map showing dissolved-solids/specific conductance ratio and geochemical facies in the Fort Union Formation.

GROUND-WATER DEVELOPMENT

Wells and springs probably supplied less than 1,000 acre-feet of water in 1974, probably less than half of which was utilized.

The towns of Solen, Kenel, McLaughlin, and Trail City obtain their municipal supplies from wells tapping the Fox Hills Formation. Selfridge and McIntosh use wells tapping the Hell Creek Formation. Fort Yates takes its water from Lake Oahe. Where potable well water can be obtained, ground water commonly is utilized for domestic supplies, but its use for livestock supplies is much less. Most stock water normally is obtained from dugouts and stock ponds. Where potable ground water is not available, most ranchers and residents haul water from nearby towns or ranches, commonly storing it in cisterns.

Development of deep artesian aquifers in Corson and Sioux Counties is slight—so far as is known, only three wells have ever been drilled; one of these is used as an emergency fire-fighting supply at St. Francis Mission (near Wakpala), one well (near Little Eagle) is unused, and one well (about 11 miles northeast of Wakpala) is a stock supply. Although high cost is an important factor, the principal reason development has been slight is the moderate to high salinity of the water—from 2,300 to more than 200,000 mg/L of dissolved solids. The Sundance Formation probably contains the best quality artesian water. The dissolved-solids concentration in this formation ranges from 2,300 mg/L along the eastern edge of the reservation to a maximum of more than 10,000 mg/L in the northwestern part of the reservation.

SUMMARY

Shallow ground water is not obtainable in much of the area and, where it is found, it often is of poor quality. Surface water, with the exception of the Missouri and Cannonball Rivers, though a valuable and widely distributed resource, is undependable because of scanty and erratic precipitation. Artesian water from deeply buried bedrock aquifers underlies all of the reservation. These aquifers are not, and probably will not, become highly developed sources of water both because of the high cost of constructing deep wells and because of the high to very high salinity of artesian water in most of the area.

The best chemical quality and largest volume supply of water available within the reservation is from Lake Oahe, a large reservoir on the Missouri River. Development of some of the more than 16 million acre-feet of annual flow in the Missouri appears to be an attractive solution to water shortages and a boon to economic improvement, particularly for irrigation. However, the financial cost of such development probably will restrict it to large projects or to individual users within a mile or so of the reservoir; in general, the greater the distance from the reservoir, the higher the cost and the larger the area that should be developed.

Surface runoff is widely developed for livestock supplies. Although evaporation losses are high, as much as 39 inches a year, dams and dugouts are a comparatively inexpensive way to hold snowmelt and storm runoff for later use at widely dispersed sites. Use of this type of water development will continue to grow because of its many advantages.

Shallow ground water of fairly good quality is available in only a few areas. These are (1) from the Fort Union Formation, (2) where both the Hell Creek and Fox Hills Formations are present, (3) where the Fox Hills Formation is at least 150 to 200 ft thick, (4) in the alluvium along Cedar Creek and the Cannonball River, (5) in the outwash and alluvial fill of buried valleys in northeastern Sioux County, (6) locally on a few terraces, and (7) locally in alluvium along the Grand River. Most future development of shallow ground water probably will be for stock and domestic wells in the favorable areas. Water quality, of great importance in considering any possible source of supply, is of particular concern for shallow wells because of the ease of pollution from surface sources, the possible high nitrate concentrations, and the known possibility that the water may contain high selenium concentrations where it is or may have been in contact with the Pierre Shale.

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Table 3.—Significance of chemical and physical properties of water.

Of considerable use in compiling the significance column was the California State Water Resources Control Board publ. 3A, "Water Quality Criteria," 2d edition, by J. E. McKee and Harold Wolf, 548 pages, 1963.

Limits, where given, are those set forth by the U.S. Environmental Protection Agency (1975, 1977). The unit mg/L are approximately equivalent to parts per million. The unit µg/L are approximately equivalent to parts per billion.

