

Prepared in cooperation with Turtle Mountain Band of Chippewa Indians

Assessment of Groundwater Quality Data for the Turtle Mountain Indian Reservation, Rolette County, North Dakota, 1970–2012

Data Series 732

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By Robert F. Lundgren and Kevin C. Vining

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**U.S. Department of the Interior
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Contents

Abstract.....	1
Introduction.....	1
Purpose and Scope	1
Previous Studies	1
Data Sources.....	4
Physical Setting of the Study Area	5
Aquifers	5
Land Use.....	5
Assessment of Groundwater Levels.....	6
Assessment of Groundwater Quality.....	6
Fox Hills and Hell Creek Aquifers.....	6
Rolla Aquifer	7
Shell Valley Aquifer	7
Implications.....	14
Summary.....	14
References Cited.....	14
Supplements	17

Figures

1. Maps showing location of the Turtle Mountain Indian Reservation and groundwater measuring wells in major aquifers and Shell Valley aquifer, Rolette County, North Dakota	2
2. Graph showing annual water withdrawals from the Shell Valley aquifer, 1981 through 2011	6
3. Graphs showing annual water levels near Rolette, Thorn, and Shell Valley production wells, 1981 through 2011	7
4. Graphs showing groundwater concentrations from North Dakota State Water Commission wells in the Shell Valley aquifer for selected constituents that exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels	12
5. Graphs showing groundwater concentrations from U.S. Geological Survey wells in the Shell Valley aquifer for selected constituents that exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels.....	13

Tables

1. Sources of groundwater-quality data available, 1970 through 2012.....	4
2. Annual acreages of major crops planted in Rolette County, North Dakota, 1997 through 2011	5
3. Locations of North Dakota State Water Commission groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota	8
4. Locations of U.S. Geological Survey groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota	10

Supplements

1. Water-quality data available in the North Dakota State Water Commission database for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, 1970 through 2012	17
2. Water-quality data available in the U.S. Geological Survey database for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, 1970 through 2012.....	17

Conversion Factors and Datum

Inch/Pound to SI

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	4,047	square meter (m ²)
square foot (ft ²)	929.0	square centimeter (cm ²)
square foot (ft ²)	0.09290	square meter (m ²)
square mile (mi ²)	2.590	square kilometer (km ²)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
 $^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$

All lake levels and elevations used in this report are referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

Elevation, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius ($\mu\text{S}/\text{cm}$ at 25 °C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g}/\text{L}$).

Assessment of Groundwater Quality Data for the Turtle Mountain Indian Reservation, Rolette County, North Dakota, 1970–2012

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Abstract

The Turtle Mountain Indian Reservation relies on groundwater supplies to meet the demands of community and economic needs. The U.S. Geological Survey, in cooperation with the Turtle Mountain Band of Chippewa Indians, examined historical groundwater-level and groundwater-quality data for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers. The two main sources of water-quality data for groundwater were the U.S. Geological Survey National Water Information System database and the North Dakota State Water Commission database. Data included major ions, trace elements, nutrients, field properties, and physical properties.

The Fox Hills and Hell Creek aquifers had few groundwater water-quality data. The lack of data limits any detailed assessments that can be made about these aquifers. Data for the Rolla aquifer exist from 1978 through 1980 only. The concentrations of some water-quality constituents exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels. No samples were analyzed for pesticides and hydrocarbons.

Numerous water-quality samples have been obtained from the Shell Valley aquifer. About one-half of the water samples from the Shell Valley aquifer had concentrations of iron, manganese, sulfate, and dissolved solids that exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels. Overall, the data did not indicate obvious patterns in concentrations.

Introduction

The Turtle Mountain Indian Reservation, located in northern Rolette County, North Dakota (fig. 1A), relies on groundwater supplies to meet the demands of community and economic needs. To maintain high-quality water supplies, monitoring of the groundwater resources is necessary. Various entities have monitored groundwater quality from many locations to assist reservation agencies in making decisions about water distribution and use. Although considerable amounts of

groundwater-level and water-quality data have been collected, much of the data reside in Federal, State, and tribal databases, and have not been consolidated or assessed.

To assist the Turtle Mountain Indian Reservation with groundwater data and investigations, the U.S. Geological Survey (USGS), in cooperation with the Turtle Mountain Band of Chippewa Indians, examined historical groundwater-level and groundwater-quality data for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, and produced an assessment of the data for the reservation. Reservation agencies can use this assessment to determine future water-quality sampling needs to fulfill the reservation's monitoring requirements and to extend tribal data coverage.

Purpose and Scope

The purpose of this report is to present an assessment of groundwater data for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers in northern Rolette County, North Dakota and especially in the vicinity of the Turtle Mountain Indian Reservation for 1970 through 2012. This report presents data from available Federal, State, and tribal sources that include groundwater-quality data, and annual water-level data and annual withdrawals from the Shell Valley aquifer.

Previous Studies

Searches through Federal, State, and tribal records for previous investigation studies or groundwater modeling in Rolette County revealed earlier studies by the USGS. In 1975, a study was done by the USGS in cooperation with the U.S. Public Health Service to locate a suitable groundwater supply for the city of Belcourt, North Dakota (Randich, 1975). An investigation of groundwater resources in Rolette County was made cooperatively by the USGS, North Dakota State Water Commission (NDSWC), North Dakota Geological Survey, and the Water Management Districts of Bottineau and Rolette Counties (Randich and Kuzniar, 1984). The results of the three-part investigation consist of an interpretative report describing the geology of the study area, a compilation of the

2 Assessment of Groundwater Quality Data for the Turtle Mountain Indian Reservation, Rolette County, North Dakota, 1970–2012

