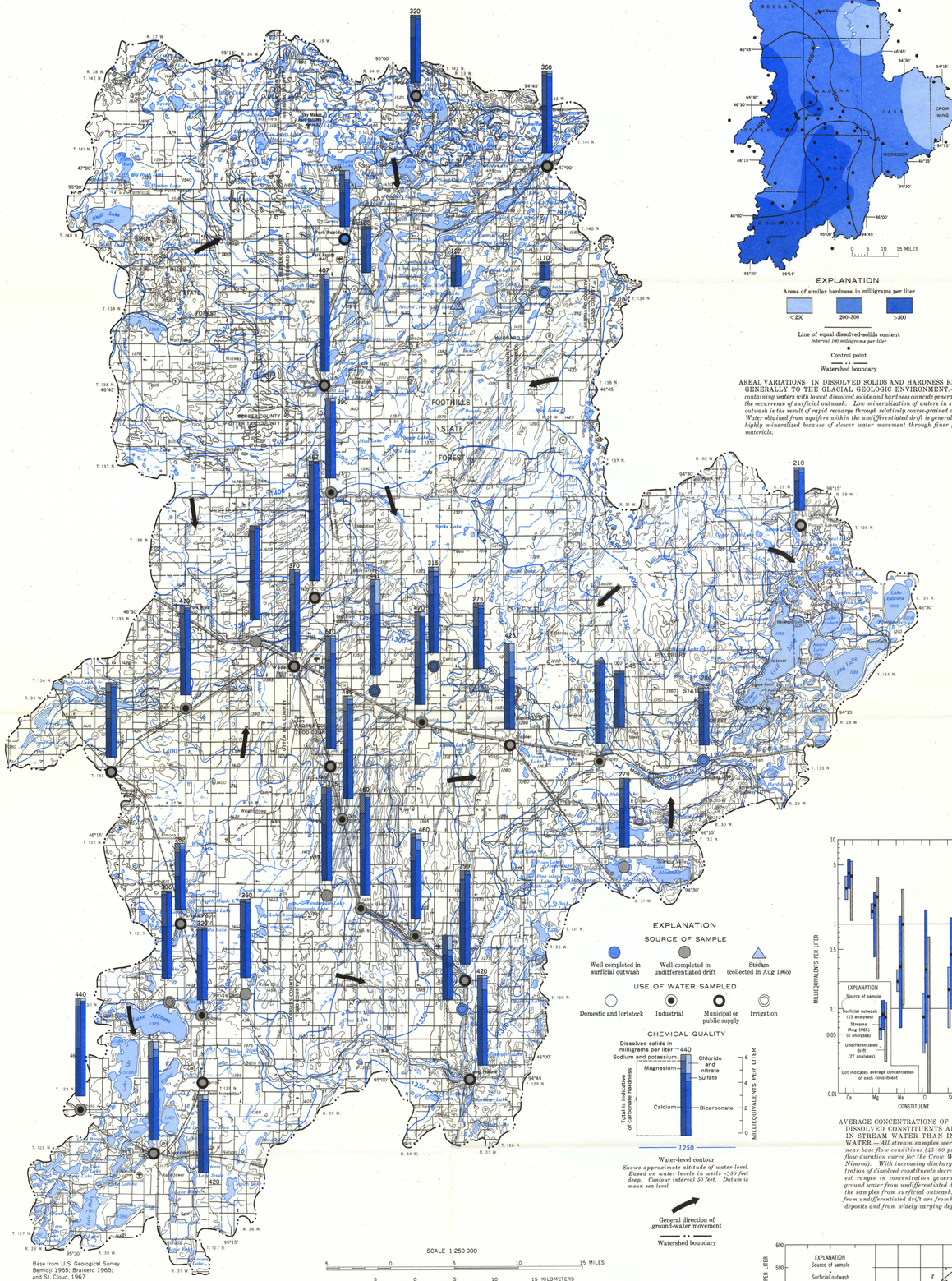
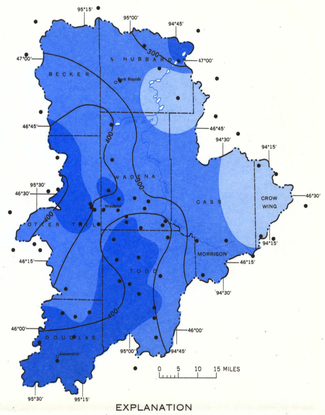
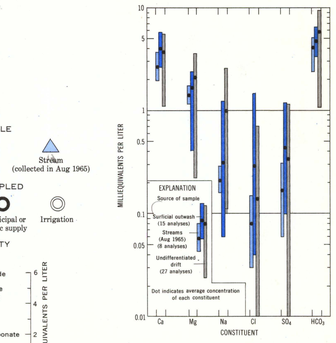
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

