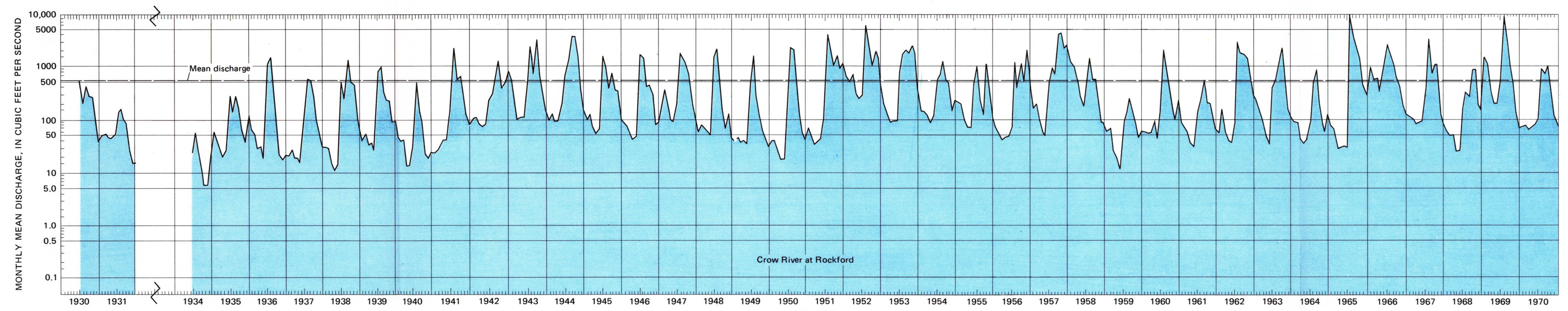
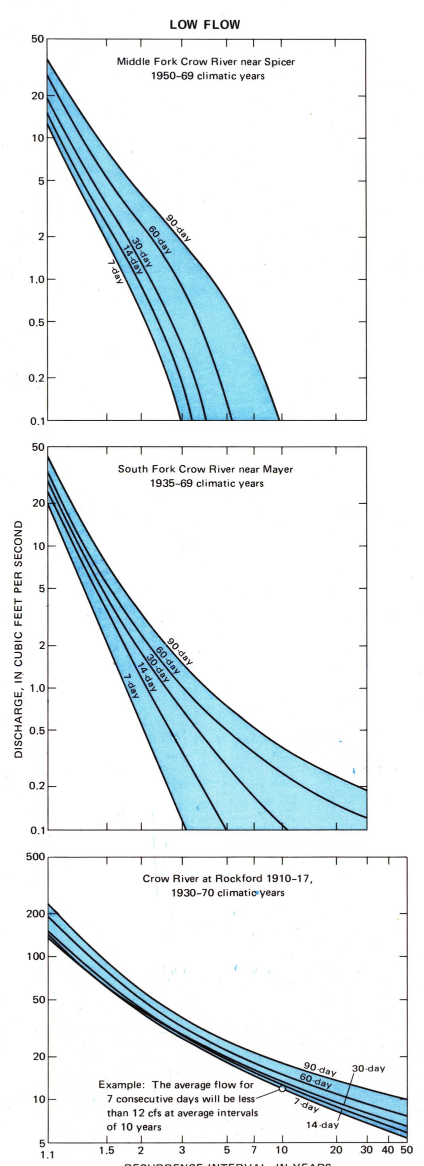
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

SURFACE WATER



FLUCTUATIONS IN STREAMFLOW ARE CAUSED BY VARIATIONS IN PRECIPITATION AND TEMPERATURE.— *Generally, the highest streamflow is in the spring, as a result of snowmelt. This is followed by a recession through the late summer, fall and winter. The highest monthly mean discharge recorded for the Crow River at Rockford was in April 1965.*

The extreme monthly mean lows were recorded during July and August of 1934; however, winter freezeup is the most common cause of extended periods of low flow.



LOW FLOWS ARE LARGELY DISCHARGE FROM THE GROUND-WATER SYSTEM.—*Low-flow frequency curves reflect hydrogeologic conditions and indicate the contributions to streamflow from ground-water sources. Relatively low flow or no flow during dry periods indicates that ground water is not readily transmitted to streams in much of the watershed. Winter freezeup after long periods of low flow may, in some years, produce periods of no flow on most of the larger tributaries.*

LOW-FLOW PARTIAL-RECORD SITES

Letter key	Measurement site: Number	Measurement site: Name	Estimated 7-day minimum discharge 2-year recurrance interval (cfs)	Estimated water year peak discharge, 10-year recurrence interval (cfs)
A	5-2783.4	North Fork Crow River near Delano	30	4,000
B	5-2784.5	Buffalo Creek near Plato	------	150
C	5-2788.3	Buffalo Creek near Buffalo Lake	------	110
D	5-2788.35	Buffalo Creek tributary near Buffalo Lake	------	100
E	5-2770.5	Grove Creek near Manannah	------	30

CREST-STAGE PARTIAL-RECORD STATIONS

Letter key	Gaging station: Number	Gaging station: Name	Drainage area (square miles)	Years of record (water years)	Discharge (cfs): Maximum	Discharge (cfs): Minimum
F	5-2761.0	North Fork Crow River tributary near Paynesville	0.58	1960-70	68	No flow
G	5-2783.5	Fountain Creek near Montrose	6.73	1962-70	109	No flow
H	5-2787	Otter Creek near Lester Prairie	30.2	1961-70	525	No flow
I	5-2787.5	Otter Creek tributary near Lester Prairie	1.54	1962-70	87	No flow
J	5-2788.5	Buffalo Creek tributary near Brownton	9.45	1961-70	124	No flow
K	5-2790.3	South Fork Crow River tributary near Mayer	7.74	1962-70	306	No flow
L	5-2803	School Lake Creek tributary near St. Michael	2.04	1964-70	434	No flow

