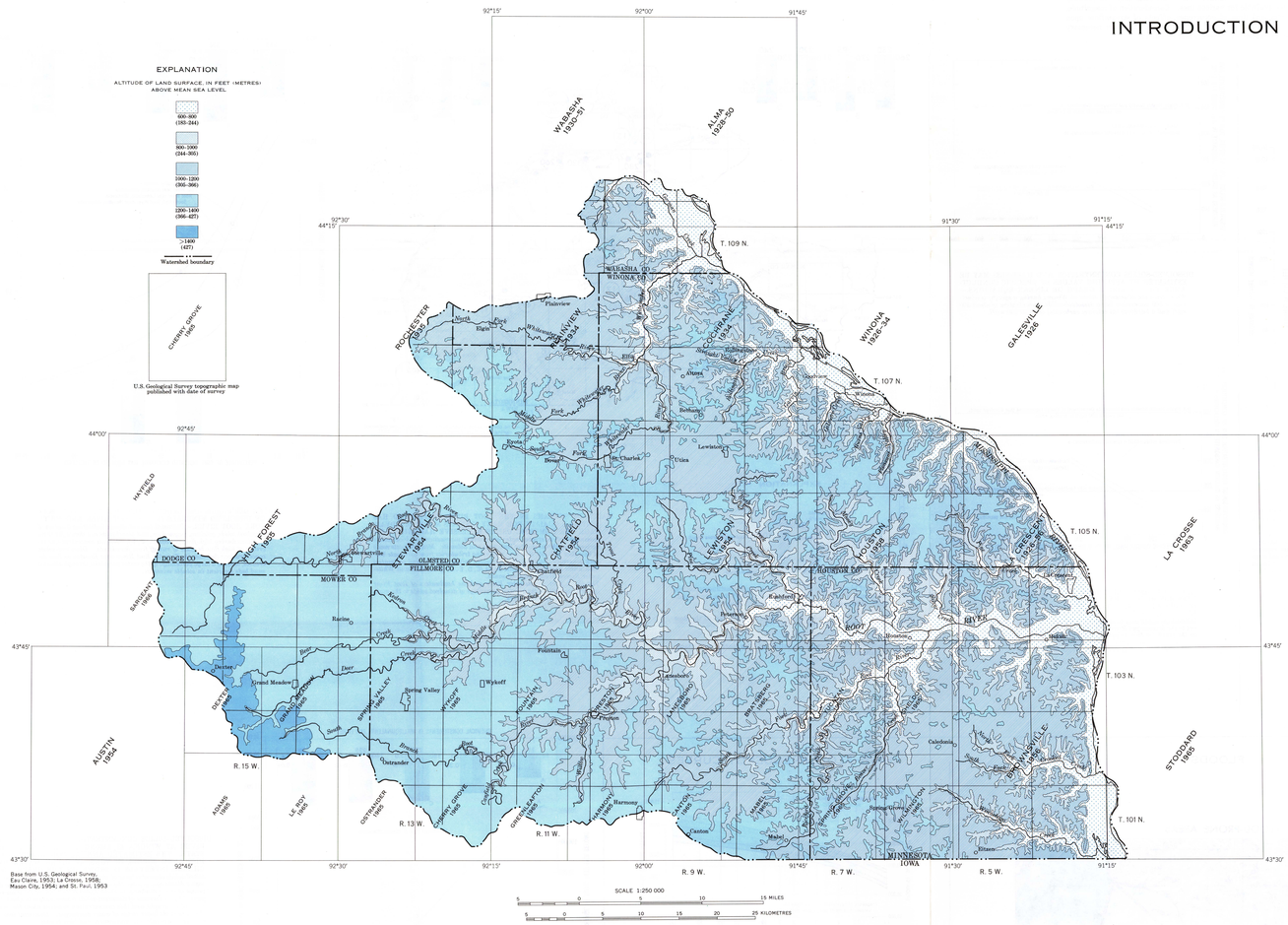
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

HYDROLOGIC INVESTIGATIONS
ATLAS HA-548 (SHEET 1 OF 3)

INTRODUCTION



Base from U.S. Geological Survey, Eau Claire, 1953; La Crosse, 1958; Mason City, 1954; and St. Paul, 1953