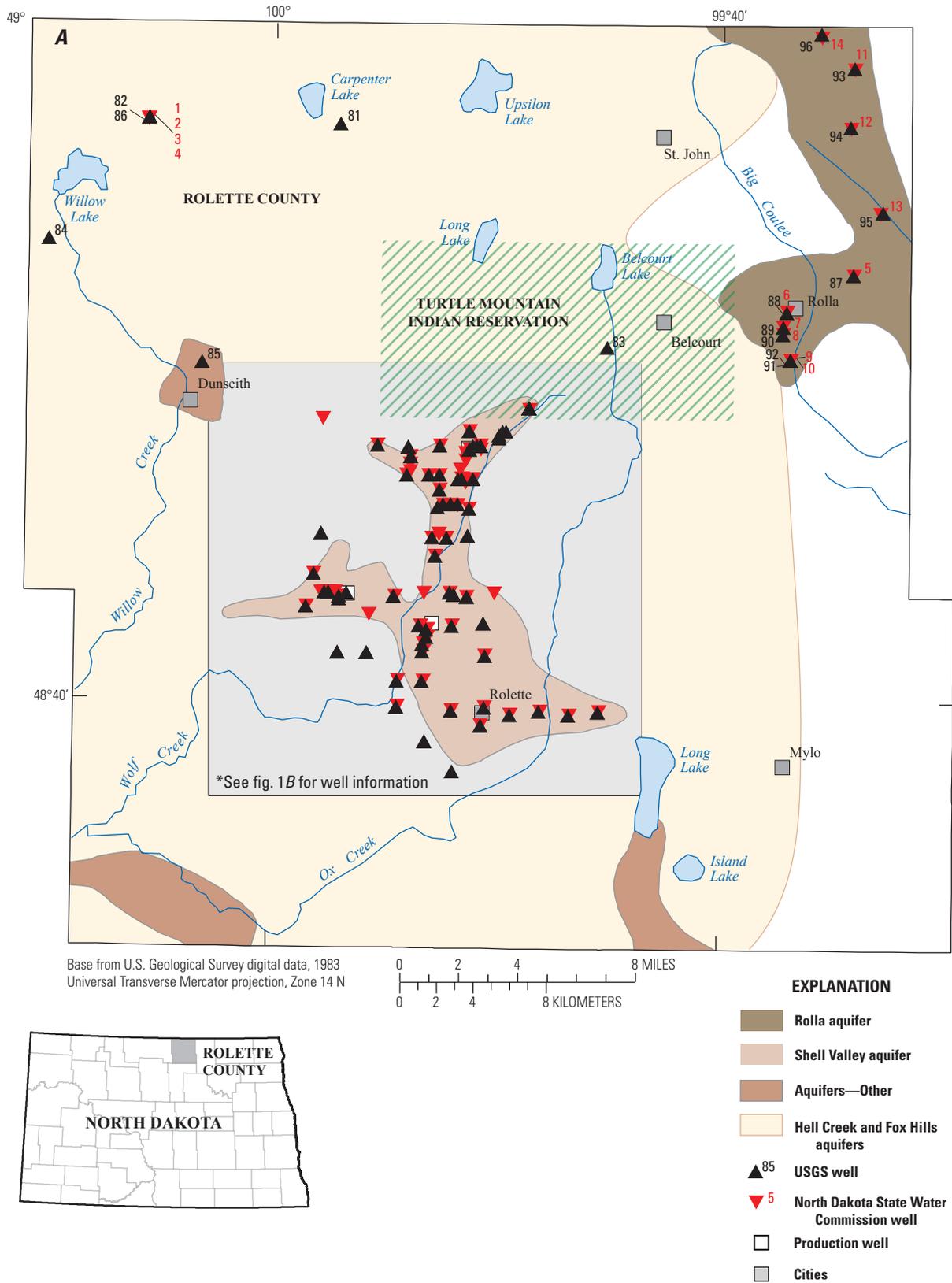
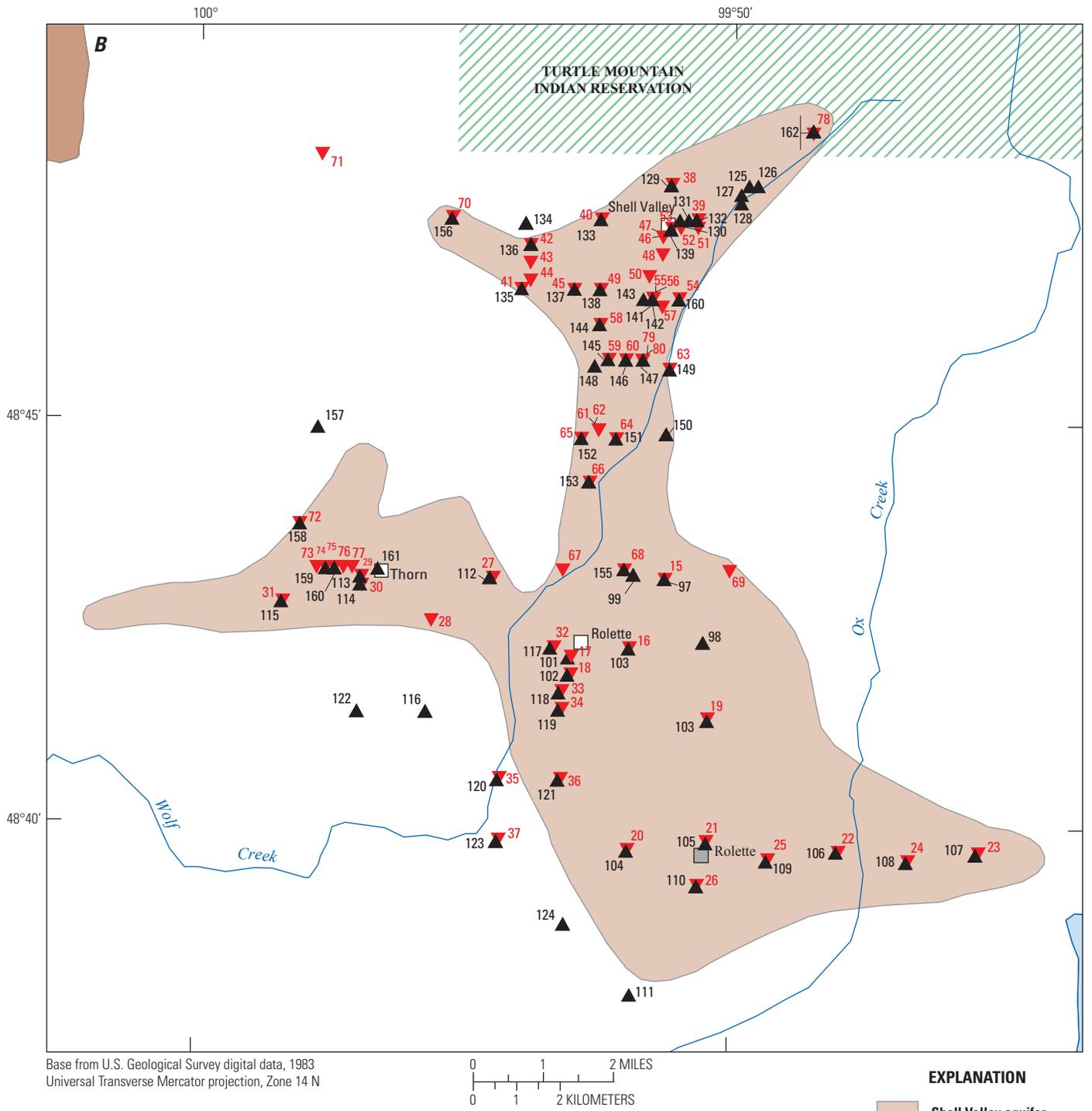


Figure 1. Location of the Turtle Mountain Indian Reservation and groundwater measuring wells in A, major aquifers and B, Shell Valley aquifer, Rolette County, North Dakota.



Base from U.S. Geological Survey digital data, 1983
 Universal Transverse Mercator projection, Zone 14 N

Figure 1. Location of the Turtle Mountain Indian Reservation and groundwater measuring wells in A, major aquifers and B, Shell Valley aquifer, Rolette County, North Dakota.—Continued

geologic and hydrologic data (Kuznair and Randich, 1982), and an interpretative report describing groundwater resources (Randich and Kuzniar, 1984).

In 1995, a study was done by the USGS in cooperation with the Turtle Mountain Band of Chippewa Indians that examined groundwater and surface-water sources to determine the quality of the water in the Shell Valley aquifer (Strobel, 1997). Samples were collected and analyzed for major ions, selected trace metals, agricultural chemicals, and selected hydrocarbons. Agricultural chemicals were not detected in water samples from the aquifer; however, the study indicated the presence of hydrocarbons in the Shell Valley aquifer and in the surface water near the aquifer. In 1997, an additional study was done by the USGS to determine the occurrence, distribution, and concentration of hydrocarbons in and near the Shell Valley aquifer (Berkas, 1999). Using the enzyme-linked immunoassay method, analyses of the 1997 water samples indicated the presence of polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and pentachlorophenol (PCP) in the study area. Because hydrocarbons were detected, selected samples were analyzed using the gas chromatography (GC) method to detect individual compounds and determine the concentrations of those compounds. Concentrations for all compounds detected using the GC method were less than the minimum reporting levels for each constituent (Berkas, 1999).