QUALITY OF WATER

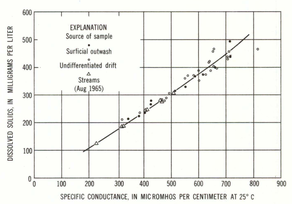




AREAL VARIATIONS IN DISSOLVED SOLIDS AND HARDNESS RELATE GENERALLY TO THE GLACIAL GEOLOGIC ENVIRONMENT.—*Areas containing waters with lowest dissolved solids and hardness coincide generally with the occurrence of surficial outwash. Low mineralization of waters in surficial outwash is the result of rapid recharge through relatively coarse-grained deposits. Water obtained from aquifers within the undifferentiated drift is generally more highly mineralized because of slower water movement through finer grained materials.*



AVERAGE CONCENTRATIONS OF ALL MAJOR DISSOLVED CONSTITUENTS ARE LOWER IN STREAM WATER THAN IN GROUND WATER.—*All stream samples were collected at near base flow conditions (15-40 percent on the flow duration curve for the Crow Wing River at Nimrod). With increasing discharge, the concentration of dissolved constituents decreases. Greatest ranges in concentration generally occur in ground water from undifferentiated drift. Unlike the samples from surficial outwash, the samples from undifferentiated drift are from heterogeneous deposits and from widely varying depths.*



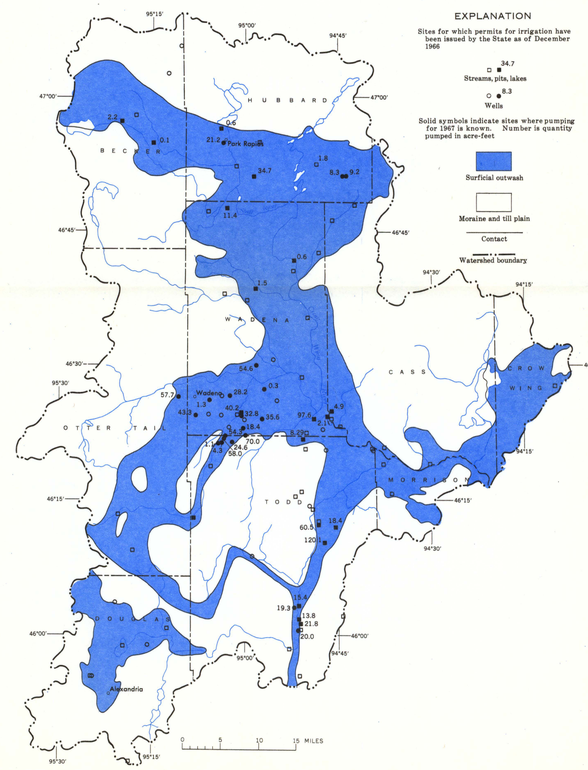
ANALYSES OF WATER SAMPLES FROM THE WATERSHED SHOW A NEARLY LINEAR RELATIONSHIP BETWEEN SPECIFIC CONDUCTANCE AND DISSOLVED SOLIDS.—*The readily obtained specific conductance can be used to estimate the dissolved solids, although the relationship is less well defined at higher concentrations.*