Constituent or property	Recommended limit (mg/L)	Significance
Temperature		Affects the usefulness of water for many purposes. Generally, users prefer water of uniformly low temperature. Temperature of ground water tends to increase with increasing depth to the aquifer.
Silica (SiO_2)		Forms hard scale in pipes and boilers and may form deposits on blades of steam turbines. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	.3	Forms rust-colored sediment; stains laundry, utensils, and fixtures reddish-brown. Objectionable for food and beverage processing.
Manganese (Mn)	.05	Causes gray or black stains on porcelain, enamel, and fabrics. Can promote growth of certain kinds of bacteria.
Calcium (Ca) and Magnesium (Mg)		Cause most of the hardness and scale-forming properties of water (See hardness).
Sodium (Na) and Potassium (K)		Large amounts may limit use of water for irrigation and industrial use and, in combination with chloride, give water a salty taste. Abnormally high concentrations may indicate natural brines, industrial brines, or sewage.
Bicarbonate (HCO_3)		In combination with calcium and magnesium forms carbonate hardness.
Sulfate (SO_4)	250	Sulfates of calcium and magnesium form hard scale. Large amounts of sulfate have a laxative effect on some people and, in combination with other ions, give water a bitter taste.
Chloride (C1)	250	Large amounts increase the corrosiveness of water and, in combination with sodium, give water a salty taste.
Fluoride (F)	1.5	Reduces incidence of tooth decay when optimum fluoride content is present in water consumed by children during the period of tooth calcification. Excessive amounts of flouride may cause mottling of teeth.
Nitrate (NO_3) (as N)	45* 10*	Concentrations higher than local average may indicate pollution by feed-lot runoff, sewage, or fertilizers. Concentrations higher than 45 mg/L may be injurious when used in feeding infants.
Boron (B)		Essential to plant growth, but may be toxic to crops when present in excessive concentrations in irrigation water. Sensitive plants may show damage when irrigation water contains more than 0.67 mg/L and even tolerant plants may be damaged when boron exceeds 2.0 mg/L.
Dissolved solids	500	The total of all dissolved mineral constituents, usually expressed in milligrams per liter or in parts per million of weight. The concentration of dissolved solids may affect the taste of water. Water that contains more than 1,000 mg/L is unsuitable for many industrial uses. Some dissolved mineral matter is desirable, otherwise the water would have a flat taste.
Hardness as $CaCO_3$		Related to the soap consuming power of water; results in formation of scum when soap is added. May cause deposition of scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate in water is called carbonate hardness; hardness in excess of this amount is called non-carbonate hardness. Water that has a hardness less than 61 mg/L is considered soft; 61-120 mg/L moderately hard; 121-180 mg/L, hard; and more than 180 mg/L, very hard.
Percent sodium (Na)		Ratio of sodium to total cations in equivalents per million (epm) expressed as a percentage. Important in irrigation waters; the higher the percent sodium, the less suitable the water for irrigation.
Sodium-adsorption-ratio (SAR)		A ratio used to express the relative activity of sodium ions in exchange reactions with soil. Important in irrigation water; the higher the SAR, the less suitable the water for irrigation.
Residual sodium carbonate (RSC)		The amount, expressed in epm, of carbonate and bicarbonate a water would contain after the removal of an equivalent amount of calcium and magnesium. RSC is a measure of the "black alkali" hazard of water. Water having an RSC greater than 2.5 epm is not considered suitable for irrigation; an RSC of 1.25 to 2.5 epm is considered marginal; and an RSC of less than 1.25 epm is considered "probably safe" for irrigation.
Specific conductance		A measure of the ability of a unit cube of water to conduct an electrical current; varies with temperature, therefore reported at 25°C (77°F). Values are reported in micromhos per centimeter. Magnitude depends on concentration, kind, and degree of ionization of dissolved constituents; can be used to determine the approximate concentration of dissolved solids.
pH	6.5-8.5	A measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values lower than 7.0 indicate acidity, pH values higher than 7.0 indicate alkalinity. Water generally becomes more corrosive with decreasing pH; however, excessively alkaline water also may be corrosive.
Constituent	**Recommended limit (µg/L)**	**Significance**
Aluminum (Al)		No known necessary role in human or animal diet. Nontoxic in the concentrations normally found in natural water supplies. Concentrations greater than 1,000 µg/L may reduce yields of some crops. Long-term exposure to concentrations of more than 100 µg/L can be lethal to some types of fish.
Arsenic (As)	10 50*	No known necessary role in human or animal diet, but is toxic. A cumulative poison that is slowly excreted. Can cause nasal ulcers; skin cancer; damage to the kidneys, liver, and intestinal walls; and death.
Barium (Ba)	1,000*	Toxic; used in rat poison. In moderate to high concentrations can cause death; smaller amounts cause damage to the heart, blood vessels, and nerves.
Bromide (Br)		Not known to be essential in human or animal diet. Is non-toxic in low concentrations; less than 1,000 µg/L has no detectable affect even on fish.
Cadmium (Cd)	10*	A cumulative poison of high toxic potential. Not known to be either biologically essential or beneficial. Believed to promote renal arterial hypertension. In animal experiments, concentrations of 100 to 10,000 µg/L for one year caused liver and kidney damage; higher concentrations cause anemia, retarded growth, and death.
Chromium (Cr)	50* (hexavalent)	No known necessary role in human or animal diet. In the hexavalent form is toxic, leading to intestinal damage and to nephritis.
Copper (Cu)	1,000	Essential to metabolism; copper deficiency in infants and young animals results in nutritional anemia. Large doses of copper are toxic and may cause liver damage. Some people can detect the taste of as little as 1 to 5 mg/L of copper.
Iodide (I)		Essential and beneficial element in metabolism; deficiency can cause goiter.
Lead (Pb)	50*	A cumulative poison, toxic in small quantities. Can cause lethargy, loss of appetite, constipation, anemia, abdominal pain, gradual paralysis in the muscles, and death.
Lithium (Li)		Reported as probably beneficial in small concentrations (250 to 1,250 µg/L). Reportedly may help strengthen the cell wall and improve resistence to genetic damage and to disease. Lithium salts are used to treat certain types of psychosis.
Mercury (Hg)	2*	No known essential or beneficial role in human or animal nutrition. Liquid metallic mercury and elemental mercury dissolved in water are comparatively non-toxic, but some mercury compounds, such as mercuric chloride and alkyl mercury, are highly toxic. Elemental mercury is readily alkylated, particularly to methyl mercury, and concentrated by biological activity; fish and shellfish can contain more than 3,000 times the concentration of mercury as the water in which they live. Toxic affects of mercury compounds include chromosomal abnormalities, congenital mental retardation, progressive weakening of the muscles, loss of vision, impairment of cerebral functions, paralysis, and death.
Molybdenum (Mo)		In minute amounts, appears to be an essential nutrient for both plants and animals, but in large amounts may be toxic.
Nickel (Ni)		Highly toxic to some plants and animals. Toxicity for humans is believed to be very low.
Phosphate (PO_4)		Essential to plant growth. Concentrations higher than local average may indicate pollution by fertilizer seepage or sewage. Concentrations greater than 200 mg/L may cause diarrhea.
Selenium (Se)	10*	Essential to human and animal nutrition in minute amounts, but even a moderate excess may be harmful or potentially toxic if ingested over long periods of time. Selenium poisoning in livestock can cause loss of hair; loss of weight; abnormal hoof growth; hoof loss; liver, kidney, and heart damage; poor health and lowered disease resistance; and death. In humans, selenium can interfere with the normal function of the pancreas and other organs and effect changes in the insulin requirements of people with diabetes mellitus. Selenium is known to be a hazard in parts of South Dakota.
Silver (Ag)	50*	Causes permanent bluish darkening of the eyes and skin (argyria). Where found in water is almost always from pollution or by intentional addition. Silver salts are used in some countries to sterilize water supplies. Toxic in large dosages.
Strontium (Sr)		Importance in human and animal nutrition is not known, but believed to be essential. Toxicity believed very low—no more than calcium.
Vanadium (V)		Not known to be essential to human or animal nutrition, but believed to be beneficial in trace amounts. May be an essential trace element for all green plants. Large amounts may be toxic.
Zinc (Zn)	5,000	Essential and beneficial in metabolism; its deficiency in young children or animals will retard growth and may reduce general body resistance to disease. Seems to have no ill effects even in fairly large amounts (20,000 to 40,000 µg/L), but can impart a metallic taste or milky appearance to water. Zinc in water commonly is derived from galvanized coatings of piping; unfortunately, common contaminants of zinc used in galvanizing are cadmium and lead.