Data Sources

The two main sources of water-quality data for groundwater were the databases of the USGS National Water Information System (NWIS) database and the NDSWC database (table 1). The USGS collected data occasionally from 1978 through 1998, but no data were collected again until 2012. The NDSWC collected water-quality data for groundwater about once every 5 years from 1974 through 2008, and measured monthly water levels. The purpose of the NDSWC general sampling is to provide historical water-quality data for water appropriations, and the water levels are for withdrawal permits. Water-quality data used for this assessment are available from the USGS NWIS database (U.S. Geological Survey, 2012) and the NDSWC database (North Dakota State Water Commission, 2012). Water-quality data for groundwater samples collected in the study area from 1970 through 2012 and available from NDSWC and USGS NWIS databases are listed in supplements 1 and 2, respectively. Data included major ions, trace elements, nutrients, field properties and physical properties.

Some water-quality data were collected by the North Dakota Department of Health (NDDH) and the Turtle Mountain Tribe. The NDDH sampled selected groundwater wells in the Shell Valley aquifer from 1992 through 2011. The purpose

Table 1. Sources of groundwater-quality data available, 1970 through 2012.

[MI, major ions; TM, trace metals; Other, field and laboratory measurements; P, pesticides; H, hydrocarbons]

Aquifer	Number of wells	Number of samples collected	Periods of record	Types of data
North Dakota State Water Commission database				
Shell Valley	66	180	1974, 1977–81, 1983, 1985, 1986, 1988, 1995, 1997, 1998, 2002–04, 2007	MI, TM, nitrate, other, water levels
Rolla	10	10	1978, 1979 and 1980	MI, TM, nitrate, other, water levels
Fox Hills	2	2	1978 and 1997	MI, TM, nitrate, other, water levels
Hell Creek	2	2	1978 and 1997	MI, TM, nitrate, other, water levels
U.S. Geological Survey database				
Shell Valley	68	101	1988, 1995, 1997, 1998, 2012	MI, TM, nitrate, other, P ¹ , H ¹
Rolla	13	14	1978, 1979 and 1980	MI, TM, nitrate, other
Fox Hills	3	3	1978 and 1997	MI, TM, nitrate, other
Hell Creek	5	5	1978 and 1997	MI, TM, nitrate, other
North Dakota Department of Health (proprietary data)				
Shell Valley	20	80	1992–2011 ²	MI, TM, nitrate, other

¹Pesticides and hydrocarbon data are published in Strobel (1995) and Berkas (1999).

²About 20 groundwater wells were sampled 4 times or about every 5 years from 1992 through 2011.

of the NDDH ambient sampling is to monitor water-quality data primarily for effects of agriculture practices. About 20 private groundwater wells were sampled 4 times or about every 5 years during the 20-year period for major ions, selected trace elements, nitrate, pesticides, field properties, and physical properties. The NDDH produces internal reports using the data and those data are considered proprietary and not available for publication. The Turtle Mountain Tribe Public Utilities Commission collects treated water samples on a monthly basis from their water distribution system that blends water from three groundwater production wells, known as the Shell Valley, Rolette, and Thorn wells (fig. 1A). These water samples are analyzed for contaminants including microbial, inorganic and organic chemical contaminants, as required by the U.S. Environmental Protection Agency (USEPA). Because the water samples collected by the Turtle Mountain Tribe Public Utilities Commission were not collected directly from Shell Valley aquifer sampling wells, results from those water-quality analyses were not included in this assessment of groundwater quality.

Physical Setting of the Study Area

The Turtle Mountain Indian Reservation covers about 72 square miles in north-central North Dakota). The topography of the reservation is predominately rolling hills, and the land surface is covered mostly with forests and small lakes in the northern part of the reservation. The southern part of the reservation is low rolling hills with land areas cleared for agriculture (North Dakota Studies, 2012).

Aquifers

The major aquifers located under or near to the Turtle Mountain Indian Reservation are the Fox Hills and Hell Creek aquifers, which are composed of bedrock materials; and the Rolla and Shell Valley aquifers, which are composed of glacial-drift materials (Randich and Kuzniar, 1984). The Fox Hills sandstones of the Fox Hills and Hell Creek aquifers are about 35 to 100 feet below land surface, and the water-bearing beds of the aquifers vary from about 2 to 83 feet thick (Randich and Kuzniar, 1984). The Rolla and Shell Valley aquifers are about 0 to 35 feet below land surface, and the water-bearing beds of the aquifers vary from about 2 to 86 feet thick (Randich and Kuzniar, 1984). Other small, undifferentiated aquifers exist under Rolette County, but these aquifers are not discussed in this report.

Water from the Rolla and Shell Valley aquifers is the major supply for the city of Rolla, North Dakota, and for the Turtle Mountain Indian Reservation, respectively (Randich and Kuzniar, 1984). Water from the Shell Valley aquifer also is used for the irrigation of crops in the southern portion of the reservation and elsewhere in Rolette County. Observations

during visits to the reservation indicate that several lakes are situated in the vicinity of the aquifers. Occasionally, these lakes may act as recharge locations for the Rolla and Shell Valley aquifers. Wolf Creek, which flows near agricultural lands in the southern part of the reservation, has been identified as a potential source of recharge to the Shell Valley aquifer during periods of runoff (Randich and Kuzniar, 1984).

Land Use

Land use on the Turtle Mountain Indian Reservation is mostly recreational, with some agricultural interests especially in the southern part of the reservation (North Dakota Studies, 2012). Agricultural lands on the reservation are used for crop production or for pasture. Crop statistics for Rolette County, North Dakota, were accessed from the U.S. Department of Agriculture National Agriculture Statistics Service (U.S. Department of Agriculture, 2012). A 15-year history of crops grown in Rolette County shows a predominance of wheat production, with increased production of canola since 1999 (table 2). Although data on the use of agricultural chemicals (fertilizers, herbicides, and pesticides) for production of these crops were not available, the types and quantities of chemicals used on particular crops could be inferred from published materials about crop-production practices (North Dakota State University, 2012).

Table 2. Annual acreages of major crops planted in Rolette County, North Dakota, 1997 through 2011.

[Data obtained from <http://quickstats.nass.usda.gov/>; --, no data]

Year	Hard red spring and winter wheat	Canola	Barley and oats	Other ¹
1997	130,000	--	82,500	14,100
1998	99,800	--	69,000	22,200
1999	35,500	14,000	37,500	15,300
2000	97,800	52,500	49,400	26,300
2001	85,500	47,500	44,000	28,100
2002	89,500	50,600	56,000	39,500
2003	88,900	49,500	52,500	36,900
2004	81,000	34,500	38,000	16,100
2005	89,500	47,500	29,500	33,300
2006	106,900	42,500	22,500	19,500
2007	106,700	46,800	41,700	17,100
2008	110,800	46,600	50,000	40,100
2009	112,400	46,400	32,400	32,630
2010	105,600	63,700	25,000	39,240
2011	84,600	37,400	12,600	25,640

¹Consists of corn, flax, soybeans, and sunflowers.

Assessment of Groundwater Levels

Groundwater levels were obtained from NDSWC that provided monthly water levels in the Shell Valley aquifer from 1981 through 2011. The levels from NDSWC groundwater wells were measured by the USGS and referenced to NDSWC measurement point elevations. Levels from groundwater wells located nearest to the Shell Valley, Thorn and Rolette production wells were selected, and levels from the last month of each year were used to estimate the annual water levels from the Shell Valley aquifer.

