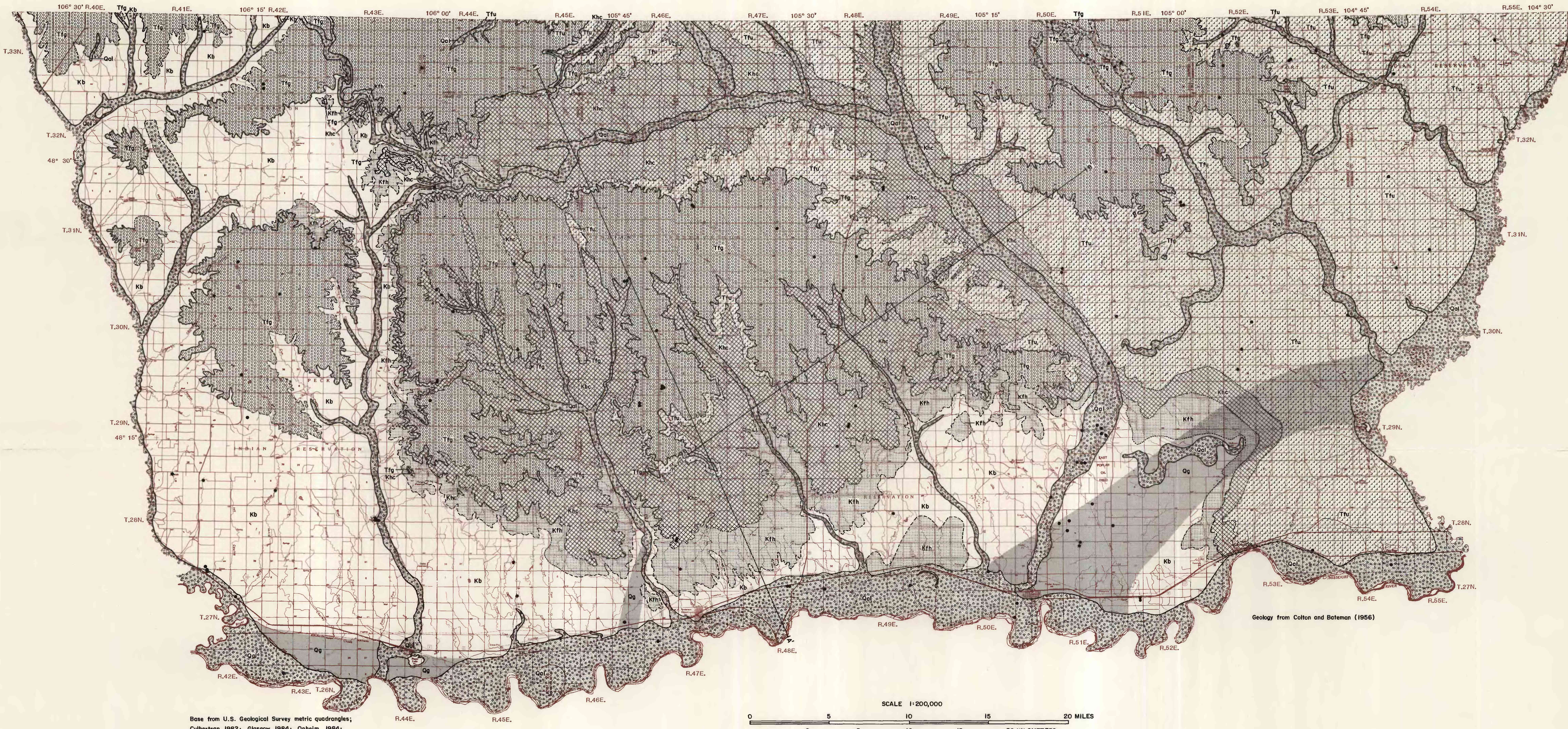

FIGURE 3.--GENERALIZED GEOLOGY AND LOCATION OF INVENTORIED WELLS AND SPRINGS.

EXPLANATION FOR FIGURES 3 AND 4

CORRELATION OF UNITS

- Qal — Holocene — QUATERNARY
- Qg — Pleistocene — QUATERNARY
- Ttg — Pliocene or Miocene — TERTIARY
- Unconformity
- Tfu — Paleocene — TERTIARY
- Gradational contact
- Khc — CRETACEOUS
- Unconformity
- Kfh — Montana Group — Upper Cretaceous — CRETACEOUS
- Gradational contact
- Kb — Montana Group — Upper Cretaceous — CRETACEOUS
- Subsurface only
- Kjrw

DESCRIPTION OF UNITS

Qal ALLUVIUM (HOLOCENE)--Fine- to coarse-grained flood-plain deposits of Missouri River and major tributaries. Chiefly silt and local gravel lenses. Thickness is 15 to 30 feet beneath valleys of smaller tributaries, but may be more than 140 feet under Missouri River flood plain. Also includes colluvial and lacustrine deposits and glacial-outwash deposits in large outwash channels. Small channels not shown

Qg THICK GLACIAL DEPOSITS (PLEISTOCENE)--Mainly till but includes sand, gravel, and silt. Thickness averages 100 feet but may be 225 feet in places. Similar thin deposits, which cover the bedrock units in most of the reservation, are not shown. Inferred positions of underlying bedrock formations shown by patterns given below

Ttg FLAXVILLE FORMATION (PLIOCENE OR MIOCENE)--Sand and gravel, mostly brown and red quartzite. Caps highland areas ranging in altitude from 2,600 to 3,000 feet above sea level. Thickness generally 30 to 50 feet but greater than 80 feet reported. Well sorted and stratified; consists of about 5 percent silt, 35 percent sand, 60 percent pebbles, and a few cobbles

Tfu FORT UNION FORMATION (PALEOCENE)--Interbedded gray clay, buff silt, lignite, buff calcareous sandstone, brown carbonaceous clay, olive-gray sand, gray bentonitic clay, and silty limestone concretions. Average thickness about 600 feet. Well sorted and stratified. Marked lateral variation in lithology. Lower contact arbitrarily placed at base of lowest mappable lignite coal bed

Khc HELL CREEK FORMATION (UPPER CRETACEOUS)--Sequence of shale, siltstone, sandstone, and carbonaceous shale about 280 feet thick; well stratified. Overall appearance is somber greenish gray. Lower 50 to 100 feet is predominantly medium-int. sand, locally cemented to sandstone. Contains vertebrate remains--generally ceratopsian. A few quartzite pebbles in basal 50 feet

Kfh FOX HILLS SANDSTONE (UPPER CRETACEOUS--MONTANA GROUP)--Upper continental sandstone unit 50 to 80 feet thick underlain by transitional thin-bedded well-laminated marine shale unit 35 feet thick. Upper unit contains numerous concretions. Lower unit grades to silt toward top. Upper parts of formation commonly removed by erosion before deposition of Hell Creek Formation

Kb BEARPAW SHALE (UPPER CRETACEOUS--MONTANA GROUP)--Dark olive-gray, slightly fissile and jointed semiconsolidated clayey shale. Contains hard ellipsoidal concretions, many containing marine fossils. A few sandy shale beds in upper part. Thickness about 1,100 feet, of which only the upper 600 feet is exposed. Bentonite present as thin seams and disseminated throughout some zones

Kjrw JUDITH RIVER FORMATION (UPPER CRETACEOUS--MONTANA GROUP) AND OLDER ROCKS, UNDIFFERENTIATED--Judith River Formation consists of regressive deposits of nonmarine and shallow-water marine strata with thickness generally 90 to 136 feet. At depth, the Mississippian Madison Group consists of marine carbonates and evaporites with thickness of 1,700 to 2,000 feet

CONTACT--Long dashed where approximately located, medium dashed where gradational, short dashed where concealed