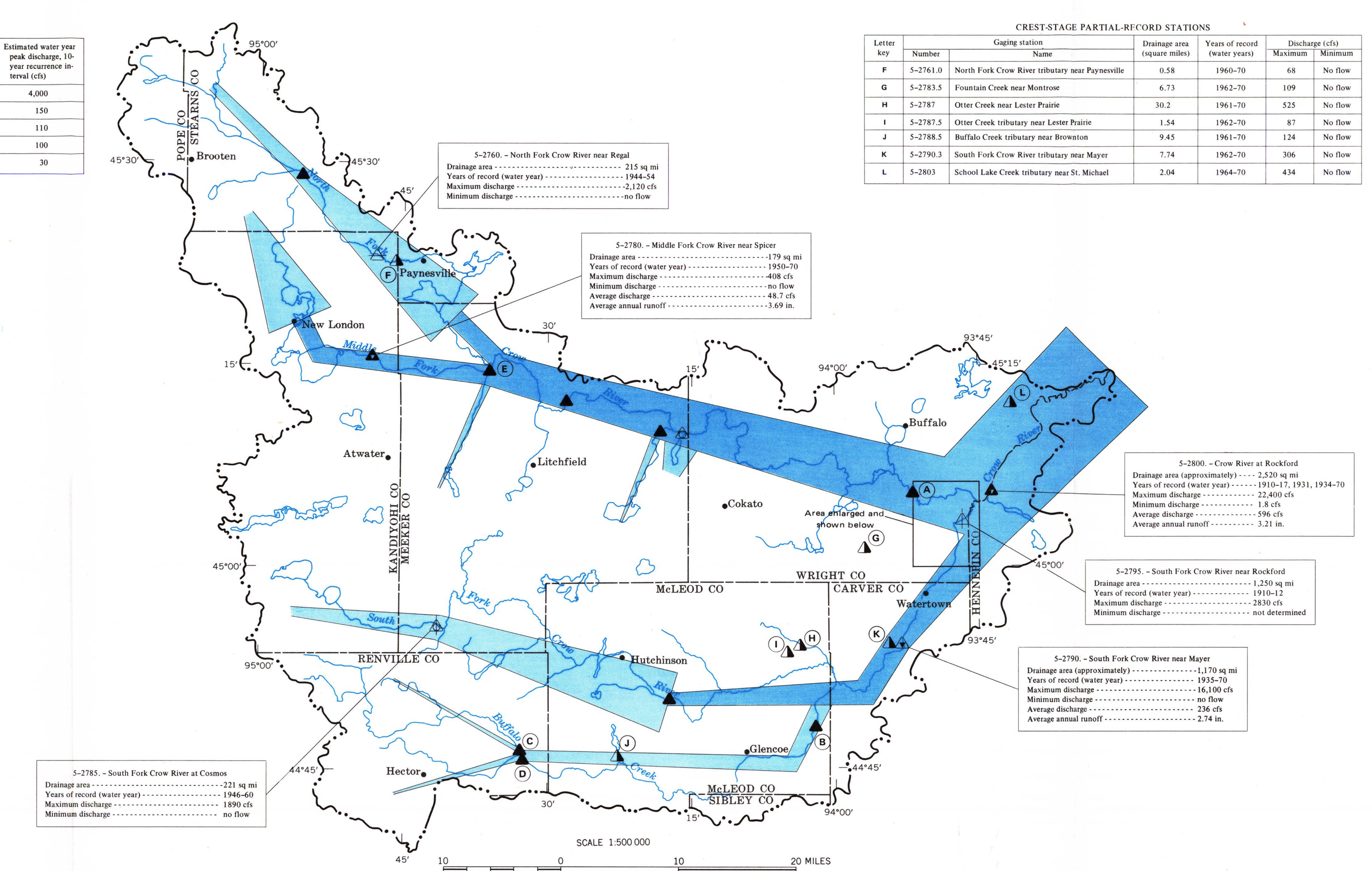
EXPLANATION

CUBIC FEET PER SECOND 0, 100, 200, 300 / 0, 10, 20, 30

Scale of flow during September 20-22, 1971
Width of color pattern along stream indicates approximate flow, in cubic feet per second

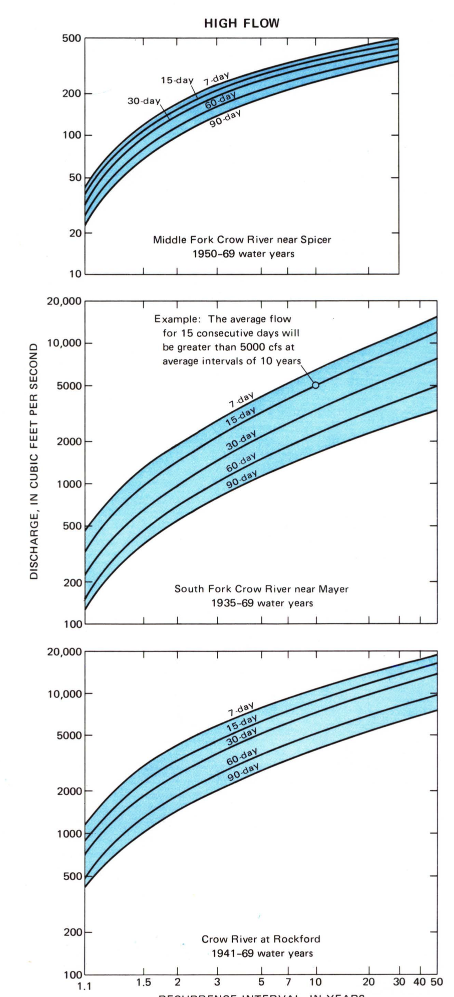
GAGING STATIONS

- Automatic recording gage
- Daily nonrecording gage
- Discontinued automatic recording gage
- Discontinued daily nonrecording gage
- Crest-stage partial-record station
- Low-flow partial-record station
- Estimated flow site
- (A) Letter key
- Watershed boundary



THE FLOW DIAGRAM SHOWS THE DISTRIBUTION OF STREAMFLOW IN THE WATERSHED DURING THE BASE-FLOW PERIOD, SEPTEMBER 20-22, 1971

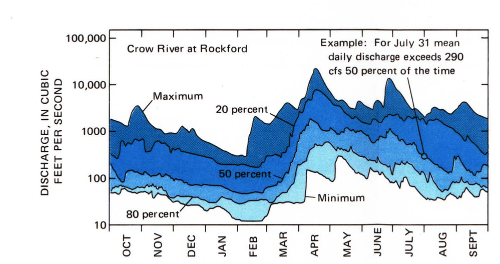
Ground water and lake storage were the major source of streamflow during a base-flow investigation September 20-22, 1971. A series of discharge measurements and flow estimates were made to determine the distribution of surface-water resources in the watershed within the given time interval. There was no measureable precipitation for 10 days before this period, so the streamflow measured represents base-flow yields from the watershed. Flow-duration curves indicate that base flow at this time was fairly high because it is equaled or exceeded more than 50 percent of the time. The Middle Fork Crow River contributes the most water per river mile, 1.33 cfs per mi (cubic feet per second per mile). The North Fork Crow River contributes 0.89 cfs per mi, and the South Fork Crow River yields the smallest rate, 0.63 cfs per mi. Base flow is related to the geology of the watershed. (See surficial geology map on Sheet 2.) The largest areas of outwash deposits are in the Middle Fork and North Fork basins. The South Fork drains an area of predominantly till, with low hydraulic conductivity.



