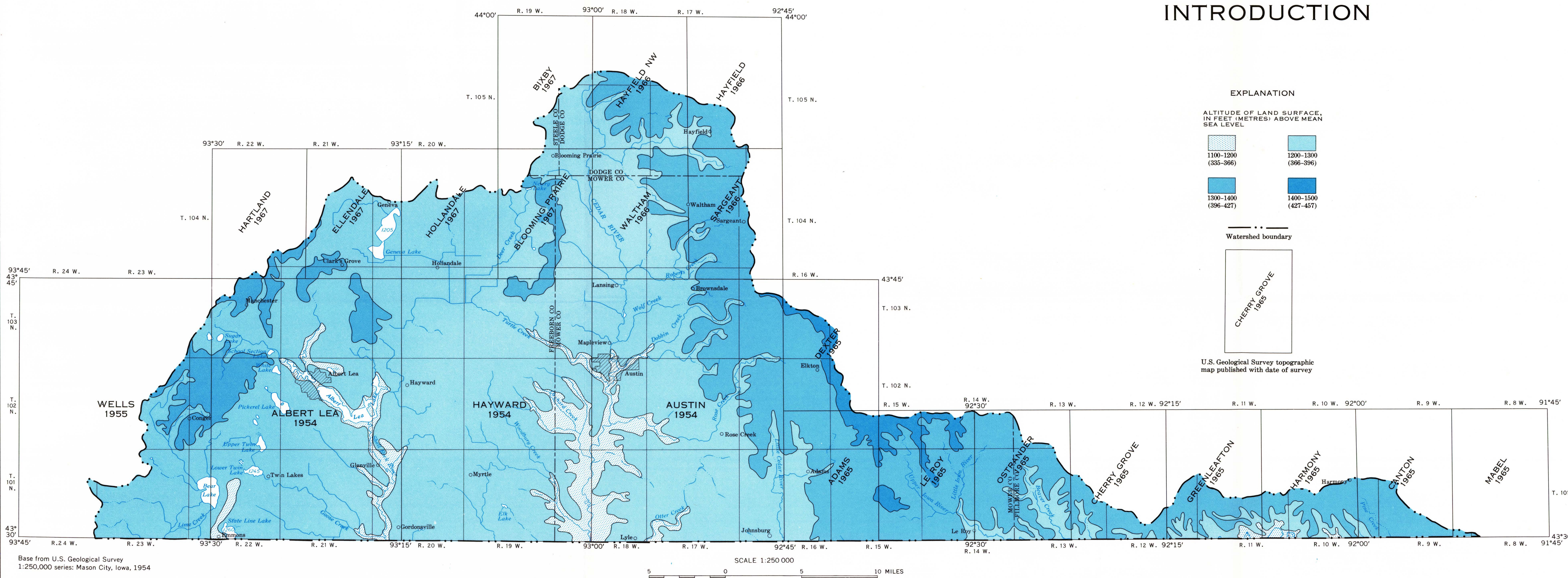
INTRODUCTION



THE CEDAR RIVER WATERSHED UNIT (AS ESTABLISHED BY THE STATE OF MINNESOTA) CONSISTS OF 1,204 SQUARE MILES (3,118 SQUARE KILOMETRES) OF FLAT OR GENTLY UNDULATING PLAIN

The watershed is drained by the Cedar River and several smaller streams that flow south into Iowa and eventually into the Mississippi River.

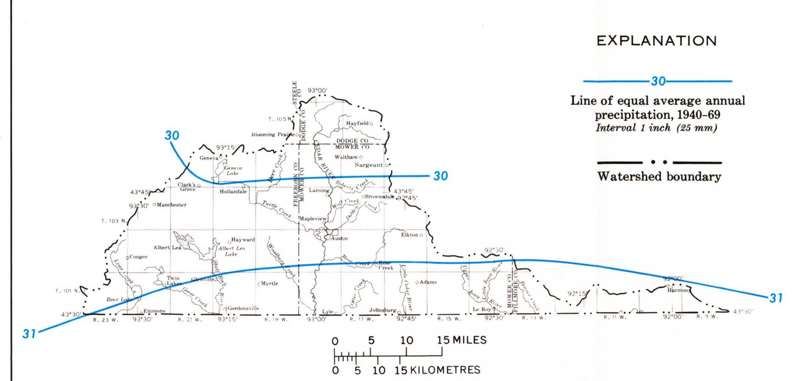
Its easternmost neck is part of a broad, flat, well-drained plain, covered by a thin sheet of glacial drift. Sinkholes have formed in the near surface carbonate bedrock, and a karst topography is developing. Farther north, along the east boundary, the drift is more than 200 feet (61 m) thick, and the land surface reaches altitudes of more than 1,450 feet (442 m)—the highest area in southeastern Minnesota. In the central part of the watershed in the southern flood plain of the Cedar River, the drift is less than 100 feet (30 m) thick, and the land surface altitude is less than 1,140 feet (347 m). The western part is dominated by a terminal moraine of the last Wisconsin glacier. Here the drift is more than 300 feet (91 m) thick, is poorly drained, and has numerous lakes.