*Mandatory limit.

Table 4.—Selected chemical analyses. Analyses by U.S. Geological Survey Laboratory unless otherwise noted.

Reported in milligrams per liter (mg/L) except as indicated. One milligram per liter is approximately equal to one part per million.

Location: Township Range Section	Date of collection	Source of water	Discharge in cubic feet per second (cfs)	Depth of well (feet)	Temperature (°C)	Silica (SiO_2)	Iron (Fe) (µg/L)	Manganese (Mn) (µg/L)	Calcium (Ca)	Magnesium (Mg)	Sodium (na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate plus nitrite (dissolved as N)	Phosphorus (total as P)	Boron (B) (µg/L)	Dissolved Solids: Residue at 180°C	Dissolved Solids: Calculated	Hardness: Calcium, Magnesium	Hardness: Noncarbonate	Percent sodium	Sodium-adsorption-ratio (SAR)	Residual sodium carbonate (RSC)	Specific conductance (micromhos per centimeter at 25°C)	pH
23-29-34	6-15-72	Missouri River-Lake Oahe	--	--	23.5	5.6	30	0	51	21	66	4.5	185	0	190	7.8	0.5	0.00	--	130	456	438	210	62	40	2.0	0	675	7.9
124-79-1[1,3]	2- -67	Missouri River-Lake Oahe	--	--	--	--	0	0	57	21	60	4.3	190	0	183	8	.6	.21	--	--	461	446	228	72	36	1.7	0	--	7.9
12-31-1[3]	6-16-72	Missouri River-Lake Oahe	--	--	17.0	5.6	40	30	45	18	60	4.5	167	0	170	6.7	.4	.16	--	100	412	394	190	49	40	1.9	0	619	8.0
130-89-33	3-13-72	Cedar Creek near Pretty Rock	3,480	--	--	5.0	400	80	33	13	33	8.7	110	0	120	0.7	.1	1.5	--	90	302	265	130	41	33	1.2	0	447	7.1
130-89-33	9-14-72	Cedar Creek near Pretty Rock	9.0	--	17.0	4.9	0	30	140	110	340	11	360	0	1,200	7.0	.4	.4	--	990	2,020	1,995	790	490	48	5.2	0	2,600	7.9
131-84-3	10- 2-73	Cannonball River near Shields upstream of Shields aquifer	14.1	--	16.5	5.9	0	10	55	59	260	7.5	280	6	660	10	.7	2.5	--	690	1,220	1,210	380	140	59	5.8	0	1,710	8.3
132-83-30	10- 2-73	Cannonball River on Shields aquifer	14.3	--	17.0	6.6	60	10	53	43	240	7.0	270	3	590	9.6	.3	1.0	--	340	1,120	1,090	310	83	62	5.9	0	1,570	8.3
132-83-8	10- 2-73	Cannonball River downstream of Shields aquifer	14.6	--	17.5	7.9	40	10	47	32	210	6.5	250	0	500	8.1	.3	2.0	--	430	997	939	250	42	64	5.8	0	1,390	8.2
134-82-36	1-25-72	Cannonball River at Breien	17	--	0.0	7.1	0	20	140	80	360	9.3	650	0	930	16	.6	1.0	--	840	1,890	1,870	680	140	53	6.0	0	2,500	8.0
134-82-36	3-21-72	Cannonball River at Breien	1,920	--	5.0	7.0	50	60	41	17	46	7.8	130	0	170	.8	.1	6.7	--	0	332	362	170	69	35	1.5	0	550	7.3
131-82-18	5- 4-71	Froelich Reservoir-Porcupine Creek	--	--	13.5	4.4	260	10	13	4.7	50	6.9	180	0	16	2.8	.5	1.0	--	280	198	195	52	0	64	3.0	1.91	309	7.8
21-16-30	6-15-72	Grand River at Shadehill (Perkins Co.)	300	--	22.0	3.5	160	10	34	21	180	7.8	274	0	360	3.2	.3	.11	--	330	852	746	170	0	68	6.0	1.06	1,130	8.1
20-27-28	6-15-72	Grand River at Little Eagle	174	--	22.5	5.7	240	0	41	21	180	8.0	311	0	350	5.7	.3	.01	.21	290	836	765	190	0	66	5.7	1.33	1,170	7.8
19-26-17[1]	6-24-74	Terrace	--	28	--	--	90	10	78	34	180	6.2	590	0	210	16	.6	.23	--	--	835	820	336	0	59	4.3	2.98	1,200	7.8
19-29-3[2]	7-17-64	Terrace and alluvium	--	32	--	--	150	2,320	340	63	650	28	280		2,100	90	1.8	0	--	--	2,870	3,510	1,120	0	55	8.5	6.13	4,100	--
20-27-21[2]	7-17-64	Terrace	--	--	--	--	5,790	160	220	68	220	12	510		785	10	.7	--	--	--	--	1,540	840	329	36	3.3	0	2,200	--
21-24-14[1]	2-20-75	Terrace	--	54	--	--	2,870	270	110	38	64	6.5	484	0	153	5.3	.9	<1	--	--	660	624	425	35	11	.5	0	978	7.3
22-29-14[1]	8- 9-74	Terrace and alluvium	--	32	--	--	70	1,710	290	200	680	15	505	0	2,490	15	.6	< .01	--	--	4,500	3,940	1,530	1,130	49	7.5	0	--	8.2
130-80-3	8-16-71	Shields aquifer	--	190	7.0	27	1,300	10	41	22	360	5.2	700	0	360	27	1.0	2.5	--	1,200	1,220	1,200	190	0	80	11	7.67	1,380	8.0
131-80-33	8-18-71	Shields aquifer	--	168	7.0	24	0	100	48	25	220	5.8	530	0	250	9.8	.8	2.5	--	1,100	869	853	220	0	68	6.5	4.29	1,330	8.1
132-82-19	11-23-71	Shields aquifer	--	64	8.0	19	2,100	10	52	10	88	3.3	390	0	51	1.1	.6	1.0	--	350	413	423	170	0	52	2.9	5.29	662	7.7
