GEOHYDROLOGY OF THE DEEP BEDROCK AQUIFERS (CONT'D.)

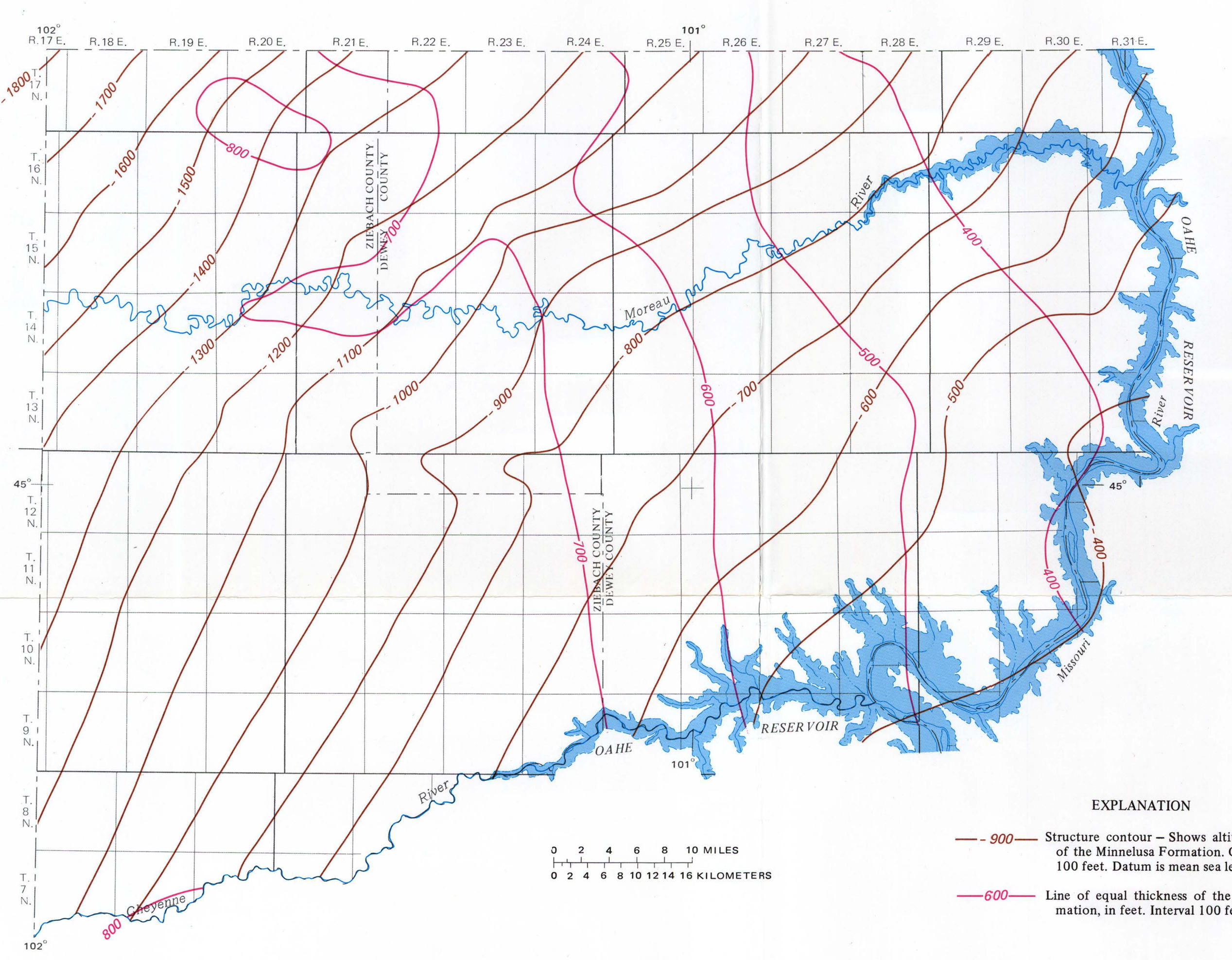

Figure 10. – Map showing structure contours and thickness of the Minnelusa Formation.