Water levels in the Shell Valley aquifer often fluctuate by several feet annually in response to natural processes and to municipal and irrigation pumping, although water-level recovery was noted during periods with no pumping activity (Randich and Kuzniar, 1984). Annual water withdrawals from the Shell Valley aquifer for 1981 through 2011 show a relatively steady increase from 1981 through 2006 (fig. 2). Aquifer water levels tended to decrease during the period of increased withdrawals, but from 1999 to 2011, water levels mostly increased or stabilized (fig. 3).

Assessment of Groundwater Quality

Groundwater-quality data were obtained from several groundwater sampling wells in Rolette County (tables 3 and 4). Groundwater sampling wells discussed in this report were located in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers only. Sample concentrations also were compared to USEPA drinking water maximum contaminate levels (MCL) and secondary maximum contaminate level (SMCL) (U.S. Environmental Protection Agency, 2012). An MCL refers to the highest level or concentration that is allowed in drinking water for protection of health and is an enforceable standard. An SMCL is a nonenforceable guideline and addresses either cosmetic or aesthetic effects. Water concentrations above a SMCL may result in tooth or skin discoloration or taste, odor, or color issues.

Fox Hills and Hell Creek Aquifers

Very few groundwater samples have been obtained from the Fox Hills and Hell Creek aquifers (supplements 1 and 2).

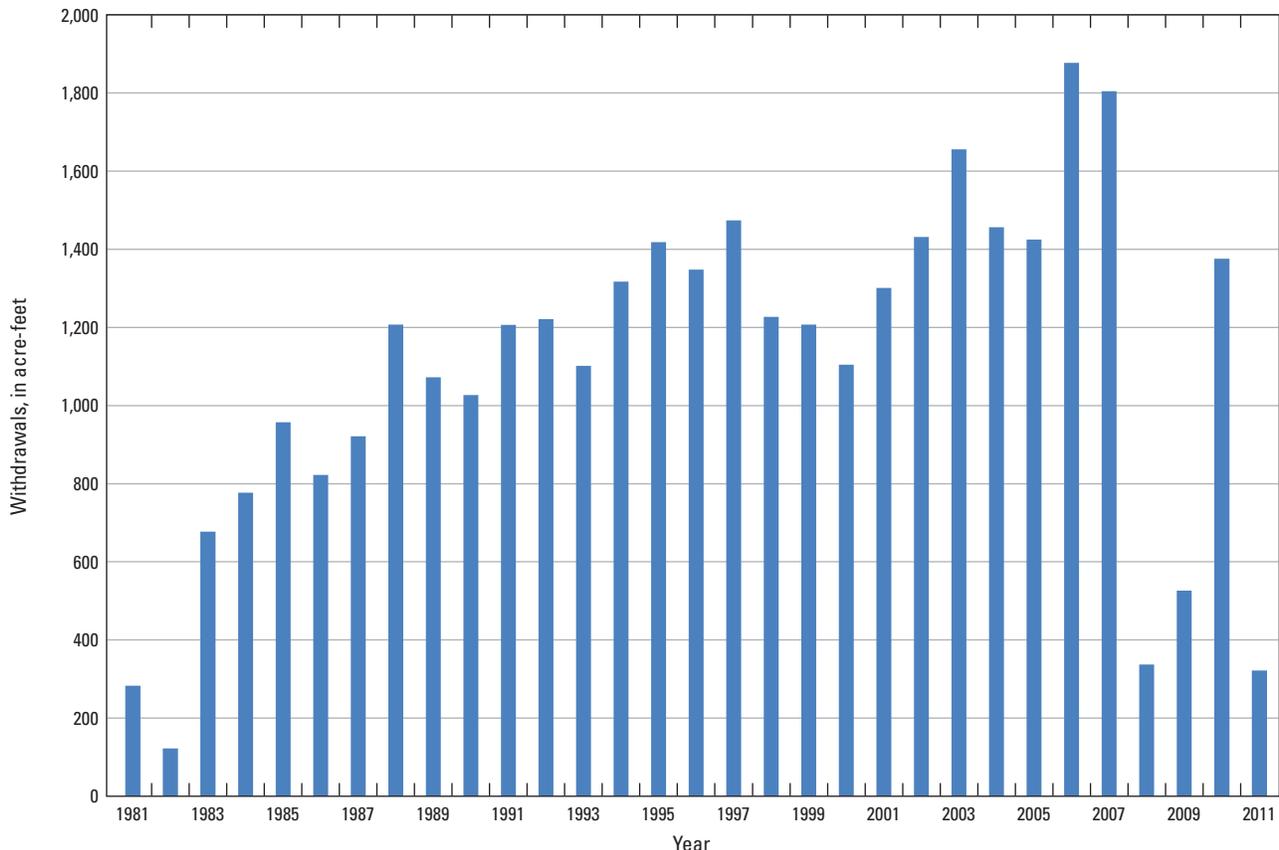


Figure 2. Annual water withdrawals from the Shell Valley aquifer, 1981 through 2011.

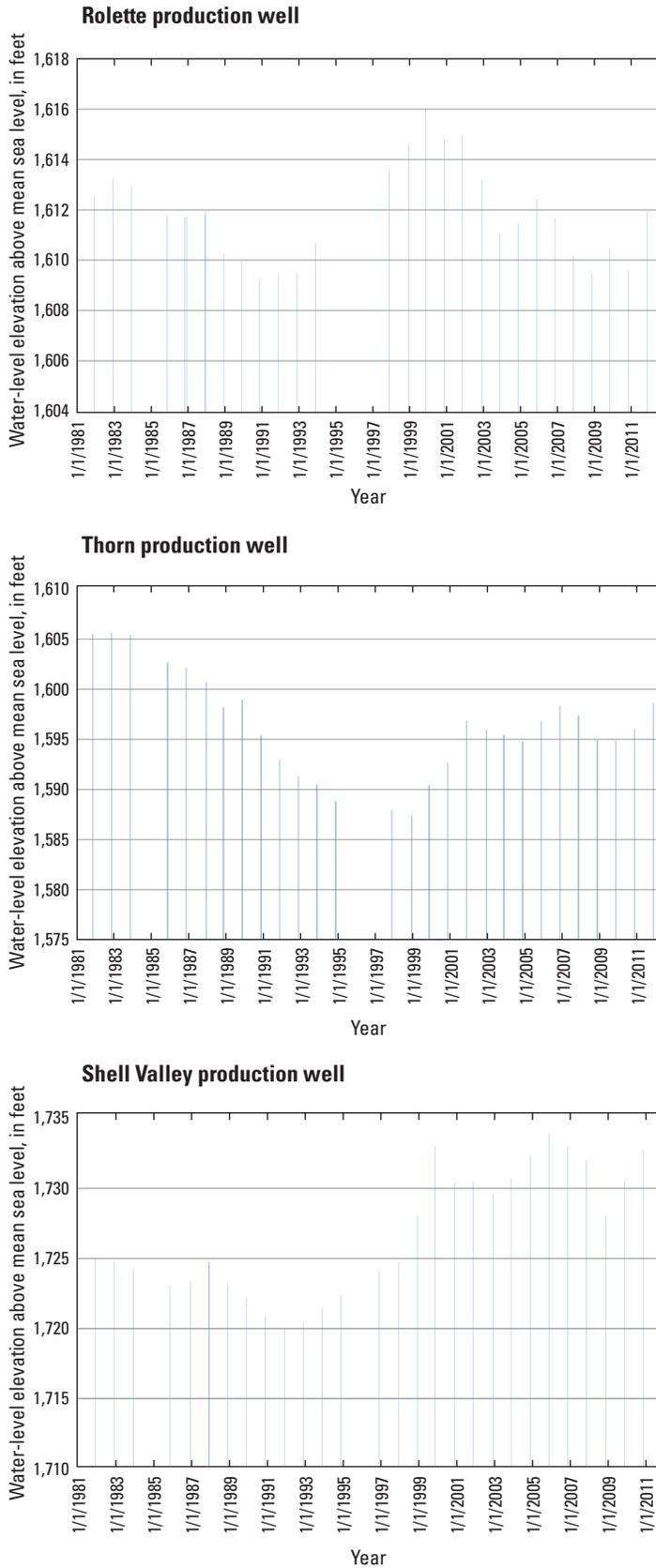


Figure 3. Annual water levels near Rolette, Thorn, and Shell Valley production wells, 1981 through 2011.