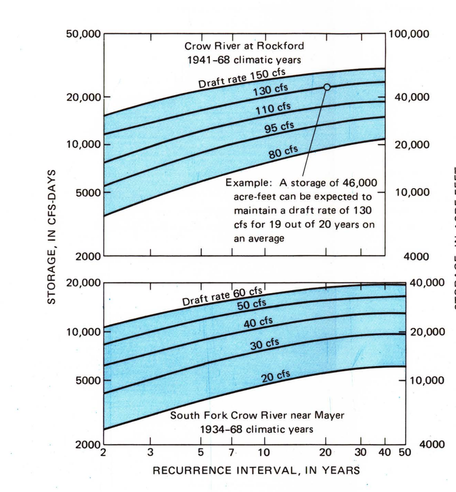
HIGH FLOWS ARE LARGELY FROM SNOWMELT AUGMENTED AT TIMES BY SPRING RAINS; HOWEVER, HIGH FLOWS OF SHORT DURATION MAY OCCUR AS A RESULT OF INTENSE RAINSTORMS.—*High-flow frequency curves reflect the similar frequency-duration relationships in the watershed, due to its uniform climate and physiography. Difference in drainage area is the reason for the different magnitudes of high flow. These curves are a necessary tool in the design of flood-control reservoirs and channel improvements.*

LAKES AND STREAMS IN THE WATERSHED ARE AN IMPORTANT ALL-SEASON RECREATIONAL RESOURCE.—*They provide fish and wildlife habitat and are used for hunting, fishing, and other water sports. Although little consumptive use is made of surface water, it is potentially a valuable source of water supply. The data shown in the table below were obtained from the Minnesota Department of Natural Resources.*

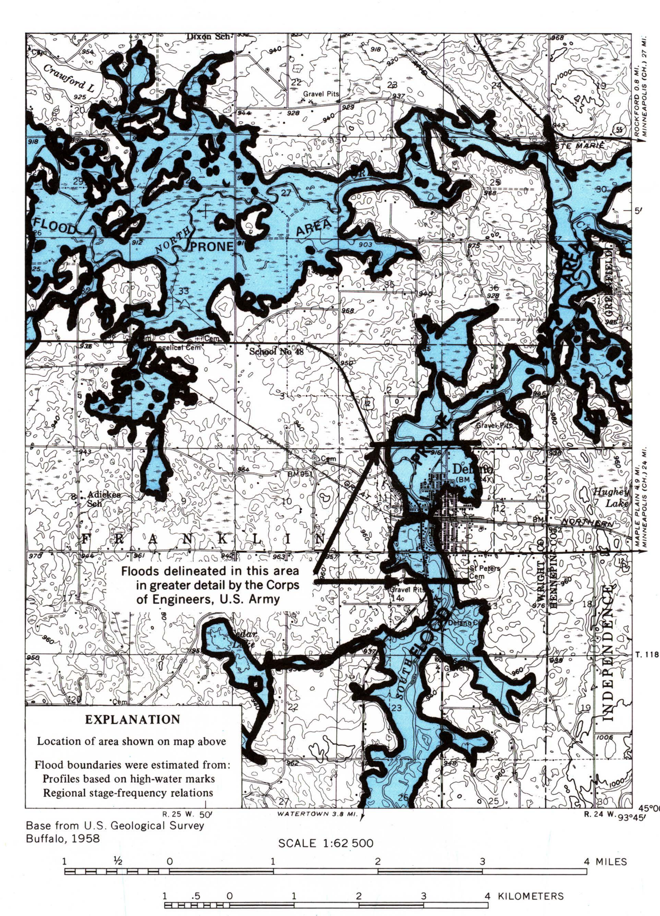
Name (county)	Surface area (acres)	Depth (feet): Max.	Depth (feet): Avg. or med.	Outlet control	Fish and game classification	Remarks
Big Kandiyohi (Kandiyohi)	2,877	18	------	Dam	Rough fish-warm water game fish.	Has public access. Periodic winterkill. Rough fish removed periodically. Recently stocked with catfish fingerlings and northern pike yearlings.
Calhoun (Kandiyohi)	1,396	13	------	Dam	No classification.	Has public access. Periodic winterkill. Fish rescue when necessary. Has no stocking program.
Diamond (Kandiyohi)	1,697	27	20	Dam	Warm water game fish.	Rough fish removed periodically. Recently stocked with northern pike adults, yearlings, and fingerlings, sunfish and crappie adults.
Elizabeth (Kandiyohi)	1,153	8	Less than 5	Dam	Bullhead	Has public access. Periodic winterkill. Rough fish removed periodically.
Green (Kandiyohi)	5,821	110	30	Dam	Warm water game fish.	Has public access. Rough fish removed periodically. Recently stocked with northern pike yearlings, walleye and large mouth bass fingerlings.
Lillian (Kandiyohi)	1,608	7	5	Natural	Bullhead.	Has public access. Periodic winterkill. Fish rescue operations when necessary.
Mud (Kandiyohi)	2,516	8	4	Dam	Water fowl-muskrat-fish.	Has public access. Periodic winterkill. Fish rescue operations when needed.
Nest (Kandiyohi)	1,019	40	15	Dam	Warm water game fish	Has public access. Rough fish removed periodically. Recently stocked with large mouth bass and walleye fingerlings.
Wagonga (Kandiyohi)	1,792	17	7	Dam	Marginal fish-game.	Has public access. Occasional removal of rough fish.
Cedar (McLeod)	2,137	12	7	Natural	Water fowl-warm water game fish	Has public access. Periodic winterkill. Fish rescue operations when necessary.
Belle (Meeker)	1,035	25	16	Natural	Warm water game fish.	Has public access. Rough fish removed periodically. Recently stocked with northern pike adults and yearlings and walleye fingerlings.
Francis (Meeker)	1,172	15	9	Dam	Warm water game fish.	Rough fish removed occasionally. Recently stocked with northern pike and walleye fingerlings.
Jennie (Meeker)	1,089	19	------	Natural	Warm water game fish.	Has public access. Rough fish removed periodically. Recently stocked with walleye and northern pike fingerlings.
Ripley (Meeker)	1,060	22	13	Natural	Warm water game fish.	Occasional removal of bullheads. Recently stocked with northern pike fingerlings, yearlings, and adults; large mouth bass fingerlings and yearlings.
Washington (Meeker)	2,524	17	5	Dam	Rough fish-warm water game fish	Has public access. Rough fish removed periodically. Periodic winterkill. Fish rescue operations when necessary. Recently stocked with walleye and large mouth bass fingerlings.
Rice (Stearns)	1,568	41	11	Natural	Warm water game fish.	Has public access. Rough fish removed periodically. Recently stocked with northern pike and large mouth bass fingerlings.
Koronis (Stearns)	3,471	132	------	Dam	Walleye	Has public access. Rough fish removed periodically. Recently stocked with northern pike and walleye fingerlings.
Buffalo (Wright)	1,510	30	------	Dam	Warm water game fish.	Has public access. Rough fish removed periodically. Recently stocked with northern pike and walleye fingerlings and walleye fry.
Maple (Wright)	1,013	76	19	Natural	Walleye-northern pike.	Has public access. Rough fish removed periodically. Recently stocked with northern pike and walleye fingerlings.
Pelican (Wright)	2,793	9	3	Natural	Waterfowl-muskrat.	Has public access.
Twin (Wright)	1,012	88	------	Natural	Walleye-northern pike.	Has public access. Rough fish removed occasionally Recently stocked with walleye fry and fingerlings