MOST WATER THROUGHOUT THE WATERSHED IS OF THE CALCIUM BICARBONATE TYPE

Water is normally suitable for most purposes, although certain uses may require water treatment. Ground water is very hard (greater than 180 milligrams per liter) in most parts of the watershed. This is related to the presence of abundant carbonate rock fragments in the glacial drift. Dissolved solids rarely exceed a concentration of 500 mg/l, the recommended limit for domestic use (U.S. Public Health Service, 1962). Nitrate content is generally below 45 mg/l, the recommended maximum for drinking water. Exceptions occur locally where polluted seepage reaches shallow aquifers. Although seldom exceeding 3.0 mg/l, dissolved iron in about two-thirds of all ground water samples exceeds 0.3 mg/l, the concentration above which it may become troublesome. Water from surficial outwash is generally satisfactory for irrigation in terms of sodium hazard, salinity hazard, and boron content.

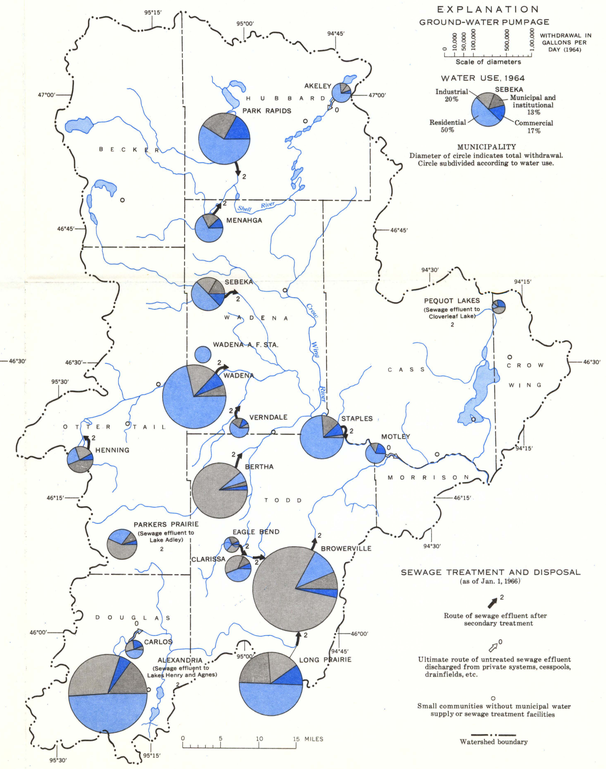
The configuration of the water table conforms generally to topography. Ground water moves from high morainal areas toward major streams which flow across topographically lower outwash plains. Quality of ground water is related to the rate of movement, the mineral composition of the surrounding rocks, and the total contact time with those rocks.

WATER USE



INCREASING AMOUNTS OF WATER ARE BEING WITHDRAWN FROM STREAMS AND SURFICIAL OUTWASH FOR IRRIGATION IN THE WATERSHED

The locations for which irrigation permits have been issued are largely within the areas of surficial outwash. Because the agricultural productivity of sandy soils in these areas is often limited by poor water retention, outwash areas benefit most from supplemental irrigation. Most permits for irrigation in the watershed have been issued since 1960. Total reported pumpage for irrigation in 1967 was about 1,115 acre-feet of water. Data pertaining to selected irrigation wells are included in the table below.



WATER WITHDRAWALS IN POPULATION CENTERS IN THE WATERSHED ARE LARGELY FOR RESIDENTIAL (40 PERCENT OF TOTAL) AND INDUSTRIAL (35 PERCENT OF TOTAL) USE

In 1964, total reported water use in population centers was about 1,700,000 gpd (or 1,150 acre-feet per day). With the exception of Sebeka, where part of the village supply is derived from Cretaceous bedrock, all water for population centers is obtained from the glacial drift. Specific information pertaining to municipal wells is given in the table below.