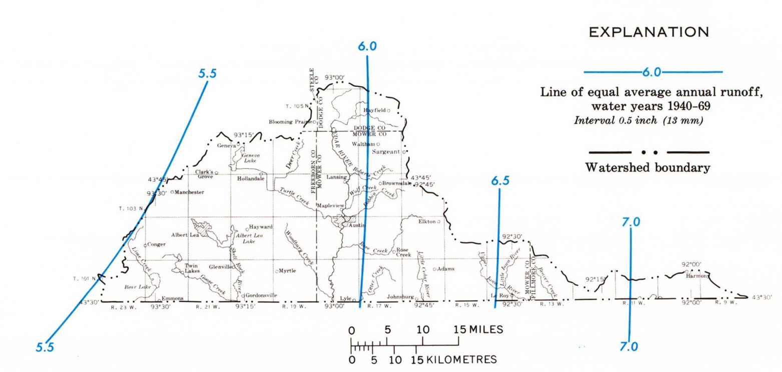
The watershed is mostly prairie and is well suited for farming, which is the dominant economic activity.

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

WATER BUDGET

PRECIPITATION		RUNOFF		EVAPOTRANSPIRATION		UNDERFLOW		CHANGE IN STORAGE
30.3 inches (770 mm)	=	5.9 inches (150 mm)	+	24.4 inches (620 mm)	±	0	±	0
(measured)		*(measured)*		*(remainder)*		*(estimated)*		*(assumed)*
Average annual, 1940-69		Average annual, from stream-gaging records water years 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 (2.5 mm)		Long-term gains in ground-water, surface-water, and soil-moisture storage are assumed to be balanced by long-term losses





THE AVERAGE ANNUAL WATER BUDGET FOR 1940-69 SHOWS THAT PRECIPITATION ON THE WATERSHED IS EQUAL TO SURFACE RUNOFF PLUS EVAPOTRANSPIRATION

The areal distribution of precipitation is fairly uniform throughout. The pronounced increase in runoff from west to east is probably due to the difference in topography as well as in geology. In the western part, numerous lakes and clayey moraines impede drainage and increase evapotranspiration. In the central and eastern parts, a well-developed drainage system tends to increase runoff. In the eastern neck, karst topography and some incised valleys facilitate discharge of ground water to the streams, thereby increasing runoff.