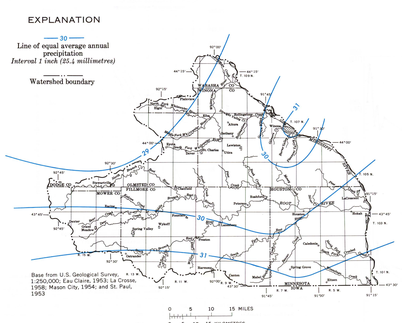
THE LAND SURFACE OF THE 2,570-SQUARE-MILE (6,655 km²) ROOT RIVER WATERSHED UNIT, AS DEFINED BY THE STATE OF MINNESOTA, VARIES FROM ROLLING PRAIRIES IN THE WEST TO PLATEAUS SEPARATED BY DEEPLY INCISED BEDROCK VALLEYS IN THE NORTH AND EAST

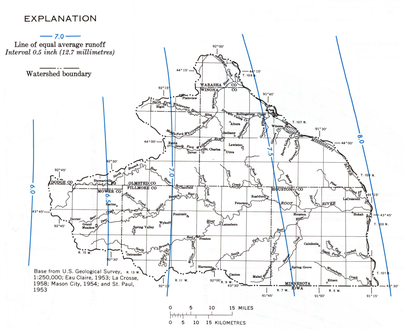
The Root River drains about 1,670 square miles (4,325 km²) and falls from an altitude of about 1,400 feet (427 m) at its headwaters area in the west to about 650 feet (198 m) at its mouth. The Whitewater River and other small streams that flow directly into the Mississippi River drain the remaining 900 square miles (2,330 km²).

The bedrock valleys were eroded before, during, and after glacial time. Thin loess covers the upland bedrock surfaces and extends onto valley slopes in some areas. Gray till covers upland areas at the west end of the watershed and extends into some bedrock valleys. Silty and clayey loam derived from these sediments plays a vital role in the dominantly agricultural economy of this watershed.

Topographic quadrangle maps published by the U.S. Geological Survey are available for the entire watershed.

WATER BUDGET





29.5 inches (749 millimetres) PRECIPITATION	=	7.2 inches (183 millimetres) RUNOFF	+	22.3 inches (566 millimetres) EVAPOTRANSPIRATION	±	0 UNDERFLOW	±	0 CHANGE IN STORAGE
Average annual, for 1940–69		*Average annual, from stream-gaging records for 1940–69*		*Obtained by difference in water budget*		*The difference between ground-water flow into and out of the watershed is estimated to be less than 0.1 inch (2.54 millimetres)*		*Long-term gains in ground-water, surface-water, and soil-moisture storage are assumed to be nearly balanced by long-term losses*

THE AVERAGE ANNUAL WATER BUDGET FOR 1940–69 SHOWS THAT WATER ENTERING THE WATERSHED AS PRECIPITATION IS APPROXIMATELY EQUAL TO RUNOFF PLUS EVAPOTRANSPIRATION

Precipitation increases from north to south and runoff increases from west to east. Increased runoff toward the east may be due to poor absorption of water by compacted loess (windblown silt and very fine sand) and to discharge of ground water in deeply incised stream valleys at the downstream end of the watershed.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the contribution of data for this report by well owners and drillers in the area. Some well logs were obtained from the Minnesota Geological Survey. Water analyses by Minnesota Department of Health and soil maps by U.S.Soil Conservation Service aided the interpretation of water quality.