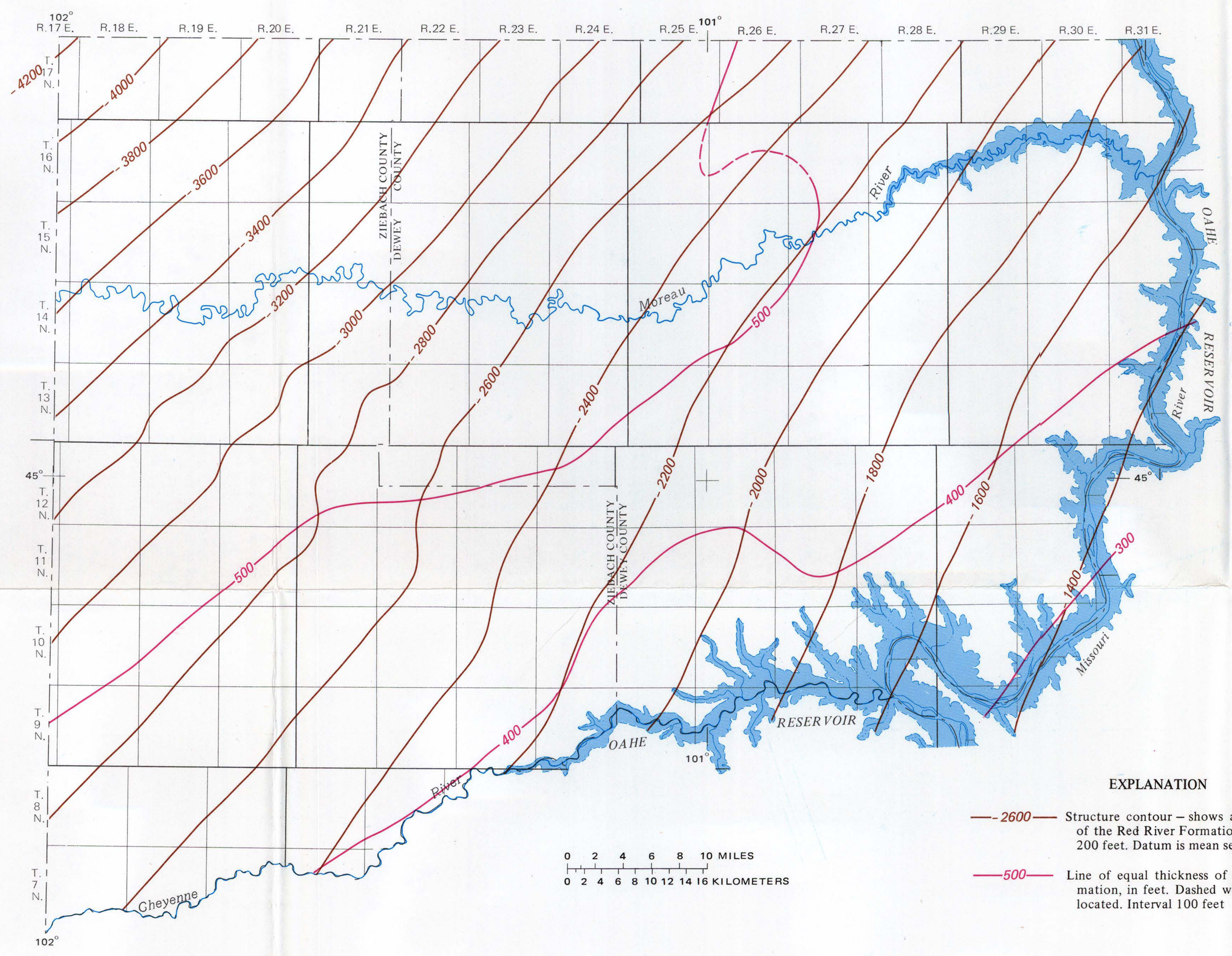

Figure 14. – Map showing structure contours and thickness of the Red River Formation.

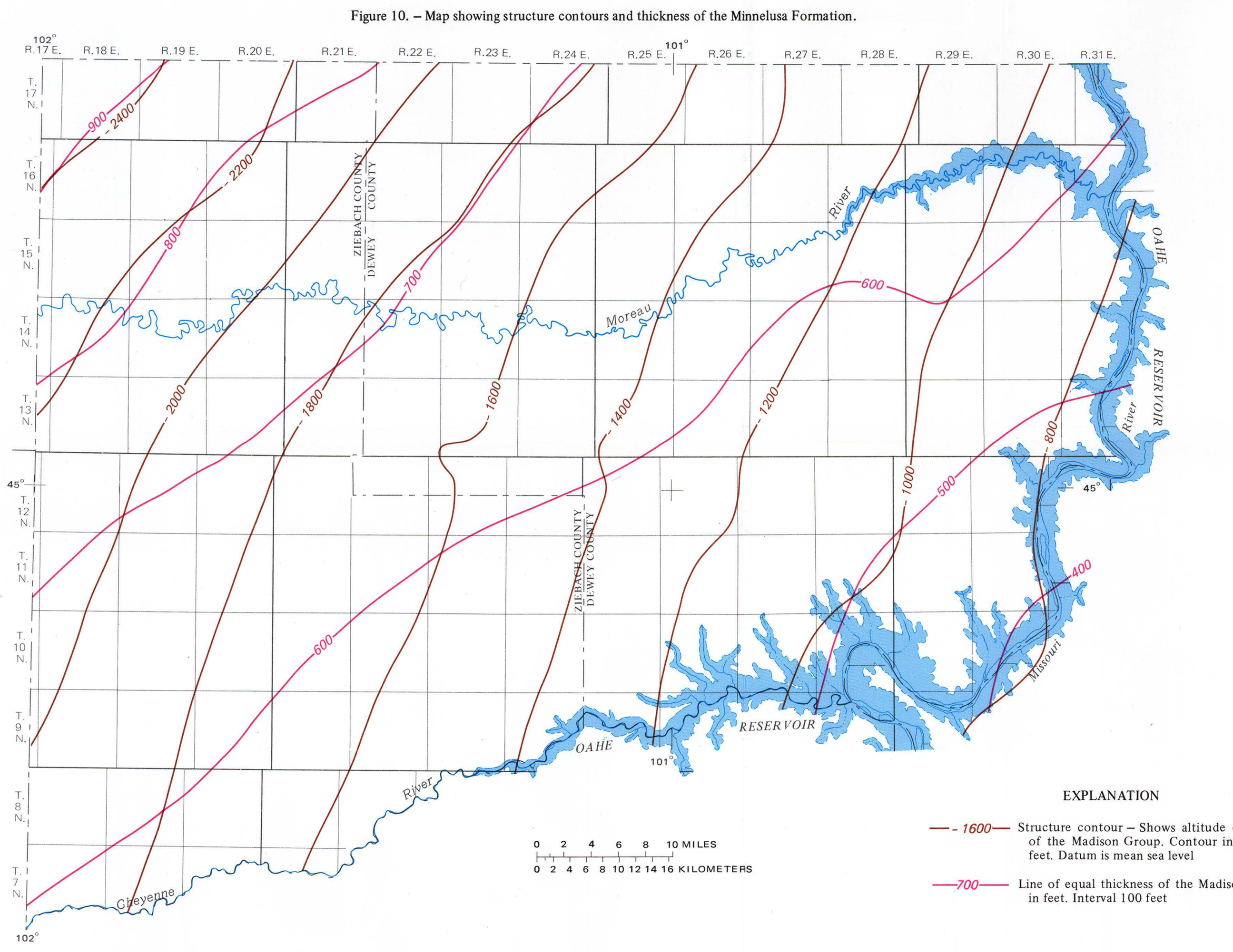

Figure 11. – Map showing structure contours and thickness of the Madison Group.