A—A' LINE OF GEOLOGIC SECTION

WELL

SPRING

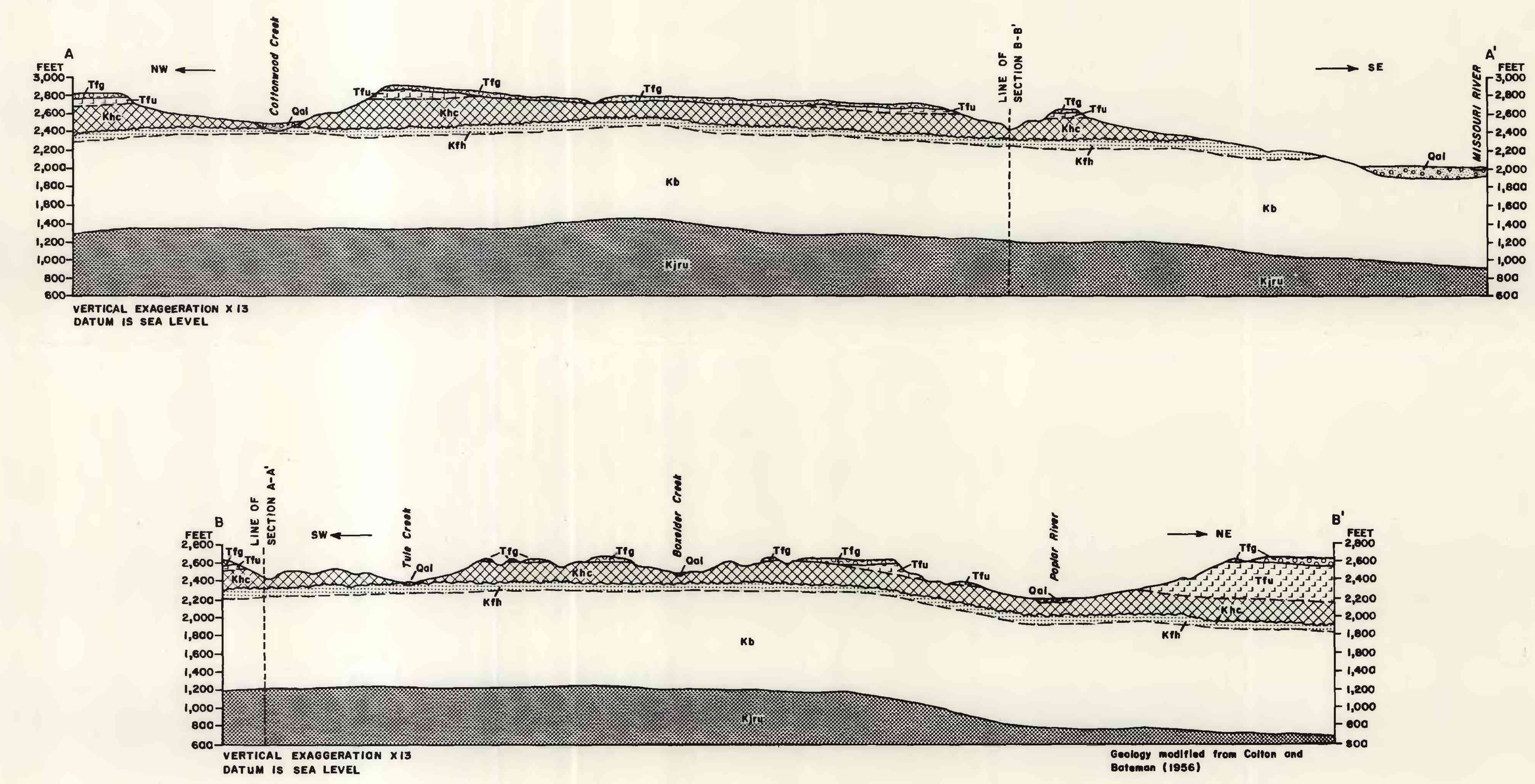

FIGURE 4.--GEOLOGIC SECTIONS.

INTRODUCTION

In many parts of the Fort Peck Indian Reservation, which is located in northeastern Montana (fig. 1), ground water is the only source of water supply. Recently, some tribal residents have become concerned that the quality of water from their domestic wells has deteriorated. In response to this concern, the U.S. Geological Survey, in cooperation with the Water Resources Office of the Fort Peck Tribes, made a reconnaissance study of the ground-water resources of the reservation.

Purpose and Scope

This report describes the results of the reconnaissance study, which was conducted during 1989-90. Specifically, the report describes the generalized geology and ground-water resources, and presents the well-inventory and water-quality data collected during 1989. As part of the study, existing geologic and hydrologic data were compiled, additional wells and springs were inventoried, short-term water-level fluctuations in wells were monitored, water samples were collected from selected wells and analyzed for chemical quality, and all information was put in a computer-accessible format.

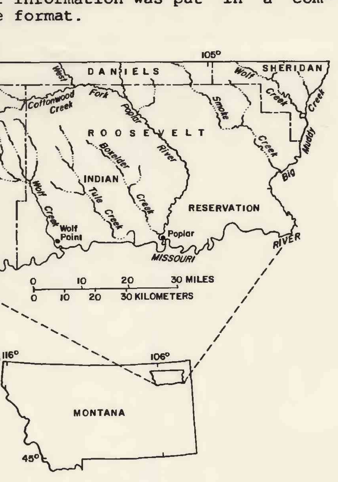

FIGURE 1.--LOCATION OF STUDY AREA.

General Description of Area

The Fort Peck Indian Reservation includes an area of about 3,280 mi^2 in parts of Daniels, Roosevelt, Sheridan, and Valley Counties. The reservation is bounded by Porcupine Creek and the Milk River on the west, Big Muddy Creek on the east, and the Missouri River on the south. On the north, the border is the 48°38′ parallel, which is 40 mi north of the mouth of the Milk River.

Three general types of terrain characterize the area. The Missouri River valley bottom is irrigated farmland with deciduous trees. Near the major Missouri River tributaries, which dissect the reservation, the land surface is generally rolling to rough rangeland (badlands) used primarily for livestock grazing. High benchlands, the third type of terrain, are characterized by relatively fertile soils, which are well suited for the production of small grains.

The reservation has a semiarid climate that is typical of the northern Great Plains. Normal annual precipitation ranges from about 12.0 to 13.5 in., with most precipitation received in June. Mean annual temperature ranges from about 40 to 52 °F. The mean monthly temperatures range from 7.1 °F in January to about 71 °F in July (National Oceanic and Atmospheric Administration, 1982).

Well and Spring Numbering System

In this report, wells and springs are numbered according to geographic position within the rectangular grid system used in Montana by the U.S. Bureau of Land Management. The location (local) number consists of 14 characters. The first two characters specify the township and its position north (N) of the Montana Base Line. The next two characters specify the range and its position east (E) of the Montana Principal Meridian. The next two characters are the section number. The next four characters designate the quarter section (160-acre tract), quarter-quarter section (40-acre tract), quarter-quarter-quarter section (10-acre tract), and quarter-quarter-quarter-quarter section (2.5-acre tract), respectively, in which the well or spring is located. The subdivisions of the section are designated A, B, C, and D in a counterclockwise direction, beginning in the northeast quadrant. The last two characters form a sequence number indicating the order of inventory. For example, as shown in figure 2, well 31N52E05CDDB02 is the second well inventoried in the NW1/4 of the SE1/4 of the SE1/4 of the SW1/4 of section 5, in Township 31 North, and Range 52 East.

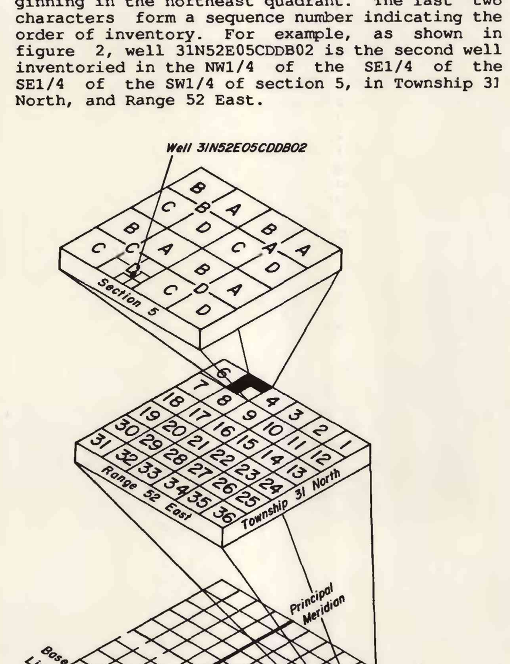

FIGURE 2.--WELL AND SPRING NUMBERING SYSTEM.