THE VARIATION OF DAILY MEAN DISCHARGE DURING 1950-68 IS SHOWN BY THE DAILY DURATION HYDROGRAPH.—*The range in flow is smallest in January, whereas the lowest and most uniform daily mean discharge occurs in February. The greatest range and the highest discharges are in April.*



THE APPROXIMATE STORAGE REQUIRED TO MAINTAIN SPECIFIED DRAFT RATES FOR VARIOUS RECURRENCE INTERVALS CAN BE DETERMINED FROM DRAFT-STORAGE CURVES.—*Low streamflow can be increased by release of water stored during periods of high flow. Storage required is not adjusted for losses by evaporation or seepage. Average annual evaporation is 31 inches or 2.3 cubic feet per second per square mile of water surface (U.S. Department of Commerce National Weather Service, 1959).*

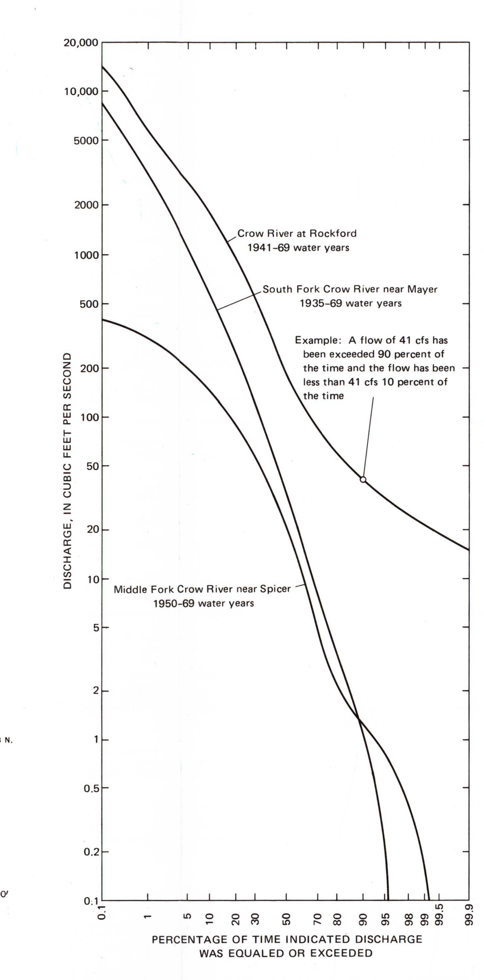


Base from U.S. Geological Survey Buffalo, 1958

SCALE 1:62 500

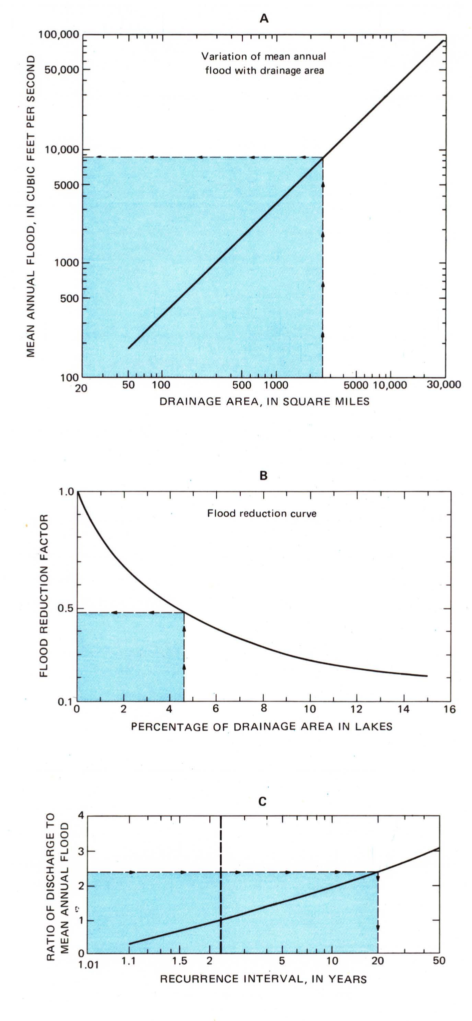
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

MAJOR FLOOD-PRONE AREAS OCCUR UPSTREAM FROM THE CONFLUENCE OF THE NORTH AND SOUTH FORKS OF THE CROW RIVER.—*On the average, the areas shown on this map have a 1-in-100 chance of being inundated during any year.*



FLOW-DURATION CURVES ARE USED TO DETERMINE STREAMFLOW AND BASIN CHARACTERISTICS.—*Duration curves are used to estimate the percentage of time a specified discharge will be equaled or exceeded in the future. By simple subtraction, the percentage of time that flow may be equal to or less than a specified amount may also be estimated.*

The Middle Fork Crow River near Spicer has a sustained high flow because of water released from storage in lakes directly above the station. Its flow-duration curve has a moderate slope at lower discharges until the 90-percent point, when diminishing ground-water contribution and winter freezeups make it dip sharply. Curves for the South Fork Crow River near Mayer and Crow River at Rockford both have moderate slopes in the high discharge range, but the former stream does not hold up well in the medium to low range because of little ground-water contribution and winter freezeups.