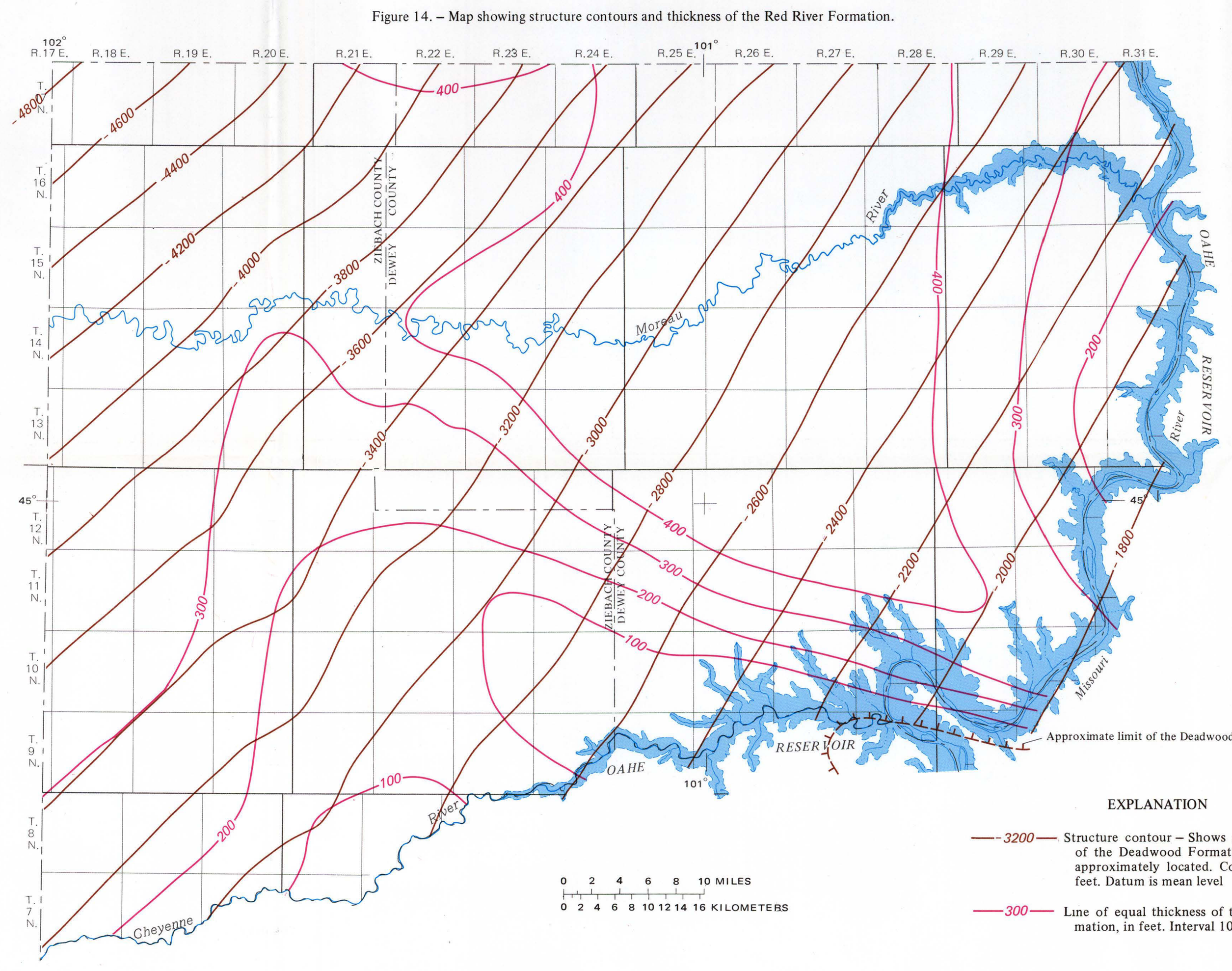

Figure 15. – Map showing structure contours and thickness of the Deadwood Formation.