133-79-29	5- 8-73	Beaver Creek aquifer	--	113	10.0	21	180	470	67	52	520	11	950	0	700	10	.6	1.0	--	970	1,870	1,860	380	0	74	12	7.97	2,630	8.0
133-80-12	8-11-71	Beaver Creek aquifer	--	134	7.0	19	6,500	160	22	7.5	500	4.7	690	5	600	3.3	.7	3.6	--	1,300	1,540	1,520	86	0	92	23	9.59	2,210	8.2
134-79-23	4-11-59	St. James aquifer	--	50	8.5	19	20	100	51	27	54	5.9	360	0	33	4.2	.4	20	--	200	387	395	240	0	32	1.5	1.10	648	8.5
134-79-32	10-23-73	St. James aquifer	--	288	9.0	24	120	160	17	6.4	380	3.8	920	0	140	6.6	1.3	1.0	--	2,100	1,040	1,040	69	0	92	20	13.70	1,670	8.2
18-15-12[1,3]	9- -65	Fort Union Formation	--	225	--	--	400	<50	25	3	906	5.5	634	0	1,440	22	1.3	.3	--	--	2,790	2,720	77	0	96	46	8.85	--	8.0
21-17-14	6- 6-73	Fort Union Formation	--	42	9.2	11	50	80	120	44	790	7.6	677	0	1,400	98	1.0	4.4	.00	910	3,300	2,830	480	0	78	16	1.5	3,930	7.5
21-19-6	6- 6-73	Fort Union Formation	--	57	9.0	14	2,500	--	72	38	120	6.2	403	0	250	4.7	1.1	.00	--	300	803	707	340	6	43	2.8	0	1,100	7.1
22-20-19	6- 5-73	Fort Union Formation	--	65	9.0	13	1,800	1,400	240	110	250	8.7	587	0	1,100	12	1.1	.00	.03	350	2,240	2,030	1,100	580	34	3.4	0	2,530	7.1
23-17-14	6- 5-73	Fort Union Formation	--	287	--	9.6	30	40	25	5.7	490	6.9	557	0	660	2.8	.9	.05	.06	1,500	1,690	1,480	87	0	92	23	7.41	2,230	7.9
23-22-20	6-13-73	Fort Union Formation	--	90	9.0	16	4,700	--	72	27	34	3.1	379	0	61	4.0	.1	.01	--	80	428	409	290	0	20	.9	.39	685	7.4
129-88-5	7- 4-73	Fort Union Formation	--	180	13.0	8.2	50	0	4.6	2.3	410	2.7	780	7	210	39	3.0	2.5	.10	1,900	1,080	1,080	21	0	97	39	12.59	1,710	8.3
18-17-13	5-24-73	Hell Creek Formation	--	180	9.5	11	30	--	8.2	1.5	380	2.5	826	0	200	4.9	1.3	.15	--	1,500	1,070	1,020	27	0	97	32	13	1,610	8.1
18-20-10	9-27-73	Hell Creek Formation	--	165	--	11	40	13	3.9	.5	310	1.4	516	0	240	3.0	1.0	.31	.37	700	832	829	12	0	98	39	8.2	1,300	8.1
19-22-29	9-27-73	Hell Creek Formation	--	64	10.0	28	40	60	170	37	440	3.8	328	0	600	220	.4	75	--	590	2,120	1,990	580	310	62	80	0	2,920	7.0
21-19-18	6- 6-73	Hell Creek Formation	--	210	9.2	7.4	290	30	4.1	.6	320	1.3	655	0	190	49	1.8	.36	.25	1,000	968	857	13	0	98	39	10	1,390	8.2
23-17-23	6- 5-73	Hell Creek Formation	--	600	--	6.9	30	10	3.1	.5	400	1.7	932	0	5.8	110	4.1	.00	.18	2,000	1,050	995	10	0	99	56	15	1,680	8.1
23-22-36	6-12-73	Hell Creek Formation	--	212	--	12	50	10	11	1.5	350	1.4	710	0	180	4.1	1.0	.51	.37	1,200	964	916	34	0	96	26	11	1,460	8.0
23-26-30	6-12-73	Hell Creek Formation	--	80	9.0	22	40	170	100	35	280	3.2	535	0	370	62	.6	25	.37	1,200	1,320	1,260	390	0	61	6.1	9.0	1,840	7.2
129-88-5	7- 4-73	Hell Creek Formation	--	348	11.0	9.8	1,100	20	3.8	1.1	420	1.5	830	28	130	61	4.2	1.0	.13	2,000	1,060	1,080	14	0	98	46	14.24	1,710	8.6
130-81-31	12-10-71	Hell Creek Formation	--	225	--	17	0	10	6.7	.4	340	1.3	580	13	250	.0	.4	1.0	--	440	928	920	18	0	97	35	9.58	1,440	8.4
130-86-28	6-10-73	Hell Creek Formation	--	210	11.0	19	50	0	5.6	1.4	440	1.4	820	0	240	45	3.2	1.5	.15	3,200	1,200	1,170	20	0	98	43	13.04	1,800	8.1
131-81-31	12-15-71	Hell Creek Formation	--	200	--	17	260	10	12	2.4	590	2.6	980	0	480	18	1.0	1.0	--	1,100	1,530	1,620	40	0	97	41	15.52	2,420	8.1
131-85-8[3]	11-17-71	Hell Creek Formation	--	394	--	18	280	0	4.7	1.6	420	1.2	830	13	19	150	3.2	1.0	--	170	1,040	1,050	18	0	98	43	13.63	1,340	8.4
18-19-28	10- 3-73	Fox Hills Formation	--	195	--	10	440	30	7.8	.7	480	1.9	568	9	650	5.4	1.3	.87	--	1,900	1,530	1,450	440	0	98	44	9.2	2,240	8.4
18-21-6	10- 2-73	Fox Hills Formation	--	130	9.5	8.6	420	42	4.9	.4	430	1.6	675	0	5.0	270	1.3	.62	.25	2,200	1,160	1,060	14	0	98	50	11	1,850	7.9
18-27-5	9-25-73	Fox Hills Formation	--	50	9.0	17	200	710	270	120	380	13	441	0	1,300	100	.0	22	--	460	2,690	2,520	1,200	0	41	4.8	0	3,220	7.5
19-23-18	9-26-73	Fox Hills Formation	--	140	10.0	9.5	20	60	30	7.4	460	2.3	510	0	650	14	.7	5.8	--	770	1,460	1,450	110	0	90	20	7.3	2,130	7.9