Data Collection

As an initial step in establishing a monitoring-well network, 118 wells and 2 springs (fig. 3) were inventoried to supplement existing geologic and hydrologic data. The data collected onsite include location, type of site, altitude of land surface, use of water, depth of well, water level, water-level status, altitude of water level, specific conductance, pH, water temperature, and principal aquifer (table 1). Available lithologic well logs were obtained for hydrologic analysis.

A monitoring network of 53 wells was selected using inventory data. The wells were selected to represent geographically the major aquifers in the reservation. Water levels were measured twice during 1989 at each well in the network; specific conductance, pH, and water temperature were also measured twice, where possible.

Water samples for chemical analysis were collected from 20 selected wells during July 1989. Water samples were measured for physical properties and analyzed for major-ion concentrations (table 2) and trace-element and organic-carbon concentrations (table 3). In addition, nine water samples were analyzed for the stable isotopes of oxygen and hydrogen (table 3). The water samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory in Denver, Colo.

Acknowledgments

Appreciation is expressed to the many landowners who permitted access to their property and provided information about their wells and springs. Appreciation is also extended to the Water Resources Office and the Office of Environmental Protection of the Fort Peck Tribes and to the Montana Bureau of Mines and Geology for supplying data for existing wells.

GENERALIZED GEOLOGY

The generalized geology is shown in figure 3; glacial deposits thinner than about 80 ft, which cover the bedrock units in most of the reservation, are not shown on the map. Except for the Bearpaw Shale, the mapped geologic units, which range in age from Late Cretaceous to Holocene, yield most of the ground water used in the reservation. The generalized thickness and structure are shown in the geologic sections (fig. 4).

The Upper Cretaceous Bearpaw Shale consists of dark clayey shale. This unit underlies the entire reservation and is exposed at land surface in southern and western areas. Where exposed, the shale forms either badlands or small hills having gentle slopes (Jensen and Varnes, 1964).

The Upper Cretaceous Fox Hills Sandstone consists of an upper sandstone unit and a lower marine shale. This formation is exposed at land surface in areas east of Little Porcupine Creek and north of the Missouri River near Wolf Point.

The Upper Cretaceous Hell Creek Formation consists dominantly of shale, siltstone, and sandstone. The formation is exposed at land surface in areas between Little Porcupine Creek and the Poplar River. Hills resulting from erosion of beds of the Hell Creek and Fox Hills are capped by sandstone ledges.

The Paleocene Fort Union Formation consists dominantly of gray clay, buff silt, buff sandstone, and olive-gray sand irregularly interbedded with dark carbonaceous seams and thin and discontinuous lignite coal beds (Witkind, 1959). The Fort Union Formation is exposed at land surface in areas between Little Porcupine Creek and Smoke Creek in the north-central part of the reservation and in a small area in the southeast corner. Most beds easily erode on exposure and are distinguished by the darkness of the lignite.

The Flaxville Formation, of Pliocene or Miocene age, consists of sand and gravel composed of siliceous pebbles such as quartzite, chert, opal, flint, chalcedony, and some silicified wood (Witkind, 1959). The gravels, which form the cap of even-topped plateaus and benches, are at land surface north of Cottonwood Creek and between Little Porcupine Creek and the Poplar River.

Pleistocene glacial deposits consist mainly of till, but also contain deposits of sand, gravel, and silt. These glacial deposits generally are present throughout the reservation, except for a gravel-capped plateau at the heads of Wolf Creek and Tule Creek drainages. The location of glacial deposits thicker than about 80 ft is shown in figure 3.

Holocene alluvium consists of flood-plain deposits of silt and local gravel lenses. These deposits are present along the Missouri River and major tributaries.

SUMMARY

Aquifers that are commonly used in the Fort Peck Indian Reservation for water supply exist in the Quaternary deposits (alluvium and glacial deposits), Flaxville Formation, Fort Union Formation, and a combination of the Fox Hills Sandstone and the lower part of the Hell Creek Formation. The alluvial aquifers are present mainly along the major stream valleys. Glacial aquifers are present in most of the reservation, but water yields differ greatly with location. The Flaxville aquifer is present in the northern and central parts of the reservation, and the Fort Union aquifer is present in the north-central and eastern parts. The Fox Hills-lower Hell Creek aquifer is present in all areas of the reservation, except the extreme south-central and western parts.

The median specific conductance of representative samples of water collected from wells and springs in the reservation was 1,270 µS/cm, the median pH was 7.4, and the median temperature was 9.5 °C. Water from 10 wells completed in Quaternary aquifers and in the Madison Group and located in areas of water-quality concern north of Poplar had specific-conductance values greater than 4,500 µS/cm.

Water samples from wells in the area of water-quality concern contained chloride concentrations that were much larger than from wells elsewhere in the reservation. Values of dissolved organic carbon also were larger in the area of water-quality concern than elsewhere.

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CONVERSION FACTORS, ABBREVIATED WATER-QUALITY UNITS, AND VERTICAL DATUM

Multiply	By	To obtain
acre	4,047	square meter
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer

Temperature can be converted to degrees Fahrenheit (°F) or degrees Celsius (°C) by the equations:

$$°F = 9/5\ (°C) + 32$$
$$°C = 5/9\ (°F - 32)$$

Abbreviated water-quality units used in report:

µg/L micrograms per liter
µS/cm microsiemens per centimeter at 25 °C
mg/L milligrams per liter

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--A geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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RECONNAISSANCE OF GROUND-WATER RESOURCES OF THE FORT PECK INDIAN RESERVATION, NORTHEASTERN MONTANA

By
Joanna N. Thamke
September 1991

GROUND-WATER RESOURCES

Aquifers

Principal aquifers in the reservation exist in Quaternary deposits, Flaxville Formation, Fort Union Formation, and a combination of the Fox Hills Sandstone and the lower part of the Hell Creek Formation. The Quaternary aquifers include alluvium and glacial deposits. Generalized areas of occurrence of the principal aquifers are shown in figures 5-8. The boundaries of the aquifers were interpreted from geology mapped by Colton (1955, 1963a-i, 1964) and Colton and Bateman (1956).

The alluvial aquifers are present mainly along major stream valleys (fig. 5). The aquifers are recharged by infiltration of precipitation and streamflow and by lateral flow from adjacent aquifers, and are discharged by streamflow, evapotranspiration, leakage to underlying aquifers, and water withdrawals. Rivers occupying the alluvial valleys affect the hydraulic gradient within the aquifer.

The glacial aquifers are present in most of the reservation. Because water yields from these aquifers differ greatly with location, their areal extent was not interpreted in this study. However, the location of wells completed in glacial aquifers is shown in figure 5. These aquifers are recharged by infiltration of precipitation and streamflow and are discharged by streamflow, evapotranspiration, springs, leakage to underlying aquifers, and water withdrawals. Hydraulic gradients in the glacial aquifers fluctuate according to local flow systems.

The Flaxville aquifer is present in the northern and central parts of the reservation (fig. 6) and is mostly unconfined. The aquifer is recharged by infiltration of precipitation and is discharged by evapotranspiration, springs, leakage to underlying aquifers, and water withdrawals. The flow system of the aquifer is affected by the many streams that cut through the aquifer. Springs are common in the lower part of the aquifer near stream channels.

The Fort Union aquifer is present in the north-central and eastern parts of the reservation (fig. 7). The aquifer is recharged by infiltration of precipitation on the outcrops and by leakage from the overlying Flaxville and glacial aquifers and is discharged by subsurface outflow, evapotranspiration, and water withdrawals. Altitudes of measured water levels indicate a generally eastward flow of ground water.

The lower part of the Hell Creek Formation is hydraulically connected to the Fox Hills Formation. Together, these two units compose the Fox Hills-lower Hell Creek aquifer. This aquifer is present in all areas of the reservation except the extreme south-central and western parts (fig. 8). The aquifer is recharged by infiltration of precipitation on the outcrops and by leakage from overlying aquifers and is discharged by evapotranspiration at the outcrops and water withdrawals from the deeper and confined northeastern part of the aquifer. Altitudes of measured water levels indicate a generally eastward flow of ground water.