No samples have been obtained since 1997 (Berkas, 1999). Data from 1997 indicate somewhat greater concentrations of calcium, magnesium, and sulfate than the data from 1978. In addition, no information about pesticides and hydrocarbons exist in the datasets. The scarcity of data from the Fox Hills and Hell Creek aquifers limits any reasonable assessments that can be made about the aquifers, however all concentrations of manganese, sulfate, and dissolved solids exceeded the USEPA SMCL.

Rolla Aquifer

Although more groundwater samples have been obtained from the Rolla aquifer than from the Fox Hills and Hell Creek aquifers, data for the Rolla aquifer exist only for the period 1978 through 1980 (supplements 1 and 2). The concentrations of iron, manganese, sulfate and dissolved solids in most of the samples obtained exceeded the USEPA SMCL (U.S. Environmental Protection Agency, 2012). Also, no samples were analyzed for pesticides and hydrocarbons. The limited period of time during which water-quality samples were collected from the Rolla aquifer precludes attempts to discuss possible patterns in water-quality constituents.

Shell Valley Aquifer

Numerous water-quality samples were obtained from the Shell Valley aquifer (supplements 1 and 2; fig. 4). The NDSWC groundwater well 160-072-02CBC (well 28 on fig. 1B) had consistently large values for specific conductivity, magnesium, potassium, sodium, bicarbonate, sulfate, chloride, and dissolved solids for the five samples collected from 1981 through 2007 (supplement 1). Groundwater well 160-072-02CBC (well 28 on fig. 1B) is located between two wetlands and the groundwater at that well may be affected influenced by surface-water interaction. About one-half of the NDSWC water-quality samples from the Shell Valley aquifer had concentrations of iron, manganese, sulfate, and dissolved solids that exceeded the USEPA SMCL (U.S. Environmental Protection Agency, 2012; fig. 4). Except for the few water-quality samples obtained during the special studies in 1995 and 1997 (Strobel, 1997; Berkas, 1999), no samples were analyzed for pesticides and hydrocarbons. The USGS water-quality samples from the Shell Valley aquifer also had concentrations of iron, manganese, sulfate, and dissolved solids that exceeded the USEPA secondary maximum contaminant levels (U.S. Environmental Protection Agency, 2012; fig. 5) Overall, the data from the Shell Valley aquifer did not indicate any obvious patterns in water-quality constituent concentrations.

Two water-quality samples, one obtained in 1995 from USGS groundwater well 160-071-24DDD (well 107 on fig. 1B) and another sample obtained in 2012 from USGS groundwater well 161-072-35CDC (well 160 on fig. 1B), indicated arsenic concentrations greater than 30 micrograms per liter (supplement 2). These two samples were the only ones

Table 3. Locations of North Dakota State Water Commission groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota.

Well number (fig. 1)	Aquifer	Site name	Latitude, decimal degrees	Longitude, decimal degrees
1	Fox Hills	163-073-11CCC1	48.951118	-100.094355
2	Fox Hills	163-073-11CCC1	48.951118	-100.094355
3	Hell Creek	163-073-11CCC2	48.951118	-100.094355
4	Hell Creek	163-073-11CCC2	48.951118	-100.094355
5	Rolla	162-069-11BBB	48.876723	-99.568226
6	Rolla	162-069-17ADB	48.858761	-99.617635
7	Rolla	162-069-17DCA	48.851522	-99.620382
8	Rolla	162-069-20ABA	48.847892	-99.620348
9	Rolla	162-069-20DDD1	48.835132	-99.614808
10	Rolla	162-069-20DDD2	48.835132	-99.614808
11	Rolla	163-069-02BBB	48.977950	-99.568324
12	Rolla	163-069-15AAA	48.948938	-99.571001
13	Rolla	163-069-26DDD	48.907270	-99.548839
14	Rolla	164-069-28DDD	48.993768	-99.593090
15	Shell Valley	160-071-05BAA	48.717664	-99.853987
16	Shell Valley	160-071-07AAA	48.703430	-99.864797
17	Shell Valley	160-071-07BBC	48.701605	-99.882961
18	Shell Valley	160-071-07BCC	48.697980	-99.882954
19	Shell Valley	160-071-16BBB	48.688967	-99.840183
20	Shell Valley	160-071-19DDD	48.661846	-99.864887
21	Shell Valley	160-071-21CCB	48.663597	-99.840240
22	Shell Valley	160-071-22DDD	48.661676	-99.799083
23	Shell Valley	160-071-24DDD	48.661703	-99.755465
24	Shell Valley	160-071-26AAA	48.659863	-99.777329
25	Shell Valley	160-071-28AAA	48.659982	-99.821059
26	Shell Valley	160-071-29ADD	48.654571	-99.843055
27	Shell Valley	160-072-02AAA	48.717648	-99.907480
28	Shell Valley	160-072-02CBC	48.708838	-99.926626
29	Shell Valley	160-072-03BBB1	48.717749	-99.948501
30	Shell Valley	160-072-03BBC	48.715966	-99.948499
31	Shell Valley	160-072-05ADD	48.712431	-99.973020
32	Shell Valley	160-072-12AAB	48.703485	-99.888344
33	Shell Valley	160-072-12DAD	48.694424	-99.885612
34	Shell Valley	160-072-12DDD	48.690816	-99.885609
35	Shell Valley	160-072-13CCC	48.676413	-99.904896
36	Shell Valley	160-072-13DDD	48.676310	-99.885842
37	Shell Valley	160-072-24CCB	48.663706	-99.904967
38	Shell Valley	161-071-03BCC2	48.799213	-99.852847
39	Shell Valley	161-071-03CDD4	48.792029	-99.844619

Table 3. Locations of North Dakota State Water Commission groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota.—Continued