Most municipalities with municipal water systems also have sewage treatment facilities. Several small communities without municipal water systems discharge untreated sewage effluent from private systems, cesspools, and drainfields. Growing concern about pollution and water quality control will regulate future use of water bodies as receptacles for sewage effluent.

Data for selected municipal, irrigation, and other large-yield wells in the watershed.

Municipality	U.S.G.S. field number	Ownership	Use	Well depth (feet)	Well diameter (inches)	Yield (gpm)	Aquifer: Type and lithology	Well test data: Thickness (feet)	Specific capacity (gpm per ft.)	Tested rate (gpm)	Pumping time (hours)	Quality (Milligrams per liter): Iron (Fe)	Manganese (Mn)	Hardness as $CaCO_3$	Dissolved solids	Specific conductance (micromhos at 25°C)	pH
Akeley	141.32.28 acc	Municipal	Public supply	80	8	300	Water-table, sand	22	13.6	300	24.0	0.13	0.21	310	360	575	7.3
Aldrich	134.34.35 bdd	Private	Industrial	110	6	125			2.5	125	10.0	0.48	<0.02	250	470	655	7.3
Alexandria	128.37.17 bcc 2	Municipal	Public supply	121	16	1000	Artesian, sand	30	26.4	1000	2.0	1.30	0.09	392			7.2
	128.37.18 aaa 1			108	16	1000			43.0	1000	Unknown	1.40	0.20	432		705	7.4
	128.37.18 cdd			118	16	600	Artesian, sand	32	20.0	500	Unknown	1.40	0.20	410			6.9
	128.37.18 dea			129	16	1000			27.3	1000	2.0	2.40	0.12	350			7.3
	128.37.19 baa			105	16	1000	do	32	26.8	1000	2.0						
	128.37.21 bdb			121	12	500	do	28	33.3	500	5.0	1.50	0.09	340			6.7
	128.37.18 cbc 1	Private	Industrial	108	12	350	do	20	10.9	350	3.0	0.45	0.10	340		475	7.5
	128.37.18 cbc 2			131	20	540			24.6	540	Unknown						
Badoura	139.32.16 aaa	State of Minnesota	Irrigation	68	10	250	Artesian, sand	18	5.0	250	Unknown						
	139.32.16 aab			152	10	435	do		4.5	435	Unknown						
	139.32.16 abd			124	10	435	do	14	4.5	435	4.0						
	139.32.16 ada			68	10	100	do	25	13.7	100	5.0	<0.02	<0.02	66	110	140	7.5
	139.32.16 edd			183	10	325	do	7	2.0	325	Unknown						
Bertha	133.35.10 aaa 1	Municipal	Public supply	220	10	75			2.5	50	Unknown	0.74	<0.02	230			8.4
	133.35.10 aaa 2			160	12	375	Artesian, sand	35	29.1	350	Unknown	1.80	0.09	270			7.6
	133.35.10 aaa 3	Private	Industrial	160	12	400	do	30	5.3	280	18.0	0.56	<0.02	350	480	700	7.3
Bluffton	135.36.33 bba 1	Private	Industrial	135	6	110			1.1	110	Unknown						
	135.36.33 bba 2			141	6	90	Artesian, sand and gravel	18	2.6	90	10.0	1.40	0.06	450		935	7.3
Browerville	130.33. 8 bcc	Municipal	Public supply	50	16		Artesian, sand and gravel	10				3.90	0.13	361	399	655	7.2
	130.33. 8 bdd 1			48	8	150	do	13	18.7	150	8.0	4.00	0.14	380			7.8
	130.33. 8 bdd 2			44	10	150	do	13	18.7	150	Unknown	2.00	0.14	380			8.2