20-17-1	10-18-73	Fox Hills Formation	--	120	--	8.4	10	0	42	.6	490	2.0	815	0	4.5	310	2.3	.14	--	2,400	1,240	1,230	13	0	99	59	13	2,110	8.2
21-21-18	6-13-73	Fox Hills Formation	--	180	10.0	11	270	30	20	4.0	680	2.5	673	0	1,000	35	1.0	2.9	.09	2,000	2,310	2,100	67	0	96	36	9.7	3,130	7.3
21-27-6	6-12-73	Fox Hills Formation	--	112	9.0	16	700	160	66	28	48	2.7	407	0	63	3.7	.1	.29	.03	60	452	433	280	0	27	1.2	1.1	725	7.4
22-24-28	6-13-73	Fox Hills Formation	--	45	9.0	20	50	10	65	19	250	3.6	584	0	330	3.0	.1	.96	--	200	982	984	240	0	69	7.0	4.8	1,490	7.4
22-29-24	6-11-73	Fox Hills Formation	--	82	--	16	80	120	78	31	33	7.8	412	0	55	3.4	.3	.10	.03	100	426	429	320	0	18	.8	.31	707	7.4
23-16-21[3]	6- -73	Fox Hills Formation	--	900	--	10	60	30	2.7	.4	500	1.6	904	0	9.5	250	3.5	.00	.40	1,900	1,260	1,230	9	0	99	75	14.66	2,030	8.3
129-79-7	12-14-71	Fox Hills Formation	--	210	--	12	700	10	51	12	310	5.3	580	0	390	.4	.6	2.5	--	660	1,090	1,080	180	0	79	10	5.98	1,600	8.1
129-87-10	1- 5-73	Fox Hills Formation	--	361	10.5	11	70	10	3.4	.5	490	1.4	880	21	4.9	220	3.7	.00	.15	2,400	1,200	1,200	11	0	99	66	14.90	2,010	8.5
130-84-36	10-10-73	Fox Hills Formation	--	417	10.0	13	1,200	80	7.4	.9	540	2.0	680	11	410	130	2.0	.20	--	2,600	1,470	1,460	22	0	98	50	9.37	2,470	8.4
131-80-2	4-11-59	Fox Hills Formation	--	50	8.0	27	2,300	250	76	28	680	7.5	1,590	0	420	2.4	.3	.10	--	1,700	2,020	2,040	300	0	82	17	19.97	2,950	7.2
132-83-29	12- 3-71	Fox Hills Formation	--	400	--	17	430	10	5.0	1.6	440	1.3	860	0	220	17	3.2	1.0	--	2,000	1,140	1,140	19	0	98	44	13.72	1,760	8.2
133-80-31	5-15-73	Fox Hills Formation	--	180	8.5	24	160	180	63	25	65	5.0	440	0	27	3.5	.2	2.5	--	0	400	436	260	0	35	1.7	2.01	687	8.0
134-79-26	4-11-59	Fox Hills Formation	--	96	12.0	16	110	30	3.0	1.6	110	1.6	280	4	15	2.4	.5	1.5	--	330	296	296	14	0	94	13	4.44	476	8.3
134-82-36	9- 1-71	Fox Hills Formation	--	157	12.0	11	280	100	9.1	3.8	650	3.4	1,050	31	480	56	2.1	3.3	.05	2,700	1,870	1,780	38	0	97	46	17.47	2,670	8.5
19-29-2	5-25-72	Dakota Formation	--	2,000	--	12	20	0	27	16	2,700	13	557	0	18	3,900	.7	.02	--	5,600	7,100	6,990	130	0	98	102	6.5	12,400	7.3
20-26-33	8-18-60	Inyan Kara Group	--	2,426	32.8	14	2,100	--	57	26	3,900	19	579	0	41	6,000	.6	.20	--	6,800	10,400	10,400	251	0	97	108	4.5	17,500	7.7
22-19-11[3,4]	1- -52	Upper part of Inyan Kara Group	--	3,793 to 3,825	--			--	12	1.7	1,600		1,200	--	23	1,700	--	--	--	--	4,600	3,940	37	0	99	114	18.93	--	8.5
22-19-11[3,4]	1- -52	Lower part of Minnelusa Formation	--	5,175 to 5,196	--	--	--	--	3,220	433	50,800		156	--	21,400	83,400	--	--	--	--	140,400	159,300	9,800	9,690	92	223	0	--	6.3
21-19-8[3,4]	11-25-53	Top of Mission Canyon Limestone	--	5,410 to 5,430	--	--	--	--	1,050	129	4,380		945	--	9,000	1,800	--	--	--	--	--	17,300	3,160	2,390	75	33.9	0	--	6.9
22-19-11[3,4]	2- -52	Upper part of Mission Canyon Limestone	--	5,606 to 5,659	--	--	--	--	696	322	1,280		2,000	--	2,250	--	--	--	--	--	7,240	5,550	2,400	761	48	11	0	--	6.6
22-19-11[3,4]	2- -52	Upper part of Mission Canyon Limestone	--	5,758 to 5,820	--	--	--	--	1,060	198	3,570		320	--	2,000	6,290	--	--	--	--	13,400	13,300	3,460	3,200	69	26	0	--	7.5
22-19-23[3,4]	10-24-53	Top of Mission Canyon Limestone	--	5,454 to 5,479	--	--	--	--	1,010	165	3,060		744	--	4,600	3,160	--	--	--	--	12,740	12,400	3,300	2,690	68	27	0	--	--
18-21-26[4,5]		Upper part of Red River Formation	--	5,803 to 6,128	--	--	--	--	860	204	1,936		340	--	1,480	3,820	--	--	--	--	--	8,460	2,980	2,950	59	15	0	11,600	7.2
22-19-11[3,4]	3-10-52	Top of Red River Formation	--	7,182 to 7,305	--	--	--	--	6,510	1,160	42,400		220	--	950	79,500	--	--	--	--	130,700	130,600	21,000	20,800	81	127	0	--	6.9
22-19-11[3,4]	3-10-52	Upper part of Deadwood Formation	--	7,980 to 8,010	--	--	--	--	1,370	156	13,630		260	--	1,950	22,300	--	--	--	--	39,700	39,500	4,050	3,840	88	93	0	--	6.6