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INVENTORY OF PRESENT AND POTENTIAL WATER SUPPLIES

MUNICIPAL SUPPLIES

Municipality	Estimated population served (1970)	Water use: Annual industrial use (million gallons)	Annual domestic use (million gallons)	Total annual pumpage (million gallons)	Average daily pumpage (thousand gallons)	Per capita domestic use (gallons per day)	Water source: Aquifer	Thickness open to wells (feet)	Number of wells	Water system: Approved well depth (feet)	Usual pumping rate (gpm)	Specific capacity (gallons per minute per foot of drawdown)	Daily plant capacity (thousand gallons)	Representative quality (milligrams per liter): Year sampled	Iron (Fe)	Manganese (Mn)	Sulfate (SO4)	Chloride (Cl)	Dissolved solids, calculated	Hardness as CaCO3
Altura	334	60	7	67	185	57	Prairie du Chien-Jordan Jordan	358 90	1 1	410 375	112 370	3.3 23	694	1948 1970	... .18	... <.02	17 7.5	... 4.2	... 250	... 250
Bethany	35	0	.4	.4	1.1	31	Jordan	15	1	309	15	...	24							
Caledonia	2,619	0	98	98	269	103	Jordan	115	2	405	390	.36	1,123	1969	<.02	<.02	18	14	370	260
Canton	391	0	8.8	8.8	24	61	Prairie du Chien	85	1	404	100	1.7	144	1967	.02	<.02	12	2.0	320	290
Chatfield	1,885	13	52	65	178	76	Jordan	104	1	478	450	9.5	648	1970	<.02	<.02	18	1.5	280	260
Dexter	252	0	11	11	30	119	Cedar Valley Maquoketa- Dubuque	72	1	232	75	...	108	1971	.36	<.02	11	3.0	230	260
Dover	321	2	14	16	44	119	Prairie du Chien Jordan	102 80	1 1	200 534	100 290	... 1.4	... 504	1967	<.02	<.02	53	18	...	270
Eitzen	208	0	3.4	3.4	9.3	45	Jordan	111	1	368	30	.6	43	1963	.05	<.02	1.3	10	...	240
Elba	158	.3	6.2	6.5	18	108	Ironton-Galesville	176	1	326	125	4.2	180	1961	4.2	<.05	26	<1	...	270
Elgin	580	0	36	36	99	171	Jordan Prairie du Chien-Jordan Prairie du Chien	90 147 102	1 1 1	420 410 154	300 100 50	4.4 15	648	1968 1964 1939	<.02 .15 .3	<.02 <.02 0	20 42 56	2.1 30 21	320	250 390 590
Eyota	639	3	26	29	79	111	Jordan	55	2	612	270	4.4	778	1969	.12	.06	12	<1	290	250
Fountain	347	0	8.9	8.9	24	69	Prairie du Chien-Jordan	355	2	707	180	8.8	346	1963	.07	<.02	23	.9	310	300
Goodview	1,829	1	40	41	112	60	Mount Simon	201	1	400	360	13	576	1967	.44	<.02	76	83	550	220
Grand Meadow	869	1	27	28	77	85	Galena St. Peter	38 80	1 1	338 619	125 200	4.4 3.6	540	1953 1967	.92 .33	.17 <.02	60 44	22 7.0	... ...	340 250
Hokah	697	0	18	18	49	70	Ironton-Galesville	132	1	295	125	5.6	180	1968	.06	<.02	13	<1	300	260
Houston	1,090	0	36	36	99	91	Mount Simon	59	2	259	195	9.8	785	1968	.18	<.02	61	86	490	220
La Crescent	3,296	0	64	64	175	53	Mount Simon	400	3	550	900	14	2,390	1968	.32	<.02	25	7.6	350	280
Lanesboro	850	2	42	44	121	135	Mount Simon	420	2	910	300	3.6	886	1967	1.0	<.02	26	1.5	280	250
Lewiston	1,000	0	38	38	104	104	Jordan Ironton-Galesville	86 305	2 1	426 725	125 350	2.4	986	1967	.06	<.02	12	1.3	230	210
Mabel	888	0	34	34	93	105	Prairie du Chien	110	2	150	360	...	720	1968	.78	<.02	19	4.4	360	260
Ostrander	216	0	9.1	9.1	25	116	Galena Prairie du Chien-Jordan	50 391	1 1	260 1,035	50 100	10	216	1964 1970	.05 .23	<.02 <.02	25 23	21 2.2	240 220	220 200
Peterson	269	0	9.0	9.0	25	93	Franconia	142	1	245	248	19	357	1967	.26	.05	13	1.0	300	250
Preston	1,413	6	58	64	175	112	Jordan	61	2	327	350	18	936	1968	.27	<.02	14	<1.2	280	280
Racine	197	0	7.3	7.3	20	102	St. Peter Maquoketa to St. Peter	40 395	1 1	512 495	80 150	6.7	331	1969	.06	<.02	50	<1	260	240
Rollingstone	450	0	11	11	30	67	Ironton-Galesville Mount Simon	267	2	410	100	...	223	1968	.41	<.02	14	<1	270	260
Rushford	1,318	1.2	57	58.2	159	118	Ironton-Galesville Eau Claire	275	2	375	170	8.1	605	1966	...	...	...	...	...	...
St. Charles	1,942	0	53	53	145	75	Prairie du Chien-Jordan Jordan to Ironton-Galesville	200 395	2 2	220 667	430 400	108 <1	1,670	1968 1968	<.02 .04	<.02 <.02	37 20	11 <1	380 ...	270 250
Spring Grove	1,290	41	39	80	219	83	St. Peter to Jordan Prairie du Chien-Jordan	450 122	1 1	630 557	160 200	10 13	518	1970 1970	<.02 <.02	<.02 <.02	11 8.8	7.2 7.8	390 250	230 190
Spring Valley	2,572	0	110	110	301	117	Prairie du Chien-Jordan St. Peter to Jordan	407 489	1 1	923 931	320 350	66 28	547	1969 1969	.15 .06	<.02 <.02	39 36	23 15	270 280	230 220
Stewartville	2,802	0	73	73	200	71	Prairie du Chien-Jordan St. Peter to Jordan	392 424	1 1	755 805	250 300	13 7	792	1968 1968	.25 .20	<.02 <.02	27 26	<1 <1	300 290	230 200
Utica	240	0	11	11	30	125	Jordan Prairie du Chien	60 262	1 1	480 312	100	3.3	144	1967 1949	.05	<.02	10 13	3.7 13	190	180
Winona	26,438	290	900	1,190	3,260	93	Outwash sand and gravel Mount Simon	40 350	5 5	150 500	900 1,200	25 27	15,746	1968 1968	1.8 .44	.67 .02	42 47	26 35	360 410	250 180
Wykoff	450	4	11	15	41	67	St. Peter Prairie du Chien Jordan	140 75	1 1	450 834	80 200	3.8 12	403	1963 1960	... .72	... <.02	... 19	0	... ...	270 ...
Total	57,885	424.5	1,919.1	2,343.6	6,420.4	91														