	130.33. 8 aca 1	Private	Industrial	49	24	325	do	5	21.6	325	Unknown	1.90	0.21	300	390	645	7.7
	130.33. 8 aca 2			57	16	390	do	14	48.6	390	Unknown				457		
	130.33. 8 aca 3			42	16	185	Artesian		31.1	185	Unknown						
	130.33.20 dda		Irrigation	41	16	450	Water-table, sand and gravel	32				<0.02	<0.02	250	410	500	7.1
	130.33.22-23			41	18	500	do	36	41.5	500	6.0						
Carlos	129.36.18 cba	Private	Irrigation	51	16	825	Artesian, sand	46	137.5	825	4.0						
	129.37.23 add	Municipal	Public supply	127	8	135			10.0	100	8.0	1.30	0.06	320	420	635	7.1
Clarissa	131.34.27 ccc 1	Municipal	Public supply	82	24	250			6.5	250	Unknown	2.80	0.14	370			8.1
	131.34.27 ccc 2			82	6												
	131.34.27 abb 1	Private	Industrial	35	8	100			50.0	100	Unknown						
	131.34.27 abb 2			35	8	130	Artesian, sand	22	32.6	130	Unknown	0.11	<0.02	320	460	650	7.4
Deer Creek	134.37.26 bdd	Private	Industrial	186	10	150	Artesian, sand and gravel		21.4	150	Unknown	4.10	0.15	330	410	625	7.3
Eagle Bend	131.35.13 ddd	Municipal	Public supply	195	8	210	Artesian, sand	13.5	1.7	205	8.0	1.20	<0.01	260			7.9
	131.35.12 cdc	Private	Industrial	178	8	250	Artesian		6.2	50	Unknown	0.72	<0.02	320	460	710	7.3
	131.34.20 acc		Irrigation	33	14	400	Artesian, sand and gravel	20.5	100.0	400	6.0						
Garfield	129.38.32 cca	Private	Industrial	279	8	30	Artesian, sand	5	0.1	30	Unknown	0.56	0.29	360	440	705	7.1
Henning	133.38.23 bbc 1	Municipal	Public supply	86	10	260	Artesian, sand and gravel	28	28.6	200	Unknown	6.90	0.12	270			7.5
	133.38.23 bbc 2			89	8	210	do	34	30.0	150	Unknown	1.80	0.09	270			7.6
Hewitt	133.35.18 cdd	Municipal	Fire protection	150	8	150	Artesian, sand	17	2.5	150	8.0	1.70	0.04	350	610	760	7.3
Long Prairie	129.33.20 bdd 1	Municipal	Public supply	42	12	150			75.0	150	24.0	3.10	0.13	260			7.8
	129.33.20 bdd 2			96	12	225	Artesian		12.5	175	24.0	2.50	0.21	260			7.4
	129.33.21 bbd			102	12	250	Artesian		9.6	250	24.0	1.20	0.07	340	420	635	7.1
	129.33. 5 cdd	Private	Irrigation	51	18	400	Artesian, sand	31	36.4	400	30.0						
	130.33.32 caa			53	18	500	Artesian, sand	43	83.3	500	60.0						
Menahga	138.35.22 aad	Municipal	Public supply	226	12	500	Artesian, sand and gravel	51	33.3	500	Unknown	2.60	0.08	235	407	656	7.6
Motley	133.31.19 bcc	Municipal	Public supply	84	8	50	Artesian, sand and gravel	11	6.2	50	8.0	1.10	0.99	330			
Parkers Prairie	131.37.23 bba 1	Municipal	Public supply	117	10	500	Artesian, sand and gravel	14	33.3	500	25.0	3.10	0.13	260			
	131.37.23 bba 2			129	12	700	do	20				2.40	0.21	246	282	465	7.5
	131.37.23 baa	Private	Industrial	137	10	500	do	24	16.6	500	64.0	4.90	0.09	290	370	560	7.2
Park Rapids	140.35.23 dca 1	Municipal	Public supply	161	12	620	Artesian, sand and gravel	59	36.5	620	Unknown						