Most ground-water withdrawals are from wells completed in the alluvial aquifers. The second most common source is wells completed in the Fox Hills-lower Hell Creek aquifer. East of 106° long., well yields in the reservation range from 5 to 25 gal/min for alluvial aquifers, 10 to 50 gal/min for glacial aquifers, 10 to 25 gal/min for the Flaxville aquifer, 2 to 10 gal/min for the Fort Union aquifer, and 10 to 25 gal/min for the Fox Hills-lower Hell Creek aquifer (Donovan, 1988, p. 34). The water withdrawn is used mostly for livestock watering and domestic purposes.

Secondary aquifers in the reservation are those deeper than the Fox Hills-lower Hell Creek aquifer. In this study, the deeper units inventoried were the Judith River aquifer of Late Cretaceous age and the Madison aquifer of Mississippian age. These secondary aquifers generally are not used for water sources in the reservation because of their depth and the thickness of the overlying Bearpaw Shale, which is difficult to drill.

Water Levels and Physical Properties of the Water

At each site inventoried during 1989, water level, specific conductance, pH, and water temperature were measured where possible. Each aquifer has a distinct range in altitude of water levels and a distinct median specific conductance; therefore, each is discussed separately. Median values of specific conductance were calculated for water from the principal aquifers. To avoid overemphasizing multiple measurements, the median was computed using one value per well or spring; if multiple samples were available for a well or spring, the mean from the samples was used to represent the aquifer at that site. Except for well 32 completed in the Madison Group, values of pH and water temperature did not significantly differ from aquifer to aquifer, so only a median value for all water samples is identified.

The median specific conductance of representative samples of water collected from wells and springs in the reservation was 1,270 µS/cm. Water from 10 wells completed in Quaternary aquifers and the Madison Group in an area of water-quality concern north of Poplar (wells 32, 34-38, 56, 58, 59, 61) had specific-conductance values that were greater than 4,500 µS/cm. These samples were excluded from calculations of median specific conductance, because the water may be contaminated. Reservation-wide, the median pH was 7.4 and the median temperature was 9.5 °C.

During 1989, 35 wells completed in the alluvial aquifers were inventoried. Depth of wells ranged from 12 ft near the Poplar River (well 57) to 112 ft near Tule Creek (well 70). Altitudes of water level ranged from 1,895 ft near the Missouri River (well 40) to 2,743 ft near West Fork Wolf Creek (well 66). The median specific conductance was 1,480 µS/cm.

Eighteen wells and 2 springs producing water from glacial aquifers were inventoried during 1989. Depth of wells ranged from 13 ft in the northeastern part of the reservation (well 112) to 150 ft in the southeast (well 33). Altitudes of water level ranged from 1,924 ft in the southeast (well 16) to 2,857 ft in the northwest (well 79). The median specific conductance was 1,760 µS/cm.

During 1989, 17 wells completed in the Flaxville aquifer were inventoried. Depth of wells ranged from 18 ft in the northwestern part of the reservation (well 78) to 100 ft in the central part (wells 48 and 49). Altitudes of water level ranged from 2,652 ft in the central part (well 88) to 2,899 ft in the northwest (well 106). The median specific conductance was 712 µS/cm.

Eighteen wells completed in the Fort Union aquifer were inventoried during 1989. Depth of wells ranged from 20 ft (well 117) to 310 ft (well 104) in the northeastern part of the reservation. Altitudes of water level ranged from 1,912 ft in the southeast (well 39) to 2,840 ft in the central part (well 85). The median specific conductance was 1,270 µS/cm.

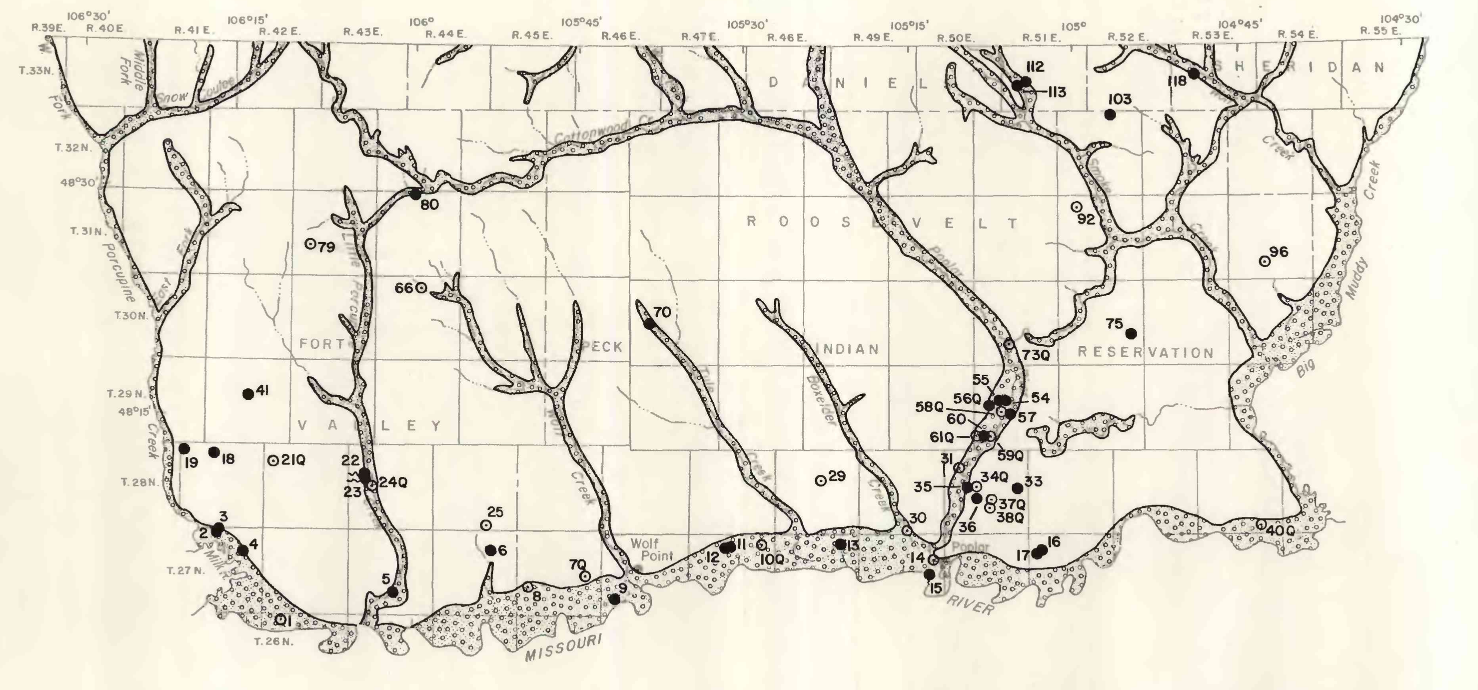

FIGURE 5.--GENERALIZED AREA OF THE ALLUVIAL AQUIFERS AND LOCATION OF WELLS AND SPRINGS COMPLETED IN QUATERNARY AQUIFERS.

FIGURE 6.--GENERALIZED AREA OF THE FLAXVILLE AQUIFER AND LOCATION OF WELLS COMPLETED IN THE AQUIFER.