Table 4 (continued). Reported in micrograms per liter (µg/L) except as indicated. One microgram per liter is approximately equal to one part per billion.

Location: Township Range Section	Date of collection	Aluminum (Al)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bromide (Br)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Cyanide (CN) (mg/L)	Iodide (I)	Lead (Pb)	Lithium (Li)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Strontium (Sr)	Vanadium (V)	Zinc (Z)
23-29-34	6-15-72	0	2	0	--	60	0	0	1	2	--	6	2	40	0.1	2	4	4	--	500	1.0	10
124-79-1[1,3]	2- -67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
12-31-1[3]	6-16-72	10	1	0	--	30	0	0	1	8	--	7	2	40	.1	2	2	3	--	420	.9	20
130-89-33	3-13-72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
130-89-33	9-14-72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
131-84-3	10- 2-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
132-83-30	10- 2-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
132-83-8	10- 2-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-82-36	1-25-72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-82-36	3-21-72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
131-82-18	5- 4-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
21-16-30	6-15-72	50	0	0	--	--	0	0	10	4	--	--	2	0	.1	3	0	6	0	410	2.0	10
20-27-28	6-15-72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
19-26-17[1]	6-24-74	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
19-29-3[2]	7-17-64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
20-27-21[2]	7-17-64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
21-24-14[1]	2-20-75	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-29-14[1]	8- 9-74	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
130-80-3	8-16-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
131-80-33	8-18-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
132-82-19	11-23-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
133-79-29	5- 8-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
133-80-12	8-11-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-79-23	4-11-59	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-79-32	10-23-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18-15-12[1,3]	9- -65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
21-17-14	6- 6-73	0	4	0	--	200	0	0	1	6	--	30	0	270	.1	1	1	24	0	3,500	.0	200
21-19-6	6- 6-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0	--	--	--	--
22-20-19	6- 5-73	10	0	0	--	30	0	0	2	3	--	40	0	310	.1	0	48	2	0	4,300	.0	100
23-17-14	6- 5-73	10	5	0	--	40	0	0	0	6	--	20	0	10	.2	4	1	2	0	730	.0	270
23-22-20	6-13-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
129-88-5	7- 4-73	20	0	0	0	--	0	0	1	6	.04	--	13	40	.2	9	4	6	0	130	.9	100
18-17-13	5-24-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.0	--	--	--	--
18-20-10	9-27-73	0	0	0	--	100	0	0	1	250	--	--	3	70	.0	15	4	4	0	60	1.0	300
19-22-29	9-27-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--
21-19-18	6- 6-73	0	0	0	--	30	1	0	1	11	--	10	2	40	.0	4	4	5	0	120	.0	360
23-17-23	6- 5-73	0	16	100	--	900	0	0	1	5	--	100	1	40	.1	12	1	.0	0	110	1.5	130
23-22-36	6-12-73	0	0	0	--	400	0	0	2	11	--	20	1	70	.5	0	8	4	0	130	.0	40
23-26-30	6-12-73	0	2	100	--	7,100	0	0	2	30	--	70	1	80	.3	2	38	6	0	750	.4	40
129-88-5	7- 4-73	0	0	0	0	--	0	0	1	7	.00	--	3	50	.1	21	3	8	1	100	1.3	100
130-81-31	12-10-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
130-86-28	6-10-73	20	9	200	0	--	1	0	2	11	.01	--	5	50	.2	100	3	5	0	110	0	150
131-81-31	12-15-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
131-85-8[3]	11-17-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18-19-28	10- 3-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--
18-21-6	10- 2-73	60	0	0	--	700	1	0	1	22	--	--	4	60	.0	2	4	4	0	80	9.0	400
18-27-5	9-25-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--
19-23-18	9-26-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--
20-17-1	10-18-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4	--	--	--	--
21-21-18	6-13-73	10	10	0	--	200	0	0	0	5	--	20	2	130	.0	11	11	2	0	420	.1	120
21-27-6	6-12-73	0	6	100	--	300	0	0	0	3	--	80	1	80	.3	0	7	0	0	270	.0	20
22-24-28	6-13-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--
22-29-24	6-11-73	0	0	0	--	50	0	0	0	3	--	0	3	60	.0	0	6	2	0	410	.8	30
23-16-21[3]	6- -73	0	0	100	--	1,500	0	0	0	3	--	3,400	1	70	.2	8	1	0	0	110	8.4	30
129-79-7	12-14-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
129-87-10	1- 5-73	10	2	0	0	--	1	0	1	3	.00	--	1	60	.1	9	0	3	0	130	5.6	30
130-84-36	10-10-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
131-80-2	4-11-59	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
132-83-29	12- 3-71	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
133-80-31	5-15-73	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-79-26	4-11-59	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
134-82-36	9- 1-71	0	0	0	0	--	0	0	0	4	.00	--	3	120	.9	5	2	4	0	100	.0	20
19-29-2	5-25-72	10	0	0	--	14,000	1	0	0	7	--	3,500	2	390	.0	1	2	3	--	1,200	140	30
20-26-33	8-18-60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	1- -52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	1- -52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
21-19-8[3,4]	11-25-53	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	2- -52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	2- -52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-23[3,4]	10-24-53	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18-21-26[4,5]		--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	3-10-52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
22-19-11[3,4]	3-10-52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[1]S. Dak. Dept. Health, Pierre.
[2]Station Biochemistry, S. Dak. State Univ., Brookings.
[3]Not in report area.
[4]Gulf Oil Co.
[5]Drill-stem test of oil-test hole.