WATER USE 1970 (million gallons)

	Ground water	Surface water	Total
Public supply			
Domestic (population 57,900)	1,920	0	1,920
Industrial	424	0	424
Rural supply			
Domestic (population 44,100)	1,210	0	1,210
Livestock	1.580	279	1,859
Irrigation	7	2	9
Self supplied			
Industrial	2,170	312	2,482
Thermoelectric power	0	6,110	6,110
Watershed totals (population 102,000)	7,311	6,703	14,014

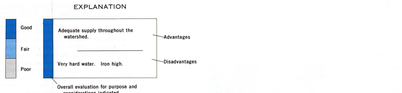
METRIC CONVERSION TABLE

1 in (inch)	=	2.54 cm (centimetres) = 25.4 mm (millimetres)
1 ft. (foot)	=	0.3048 m (metres)
1 mi^2 (square mile)	=	2.59 km^2 (square kilometres)
1 acre	=	0.405 ha (hectares)
1 ac-ft (acre-foot)	=	0.1234 hm (hectometres)
1 gal (gallon)	=	3.785 l (litres)
1 gpm (gallon per minute)	=	0.06308 l/s (litres per second)
1 gpm/ft (gallon per minute per foot)	=	0.207 (l/s)/m (litres per second per metre)
1 ft^3/s (cubic foot per second)	=	0.0283 m^3/s (cubic metres per second)
1 (ft^3/s)/mi (cubic foot per second per mile)	=	0.0176 (m^3/s)/km (cubic metres per second per kilometres)
1 ton (short)	=	0.9072 t (tonne)