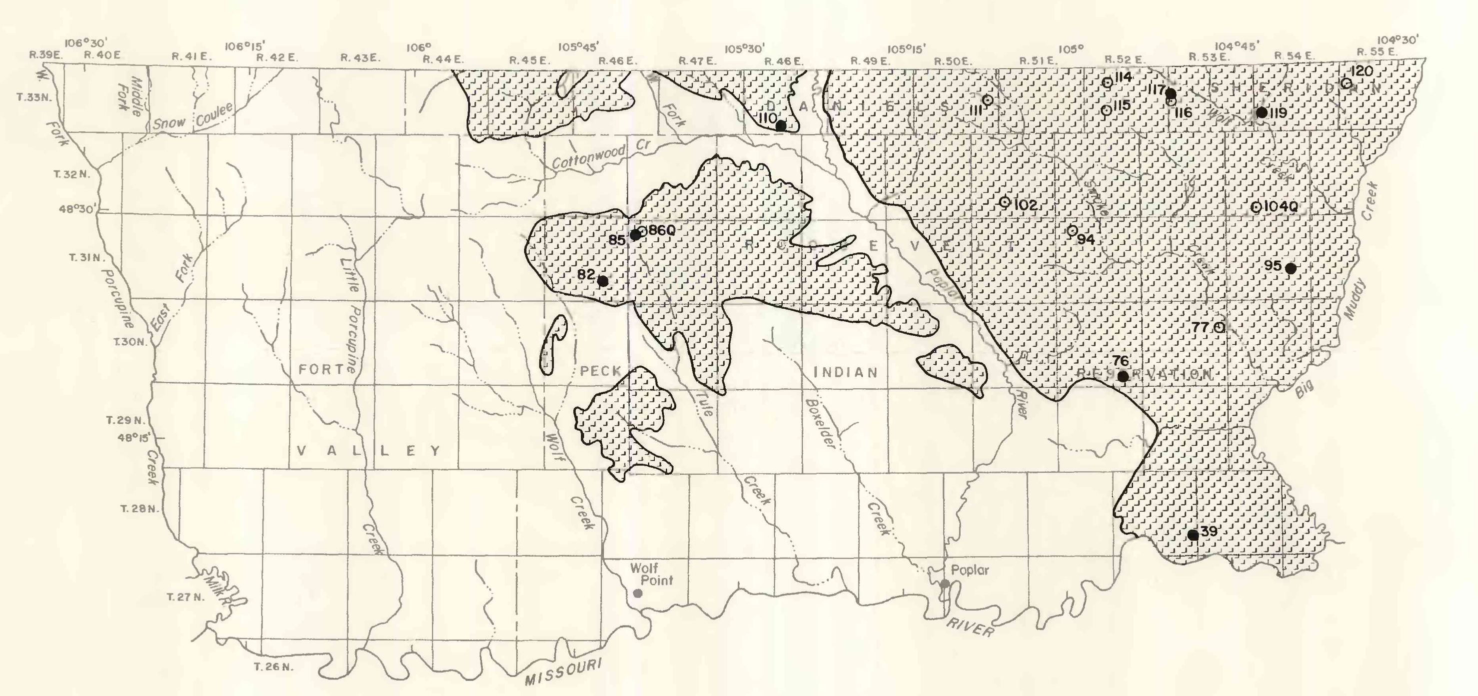

FIGURE 7.--GENERALIZED AREA OF THE FORT UNION AQUIFER AND LOCATION OF WELLS COMPLETED IN THE AQUIFER.

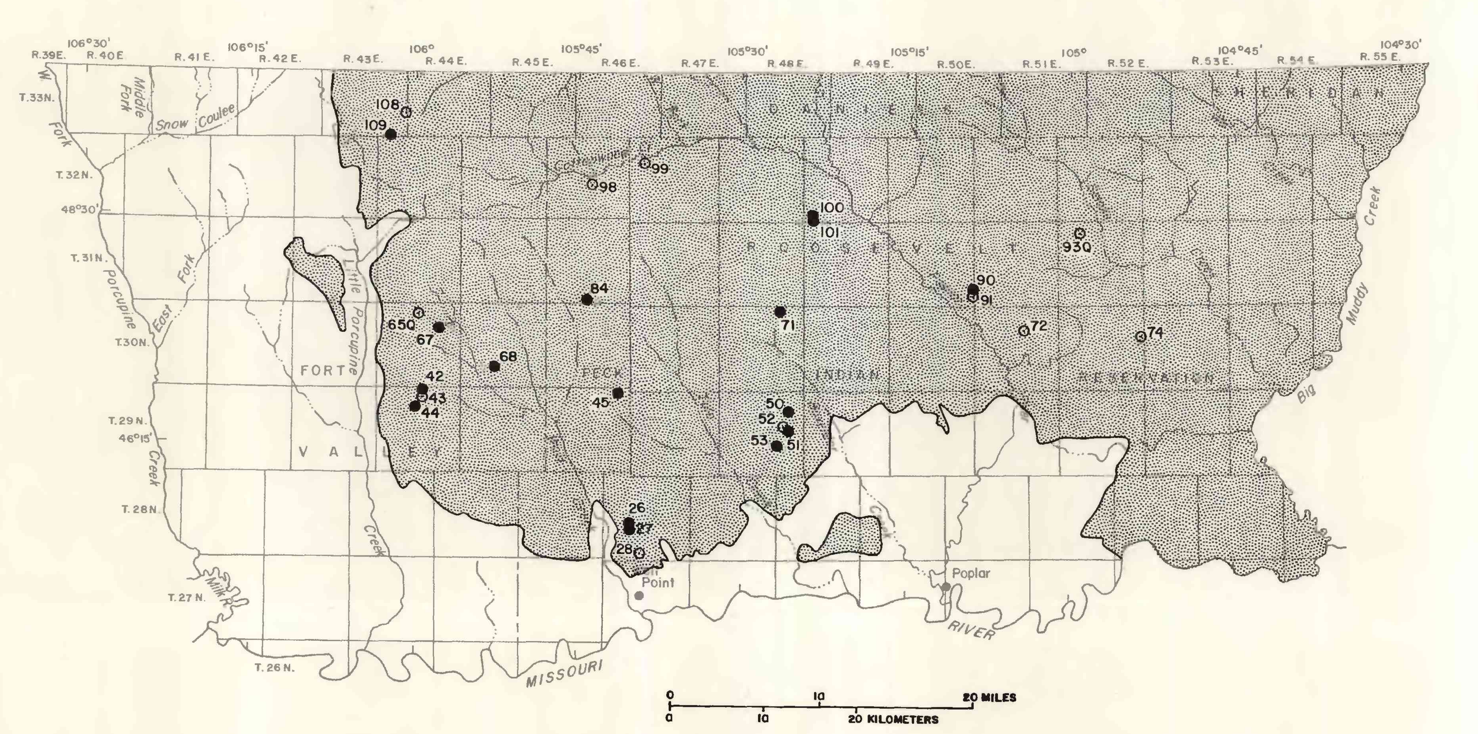

FIGURE 8.--GENERALIZED AREA OF THE FOX HILLS-LOWER HELL CREEK AQUIFER AND LOCATION OF WELLS COMPLETED IN THE AQUIFER.

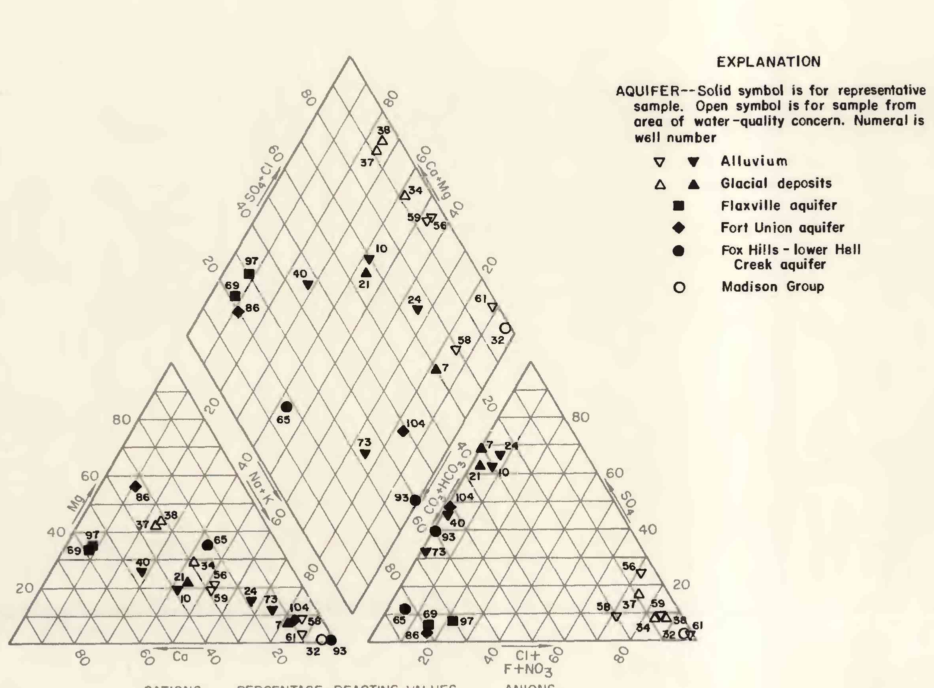

FIGURE 9.--TRILINEAR DIAGRAM SHOWING CHEMICAL-QUALITY DATA. DATA ARE CONVERTED FROM MILLIGRAMS PER LITER TO MILLIEQUIVALENTS PER LITER, THEN VALUES FOR EACH CATION AND ANION ARE PLOTTED AS A PERCENTAGE OF TOTAL MILLIEQUIVALENTS PER LITER.