WATER QUALITY

The importance of the various chemical constituents in water depends not only upon the amount of the substance present, but also upon the use made of the water. For domestic use, the U.S. Public Health Service (1962) suggests that water contain no more than 1,000 mg/L dissolved solids; however, as much as half the population of South Dakota drinks water that contains more than 1,000 mg/L dissolved solids. Livestock generally has greater salt tolerance than people; pigs, one of the less salt-tolerant animals, can drink water containing as much as 4,200 mg/L dissolved solids (Officers of the Dept. of Agr. and Govt. Chem. Lab., 1950). Most crops have less salt tolerance than animals; irrigation water containing 1,200 to 1,500 mg/L dissolved solids is barely acceptable in quality, if low in sodium, to unsuitable if sodium constitutes much more than half of the cations. An outline of the significance of various constituents is given in table 3.

Selected chemical analyses of surface and ground water are presented in table 4 to show the general variation of constituents.

All the aquifers below the Pierre Shale yield warm to hot water; temperature ranges from 86°F for the cooler part of the Dakota Formation to at least 163°F, reported on the geophysical log of an oil test that penetrated the Deadwood Formation. Maximum temperature in the Red River or Deadwood Formation may be more than 212°F. Thus these aquifers constitute a reservoir of low temperature geothermal energy. The total amount of energy stored in these aquifers at temperatures greater than 95°F probably exceeds 500 quadrillion Btu (British thermal units) or 150 trillion kWh (kilowatt hours) electrical equivalent. The energy stored at temperatures greater than 68°F may be greater than 900 quadrillion Btu (250 trillion kWh electrical equivalent). The economic feasibility of developing this geothermal resource depends, of course, upon local conditions, available technology, energy needs, costs of alternatives, and many other factors.

The high salinity of the artesian water is due mostly to salts dissolved from beds of evaporite minerals such as halite (sodium chloride) and anhydrite (calcium sulfate). Dedolomitization (dissolving calcium-magnesium carbonate and redepositing calcium carbonate) of dolomitic facies may be an important process in determining the content and composition of dissolved solids in water from the lower salinity part of some of these aquifers.

The chemical characteristics of water from bedrock formations overlying the Pierre Shale are summarized below. Some of the interpretation and inferences made in the geochemical discussion are based upon two premises:

(1) That a regional aquifer, as outlined in the section on shallow ground-water resources, does, in fact, exist.

(2) That the natural concentration of nitrate in water from these formations is less than 0.46 mg/L reported as N (nitrogen; this is equivalent to 2 mg/L as nitrate). Concentrations larger than this are assumed to reflect either surface leakage into the well or local recharge of water containing leachant from fertilizer, sewage, barnyards, or feedlots.

Fox Hills Formation.—Dissolved-solids concentration tends to be high where the Fox Hills (see fig. 20) is thin, or where wells are screened near the base of the formation, or in wells that bottom in the Pierre Shale, or where the most permeable beds in the Fox Hills received recharge through several hundred feet of overlying beds. Water from the Timber Lake Member commonly contains less than 1,000 mg/L dissolved solids; exceptions are where the Timber Lake is clayey or where it is overlain by several hundred feet of other strata. But for the exceptions listed above, dissolved solids concentration in water in the Fox Hills Formation tends to increase to the west or northwest.

The dissolved-solids/specific conductance ratio ranged from 0.58 to 0.91, but all values larger than 0.70 were from water high in nitrate.

Sodium concentration exceeds 60 percent of the cations except where the dissolved-solids concentration is less than 700 mg/L.

The major anion is bicarbonate except in the eastern area of Fox Hills outcrop where it is sulfate. Sulfate is also the dominant anion in water from some of the scattered wells that showed anomalously high concentrations of nitrate.