Well number (fig. 1)	Aquifer	Site name	Latitude, decimal degrees	Longitude, decimal degrees
40	Shell Valley	161-071-04CCC	48.791937	-99.874838
41	Shell Valley	161-071-07DDD	48.777416	-99.899589
42	Shell Valley	161-071-08BCB	48.786528	-99.896868
43	Shell Valley	161-071-08CBB	48.782862	-99.896865
44	Shell Valley	161-071-08CCB	48.779202	-99.896862
45	Shell Valley	161-071-08DCD	48.777351	-99.883093
46	Shell Valley	161-071-09AAD1	48.788330	-99.855632
47	Shell Valley	161-071-09AAD2	48.788330	-99.855632
48	Shell Valley	161-071-09ADD	48.784690	-99.855640
49	Shell Valley	161-071-09CCC	48.777368	-99.874852
50	Shell Valley	161-071-09D	48.780167	-99.859779
51	Shell Valley	161-071-10BAA	48.790221	-99.844613
52	Shell Valley	161-071-10BBA	48.790191	-99.850115
53	Shell Valley	161-071-10BBB	48.790181	-99.852873
54	Shell Valley	161-071-15BBA	48.775669	-99.850235
55	Shell Valley	161-071-16AAB	48.775653	-99.858430
56	Shell Valley	161-071-16AAB1	48.775653	-99.858430
57	Shell Valley	161-071-16AAD	48.773836	-99.855696
58	Shell Valley	161-071-16BCC	48.770180	-99.874856
59	Shell Valley	161-071-16CCD	48.762966	-99.872133
60	Shell Valley	161-071-16CDD	48.762947	-99.866651
61	Shell Valley	161-071-21CCC1	48.748431	-99.875014
62	Shell Valley	161-071-21CCC2	48.748431	-99.875014
63	Shell Valley	161-071-22BBB	48.761069	-99.853132
64	Shell Valley	161-071-28BAB	48.746593	-99.869460
65	Shell Valley	161-071-29AAB	48.746646	-99.880433
66	Shell Valley	161-071-29DAD	48.737601	-99.877642
67	Shell Valley	161-071-32DCC	48.719428	-99.885780
68	Shell Valley	161-071-33CDD	48.719513	-99.866613
69	Shell Valley	161-071-34DDD	48.719440	-99.833751
70	Shell Valley	161-072-01DDD	48.792107	-99.921345
71	Shell Valley	161-072-02BBB	48.804759	-99.962423
72	Shell Valley	161-072-34ADB	48.728556	-99.967965
73	Shell Valley	161-072-35CCC	48.719466	-99.962539
74	Shell Valley	161-072-35CCD	48.719478	-99.959798
75	Shell Valley	161-072-35CDC	48.719501	-99.957053
76	Shell Valley	161-072-35CDD	48.719513	-99.954304
77	Shell Valley	161-072-35DCC	48.719542	-99.951550
78	Shell Valley	162-071-36CBC2	48.809937	-99.808876
79	Shell Valley	161-071-16DCD1	48.762805	-99.861609
80	Shell Valley	161-071-16DCD1	48.762805	-99.861609

Table 4. Locations of U.S. Geological Survey (USGS) groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota.

Well number (fig. 1)	Aquifer	USGS well identification number	Site name	Latitude, decimal degrees	Longitude, decimal degrees
81	Fox Hills	485659099570501	163-072-14ABB	48.949726	-99.951796
82	Fox Hills	485707100053701	163-073-11CCC1	48.951949	-100.094018
83	Hell Creek	485027099450401	162-070-20DBA	48.840838	-99.751536
84	Hell Creek	485330100100301	162-073-06ABA	48.891670	-100.167910
85	Hell Creek	484955100030801	162-073-25AAD	48.831946	-100.052634
86	Hell Creek	485707100053702	163-073-11CCC2	48.951949	-100.094018
87	Rolla	485237099340601	162-069-11BBB	48.876951	-99.568754
88	Rolla	485131099370301	162-069-17ADB1	48.858617	-99.617922
89	Rolla	485105099371301	162-069-17DCA	48.851395	-99.620700
90	Rolla	485052099371302	162-069-20ABA2	48.847783	-99.620700
91	Rolla	485007099365301	162-069-20DDD1	48.835283	-99.615145
92	Rolla	485007099365302	162-069-20DDD2	48.835283	-99.615145
93	Rolla	485844099340501	163-069-02BBB	48.978897	-99.568472
94	Rolla	485659099341501	163-069-15AAA	48.949730	-99.571251
95	Rolla	485429099324701	163-069-25CCC	48.908063	-99.546808
96	Rolla	485944099353501	164-069-28DDD	48.995564	-99.593472
97	Shell Valley	484304099511301	160-071-05BAA	48.717778	-99.854034
98	Shell Valley	484217099502901	160-071-05DDD	48.704723	-99.841812
99	Shell Valley	484307099514801	160-071-06AAA	48.718612	-99.863756
100	Shell Valley	484212099515301	160-071-07AAA	48.703334	-99.865144
101	Shell Valley	484205099530101	160-071-07BBC	48.701389	-99.884032
102	Shell Valley	484152099530101	160-071-07BCC	48.697778	-99.884032
103	Shell Valley	484119099502401	160-071-16BBB1	48.688611	-99.840423
104	Shell Valley	483942099515301	160-071-19DDD	48.661666	-99.865143
105	Shell Valley	483948099502401	160-071-21CCB	48.663333	-99.840422
106	Shell Valley	483942099475801	160-071-22DDD	48.661666	-99.799868
107	Shell Valley	483941099452101	160-071-24DDD	48.661389	-99.756259
108	Shell Valley	483935099463901	160-071-26AAA	48.659722	-99.777925
109	Shell Valley	483935099491601	160-071-28AAA1	48.659722	-99.821534
110	Shell Valley	483916099503401	160-071-29ADD	48.654444	-99.843199
111	Shell Valley	483755099514801	160-071-31DDD	48.631943	-99.863754
112	Shell Valley	484304099542901	160-072-02AAA	48.717778	-99.908476
113	Shell Valley	484304099565501	160-072-03BBB1	48.717778	-99.949029
114	Shell Valley	484258099565501	160-072-03BBC	48.716111	-99.949029
115	Shell Valley	484245099582301	160-072-05ADD	48.712500	-99.973472
116	Shell Valley	484124099554001	160-072-10DDD	48.690000	-99.928196
117	Shell Valley	484212099532101	160-072-12AAB	48.703333	-99.889587
118	Shell Valley	484139099531101	160-072-12DAD	48.694167	-99.886810
119	Shell Valley	484126099531101	160-072-12DDD	48.690555	-99.886810
120	Shell Valley	484034099541901	160-072-13CCC1	48.676111	-99.905697

Table 4. Locations of U.S. Geological Survey (USGS) groundwater sampling wells in the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, Rolette County, North Dakota.—Continued