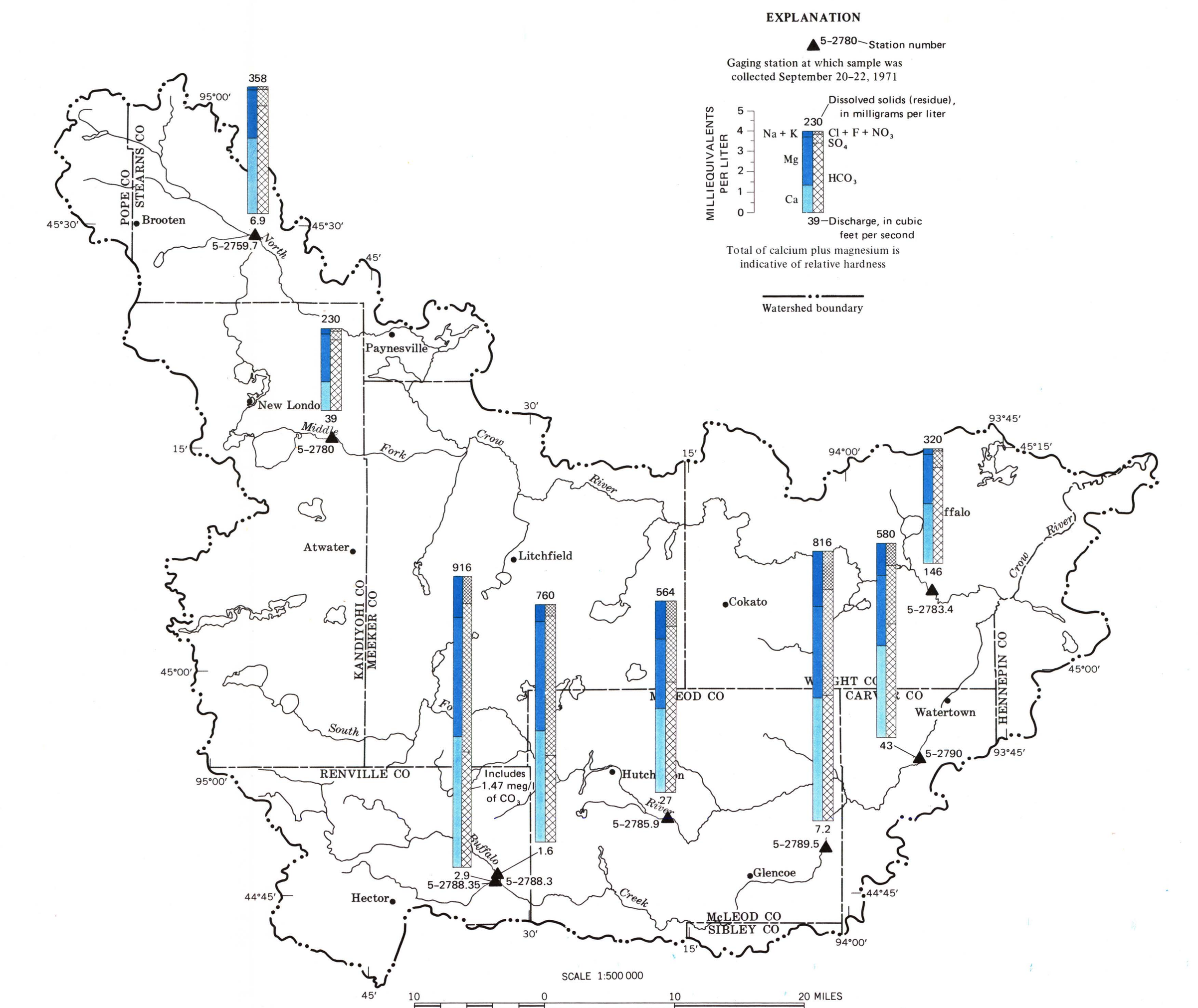


FREQUENCY AND MAGNITUDE OF FLOODING IS RELATED TO DRAINAGE AREA AND PERCENTAGE OF LAKES IN THE BASIN.—*The magnitude and frequency of floods can be determined from the relation curves A, B, and C (Patterson and Gamble, 1968). These curves refer to streams within the Crow River watershed. Example.—Find the recurrence interval of a flood of 10,000 cfs for the Crow River at Rockford. The drainage area at this site is 2,520 sq mi, and the area of lakes above the site is 4.6 percent of the total drainage area.*

1. *Relation curve "A" shows that, for a drainage area of 2,520 sq mi, the discharge for the mean annual flood is 8,800 cfs.*
2. *Relation curve "B" shows that, for a site whose drainage area is 4.6 percent lakes, the flood reduction factor is 0.48, and the discharge for the adjusted mean annual flood is 8,800 ×0.48, or 4,200 cfs.*
3. *The ratio of a flood of 10,000 cfs to the adjusted mean annual flood of 4,200 cfs is 10,000/4,200, or 2.38.*
4. *Entering the frequency curve "C" with the ratio of 2.38 shows that the flood wth a discharge of 10,000 cfs will occur on an average once every 20 years.*

The magnitude of a flood at a specified recurrence interval at this same site can also be found by reversed procedure.

WATER QUALITY



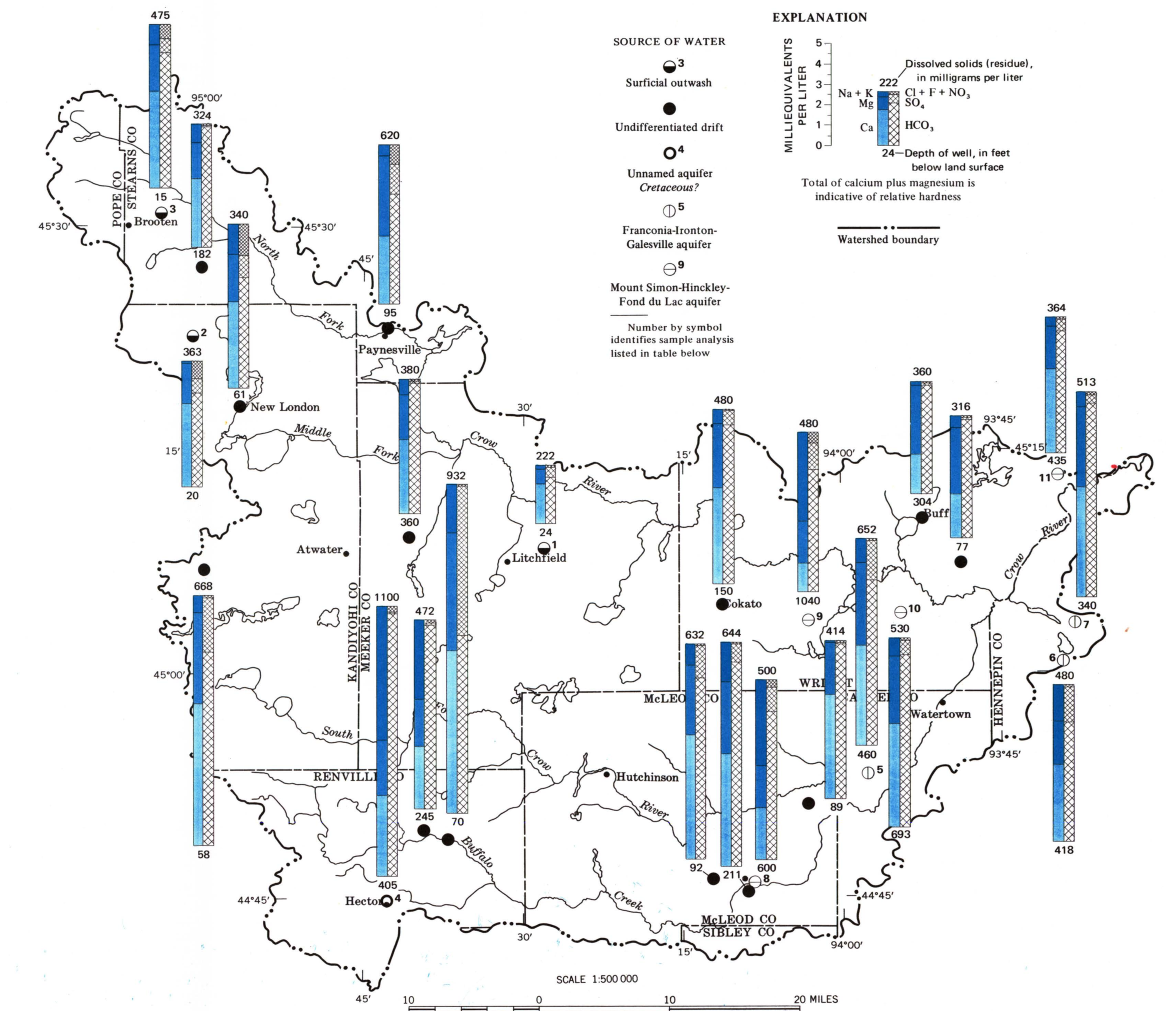
THE NORTH AND SOUTH FORKS OF THE CROW RIVER DIFFER CONSIDERABLY IN WATER QUALITY DURING PERIODS OF LOW FLOW