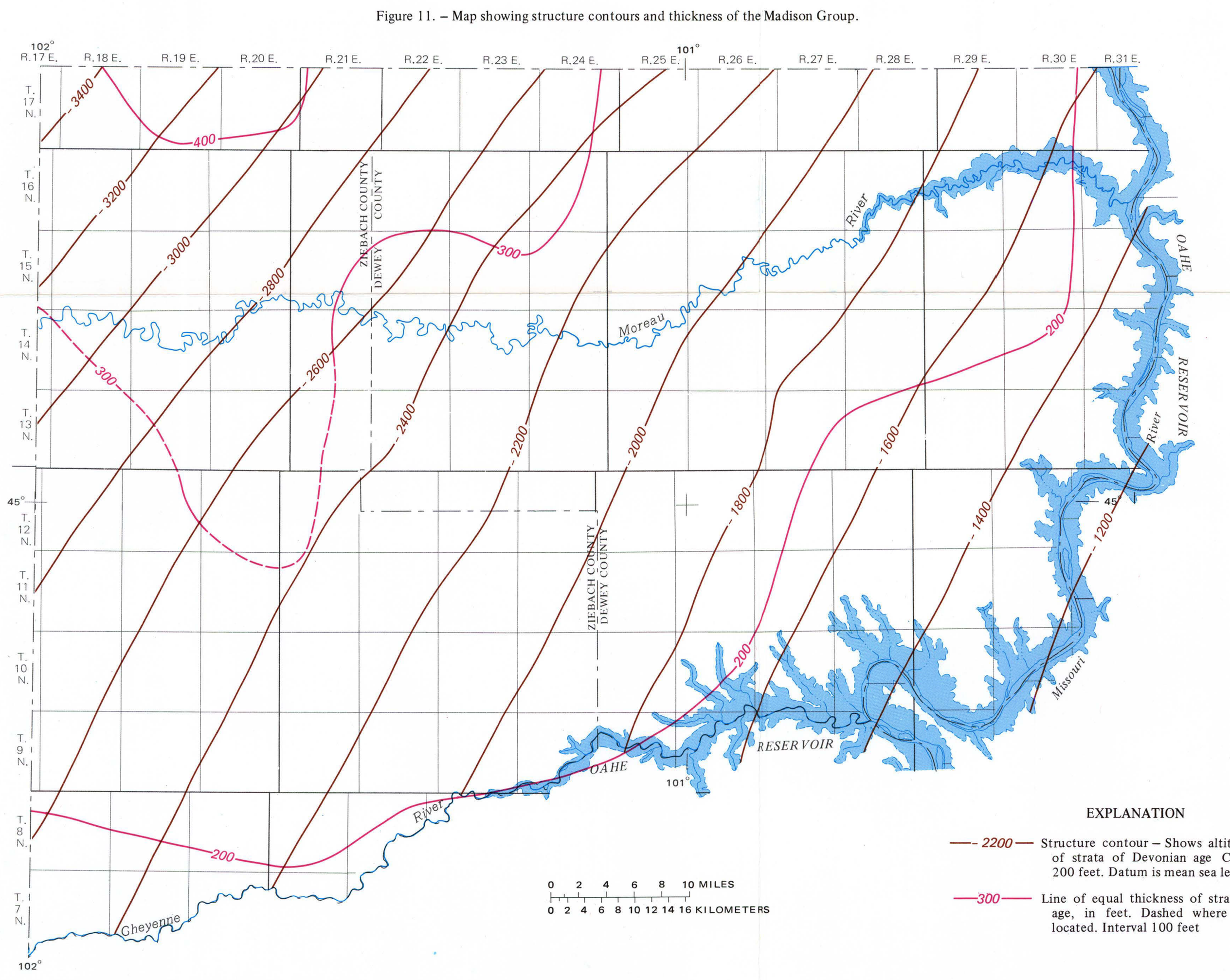

Figure 12. – Map showing structure contours and thickness of the undifferentiated formations of Devonian age.

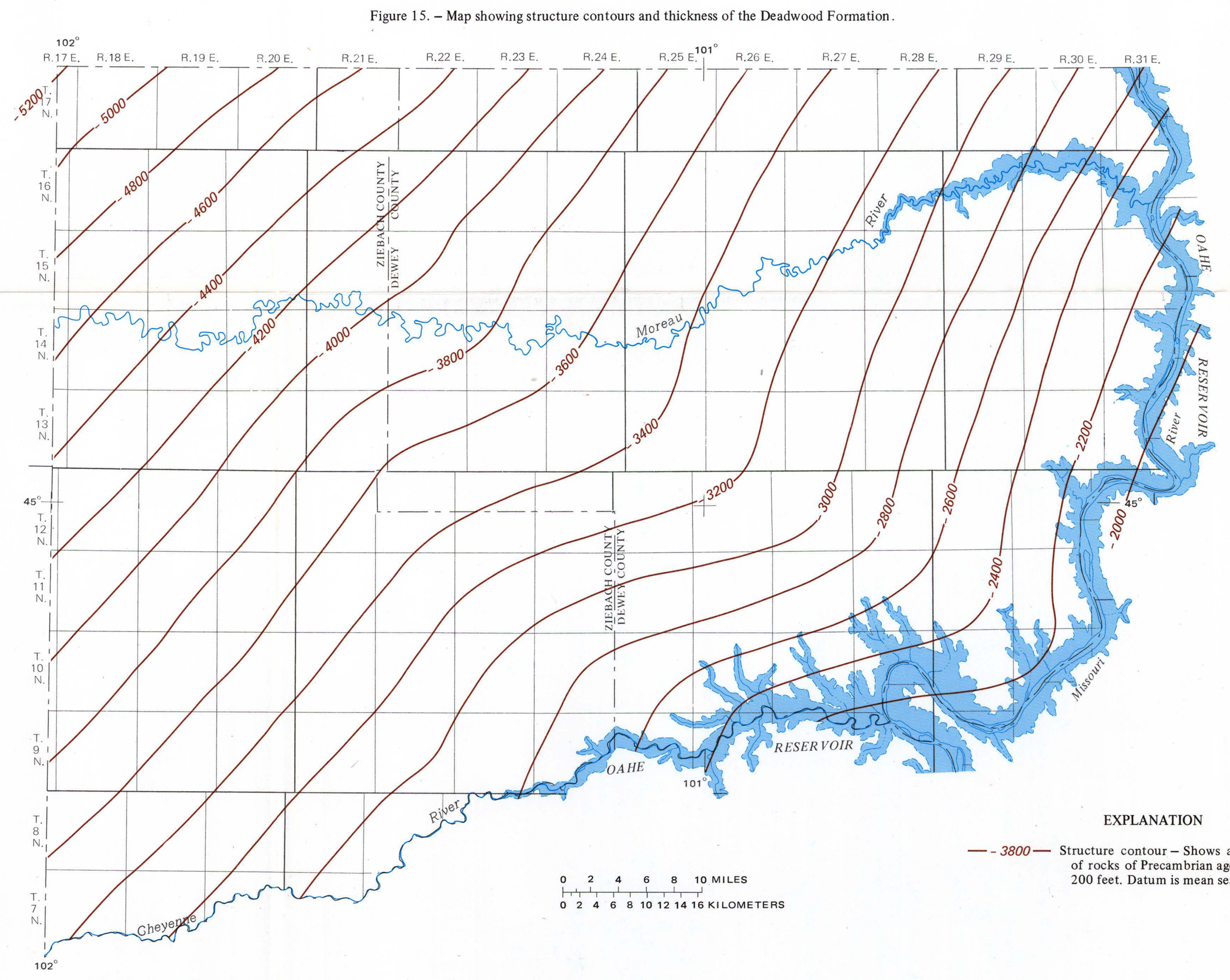

Figure 16. – Structure contour map of the Precambrian surface.