	140.35.23 dca 2			52	16	305	Water-table, sand and gravel	51	23.5	305	24.0	0.03	0.00	218	267	426	7.7
	140.35.23 dca 3			51	16	270	Water-table, sand	51	30.3	270	3.0	<0.02	<0.02	220			8.0
	140.35.26 aba			50	16	250	do	50	28.8	230	Unknown	<0.02	<0.02	210			7.7
	142.34.26 dbb	Private	Recreational	122	6	150	Artesian, sand	35	75.0	150	24.0	0.13	0.13	260	320	490	7.5
Pequot Lakes	136.29.15 add	Municipal	Public supply	143	12							8.20	<0.02	160	210	320	7.6
Pillager	133.30.16 ccd	Public school	Institutional	75	6	100	sand	15	10.0	100	Unknown	<0.02	0.19	210	280	425	7.4
	133.30.21 bba	Private	Industrial	84	6	100	sand and gravel		9.0	90	Unknown						
Sebeka	137.35.34 caa 1	Municipal	Public supply	380	8	245	Artesian, cretaceous bedrock		2.7	245	Unknown						
	137.35.34 caa 2			380	8	225	do		3.8	225	Unknown	0.69	<0.02	250			7.9
	137.35.34 cdb			345	10	600	Artesian, sand	13	8.9	600	8.0	0.78	0.02	250			7.9
	137.35.34 caa 3	Private	Industrial	312	10	800	Artesian (flow), sand and gravel	19	18.0	180	7.0	1.10	<0.02	240	390	600	7.4
Staples	133.33.12 abb	Municipal	Public supply	67	16	300			17.6	300	9.0	2.40	0.28	240			7.6
	133.33.12 bab 1			73	16	250	Artesian, sand and gravel		9.6	250	10.0	2.60	0.26	284	425	639	7.4
	133.33.12 bab 2			67	12	500	Artesian, sand and gravel		12.2	500	Unknown	1.80	0.42	320			7.8
Verndale	134.34.30 aab	Municipal	Public supply	41	24	120	Water-table, sand and gravel	40	25.0	120	3.5	0.73	0.23	350			6.9
	134.34.30 abb	Private	Industrial	36	8	50			16.6	50	Unknown	<0.02	0.03	340	470	675	7.6
	134.34.12 bda		Irrigation	28	18	240	Artesian, sand	4	18.5	240	4.0						
	134.35.25 ddb			42	12	500	Water-table, sand and gravel	41	62.5	500	5.0						
Wadena	134.35. 5 ccc 1	Municipal	Public supply	30	365	600	Water-table, sand					<0.02	0.02	320	730	950	7.6
	134.35. 5 ccc 2			86	12	600	Water-table, sand		17.4	600	Unknown	2.50	0.14	320			7.5
	134.35. 5 dab 1			30	360	500	Water-table, sand										
	134.35. 5 dab 2			69	20	400	Artesian					5.10	0.30	280			7.6
	134.35. 6 ddd			83	20	500	do					2.50	0.12	290			7.6
	134.35. 7 cbc 1			227	12	350	Artesian, sand		3.2	350	Unknown	2.40	0.05	240	370	580	7.0
	134.35. 7 cbc 2			118	12	500	Artesian, sand and gravel	23	8.9	500	24.0	1.80	<0.02	260			7.2
	135.35. 9 cca 1	U.S. Air Force	Public supply	120	8	35	do	4	3.2	35	Unknown	6.90	0.00	465	495	828	7.3
	135.35. 9 cca 2			141	8	50	do	7	33.3	50	Unknown	2.90	0.00	368	398	669	7.1
	134.36. 2 dca	Private	Irrigation	80	6	660			62.9	660	4.5						

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WATER RESOURCES OF THE CROW WING RIVER WATERSHED, CENTRAL MINNESOTA

By
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1972