The analyses shown above and included in the table below are for samples collected during a base-flow period when most streamflow was contributed by the ground-water system. Dissolved solids were relatively low in the North Fork Crow River. The North Fork drains an area of which a significant part is outwash composed largely of relatively insoluable minerals. In contrast, the South Fork drains an area composed almost entirely of till, some components of which are more soluble. Concentrations of most individual constituents are also higher in the South Fork and its tributaries. The streams during this period contained calcium magnesium bicarbonate type water except in the upper part of the Buffalo Creek system, where the water was of the calcium magnesium sulfate type.

Analyses of the Crow River at Rockford (table) illustrate the relationship of water quality to discharge. Dissolved-solids content and concentrations of several individual constituents are generally lowest when discharge is highest.

Chemical constituents and hardness in milligrams per liter [Analyzed by U.S. Geological Survey]

Station number	Station name and date of collection	Discharge (cfs)	Dissolved silica	Iron	Manganese	Calcium	Magnesium	Dissolved sodium	Dissolved potassium	Bicarbonate	Dissolved sulfate	Dissolved chloride	Fluoride	Nitrate	Boron	Dissolved solids (residue)	Hardness as $CaCO_3$	pH	Color
5-2759.7	North Fork Crow River near Georgeville Sept. 20, 1971	6.9	18	0.02	0.13	73	28	6.3	3.2	327	39	4.9	0.4	0.5	0.92	358	300	8.0	20
5-2780	Middle Fork Crow River near Spicer Sept. 20, 1971	39	16	.03	.04	28	29	5.2	3.6	213	23	4.6	.4	0	.09	230	190	8.3	10
5-2783.4	North Fork Crow River near Delano Sept. 21, 1971	146	14	.01	.05	57	29	9.4	4.5	289	39	7.9	.5	.3	.10	320	260	8.1	30
5-2785.9	South Fork Crow River at Biscay Sept. 21, 1971	27	21	.10	.05	82	42	39	8.9	333	130	45	.7	1.1	.23	564	380	7.9	30
5-2788.3	Buffalo Creek near Buffalo Lake Sept. 21, 1971	1.6	14	.01	.07	110	66	18	5.5	260	330	17	.5	1.0	.16	760	550	8.0	20
5-2788.35	Buffalo Creek tributary near Buffalo Lake Sept. 21, 1971	2.9	11	.02	.02	130	72	45	5.0	254	350	40	.7	11	.32	916	620	8.6	30
5-2789.5	Buffalo Creek near Plato Sept. 21, 1971	7.2	16	.02	.05	120	54	58	6.6	377	250	68	.7	3.7	.22	816	520	8.3	30
5-2790	South Fork Crow River near Mayer Sept. 22, 1971	43	17	0	.11	91	42	31	7.3	344	140	40	.6	1.1	.20	580	400	8.3	30
5-2800	Crow River at Rockford																		
	March 14, 1963	50	20	0.40	0.49	80	29	25	6.1	372	38	16.0	0.2	9.0	------	415	320	8.1	18
	September 28, 1967	54	16	.01	.06	78	37	34	6.0	367	67	31	.4	1.2	.10	460	346	7.9	12
	November 29, 1963	86	12	.03	.06	79	39	24	4.8	379	68	19	.3	.1	.08	441	356	7.9	5
	July 29, 1961	136	17	.04	0	62	25	15	6.8	285	35	12	.3	3.0	------	343	256	7.3	------
	October 1, 1968	231	17	.03	.15	75	31	16	6.0	306	80	15	.1	4.5	.08	411	316	7.5	5
	July 29, 1970	237	16	.05	.02	61	29	18	5.7	280	55	21	0	2.6	.06	369	273	7.8	12
	May 27, 1970	562	11	.14	.10	65	34	23	6.0	275	90	23	.2	3.8	.02	419	300	7.9	20
	April 1, 1962	950	12	.13	.21	37	11	8.6	6.4	143	23	9.7	.2	12	.02	218	138	7.0	35
	June 26, 1964	960	15	.07	0	63	27	15	5.4	264	71	17	.5	1.2	.07	356	268	7.8	12
	April 14, 1970	960	16	.26	.08	67	28	13	5.7	208	110	21	0	18	.02	444	280	7.6	20
	April 28, 1971	1990	6.9	0	.01	57	22	10	7.6	246	73	15	.2	------	.07	310	230	8.0	5
	May 15, 1952	2350	7.9	.06	--------	56	24	5.9	5.2	248	45	3.0	.2	2.5	.06	298	238	7.5	31
	Recommended upper limits: State class A domestic consumption waters			0.30	0.05						250	250	1.5	45		500			



VERY HARD AND MODERATELY TO HIGHLY MINERALIZED GROUND WATER TYPIFIES THE ENTIRE WATERSHED

Dissolved solids and hardness are lowest in waters from surficial outwash because of the predominance of insoluble minerals and the diluting effect of direct recharge from precipitation. Nitrate concentration (generally a measure of organic pollution) is highest in these unconfined aquifers. Other constituents do not show well-defined relationships between concentration and source of water (table below).

Most ground water in the watershed is of the calcium magnesium bicarbonate type. Relatively high percentages of dissolved sodium and low percentages of calcium and magnesium are found in some bedrock waters. This water softening is probably due to cation exchange of calcium and magnesium for sodium in overlying shale or till.