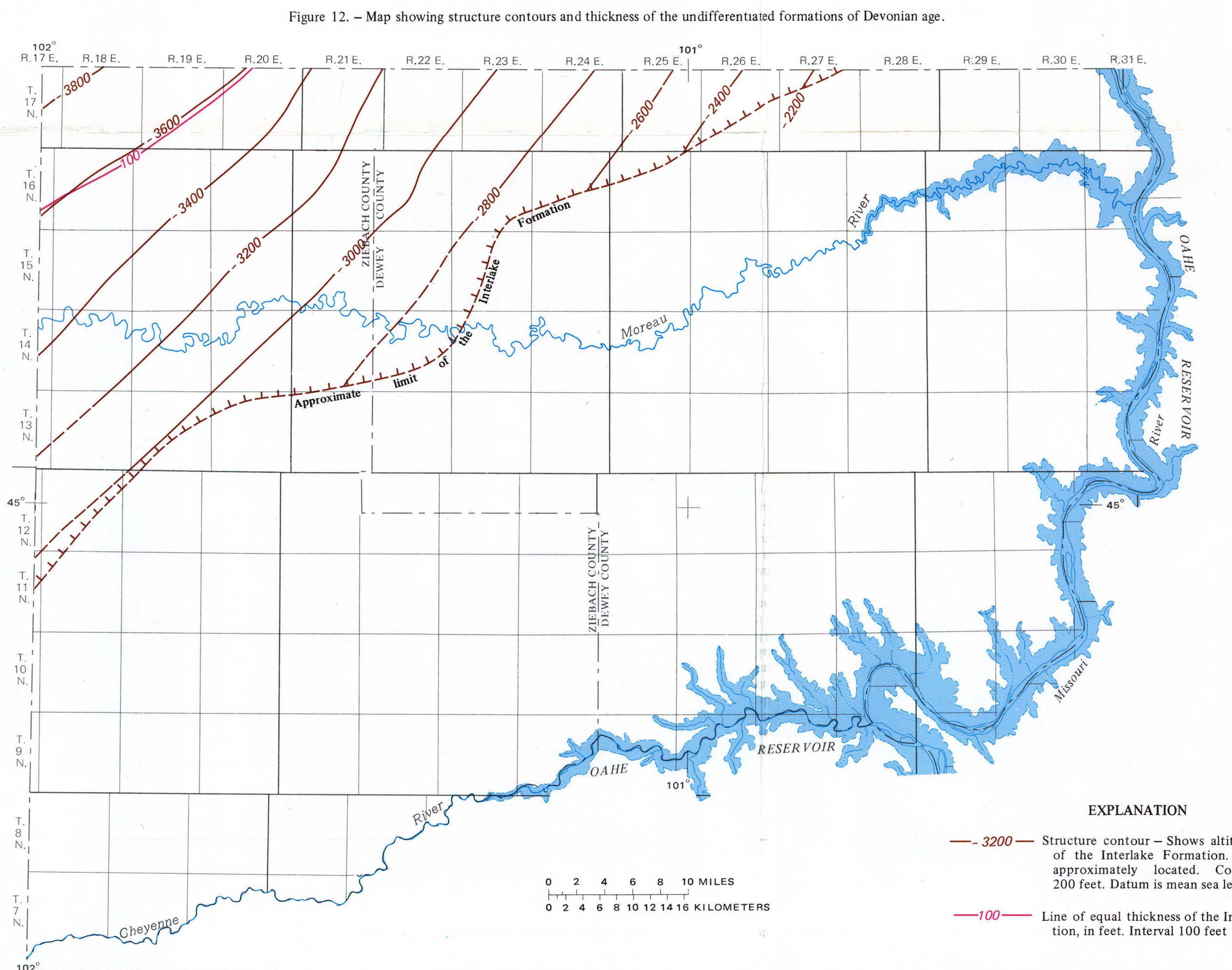

Figure 13. – Map showing structure contours and thickness of the Interlake Formation.

GROUND-WATER DEVELOPMENT

Wells and springs probably supplied less than 1,500 acre-ft of water in 1974, probably less than half of which was utilized.

The towns of Eagle Butte and Dupree obtain their municipal supplies from wells tapping the Madison Group. Bridger Day School and Cherry Creek communities use wells tapping alluvium along the Cheyenne River. Bear Creek community obtains a meager supply from wells tapping alluvium and terrace deposits. Timber Lake, Isabel, and other communities in the northern part of the area use wells tapping the Timber Lake Member of the Fox Hills Formation or the aquifer in the Hell Creek and Fox Hills Formations. 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 their water from nearby towns or ranches, commonly storing it in cisterns. The most widely used sources for hauled water are at Faith (well tapping the Hell Creek Formation), Eagle Butte and Dupree, Circle P Springs, Timber Lake, and the Swiftbird Camp (treatment plant for Lake Oahe water). Several schools and small communities, such as White Horse, use water from ponds.

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) recommends 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 have greater salt tolerance than people; pigs, one of the less salt tolerant animals, can drink water that contains as much as 4,200 mg/L of dissolved solids (Hem. 1970). Most crops have less salt tolerance than animals; irrigation water that contains 1,200 to 1,500 mg/L of dissolved solids is barely acceptable in quality if it is low in sodium. If sodium constitutes much more than half of the cations the water is unsuitable. 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.

Shallow wells are particularly vulnerable to pollution because the depth to the well screen is too short for adequate natural filtration of downward-moving soil water and because the wells often are near sources of contamination such as barnyards or feedlots.

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. Public Health Service (1962) or the U.S. Environ mental Protection Agency (1975). The unit mg/L is approximately equivalent to parts per million. The unit µg/L is approximately equivalent to parts per billion

Constituent or property	Recommended limit (mg/L) *Mandatory limit	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)	0.3	Forms rust-colored sediment; stains laundry, utensils, and fixtures reddish-brown. Objectionable for food and beverage processing.
Manganese	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 (Cl)	250	Large amounts increase the corrosiveness of water and, in combination with sodium, give water a salty taste.
Floride (F)	1.5	Reduces incidence of tooth decay when optimum flouride content is present in water consumed by children during the period of tooth calcification. Excessive amounts of fluoride may cause mottling of teeth
Nitrate (NO_3)	45* 10*	Concentrations higher than local average may indicate pollution by feedlot 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 noncarbonate 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		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.
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 nontoxic 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 1 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 resistance 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 nontoxic, 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 function, 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		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.
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 that of 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.