TABLE 1.--RECORDS OF INVENTORIED WELLS AND SPRINGS

[-- or -, no data or not applicable]

Local number--numbering system described in text.
Type of site--C, collector well; S, spring; W, well.
Altitude of land surface--in feet above sea level.
Primary use of water--C, commercial; H, domestic; I, irrigation; S, livestock; U, unused; Z, other.
Depth of well--in feet below land surface.
Water level--in feet below land surface.
Water-level status--P, pumping; R, recently pumped.
Water-level source--A, measured by Fort Peck Tribes; S, measured by U.S. Geological Survey.
Altitude of water level--in feet above sea level.
Specific conductance--in microsiemens per centimeter at 25 degrees Celsius; onsite measurement.
pH--onsite measurement.
Water temperature--in degrees Celsius.
Principal aquifer--Qal, Quaternary alluvium
Qg, Pleistocene glacial deposits
Tfg, Flaxville Formation
Tfu, Fort Union Formation
Kfh-Khc, Fox Hills-lower Hell Creek aquifer
Kjr, Judith River Formation
Mm, Madison Group

Well or spring number	Local number	Type of site	Altitude of land surface (feet)	Primary use of water	Depth of well (feet)	Water level (feet)	Water-level status	Water-level source	Altitude of water level (feet)	Date of measurement	Specific conductance (µS/cm)	pH (units)	Water temperature (°C)	Principal aquifer	Well or spring number
1	26N43E05CAAB01	W	2,035	H	38	16.36	-	S	2,019	04-26-89	1,500	7.4	10.0	Qal	1
	-	-	--	-	--	15.86	-	S	2,019	10-28-89	1,400	7.0	10.0	--	
2	27N42E04ABBA01	W	2,080	U	94	--	-	-	--	--	--	--	--	Qal	2
3	27N42E04ABCC01	W	2,065	U	90	--	-	-	--	--	--	--	--	Qal	3
4	27N42E11CADC01	W	2,060	H	100	9.39	-	S	2,051	04-26-89	3,400	7.3	11.0	Qal	4
5	27N44E27BCCA01	W	2,070	H	43	22.30	-	S	2,048	06-08-89	3,020	8.1	10.5	Qal	5
6	27N45E11CBBA01	W	2,210	H	33	--	-	-	--	06-09-89	910	7.4	10.5	Qg	6
7	27N46E23AAAB01	W	2,060	H	65	54.44	-	S	2,006	06-09-89	3,390	7.2	10.5	Qg	7
	-	-	--	-	--	54.25	-	S	2,006	07-21-89	3,200	7.3	12.0	--	
8	27N46E30AADB01	W	2,020	H	60	23.96	R	S	1,996	04-27-89	1,490	7.7	9.0	Qal	8
	-	-	--	-	--	22.93	-	S	1,997	10-24-89	1,180	7.2	11.0	--	
9	27N47E30AABD01	W	1,990	H	57	--	-	-	--	04-27-89	1,310	7.7	9.5	Qal	9
10	27N48E01CCCD01	W	1,980	H	32	19.00	-	S	1,961	06-10-89	2,200	7.9	11.5	Qal	10
	-	-	--	-	--	22.75	P	S	1,957	07-20-89	2,650	7.1	14.0	--	
11	27N48E04DACB01	W	1,980	H	25	--	-	-	--	--	--	--	--	Qal	11
12	27N48E04DACC01	W	1,980	H	38	20.12	-	S	1,960	04-28-89	2,720	7.5	8.0	Qal	12
13	27N49E02CAAD01	W	1,970	H	72	17.23	-	S	1,953	06-12-89	1,420	8.5	10.0	Qal	13
14	27N50E12CCBC01	W	1,955	H	60	14.00	-	S	1,941	06-10-89	1,800	7.7	13.0	Qal	14
	-	-	--	-	--	14.20	P	S	1,941	08-03-89	1,850	7.4	14.0	--	
15	27N50E14DDAA01	W	1,960	H	--	--	-	-	--	06-10-89	825	8.2	16.5	Qal	15
16	27N52E07DABB01	W	1,995	H	125	71.44	-	S	1,924	06-12-89	2,700	7.9	8.0	Qg	16
17	27N52E07DABB02	W	1,995	U	90	--	-	-	--	--	--	--	--	Qg	17
18	28N42E04CBAA01	W	2,405	H	22	12.07	-	S	2,393	04-27-89	2,810	7.3	6.5	Qal	18
19	28N42E06BACD01	W	2,275	H	17	4.25	-	S	2,271	05-14-89	1,500	7.3	6.0	Qal	19
20	28N42E33CDDD01	W	2,100	S	635	--	-	-	--	04-26-89	4,200	8.1	8.0	Kjr	20
21	28N43E07AABD01	W	2,440	S	64	56.18	-	S	2,384	06-07-89	1,520	7.5	9.0	Qg	21
	-	-	--	-	--	56.70	P	S	2,383	07-21-89	1,500	7.4	11.0	--	
22	28N44E17CCBD01	S	2,345	S	--	--	-	-	--	06-08-89	2,000	7.7	9.0	Qg	22
23	28N44E17CCCD01	S	2,340	H	--	--	-	-	--	06-08-89	1,440	7.7	9.5	Qg	23
24	28N44E17CDCC01	W	2,280	H	40	9.68	-	S	2,270	06-08-89	2,510	7.3	8.5	Qal	24
	-	-	--	-	--	10.56	-	S	2,269	07-21-89	3,000	7.2	8.5	--	
25	28N45E34ADDC01	W	2,305	H	56	44.86	-	S	2,260	06-09-89	1,100	7.6	9.5	Qg	25
	-	-	--	-	--	45.15	-	S	2,260	08-04-89	1,600	7.1	9.0	--	
26	28N47E20DADB01	W	2,355	H	137	--	-	-	--	05-01-89	1,090	8.0	9.0	Kfh-Khc	26
27	28N47E20DADB02	W	2,355	C	137	--	-	-	--	05-01-89	940	7.8	14.0	Kfh-Khc	27
28	28N47E33CBCA01	W	2,225	S	110	43.78	-	S	2,181	05-01-89	1,300	7.9	9.0	Kfh-Khc	28
	-	-	--	-	--	44.80	-	S	2,180	08-04-89	1,300	7.1	10.0	--	
29	28N49E15BACA01	W	2,110	H	15	8.89	-	S	2,101	06-10-89	3,900	8.6	13.0	Qal	29
	-	-	--	-	--	10.67	P	S	2,099	10-30-89	2,600	7.3	16.0	--	
30	28N50E34CDBC01	W	1,970	H	55	24.73	R	S	1,945	04-19-89	2,100	6.9	8.5	Qal	30
	-	-	--	-	--	25.05	-	S	1,945	08-03-89	1,850	7.2	9.0	--	
31	28N51E08BBDB01	W	1,995	S	14	6.75	-	S	1,988	06-10-89	2,120	7.1	9.5	Qal	31
	-	-	--	-	--	11.04	-	S	1,984	10-25-89	2,900	7.0	10.0	--	
32	28N51E10DBAD01	C	--	Z	--	--	-	-	--	07-24-89	200,000	6.4	80.0	Mm	32
33	28N51E13CCCC01	W	2,180	H	150	132.76	-	S	2,047	05-16-89	2,990	7.2	11.0	Qg	33
34	28N51E16CACC01	W	2,040	U	104	79.72	-	S	1,960	07-23-89	10,000	7.3	10.0	Qg	34
	-	-	--	-	--	79.60	-	S	1,960	10-25-89	--	--	--	--	