Chemical constituents and hardness, in milligrams per liter

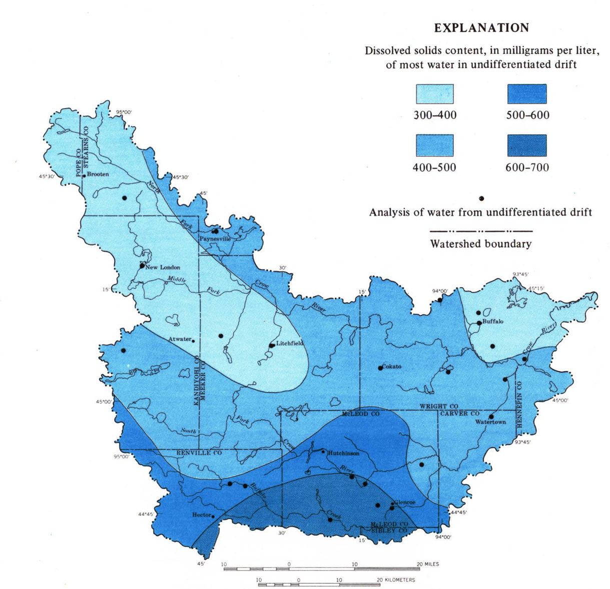
Source of ground water	Map number or statistical parameter	Dissolved silica	Iron	Manganese	Calcium	Magnesium	Dissolved sodium	Dissolved potassium	Bicarbonate	Dissolved sulfate	Dissolved chloride	Fluoride	Nitrate	Boron	Dissolved solids (residue)	Hardness as $CaCO_3$	pH	Analyzed by:
Surficial outwash	1	26	4.3	0.47	38	7.6	2.4	1.7	154	33.0	3.7	0.2	0.0	0.03	222	130	7.2	U.S. Geol. Survey
	2	20	.03	.01	85	23	2.3	2.4	284	31	2.5	0	49	.02	363	308	7.4	U.S. Geol. Survey
	3	98	.12	1	98	28	5.7	35	405	33	7.2	.1	30	.03	475	357	7.2	U.S. Geol. Survey
Undifferentiated drift[1]	Maximum	31	7.9	.33	160	70	88	7.2	657	350	58	.6	6.6	.33	932	690	7.5	U.S. Geol. Survey and Minn. Dept. Health
	Median	28	3.0	.14	88	39	19	4.0	464	46	1.6	.3	0	.20	472	370	7.3	
	Minimum	25	.12	.03	40	21	0	2.0	305	1.0	< 1	.2	0	.09	316	250	7.0	
Unnamed aquifer (Cretaceous?)	4	--------	2.1	.16	80	34	150	---------	781	< 5	20	.3	< 4.4	------	1100	340	7.3	Minn. Dept. Health
Franconia-Ironton-Galesville aquifer	5	13	.88	.11	100	49	30	8.0	491	90	3.4	1.4	0	.60	652	450	7.2	U.S. Geol. Survey
	6	--------	2.8	.11	92	26	43	---------	403	79	1.0	.2	< 4.4	------	480	340	7.1	Minn. Dept. Health
	7	22	.20	.69	110	48	13	4.4	581	26	1.7	.6	.3	.60	513	470	7.3	U.S. Geol. Survey
Mount Simon-Hinckley-Fond-du Lac aquifer	8	8.9	.54	.02	48	25	93	4.2	447	59	15	.8	0	.64	500	220	7.4	U.S. Geol. Survey
	9	---------	.08	< .02	27	13	180	2	427	67	17	.9	6.2	------	480	120	7.6	Minn. Dept. Health
	10	---------	.12	.17	100	41	19	---------	537	39	< 1	.3	< 4.4	------	530	420	7.6	Minn. Dept. Health
	11	14	7.0	.66	85	26	6.1	2.8	373	25	1.6	.2	0	.03	364	320	7.4	U.S. Geol. Survey
Recommended upper limits state class A domestic consumption waters			0.30	0.05						250	250	1.5	45		500			

[1] Based on 13 samples, except potassium, which is based on 10, and silica and boron, which are based on 8.

SELECTED WATER-QUALITY PROPERTIES OF MUNICIPAL SUPPLIES[1]