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	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)	Nitrite plus Nitrate dissolved as N	Phosphorous total as P	Boron (B) (µg/L)	Dissolved solids: Residue at 180°C	Dissolved solids: Calculated	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent Sodium	Sodium-adsorption-ratio (SAR)	Residual Sodium Carbonate (RSC)	Specific conductance (micromhos per centimeter at 25°C)	pH
12-31-1	6-16-72	Missouri River-Oahe Res.	–	17.0	5.6	40	30	45	18	60	4.5	167	0	170	6.7	0.4	0.16	–	100	412	394	190	49	40	1.9	0	619	8.0
13-31-32[1]	11- -67	Missouri River-Oahe Res.	–	–	–	200	100	60	19	68	4.5	212	0	190	8	.6	.00	–	–	511	459	230	56	39	2.2	0	–	8.1
9-24-32	6-14-72	Cheyenne River	–	23.5	9.5	90	0	85	24	67	9.8	135	0	330	15	.4	.85	–	180	688	612	310	200	31	1.7	0	867	7.4
9-24-32	1-09-74	Cheyenne River	–	.0	13	–	–	150	140	51	18	364	0	1,600	100	.7	2.9	0.09	420	–	2,670	950	650	51	6.5	0	3,400	7.8
9-19-8	5-10-72	Red Coat Creek	–	9.0	6.1	60	0	71	24	140	7.6	154	0	460	8.3	.3	.07	.23	80	–	794	280	150	52	3.7	0	1,130	7.8
8-22-6	5-11-72	Cherry Creek	–	9.0	8.9	50	0	78	30	170	8.0	145	0	540	17	.2	.29	1.0	200	–	926	320	200	53	4.1	0	1,280	7.6
14-24-17	12-21-50	Moreau River	–	–	16	40	–	240	79	920		743	0	2,200	47	.8	.18	–	–	3,870	3,820	920	310	69	1.6	0	4,630	7.7
14-24-17	6-15-72	Moreau River	–	21.0	8.7	110	0	75	24	220	9.5	252	0	540	9.1	.4	.03	.05	60	1,040	1,010	290	79	62	5.7	0	1,460	7.8
14-16-10[2]	6-14-72	Moreau River	–	22.0	7.6	250	3	18	5.3	130	5.9	222	0	190	2.2	.3	3.4	–	140	532	484	67	0	79	6.9	2.30	749	7.7
14-18-9	4-14-49	Flint Rock Creek	–	–	8.0	10	–	25	9.8	43		153	0	61	3.5	.1	.52	–	70	255	228	100	0	48	1.8	.45	382	7.4
15-20-33	4-15-49	Thunder Butte Creek	–	–	14	100	–	16	3.8	29		78	0	52	.0	.2	.0	–	–	180	154	56	0	53	1.7	.17	251	7.4
15-21-28	4-15-49	Irish (Worthless) Creek	–	–	7.9	20	–	8.0	8.5	31		76	0	50	4.0	.3	.50	–	0	176	148	55	0	55	1.8	.15	237	7.2
15-26-11cc	4-12-49	Little Moreau River	–	–	7.2	10	–	27	7.6	27		98	0	69	2.0	.3	.56	–	20	209	192	99	19	38	1.2	0	305	7.9
15-26-12[1]	4- -68	White Horse Day School Reservoir	–	–	–	0	0	120	10	130	8.1	136	0	530	3	.8	.0	–	–	936	876	350	230	44	3.1	0	–	7.4
17-22-16[1]	2- -70	Lake Isabel	–	–	–	4,000	1,200	26	6	92	8.1	283	0	46	5	.3	.0	–	–	383	330	100	0	67	4.2	2.85	–	7.3
7-18-26	7-06-60	Alluvium	29	21	10	230	540	150	38	290	16	239	0	930	47	.5	.18	–	780	1,660	1,600	530	340	53	5.5	0	2,200	7.8
9-19-7	7-08-60	Alluvium	12	12	9.3	20	0	120	28	660	7.3	422	0	1,500	18	.4	.11	–	570	2,550	2,520	410	68	77	14	0	3,370	7.5
14-19-8	7-14-60	Alluvium	24	13	13	30	370	59	18	800	7.9	797	0	1,300	18	.5	.11	–	650	2,550	2,560	220	0	88	24	12.03	3,520	7.9
14-20-4	7-15-60	Alluvium or terrace deposit	21	14.5	15	10	2,800	270	70	930	16	510	0	2,500	74	.3	.0	–	700	4,310	4,090	960	540	67	13	0	5,020	7.4
15-20-34	7-15-60	Alluvium	21	13	15	20	1,800	110	30	420	10	503	0	880	17	.3	.0	–	720	1,760	1,730	400	0	69	9.1	.26	2,390	7.5
14-23-13	7-18-60	Alluvium	26	14.5	15	20	2,900	420	110	510	22	348	0	2,300	46	.4	.07	–	570	3,810	3,600	1,520	1,200	42	5.6	0	4,170	7.3
7-18-24[1]	1- -68	Terrace deposit	40	–	–	3,500	2,200	260	73	380	10	412	0	1,400	38	.7	.0	–	–	–	2,350	970	620	46	5.3	0	–	7.2
8-22-31	7-12-60	Terrace deposit	44	11	12	690	5,900	400	84	680	9.5	427	0	2,400	103	.2	.05	–	550	4,050	3,850	1,340	990	52	8.1	0	4,600	7.5
9-19-5	7-08-60	Terrace deposit	24	23	9.2	260	420	800	80	1,600	22	329	0	2,200	2,600	.1	1.40	–	740	8,190	7,570	2,730	2,500	55	13	0	10,800	7.3
9-23-25	9-26-73	Terrace deposit	Spring	14.0	17	20	0	45	5.9	37	2.8	209	0	31	5.4	.2	1.9	–	90	247	256	140	0	36	1.4	.69	424	8.0
14-20-4	7-15-60	Terrace deposit	18	14.5	15	10	2,800	270	70	930	16	510	0	2,500	74	.3	.0	–	700	4,310	4,090	960	540	67	13	0	5,020	7.4
13-22-23	7-20-60	Terrace deposit	21	9.5	11	70	320	40	9.5	290	3.3	517	0	340	16	.3	.11	–	790	988	966	140	0	82	11	5.70	1,490	7.8
14-23-13	7-19-60	Terrace deposit	27	13	14	10	8,800	420	130	870	16	582	0	2,900	55	.4	.20	–	740	4,890	4,670	1,600	1,100	54	9.4	0	5,440	7.3