SUMMARY

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 (gal/day)	Water source: Aquifer	Thickness of uncased aquifer (feet)	Water system: Number of wells	Approximate well depth (feet)	Normal pumping rate (gal/min)	Specific capacity [(gal/min)/ft]	Daily plant capacity (thousand gallons)	Representative quality (milligrams per litre): Year sampled	Iron (Fe)	Manganese (Mn)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids, calculated	Hardness as $CaCO_3$
Adams	771	—	21	21	59	77	Cedar Valley to Galena	470	1	720	110	—	418	1970	0.14	<.02	14	3.0	250	240
							Cedar Valley	106	1	186	180	—		1964	2.0	.06	13	1.3	300	250
Albert Lea	19,418	719	371	1,090	2,986	52	Cedar Valley to Galena	175	4	320	1500	89	8,280	1970	1.6	.02	35	1.0	420	370
Austin	25,074	599	861	1,460	4,000	94	Maquoketa—Dubuque	41	3	132	1500	60	13,824	1964	.03	<.02	18	1.7	—	240
							Maquoketa—Dubuque to St. Peter	435	1	575	1000	7.2		1964	.03	<.02	19	.8	—	230
							St. Peter	53	1	558	600	6.7		1964	.14	<.02	33	1.2	—	230
							Prairie du Chien—Jordan	350	3	1015	1500	35		1964	.07	<.02	16	.7	—	250
Blooming Prairie	1,804	21	32	53	145	48	Cedar Valley—Maquoketa—Dubuque	81	2	250	280	55	691	1969	2.5	.04	<5	<1	240	250
Brownsdale	629	1.0	25	26	71	109	Cedar Valley	59	2	171	220	75	425	1967	.59	<.02	25	12	360	270
Clarks Grove	480	—	24	24	66	138	Cedar Valley	63	1	350	350	83	504	1970	1.2	<.02	<5	7.8	—	370
Conger	167	—	3.5	3.5	9.6	57	Cedar Valley—Maquoketa—Dubuque	210	1	390	125	12	180	1964	.33	<.02	5.0	.8	—	340
Elkton	134	—	4.4	4.4	12	90	Cedar Valley—Maquoketa—Dubuque	112	2	324	50	1.7	144	1970	.65	.03	6.5	7.7	310	290
Emmons	412	1.0	9.0	10	27	60	Cedar Valley	36	1	183	125	3.1	540	1953	.24	.15	2.4	—	—	320
							Prairie du Chien—Jordan	367	1	1167	250	31		1964	1.4	<.02	1.3	.5	—	330
Geneva	358	3.0	20	23	63	153	Maquoketa—Dubuque—Galena	207	1	432	150	48	216	1963	1.0	<.02	<1	<.5	300	260
Glenville	740	—	14	14	38	51	Cedar Valley—Maquoketa—Dubuque	205	1	265	125	28	792	1965	2.9	—	—	—	—	—
							Cedar Valley to Galena	270	1	370	425	71		1970	1.3	<.02	14	<1	380	200
Harmony	1,130	7.0	65	72	197	158	Prairie du Chien—Jordan	338	2	748	320	14	785	1970	<.02	<.02	14	<1	—	270
Hayfield	939	1.0	26	27	74	76	Maquoketa—Dubuque—Galena	210	1	340	230	125	331	1968	1.4	.08	<5	<1	290	250
Hayward	261	1.6	5.0	6.6	18	52	Prairie du Chien—Jordan	315	1	1045	500	75	720	1970	1.5	.02	340	8.8	830	400
Hollandale	287	—	14	14	38	132	Cedar Valley	63	2	220	250	29	612	1970	1.1	.02	10	2.7	310	180
Le Roy	870	2.0	31	33	90	98	Cedar Valley—Maquoketa—Dubuque	270	1	294	190	7.7	274	1970	.67	.02	19	<1	320	300
Lyle	522	—	22	22	60	115	Cedar Valley	127	1	252	200	—	288	1968	<.02	<.02	18	<1	260	240
Manchester	89	—	3.2	3.2	8.8	99	Cedar Valley—Maquoketa—Dubuque	273	1	423	50	—	72	1970	.75	<.02	44	2.8	440	200
Mapleview	328	2.0	8.0	10	27	67	Cedar Valley to Galena	342	1	426	150	6.0	216	1971	.98	.10	5.5	3.0	250	290
Myrtle	83	—	2.7	2.7	7.5	90	Cedar Valley	23	1	173	90	2.1	130	1970	.72	<.02	<5	<1	310	200
Rose Creek	390	—	11	11	30	77	Glacial Sand	60	1	179	100	10	482	1957	.22	.13	8.8	1.0	—	250
							Cedar Valley	95	1	192	235	24		1970	.14	.14	5.7	2.2	240	240
Sargeant	85	—	1.8	1.8	5	59	Cedar Valley	106	1	340	50	—	72	1971	1.7	.03	11	1.5	300	260
Twin Lakes	230	1.0	12	13	36	143	Cedar Valley—Maquoketa—Dubuque	197	1	370	170	19	245	1966	3.1	.08	5.9	6.2	—	400
Waltham	189	2.0	9.0	11	30	130	Cedar Valley	70	1	220	60	—	86	1970	.23	<.02	9.0	2.0	280	290
Total	55,390	1,360.6	1,595.6	2,956.2	8,097.9															