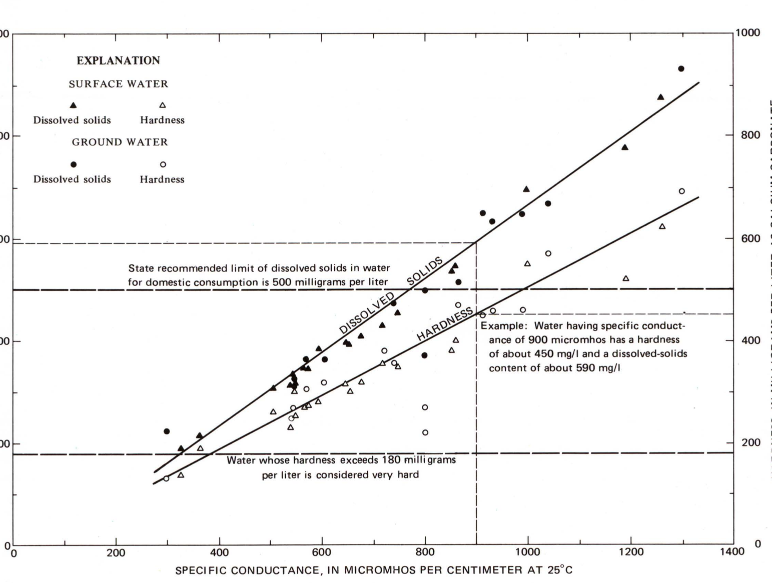
Municipality[2]	Local well number	Well depth (feet)	Source of water	Dissolved solids (residue)	Total hardness	Iron	Manganese
Atwater	------	65	Undifferentiated drift	---------	280	0.10	< 0.02
Do------	------	62	---do------------	---------	300	.80	< .02
Belgrade	------	182	Undifferentiated drift	324	250	1.3	.03
Biscay	1	160	Undifferentiated drift	600	420	2.8	.03
Brooten	1	205	Undifferentiated drift	---------	250	1.2	< .02
Brownton	1	237	Undifferentiated drift	530	330	1.1	< .02
Buffalo	1	337	Undifferentiated drift	400	290	4.5	.11
Do------	2	304	---do------------	360	270	3.4	.10
Do------	3	330	---do------------	350	270	1.4	.15
Buffalo Lake	------	375	Undifferentiated drift	---------	300	3.9	.08
Cokato	1	95	Undifferentiated drift	500	380	.47	.15
Do------	3	139	---do------------	480	400	.54	.18
Cosmos	------	335	Undifferentiated drift	---------	240	1.7	< .02
Darwin	1	200	Undifferentiated drift	---------	280	1.9	.10
Dassel	1	185	Undifferentiated drift	---------	340	.05	2.5
Do------	2	180	---do------------	---------	330	.03	< .02
Delano	1	140	Undifferentiated drift	610	430	.88	.16
Do------	2	123	---do------------	500	420	.57	.25
Do------	3	149	---do------------	480	410	.90	.19
Glencoe	------	------	Mount Simon-Hinckley-Fond du Lac	520	300	.46	< .02
Do------	------	------	---do------------	570	390	2.4	< .02
Grove City	2	294	Undifferentiated drift	---------	340	2.1	< .02
Hector	2	405	Cretaceous sandstone (?)	1100	340	2.1	.16
Howard Lake	2	1038	Mount Simon-Hinckley-Fond du Lac	480	120	.08	< .02
Hutchinson	2	261	Undifferentiated drift	---------	410	7.7	< .02
Do------	3	395	---do------------	---------	420	2.2	< .02
Do------	4	412	---do------------	---------	410	1.6	< .02
Kandiyohi	1	412	Undifferentiated drift	---------	430	1.1	.06
Lake Lillian	------	430	Undifferentiated drift	---------	200	.86	< .02
Lester Prairie	1	190	Undifferentiated drift	---------	380	2.0	< .02
Do------	2	------	---do------------	---------	370	2.5	< .02
Litchfield	7	175	Undifferentiated drift	290	250	.87	.06
Loretto	1	600	Franconia-Ironton-Galesville	560	480	2.1	.22
Do------	2	340	---do------------	513	470	.20	.69
Maple Lake	1	172	Undifferentiated drift	460	360	.02	< .02
Maple Plain	1	418	Franconia-Ironton-Galesville	480	340	2.8	.11
Do------	2	435	---do------------	440	280	1.3	.07
Mayer	1	280	Franconia-Ironton-Galesville	---------	320	1.1	.11
Montrose	1	693	Mount Simon-Hinckley-Fond du Lac	530	420	.12	.17
New Germany	1	460	Franconia-Ironton-Galesville	652	450	.88	.11
New London	1	61	Undifferentiated drift	340	340	.59	.16
Do------	2	61	---do------------	---------	350	.63	.32
Paynesville	1	105	Undifferentiated drift	---------	330	1.5	.09
Do------	2	93	---do------------	620	370	.12	.21
Plato	1	96	Undifferentiated drift	---------	380	1.6	.11
Rockford	1	142	---do------------	410	340	.16	.24
St. Michael	------	314	Mount Simon-Hinckley-Fond du Lac	320	310	.05	.05
Silver Lake	1	190	Undifferentiated drift	---------	340	.83	.13
Spicer	1	444	Undifferentiated drift	---------	250	.04	.08
Do------	2	448	---do------------	---------	250	1.2	< .02
Stewart	------	242	Undifferentiated drift	---------	460	.14	< .01
Watertown	------	------	Undifferentiated drift	480	410	.64	.12
Do------	------	------	---do------------	480	410	.88	< .02
Waverly	1	164	Undifferentiated drift	510	400	.09	.45
Winstead	2	149	Undifferentiated drift	---------	440	.97	.07
Do------	3	185	---do------------	---------	390	.41	.21

[1] Analyses are of untreated water, properties expressed in milligrams per liter
[2] For location see "WATER USE" section on sheet 1

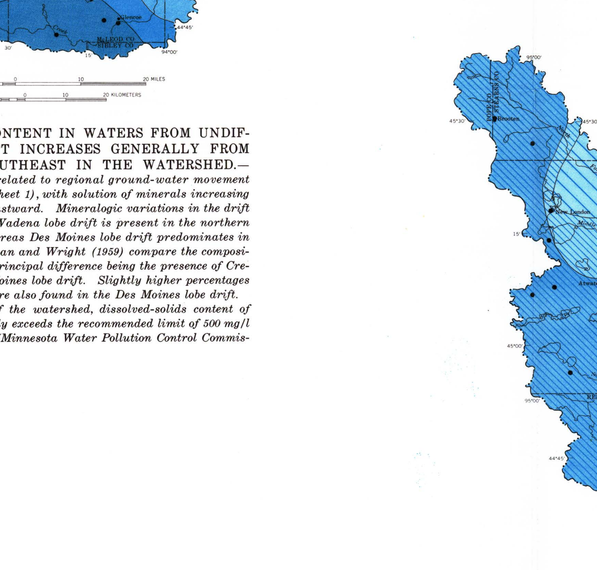


DISSOLVED-SOLIDS CONTENT IN WATERS FROM UNDIFFERENTIATED DRIFT INCREASES GENERALLY FROM NORTHWEST TO SOUTHEAST IN THE WATERSHED.—*This change is probably related to regional ground-water movement (see "Water Budget" on Sheet 1), with solution of minerals increasing as the water moves southeastward. Mineralogic variations in the drift may also have an effect; Wadena lobe drift is present in the northern half of the watershed, whereas Des Moines lobe drift predominates in the southern half. Arneman and Wright (1959) compare the composition of the two drifts, the principal difference being the presence of Cretaceous shale in the Des Moines lobe drift. Slightly higher percentages of carbonate fragments were also found in the Des Moines lobe drift.*

In the southern part of the watershed, dissolved-solids content of waters from drift commonly exceeds the recommended limit of 500 mg/l for domestic consumption (Minnesota Water Pollution Control Commission, 1967).



ESTIMATES OF DISSOLVED SOLIDS AND HARDNESS CAN BE MADE FROM MEASUREMENTS OF SPECIFIC CONDUCTANCE.—*Some waters have a dissolved-solids content that exceeds the recommended limit for domestic consumption (Minnesota Water Pollution Control Commission, 1967). Nearly all water is considered very hard.*



EXPLANATION

Iron concentration, in milligrams per liter, of most water in undifferentiated drift
- 0-1.0 — *Median of 13 analyses is 0.59 mg/l*
- 1.0-8.0 — *Median of 23 analyses is 1.9 mg/l*

Manganese concentration in milligrams per liter, of most water in undifferentiated drift
- 0-0.1 — *Median of 16 analyses is 0.04 mg/l*
- 0.1-0.5 — *Median of 20 analyses is 0.17 mg/l*

Analysis of water from undifferentiated drift

Watershed boundary

RECOMMENDED LIMITS FOR DOMESTIC CONSUMPTION FOR IRON (0.3 mg/l) AND MANGANESE (0.05 mg/l) (Minnesota Water Pollution Control Commission, 1967) ARE EXCEEDED IN MOST GROUND WATER IN THE WATERSHED.— *Water in undifferentiated drift generally contains the highest iron concentrations in the southwestern part of the watershed and the highest manganese concentrations in the northeastern part. The concentrations of these constituents are unpredictable locally because of wide lateral and vertical variations.*

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WATER RESOURCES OF THE CROW RIVER WATERSHED, SOUTH-CENTRAL MINNESOTA

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