The relative proportion of sulfate decreases and of bicarbonate and chloride increase with depth, but the difference is not significant above a well depth of 500 feet. The change is abrupt at 500 feet, but probably is an artifact, at least in part, of the small number of samples (six) analyzed from wells between 500 and 1,000 feet deep. The most likely explanation for the relative decrease in sulfate and increase in bicarbonate and chloride is that where the most permeable beds in the Fox Hills Formation are buried deeply enough so that well depths exceed 500 feet, they probably receive much (most?) of their recharge from the west. Overlying beds in the Hell Creek and Fort Union Formations probably intercept most local recharge. Where the most permeable beds in the Fox Hills are less than 500 feet below the surface, they receive proportionately more local recharge of water that contains a relatively higher sulfate content.

Chloride concentration tends to increase to the west and northwest, but the trend is slight and has local exceptions in the northwestern part of the reservation.

Bromine and iodine concentrations tend to increase from east to west. Strontium concentration tends to decrease from east to west and from south to north.

The distribution pattern of specific conductance and other chemical parameters indicates that the Fox Hills is receiving local recharge from the Shields aquifer along its path through Sioux County and from Lake Oahe where water-bearing beds in the Fox Hills are adjacent to Lake Oahe and are below the level of its surface.

Hell Creek Formation.—Where the dissolved-solids concentration of water from the Hell Creek Formation (see fig. 21) is greater than 1,000 mg/L, either the water table is more than 200 feet below the land surface, or the Hell Creek is overlain by the Fort Union Formation (usually 100 feet or more of Fort Union), or the water contains an anomalously high concentration of nitrate. In general, dissolved-solids concentration increases with increasing well depth, although local conditions such as availability of soluble salts in the soil zone and variations in vertical permeability may be important. The three areas in western Sioux and Corson Counties where the specific conductance exceeds 2,000 µmho/cm (micromhos per centimeter) may have lower lateral permeability than the surrounding area. Dissolved-solids concentration tends to be higher south of the Grand River than north of it.

The dissolved-solids/specific conductance ratio ranged from 0.59 to 0.88; all but one of the values that exceeded 0.70 came from samples that contained high nitrate concentrations.

Sodium concentration exceeds 60 percent of the cations (commonly more than 90 percent) except near the outcrop limit of the Hell Creek along the Grand River in Corson County. Even in this area, all but one sample came from water that had high nitrate concentrations.

Bicarbonate is the predominant anion except that sulfate may be dominant in the basal Hell Creek at and near the southern border of Corson County, and locally in the upper part of the Hell Creek in the north-central and northwestern parts of the reservation where the Hell Creek is overlain by the Fort Union Formation. Many of the scattered wells that have high nitrate concentrations in their water also have sulfate as the dominant anion.

The relative proportion of sulfate decreases and of bicarbonate and chloride increase with depth, but the difference is not significant above a well depth of 400 feet. The change appears to be abrupt at 400 feet, but that may be an artifact, at least in part, of the small number of samples (3, plus one anomalously high in nitrate) analyzed from wells between 400 and 700 feet deep. The most likely explanation is that where the most permeable beds in the Hell Creek Formation are buried deeply enough so that well depths exceed 400 feet, they probably receive much (most?) of their recharge from the west. Overlying beds in the Fort Union Formation and, in some areas, the upper part of the Hell Creek Formation probably intercept most local recharge. Where the more permeable zones in the Hell Creek are less than 400 feet below the land surface, they probably receive local recharge that is relatively high in sulfate.

Chloride concentration is low but increases near the western boundary of the reservation.

Fluoride concentration is low but increases from east to west and tends to increase with increasing well depth. Fluoride concentration seems to be independent of both dissolved solids and nitrate concentrations.

Boron concentration tends to increase with increasing well depth (or with increasing distance from the outcrop limit?).

Calcium and magnesium concentrations tend to decrease with increasing well depth.

Thus far, analysis of the distribution of trace elements in samples containing low nitrate concentrations has not yielded a discernable pattern.

Fort Union Formation.—The following discussion of water quality parameters (see fig. 22) in the Fort Union is based upon samples collected in the western half of its extent on the Standing Rock Indian Reservation and from adjacent areas. No wells in the Fort Union that could be sampled were found more than 6 miles east of Watauga. Of 17 samples for which nitrate concentrations were available, 9 contained more than 0.5 mg/L reported as nitrogen.

The average dissolved-solids concentration is highest of the three bedrock formations that overlie the Pierre Shale. The only water found in the Fort Union that contained less than 1,000 mg/L dissolved solids came from a few of the wells that were less than 100 feet deep. There is a general, but not strong, trend for dissolved-solids concentration to increase with depth and to increase from east to west.

The dissolved-solids/specific conductance ratio ranged from 0.63 to 0.70 in Sioux County, a fairly narrow range, but in Corson County the ratio ranged from 0.62 to 0.89, a wide range for such a small area. However, the values in the two-county area form a pattern—all values equal to or greater than 0.70 are west of a northwest-southeast line that passes just west of Keldron.

Dominant ions in the water are calcium magnesium, and bicarbonate east of Watauga. From Watauga to within 5 to 7 miles of the western border of Corson County the dominant ions are calcium, magnesium, and sulfate. Along the western edge of Corson County, and in Sioux County west of Watauga, the dominant ions are sodium and sulfate except for a narrow band from Keldron to the northeast, where the dominant ions are calcium, magnesium, sodium, and bicarbonate.

Chloride concentration is less than 15 mg/L except near the outcrop limit of the Fort Union northeast of Keldron and in a high nitrate sample from near the outcrop limit at the Perkins County line just north of the Grand River. Just west of the western boundary of the reservation, the chloride concentration increases to more than 30 mg/L.

Lithium concentration decreases to the northwest (down dip).

Strontium concentration is high (greater than 4 mg/L) and decreases to the northwest. Strontium concentration seems to decrease as the combined calcium and magnesium concentration increases.

Base from U.S. Geological Survey
Bismarck, 1954–76, and McIntosh, 1953–76,
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GEOHYDROLOGY OF THE STANDING ROCK INDIAN RESERVATION, NORTH AND SOUTH DAKOTA

By
Lewis Howells

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