35	28N51E17DDAD01	W	2,025	H	102	--	-	-	--	07-22-89	5,200	--	--	Qg	35
36	28N51E21BCAD01	W	2,010	H	--	--	-	-	--	07-20-89	6,500	--	--	Qg	36
37	28N51E22CDCC01	W	2,105	H	85	60.20	-	S	2,045	07-20-89	13,000	6.8	11.0	Qg	37
	-	-	--	-	--	59.99	-	S	2,045	10-26-89	11,400	6.7	10.5	--	
38	28N51E27BBBB01	W	2,085	Z	68	32.50	-	S	2,053	07-24-89	25,000	6.8	10.5	Qg	38
	-	-	--	-	--	42.43	-	S	2,043	10-25-89	22,500	6.3	10.0	--	
39	28N53E25DBBC01	W	1,950	H	82	37.56	-	S	1,912	05-13-89	2,520	7.3	9.5	Tfu	39
40	28N54E35CAAB01	W	1,920	H	45	23.86	-	S	1,896	06-12-89	1,380	7.3	9.5	Qal	40
	-	-	--	-	--	24.90	P	S	1,895	07-20-89	1,420	7.2	10.5	--	
41	29N42E15CAAB01	W	2,650	H	16	--	-	-	--	--	--	--	--	Qg	41
42	29N44E03BBCA01	W	2,730	H	120	51.22	-	S	2,679	10-24-89	560	7.3	9.0	Kfh-Khc	42
43	29N44E03BBCD01	W	2,720	S	90	56.78	P	S	2,663	05-15-89	560	7.7	8.0	Kfh-Khc	43
	-	-	--	-	--	55.20	P	S	2,664	10-24-89	560	7.5	9.5	--	
44	29N44E09ACDD01	W	2,740	H	130	69.58	-	S	2,670	05-15-89	760	7.7	9.5	Kfh-Khc	44
45	29N46E01BCDB01	W	2,700	S	270	--	-	-	--	05-01-89	730	7.9	9.5	Kfh-Khc	45
46	29N46E01BCDB02	W	2,700	H	--	--	-	-	--	05-01-89	530	7.4	15.0	--	46
47	29N46E01BCDB03	W	2,700	U	45	34.81	-	S	2,665	05-01-89	--	--	--	Tfg	47
48	29N46E10DAAB01	W	2,705	S	100	--	-	-	--	05-01-89	510	7.8	10.0	Tfg	48
49	29N46E10DAAC01	W	2,705	H	100	--	-	-	--	05-01-89	685	7.9	11.0	Tfg	49
50	29N48E11ADDD01	W	2,490	H	140	--	-	-	--	04-29-89	520	7.8	10.0	Kfh-Khc	50
51	29N48E14DBCC01	W	2,400	S	65	--	-	-	--	--	--	--	--	Kfh-Khc	51
52	29N48E14DCAB01	W	2,400	H	65	34.02	-	S	2,366	04-28-89	495	7.4	8.5	Kfh-Khc	52
	-	-	--	-	--	34.78	-	S	2,365	10-30-89	505	6.9	9.5	--	
53	29N48E22DDDD01	W	2,440	H	190	--	-	-	--	--	--	--	--	Kfh-Khc	53
54	29N51E16CBCC01	W	2,030	U	25	15.22	-	S	2,015	07-22-89	--	--	--	Qal	54
55	29N51E16CCAA01	W	2,025	Z	23	11.85	-	S	2,013	06-11-89	1,200	8.0	8.0	Qal	55
56	29N51E17CCCC01	W	2,065	U	87	56.90	-	S	2,008	07-22-89	9,500	7.3	10.5	Qal	56
57	29N51E21ABCC01	W	2,015	H	12	11.47	-	S	2,004	06-11-89	1,500	7.7	9.5	Qal	57
58	29N51E21BBAA01	W	2,025	U	17	11.67	-	S	2,013	04-19-89	--	--	--	Qal	58
	-	-	--	-	--	11.85	-	S	2,013	07-22-89	4,600	7.7	8.5	--	
59	29N51E31AABB01	W	2,009	U	54	20.48	-	S	1,989	04-19-89	12,000	6.8	14.0	Qal	59
	-	-	--	-	--	20.75	-	S	1,988	07-23-89	13,500	7.1	10.0	--	
60	29N51E32BBBA01	W	2,000	U	31	8.81	-	S	1,991	05-02-89	--	--	--	Qal	60
61	29N51E32BBBB01	W	2,000	U	49	10.20	-	S	1,990	04-19-89	30,000	6.8	--	Qal	61
	-	-	--	-	--	9.60	-	S	1,990	07-23-89	65,000	6.7	16.0	--	
62	30N42E01CDBC01	W	2,740	H	22	12.11	-	S	2,728	06-07-89	5,060	7.4	11.0	Tfg	62
	-	-	--	-	--	13.30	-	S	2,727	08-04-89	4,800	6.8	10.5	--	
63	30N42E08BBAA01	W	2,730	H	50	25.92	-	S	2,704	06-07-89	1,540	7.3	8.5	Tfg	63
	-	-	--	-	--	26.08	-	S	2,704	10-28-89	1,670	7.5	9.0	--	
64	30N42E33DDDD01	W	2,755	H	60	46.82	-	S	2,708	05-14-89	2,240	7.5	9.5	Tfg	64
	-	-	--	-	--	47.60	-	S	2,707	08-04-89	2,000	6.9	9.0	--	
65	30N44E03CBBB01	W	2,835	S	170	97.69	-	S	2,737	05-15-89	370	8.2	9.0	Kfh-Khc	65
	-	-	--	-	--	96.08	R	S	2,739	07-21-89	430	7.8	8.5	--	
66	30N44E03CDAC01	W	2,770	S	105	34.57	-	S	2,735	05-15-89	705	7.3	8.5	Qal	66
	-	-	--	-	--	37.14	-	S	2,733	10-24-89	660	7.1	8.5	--	
67	30N44E11CCAB01	W	2,785	I	275	85.93	-	S	2,699	05-15-89	1,130	8.2	10.0	Kfh-Khc	67
68	30N45E28BBDB01	W	2,735	H	176	153.68	-	S	2,581	06-08-89	555	6.9	9.0	Kfh-Khc	68
69	30N46E14DDDD01	W	2,715	H	40	9.41	R	S	2,706	05-01-89	555	7.7	11.0	Tfg	69
	-	-	--	-	--	9.94	-	S	2,705	07-19-89	530	7.5	12.0	--	
70	30N47E20BBBB01	W	2,545	S	112	16.33	-	S	2,529	05-02-89	440	7.3	9.0	Qal	70
71	30N48E02BBDA01	W	2,635	H	265	--	-	-	--	04-29-89	1,020	7.4	7.5	Kfh-Khc	71
72	30N51E10CCAD01	W	2,165	H	360	96.03	-	S	2,069	05-12-89	1,550	8.6	10.5	Kfh-Khc	72
	-	-	--	-	--	96.61	-	S	2,068	10-25-89	1,750	8.8	11.0	--	
73	30N51E28DCAA01	W	2,060	H	20	11.05	-	S	2,049	07-22-89	1,340	7.4	9.5	Qal	73
	-	-	--	-	--	11.15	-	S	2,049	10-25-89	1,150	7.8	10.0	--	
74	30N52E13ABAB01	W	2,230	I	276	48.46	-	S	2,182	05-11-89	2,520	8.8	8.5	Kfh-Khc	74
	-	-	--	-	--	75.03	-	S	2,155	10-29-89	2,350	8.5	9.5	--	
75	30N52E24CCCC01	W	2,160	H	60	--	-	-	--	--	--	--	--	Qg	75
76	30N52E35AAAA01	W	2,135	H	120	--	-	-	--	06-12-89	1,650	8.3	10.5	Tfu	76
77	30N53E12DCCA01	W	2,065	H	120	45.81	-	S	2,019	05-11-89	1,530	6.8	9.5	Tfu	77
	-	-	--	-	--	46.40	P	S	2,019	10-29-89	1,550	6.7	9.5	--	
78	31N42E28DCDD01	W	2,785	H	18	10.28	-	S	2,775	06-07-89	4,030	7.2	12.0	Tfg	78
79	31N43E20CDDC01	W	2,880	H	30	22.95	-	S	2,857	06-07-89	940	7.2	12.0	Qg	79
	-	-	--	-	--	24.95	-	S	2,855	08-04-89	910	7.2	13.0	--	
80	31N44E04AAAC01	W	2,670	H	25	13.85	R	S	2,656	05-15-89	830	7.4	9.5	Qal	80
81	31N45E29DDCA01	W	2,835	H	50	23.22	-	S	2,812	06-08-89	920	7.6	8.5	Tfg	81