14-28-26	4-08-59	Terrace deposit	33	8	27	40	30	140	36	300	7.7	433	0	780	13	.4	.90	–	320	1,580	1,520	500	140	56	5.8	0	2,090	7.3
13-19-17	6-25-59	Hell Creek Formation	110	9.5	12	90	60	33	6.0	230	7.3	400	0	280	1.1	.4	.56	–	250	784	774	110	0	81	9.7	4.42	1,180	7.6
16-18-15	10-18-73	Hell Creek Formation	150	–	11	40	60	16	1.5	570	5.8	624	0	780	10	.4	.06	–	1,300	1,750	1,700	46	0	96	37	9.31	2,500	8.0
17-19-29	5-25-73	Hell Creek Formation	220	9.5	9.9	50	20	8.4	.5	490	1.7	603	0	630	15	1.5	.05	–	1,800	1,510	1,460	23	0	98	44	9.42	2,170	8.3
11-18-10	10-25-73	Fox Hills Formation	140	11.0	13	60	50	28	3.9	960	5.9	1,720	0	720	7.1	.2	.03	–	2,200	2,660	2,590	86	0	96	45	26.47	3,800	7.9
12-23-9	5-22-73	Fox Hills Formation	165	11.5	11	60	360	110	19	760	5.8	406	0	1,500	59	.3	.02	–	1,200	2,620	2,670	350	22	82	18	0	3,380	7.8
13-19-27	6-25-59	Fox Hills Formation	195	11.5	11	500	30	16	2.0	520	3.9	784	0	300	200	.6	.02	–	2,200	1,540	1,460	49	0	96	33	11.89	2,300	8.0
15-18-4	5-24-73	Fox Hills Formation	70	10.0	13	30	–	62	6.8	34	1.7	267	0	26	11	.3	.91	–	130	296	295	180	0	29	1.1	.72	484	7.5
17-22-32[1]	5- -54	Fox Hills Formation	360	–	–	400	0	13	1.0	430		615	0	82	290	.95	.0	–	–	1,200	1,130	37	0	96	31	9.34	–	8.3
17-25-35	5-23-73	Fox Hills Formation	30	9.5	13	70	10	33	9.4	96	3.6	310	0	52	22	.5	.21	–	220	385	384	120	0	62	3.8	2.66	635	7.8
17-27-8	5-23-73	Fox Hills Formation	70	8.0	16	50	–	350	150	400	18	462	0	1,600	110	.4	43	–	340	3,290	3,250	1,500	1,100	37	4.5	0	3,600	7.3
10-23-13	4-09-59	Graneros Shale or Dakota Formation	1,800(?)	38	19	310	0	26	11	3,000	11	962	0	2.5	4,200	.8	.25	–	7,600	7,820	7,690	110	0	98	125	5.05	13,300	7.8
8-22-32	5-11-72	Dakota Formation	2,035	40	19	30	10	8.0	2.7	1,800	7.5	1,500	0	19	1,900	2.4	.05	–	6,600	–	4,510	31	0	99	140	23.96	7,930	7.8
9-19-5	4-09-59	Dakota Formation	2,385	48	21	40	10	7.3	2.7	2,000	5.6	1,680	0	1.3	2,100	3.3	.36	–	6,200	4,990	4,980	29	0	99	162	26.94	8,340	7.9
15-26-12	5-25-72	Dakota Formation	2,021	29.5	14	30	20	26	14	2,400	13	636	0	7.4	3,500	.8	6.3	–	7,500	5,780	6,340	120	0	97	94	7.98	11,300	7.8
10-19-13	5-25-72	Inyan Kara Group	2,883	47	24	280	20	7.3	1.6	1,400	5.8	1,430	0	1,100	570	5.2	.87	–	31,000	4,200	3,860	25	0	99	122	22.94	5,670	8.0
15-30-29	6-30-61	Inyan Kara Group and Sundance Formation	2,360	33.0	16	1,100	210	300	74	1,500	48	325	0	2,300	1,100	3.2	.14	–	2,700	5,730	5,460	1,100	780	74	20	0	7,660	7.4
15-31-8	6-30-61	Inyan Kara Group and Sundance Formation	2,266	29	13	1,800	150	160	45	400	24	225	0	1,200	73	3.1	.86	–	610	2,110	2,000	580	400	59	7.2	0	2,780	7.5
12-24-27	5-10-72	Sundance Formation	3,023	40	22	6,800	100	700	130	1,700	6.6	268	0	2,600	2,300	3.4	.04	–	2,100	–	7,620	2,300	2,100	62	15	0	10,500	6.8
15-30-26	5-24-72	Sundance Formation	2,215	–	16	360	180	110	28	750	31	345	0	1,400	280	4.6	.04	–	2,000	2,940	2,800	390	110	79	17	0	3,930	7.0
14-29-36	5-24-72	Minnelusa Formation	2,505	31.5	16	50	130	430	110	750	65	247	0	2,400	410	3.2	.40	–	2,100	4,620	4,320	1,500	1,300	50	8.4	0	5,310	6.7
13-21-31	5-11-72	Madison Group (Lodgepole Limestone)	4,500	58.0	34	50	50	400	94	110	52	146	0	1,400	120	4.0	.00	–	580	–	2,300	1,400	1,300	14	1.3	0	2,670	7.8
12-24-17	5-10-72	Madison Group (Charles Formation and Mission Canyon Limestone)	4,325	55.5	30	590	20	380	110	64	31	168	0	1,300	67	3.8	.07	–	340	–	2,080	1,400	1,300	9	.7	0	2,440	7.2
16-22-25[3,4]	3-14-53	Madison Group (Mission Canyon and Lodgepole Limestones)	4,589	–	–	–	–	430	110	950		293	0	2,000	890	–	–	–	–	5,000	–	1,500	1,300	58	10	0	–	7.2
12-22-4[3,5]	8-24-70	Red River Formation	5,078	–	–	–	–	380	97	350		183	0	1,500	300	–	–	–	–	2,780	–	1,400	1,200	36	4.2	0	–	7.0
12-22-8[3,6]	8-02-73	Red River Formation	5,078	–	–	–	–	440	96	110		185	0	1,400	130	3	.07	–	0	2,510	2,200	2,200	2,000	13	1.4	0	–	7.9
13-22-20[1,3]	8-09-70	Red River Formation	5,140	–	–	2,800	–	380	62	330	77	168	0	1,300	200	–	0	–	–	2,860	2,680	1,200	1,100	35	4.1	0	3,330	7.3