EVALUATION OF WATER RESOURCES

Purpose	Considerations	SURFACE WATER: Root River	SURFACE WATER: Tributaries and minor streams	GROUND WATER: Sand and gravel aquifers	GROUND WATER: Cedar Valley—Maquoketa—Dubuque—Galena aquifer	GROUND WATER: St. Peter aquifer	GROUND WATER: Prairie du Chien aquifer	GROUND WATER: Jordan aquifer	GROUND WATER: Ironton—Galesville aquifer	GROUND WATER: Mount Simon-Red clastics aquifer
Municipal and industrial supply	For a moderate supply, principal needs are: Quantity Minimum available surface water supply of 1 ft³/s (0.03 m³/s) or wells yielding 250 gpm (15 l/s). Quality Dissolved-solids concentration less than 500 mg/l. Hardness less than 180 mg/l.	Adequate supply. Restricted areal distribution. Requires treatment for suspended solids, bacterial disinfection, and removal of algal growth.	Many adequate with development of storage facilities. Restricted areal distribution. Requires treatment for suspended solids, bacterial disinfection, and removal of algal growth.	Very high yields possible in river alluvium. Inadequate supply except in alluvium along Mississippi, Root, and Whitewater Rivers. Very hard water. Iron generally high. Locally high dissolved solids. Susceptible to contamination.	Adequate where present in western part of watershed. Yield varies areally because of distribution of fractures. Very hard water. Iron and hardness high. Susceptible to contamination, requires treatment.	Generally adequate supply where deeply buried. Locally low yields owing to fineness of sand. Very hard water. Susceptible to contamination where near the surface.	Generally adequate supply except near valley outcrops. Yield varies areally because of distribution of fractures. Very hard water. Susceptible to contamination where near the surface, especially through sink holes, requires treatment.	Adequate supply except near valley outcrops. Very hard water. Iron high. Susceptible to contamination where near the surface.	Adequate supply throughout the watershed. Very hard water. Iron high.	Adequate supply throughout the watershed. Very hard water. Dissolved solids high. Deeply buried. Usually saline at bottom of aquifer.
Rural domestic and stock supply	For an adequate farm supply, needs are: Quantity Minimum of 5 gpm (0.3 l/s). Quality Dissolved-solids concentration less than 1,000 mg/l.	Adequate supply. Available only to riparian lands. Susceptible to contamination.	Adequate for stock. Available only to riparian lands. Susceptible to contamination.	Locally adequate supply in western part of watershed and in alluvium along the Mississippi and Root Rivers. Generally acceptable quality. Thin or absent in most areas. Very hard water. Iron generally high. Susceptible to contamination.	Adequate supply where present. Generally acceptable quality. Very hard water. Iron high. Susceptible to contamination.	Generally adequate supply where present. Acceptable quality. Susceptible to contamination. Very hard water.	Adequate supply. Generally acceptable quality. Very hard water. Susceptible to contamination.	Adequate supply except near valley outcrops. Acceptable quality. Very hard water. Iron high. Susceptible to contamination.	Adequate supply throughout the watershed. Acceptable quality. Very hard water. Iron high. Deeply buried except along Mississippi River and adjoining valleys.	Adequate supply throughout the watershed. Acceptable quality. Very hard water. Deeply buried. Usually saline at bottom of aquifer.
Irrigation supply	For an average farm, needs are: Quantity Minimum available surface water supply of 2 ft³/s (0.06 m³/s) during growing season or wells yielding 250 gpm (16 l/s). Quality Dissolved-solids concentration less than 2,000 mg/l. (Wilcox, 1955).	Adequate supply. Available only to riparian lands.	Adequate supply for limited use from some. Available only to riparian lands.	Locally adequate supply in western part of watershed, and in alluvium along Mississippi and Root Rivers. Limits of aquifer not defined locally.	Generally adequate supply where present. Yield varies areally because of distribution of fractures.	Generally adequate supply where present.	Adequate supply except near valley outcrops. Acceptable quality. Yield varies areally because of distribution of fractures.	Adequate supply except near valley outcrops. Acceptable quality.	Adequate supply throughout the watershed. Acceptable quality.	Adequate supply. Deeply buried. Sodium high locally.
Fish and wildlife habitat	Adequate depth and quality of water for fish in lakes and streams. Adequate cover for wildlife habitat is provided by: Wetlands—lakes or potholes surrounded by marsh areas. Streams—marsh and woodland along banks.	Suitable for wildlife along banks. Suitable for fish. Occasional high water.	Suitable habitat along shores and banks. Fluctuating water stage.							
Recreation	Adequate access to lakes and streams. Availability of areas suitable for hunting, fishing, and other water sports. Available resorts, lake cottages, and campgrounds. Aesthetic values and absence of pollution.	Suitable for hunting, fishing, and canoeing. Trout present locally. Occasional high water. Coliform frequently high.	Many suitable for hunting and trapping. Trout present in many tributaries and Whitewater River. Occasional high water. Coliform frequently high.							

EXPLANATION



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WATER RESOURCES OF THE ROOT RIVER WATERSHED, SOUTHEASTERN MINNESOTA

By
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1975

For sale by U.S. Geological Survey, Reston, Virginia 22092, price $2.25 per set