Well number (fig. 1)	Aquifer	USGS well identification number	Site name	Latitude, decimal degrees	Longitude, decimal degrees
121	Shell Valley	484034099531101	160-072-13DDD	48.676111	-99.886809
122	Shell Valley	484124099565701	160-072-15BBB	48.689999	-99.949584
123	Shell Valley	483948099541901	160-072-24CCB	48.663333	-99.905697
124	Shell Valley	483847099530301	160-072-36AAA	48.646388	-99.884586
125	Shell Valley	484757099494201	161-071-02BCD	48.799169	-99.828756
126	Shell Valley	484757099493201	161-071-02BDC	48.799169	-99.825978
127	Shell Valley	484750099495102	161-071-02CBB2	48.797225	-99.831256
128	Shell Valley	484744099495101	161-071-02CBC1	48.795558	-99.831256
129	Shell Valley	484757099511002	161-071-03BCC2	48.799169	-99.853199
130	Shell Valley	484731099510001	161-071-03CCD	48.791947	-99.850422
131	Shell Valley	484731099505001	161-071-03CDC1	48.791947	-99.847644
132	Shell Valley	484731099504104	161-071-03CDD4	48.791947	-99.845144
133	Shell Valley	484731099522901	161-071-04CCC	48.791946	-99.875142
134	Shell Valley	484728099535301	161-071-07AAAA	48.791113	-99.898474
135	Shell Valley	484639099535701	161-071-07DDD1	48.777501	-99.899586
136	Shell Valley	484712099534701	161-071-08BCB1	48.786668	-99.896808
137	Shell Valley	484639099525801	161-071-08DCD	48.777502	-99.883198
138	Shell Valley	484639099522901	161-071-09CCC	48.777502	-99.875143
139	Shell Valley	484724099511001	161-071-10BBB	48.790002	-99.853199
140	Shell Valley	484632099510001	161-071-15BBA	48.775558	-99.850422
141	Shell Valley	484632099513001	161-071-16AAB1	48.775557	-99.858755
142	Shell Valley	484632099513002	161-071-16AAB2	48.775557	-99.858755
143	Shell Valley	484632099514001	161-071-16ABA	48.775557	-99.861533
144	Shell Valley	484613099522901	161-071-16BCC	48.770279	-99.875144
145	Shell Valley	484547099521901	161-071-16CCD	48.763057	-99.872366
146	Shell Valley	484547099515901	161-071-16CDD	48.763057	-99.866811
147	Shell Valley	484547099514001	161-071-16DCD1	48.763057	-99.861534
148	Shell Valley	484542099523401	161-071-20AAA	48.761668	-99.876533
149	Shell Valley	484540099511001	161-071-22BBB	48.761113	-99.853201
150	Shell Valley	484452099511301	161-071-22CCC2	48.747779	-99.854035
151	Shell Valley	484448099520901	161-071-28BAB	48.746668	-99.869589
152	Shell Valley	484448099524801	161-071-29AAB	48.746668	-99.880422
153	Shell Valley	484416099523901	161-071-29DAD	48.737779	-99.877922
154	Shell Valley	481311099525801	161-071-32DCC	48.219723	-99.883188
155	Shell Valley	484311099515901	161-071-33CDD	48.719723	-99.866811
156	Shell Valley	484731099551601	161-072-01DDD	48.791946	-99.921529
157	Shell Valley	484455099574401	161-072-23CCC	48.748611	-99.962640
158	Shell Valley	484343099580301	161-072-34ADB	48.728611	-99.967917
159	Shell Valley	484310099573401	161-072-35CCD	48.719444	-99.959862
160	Shell Valley	484310099572401	161-072-35CDC	48.719444	-99.957084
161	Shell Valley	484310099563501	161-072-35DDD	48.719444	-99.943474
162	Shell Valley	484838099483101	162-071-36CBC1	48.810559	-99.809034
163	Shell Valley	484838099483102	162-071-36CBC2	48.810559	-99.809034

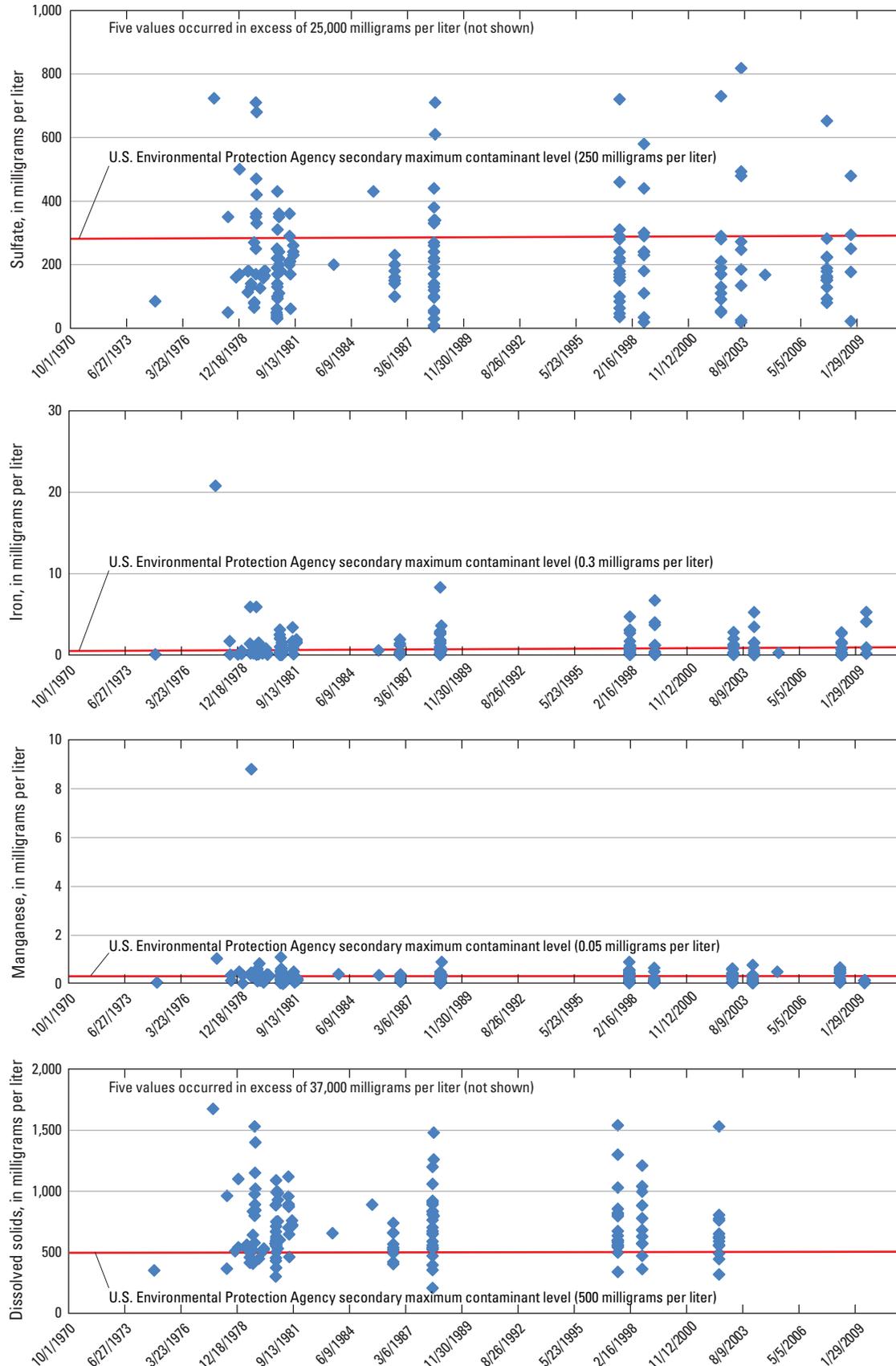


Figure 4. Groundwater concentrations from North Dakota State Water Commission wells in the Shell Valley aquifer for selected constituents that exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels.