	-	-	--	-	--	26.90	-	S	2,808	10-24-89	920	7.5	9.5	--	
82	31N46E26BCCC01	W	2,730	H	--	15.04	-	S	2,715	05-01-89	580	7.3	7.0	Tfu	82
83	31N46E33DDAA01	W	2,725	H	60	49.60	-	S	2,675	05-01-89	695	7.6	7.0	Tfg	83
	-	-	--	-	--	54.48	P	A	2,671	08-22-89	560	6.3	--	--	
84	31N46E33DDAB01	W	2,725	Z	--	--	-	-	--	06-13-89	470	7.5	7.5	Kfh-Khc	84
85	31N47E06DDDD01	W	2,870	S	55	30.10	-	S	2,840	05-02-89	655	7.8	7.0	Tfu	85
86	31N47E06DDDD02	W	2,870	H	60	34.99	-	S	2,835	05-02-89	465	7.4	9.5	Tfu	86
	-	-	--	-	--	38.91	-	S	2,831	07-19-89	440	7.5	10.0	--	
87	31N48E18BCBC01	W	2,740	H	30	--	-	-	--	04-29-89	650	7.6	10.0	Tfg	87
88	31N48E25BCCA01	W	2,680	H	30	27.82	-	S	2,652	04-29-89	2,350	7.5	8.0	Tfg	88
	-	-	--	-	--	27.87	-	S	2,652	08-04-89	1,900	7.0	8.0	--	
89	31N48E28BABD01	W	2,710	H	40	--	-	-	--	04-29-89	670	7.3	12.5	Tfg	89
90	31N50E25DDDD01	W	2,220	H	185	--	-	-	--	--	--	--	--	Kfh-Khc	90
91	31N50E36AAAA01	W	2,215	S	150	99.93	-	S	2,115	06-13-89	1,900	8.7	8.0	Kfh-Khc	91
	-	-	--	-	--	100.32	-	S	2,115	10-25-89	1,900	8.8	9.5	--	
92	31N52E05CDCD01	W	2,395	S	48	15.45	-	S	2,380	06-12-89	1,180	7.6	7.0	Qal	92
	-	-	--	-	--	17.11	-	S	2,378	10-29-89	1,160	6.5	8.0	--	
93	31N52E05CDDB01	W	2,400	H	330	43.61	R	S	2,356	06-12-89	3,000	8.6	10.0	Kfh-Khc	93
	-	-	--	-	--	45.08	-	S	2,355	07-18-89	2,150	8.4	11.0	--	
94	31N52E05CDDB02	W	2,405	Z	60	34.24	-	S	2,371	06-12-89	1,060	7.6	9.0	Tfu	94
	-	-	--	-	--	35.66	-	S	2,369	10-29-89	1,040	7.1	9.5	--	
95	31N54E23DDDD01	W	2,095	H	120	--	-	-	--	05-11-89	1,230	7.1	6.5	Tfu	95
96	31N54E28DCDC01	W	2,080	S	80	12.21	-	S	2,068	05-11-89	2,520	7.1	9.5	Qg	96
	-	-	--	-	--	14.60	-	S	2,065	10-29-89	2,400	6.8	8.0	--	
97	32N45E05BBCC01	W	2,890	H	50	29.14	R	S	2,861	05-15-89	535	7.3	8.0	Tfg	97
	-	-	--	-	--	34.05	R	S	2,856	07-19-89	500	7.4	9.5	--	
98	32N46E22BBDA01	W	2,445	S	110	32.04	-	S	2,413	05-01-89	1,390	8.9	9.5	Kfh-Khc	98
	-	-	--	-	--	28.13	-	S	2,417	10-28-89	1,320	8.9	8.0	--	
99	32N47E07DAAD01	W	2,400	H	51	41.74	-	S	2,358	05-02-89	1,340	7.5	9.5	Kfh-Khc	99
	-	-	--	-	--	41.44	-	S	2,359	10-28-89	1,460	7.1	9.0	--	
100	32N49E31DCBB01	W	2,400	S	183	--	-	-	--	--	--	--	--	Kfh-Khc	100
101	32N49E31DCDC01	W	2,390	H	200	--	-	-	--	04-29-89	1,190	9.1	11.0	Kfh-Khc	101
102	32N51E28DCCD01	W	2,655	H	249	201.19	P	S	2,454	05-12-89	1,400	6.9	9.5	Tfu	102
	-	-	--	-	--	153.13	-	S	2,502	10-27-89	1,380	7.0	9.5	--	
103	32N52E03AADC01	W	2,560	H	65	44.78	-	S	2,515	05-10-89	810	7.0	9.0	Qal	103
104	32N54E33BABC01	W	2,355	Z	310	161.50	-	S	2,194	05-11-89	2,420	7.5	10.0	Tfu	104
	-	-	--	-	--	165.04	-	S	2,190	07-18-89	2,100	7.7	10.5	--	
105	33N41E14BADD01	W	2,885	H	75	53.63	-	S	2,831	05-14-89	515	7.6	7.5	Tfg	105
	-	-	--	-	--	54.10	-	S	2,831	08-04-89	445	6.9	8.0	--	
106	33N42E33BCCC01	W	2,930	H	95	30.65	-	S	2,899	06-07-89	740	7.9	10.0	Tfg	106
107	33N42E33CCBB01	W	2,905	I	75	8.42	-	S	2,897	06-07-89	970	6.9	6.0	Tfg	107
108	33N43E25ADAD01	W	2,905	H	165	30.00	-	S	2,875	04-18-89	440	7.3	10.0	Kfh-Khc	108
	-	-	--	-	--	29.59	-	S	2,875	10-24-89	440	7.4	8.5	--	
109	33N43E35DDDD02	W	2,930	H	165	71.82	-	S	2,858	04-18-89	570	7.3	10.0	Kfh-Khc	109
110	33N48E33ADAD01	W	2,350	H	37	20.68	R	S	2,329	04-29-89	2,490	7.9	9.0	Tfu	110
111	33N50E24BDDC01	W	2,540	H	160	9.59	-	S	2,530	05-12-89	1,310	7.2	9.0	Tfu	111
	-	-	--	-	--	9.41	-	S	2,531	10-27-89	1,320	7.1	9.0	--	
112	33N51E20DCCC01	W	2,500	H	13	10.50	-	S	2,490	05-12-89	1,130	7.2	14.0	Qg	112
113	33N51E29BBBA01	W	2,505	H	38	15.43	-	S	2,490	05-12-89	2,150	6.9	11.0	Qg	113
114	33N52E17AAAB01	W	2,410	H	50	27.99	-	S	2,382	05-11-89	890	7.0	9.5	Tfu	114
	-	-	--	-	--	28.25	P	S	2,382	10-27-89	960	7.1	10.0	--	
115	33N52E29AAAA01	W	2,645	H	168	140.69	-	S	2,504	05-10-89	730	7.2	8.5	Tfu	115
	-	-	--	-	--	138.25	-	S	2,507	10-27-89	590	6.8	8.5	--	
116	33N53E19CCBB01	W	2,370	H	54	34.70	-	S	2,335	05-10-89	1,290	6.7	11.5	Tfu	116
	-	-	--	-	--	35.42	-	S	2,335	10-27-89	1,080	6.7	10.0	--	
117	33N53E19CCBC01	W	2,365	S	20	--	-	-	--	05-10-89	1,230	7.3	9.5	Tfu	117
118	33N53E20ACAB01	W	2,210	H	35	13.16	-	S	2,197	05-10-89	1,950	7.5	12.0	Qal	118
119	33N54E30DBCD01	W	2,170	H	100	--	-	-	--	05-10-89	2,400	7.4	9.0	Tfu	119
120	33N55E18DDAA01	W	2,135	H	200	38.20	-	S	2,097	05-10-89	2,240	6.9	8.0	Tfu	120
	-	-	--	-	--	44.15	-	A	2,091	08-29-89	1,600	7.8	--	--	

TABLE 2.--PHYSICAL PROPERTIES AND MAJOR-ION CONCENTRATIONS IN WATER FROM SELECTED WELLS

TABLE 3.--TRACE-ELEMENT AND ORGANIC-CARBON CONCENTRATIONS AND STABLE-ISOTOPE RATIOS IN WATER FROM SELECTED WELLS

RECONNAISSANCE OF GROUND-WATER RESOURCES OF THE FORT PECK INDIAN RESERVATION, NORTHEASTERN MONTANA

By
Joanna N. Thamke

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