Reported in micrograms per liter (µg/L). One microgram per liter is approximately equal to one part per billion.

Location (Township Range Section)	Aluminum (Al)	Arsenic (As)	Barium (Ba)	Bromide (Br)	Cadmium (Cd)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iodide (I)	Lead (Pb)	Lithium (Li)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Selenium (Se)	Silver (Ag)	Strontium (Sr)	Vanadium (V)	Zinc (Zn)	Streamflow in cubic feet per second
12-31-1	10	1	0	30	0	0	1	8	7	2	40	0.0	2	2	3	–	420	0.9	20	>44,000
13-31-32[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	>20,000
9-24-32	10	8	0	50	1	0	10	7	5	4	70	1.0	3	9	1	–	820	.6	20	5,280
9-24-32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35
9-19-8	–	8	0	70	0	0	0	4	2	2	80	.0	2	5	7	–	780	.2	8	2.5
8-22-6	–	0	0	80	0	0	0	5	6	1	80	.0	5	6	9	–	840	2.0	20	70
14-24-17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.2
14-24-17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	459
14-16-10[2]	10	1	0	30	4	0	7	32	20	7	40	.5	3	6	10	–	180	2.4	50	352
14-18-9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44.9
15-20-33	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11.0
15-21-28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18.9
15-26-11cc	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	27.4
15-26-12[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17-22-16[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7-18-26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9-19-7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14-19-8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14-20-4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15-20-34	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14-23-13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7-18-24[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8-22-31	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9-19-5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9-23-25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	14	–	–	–	–	–
14-20-4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13-22-23	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14-23-13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14-28-26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13-19-17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16-18-15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–
17-19-29	10	4	0	400	0	10	1	3	30	0	70	.0	3	4	0	0	170	.0	100	–
11-18-10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–
12-23-9	0	4	0	400	0	0	2	1	60	1	560	.5	0	5	0	0	1,400	.0	1,900	–
13-19-27	10	2	0	15,000	0	0	1	10	700	1	180	.0	1	6	2	0	280	4.3	140	–
15-18-4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–
17-22-32[1]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17-25-35	10	3	100	30	0	0	1	3	7	1	90	.5	2	4	0	0	270	.0	80	–
17-27-8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–
10-23-13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8-22-32	–	0	0	200	0	0	0	3	7,000	1	230	.0	5	2	3	–	940	52	0	–
9-19-5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15-26-12	10	3	0	15,000	2	0	0	5	3,300	4	530	.0	0	1	4	–	1,400	86	20	–
10-19-13	10	0	0	1,700	1	0	0	2	300	3	230	.5	3	2	3	–	420	8.0	8	–
15-30-29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15-31-8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12-24-27	–	0	0	300	0	0	0	0	400	1	1,200	.5	330	4	0	–	14,000	17	40	–
15-30-26	10	0	0	500	1	0	0	0	100	4	400	.5	26	0	5	–	2,200	3.3	20	–
14-29-36	10	4	0	2,800	2	0	2	4	80	0	670	.0	42	2	3	–	8,400	10	30	–
13-21-31	–	0	0	300	0	0	0	1	20	1	230	.5	7	4	0	–	11,000	1.2	8	–
12-24-17	–	0	0	100	0	0	0	0	9	1	110	.5	11	4	0	–	9,600	1.2	8	–
16-22-25[3,4]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12-22-4[3,5]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12-22-8[3,6]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13-22-20[1,3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	–	–	–	–	–

[1]Analysis by South Dakota Dept. Health, Pierre, S. Dak.
[2]Outside of Reservation boundaries.
[3]From oil test hole drill – stem test.
[4]Analysis from Shell Oil Co.
[5]Analysis by Resa Tech., Gillette, Wyo.
[6]Analysis by K.P. Moore, Casper, Wyo.

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 Cheyenne Rivers, though a valuable and widely distributed resource, is undependable because of scanty and erratic precipitation. Artesian water from deeply buried bedrock aquifers completely underlies the Reservation. These aquifers are not, and probably will not, become highly developed sources of water because of the high cost of constructing deep wells and because of the high to very high salinity of artesian water in much of the area.

The best chemical quality and largest volume supply of water available within the Reservation is from Lake Oahe, the large reservoir on the Missouri River. Development of some of the more than 16 million acre-ft 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 cost of such development probably will restrict it to large projects or to individual users within a mile or so of the reservoirs; in general, the greater the distance from the reservoir, the higher the cost and the larger the area that would be developed.

Surface runoff is widely developed for livestock supplies. Although evaporation losses are high, as much as 39 in. 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) where both the Hell Creek and Fox Hills Formations are present, (2) where the Fox Hills Formation is at least 150 to 200 ft thick, (3) in some of the alluvium along the Cheyenne River, (4) locally on a few terraces, and (5) locally in alluvium along the Moreau River. Most future development of shallow ground water probably will be for stock and domestic wells in the few 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 possibility of the occurence of high nitrate concentrations, and the known possibility of the water containing high selenium concentrations where it may be or may have been in contact with the Pierre Shale.

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1979