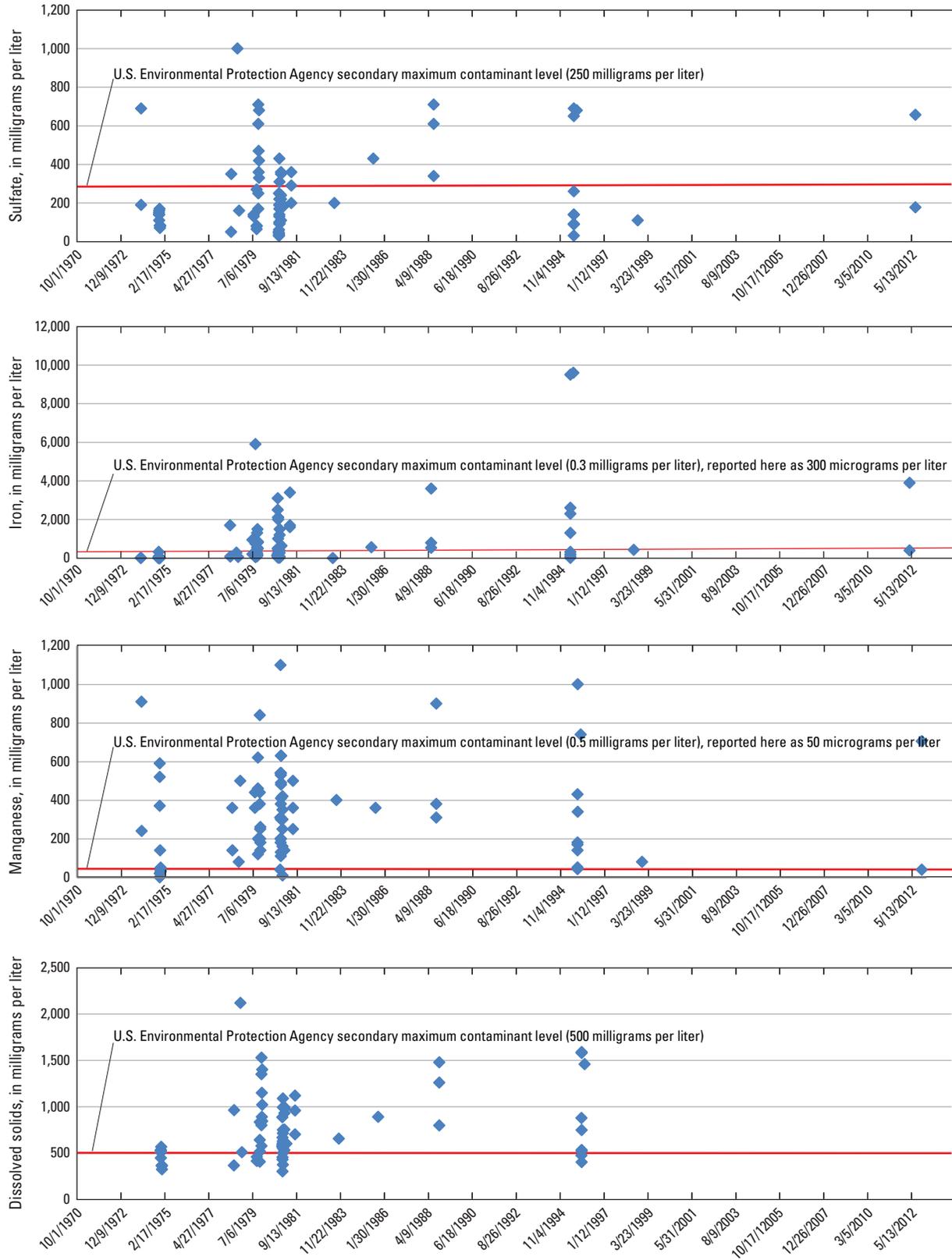


Figure 5. Groundwater concentrations from U.S. Geological Survey wells in the Shell Valley aquifer for selected constituents that exceeded the U.S. Environmental Protection Agency secondary maximum contaminant levels.

in the USGS database that had arsenic concentrations greater than the standard limit for drinking water (10 micrograms per liter). Comparisons of the USGS samples with samples from nearby NDSWC groundwater wells could not be made because samples collected by the NDSWC were not analyzed for arsenic (supplement 1). However, USGS groundwater well 161-072-35CDC (well 160 on fig. 1B) also had an arsenic concentration of 2 micrograms per liter, suggesting that the arsenic concentration is not always high and other factors may be affecting the concentration of arsenic in this well.

Implications

Water-quality data for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers are collected by various agencies for different studies and objectives. Data are collected for specific studies and on-going sampling programs. Water samples are collected from public groundwater observation wells and from private groundwater wells for selected constituents to meet agency objectives.

The Turtle Mountain Tribe may consider coordinating with Federal and State agencies that have sampling efforts and data to perform future assessments of groundwater quality. The results of the coordination may provide an efficient sampling program, and the design of a long-term and consistent strategy for groundwater sampling that may be advantageous for monitoring aquifer water quality. The types of water-quality data (major ions, metals, pesticides, hydrocarbons, and so on) collected in the future may be revised to provide missing information needed for current or future activities in or near the Shell Valley aquifer. These data also may be beneficial to other tribal, Federal, and State interests. The usefulness of the data may be enhanced while maintaining or perhaps reducing sampling costs. A modified or coordinated sampling plan could provide data from which patterns may be identified in relation to changes in climate and use or both.

Summary

The Turtle Mountain Indian Reservation relies on groundwater supplies to meet the demands of community and economic needs. The U.S. Geological Survey, in cooperation with the Turtle Mountain Band of Chippewa Indians, examined historical groundwater-level and groundwater-quality data for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, and produced an assessment of the data for the reservation. Water from the Rolla and Shell Valley aquifers is the major supply for the city of Rolla, North Dakota, and for the Turtle Mountain Indian Reservation, respectively.

Water levels in the Shell Valley aquifer often fluctuate by several feet annually in response to natural processes and

to municipal and irrigation pumping, although water-level recovery was noted during periods with no pumping activity. Aquifer water levels tended to decrease during the period of increased withdrawals, but from 1999 to 2011, water levels mostly increased or stabilized.

The two main sources of water-quality data for groundwater were the databases of the U.S. Geological Survey and the North Dakota State Water Commission. Data included major ions, trace elements, nutrients, field properties, and physical properties. The North Dakota State Water Commission collected water-quality data for groundwater about once every 5 years from 1974 through 2008. The North Dakota Department of Health sampled selected groundwater wells in the Shell Valley aquifer from 1992 through 2011 for major ions, selected trace elements, nitrate, field properties, and physical properties; however, those data are considered proprietary and not available for publication. The Turtle Mountain Tribe Public Utilities Commission collects treated water samples on a monthly basis from their water distribution system, but because the water samples were not collected directly from Shell Valley aquifer sampling wells, those data were not included in the assessment of groundwater quality.

The Fox Hills and Hell Creek aquifers had very few groundwater samples obtained. The lack of data limits any reasonable assessments that can be made about these aquifers. The concentrations for sulfate, manganese, and dissolved solids all exceeded the U.S. Environmental Protection Agency secondary maximum contaminate level. Data for the Rolla aquifer only exist for the period 1978 through 1980. The concentrations of manganese, sulfate, and dissolved solids exceeded the U.S. Environmental Protection Agency secondary maximum contaminate level. No samples were analyzed for pesticides and hydrocarbons.

Numerous water-quality samples have been obtained from the Shell Valley aquifer. The North Dakota State Water Commission groundwater well 160-072-02CBC (well 28 on fig. 1B) had consistently large values for specific conductivity, magnesium, potassium, sodium, bicarbonate, sulfate chloride, and dissolved solids for the five samples collected from 1981 through 2007. About one-half of the water-quality samples from the Shell Valley aquifer had concentrations of iron, manganese, sulfate, and dissolved solids that exceeded the U.S. Environmental Protection Agency secondary maximum contaminate level. Overall, the data from the Shell Valley aquifer did not indicate obvious patterns in concentrations.

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Supplements

Supplement 1. Water-quality data available in the North Dakota State Water Commission database for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, 1970 through 2012. The Excel file may be downloaded from http://pubs.usgs.gov/ds/732/downloads/supplement_1.xlsx.

Supplement 2. Water-quality data available in the U.S. Geological Survey database for the Fox Hills, Hell Creek, Rolla, and Shell Valley aquifers, 1970 through 2012. The Excel file may be downloaded from http://pubs.usgs.gov/ds/732/downloads/supplement_2.xlsx.

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