<less than

EVALUATION OF WATER RESOURCES

Purpose	Considerations	Surface water: Cedar River	Large lakes	Small lakes and minor streams	Ground water: Quaternary: Pleistocene sand and gravel	Devonian: Cedar Valley Limestone	Ordovician: Maquoketa—Dubuque and Galena Limestone	St. Peter Sandstone	Prairie du Chien Group and Jordan Sandstone	Cambrian: Ironton—Galesville Sandstones	Mount Simon Sandstone
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 gal/min (16 l/s). Quality: Dissolved-solids concentration less than 500 mg/l. Hardness less than 180 mg/l.	Adequate supply. / Bacterial disinfection mandatory for human consumption. Algal growth gives odor problems.	Adequate supply from some lakes for restricted use. / Water-quality data inadequate. Algal growth gives odor problems.	Many adequate with development of storage facilities. / Water-quality data inadequate. Algal growth gives odor problems.	Water-quality good where not contaminated by surface runoff. / Supply limited to a few areas of buried outwash and thin alluvial beds.	Adequate supply except where missing or thin. / Susceptible to contamination in eastern areas of thin drift. Very hard water.	Adequate supply throughout watershed. / Susceptible to contamination through sinkholes. Yield uncertain areally because of distribution of fractures.	Generally adequate supply. / Very hard water. Locally low yields due to fine sand, silt, or cementation.	Adequate supply. / Very hard water. Deeply buried in most areas.	Adequate supply in areas north and east of this watershed. Insufficient data for this area.	Adequate supply in areas north and east of this watershed. Insufficient data for this area. / Locally saline water in other areas where deeply buried.
Rural domestic and stock supply	For an adequate farm supply, needs are: Quantity: Minimum of 5 gal/min (0.3 l/s). Quality: Dissolved-solids concentration less than 1,000 mg/l.	Adequate supply. / Available only to riparian lands. Bacterial disinfection mandatory for human consumption.	Adequate supply. / Available only to riparian lands. Water-quality data inadequate.	Adequate for stock. / Available only to riparian lands. Water-quality data inadequate.	Locally adequate from buried outwash layers. / Locally iron and sulfur produce undesirable effects. These constituents may be removed by domestic treatment.	Adequate supply throughout most of watershed. / Very hard water susceptible to contamination.	Adequate supply. / Very hard water.	Adequate supply. Generally acceptable quality. / Deeply buried.	Adequate supply. / Deeply buried.	Adequate supply in areas north and east of this watershed. Insufficient data for this area.	Adequate supply in areas north and east of this watershed. Insufficient data for this area. / Locally saline water in other areas where deeply buried.
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 gal/min (16 l/s). Quality: Dissolved-solids concentration less than 2,000 mg/l is desired. Suitability of water quality for irrigation as indicated by classification of U.S. Dept. of Agriculture. (Wilcox 1955)	Adequate supply. Suitable quality for most crops. / Available only to riparian lands.	Adequate supply from some lakes. Inadequate supply from others. / Available only to riparian lands.	Adequate supply for restricted use from some. / Available only to riparian lands.	Locally adequate when present. Acceptable quality. / Aquifer not well defined.	Adequate supply. Acceptable quality.	Adequate supply. Acceptable quality. / Yield uncertain because of distribution of fractures.	Adequate supply. Acceptable quality. / Locally low yields due to fine sand, silt, or cementation.	Adequate supply. Acceptable quality. / Deeply buried.	Adequate supply in areas north and east of this watershed. Insufficient data for this area.	Adequate supply in areas north and east of this watershed. Insufficient data for this area. / Locally saline water in other areas where deeply buried.
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.	Good wildlife habitat along banks. Good fish habitat. / Occasional high water.	Excellent migratory waterfowl resting and feeding areas. Excellent wildlife habitats in marsh areas and along shores. Restricted fishing conditions.	Good migratory waterfowl resting and feeding areas. Excellent 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. Esthetic values and absence of pollution.	Hunting, fishing, and canoeing. / Occasional high water. Coliform high.	Hunting, restricted fishing, and water sports widely distributed. Public access generally available. / Water-quality data inadequate.	Hunting and trapping near many, widely distributed. / Most are shallow and may go dry. Water-quality data inadequate.							

EXPLANATION

Colors indicate overall evaluation for purpose and considerations indicated

Good — Fair — Poor

Adequate supply, generally acceptable quality. — Advantages

Very hard water, iron high. — Disadvantages

WATER USE 1970
(million gallons)

	Ground water	Surface water	Total
Public supply			
Domestic (population 54,260)	1,600	0	1,600
Industrial	1,360	0	1,360
Rural supply			
Domestic (population 24,086)	659	0	659
Livestock	543	96	639
Irrigation	24	24	48
Self supplied			
Industrial	2,090	671	2,761
Thermoelectric power	15	0	15
Watershed total (population 78,346)	6,291	791	7,082

WATER USAGE OF 7,082 MILLION GALLONS (26.81 CUBIC HECTOMETRES) IS A SMALL PART OF THE WATER BUDGET

Usage is distributed as follows: industrial (mostly farm-related industry)—58 percent, farm (for irrigation and livestock)—10 percent, and domestic—32 percent. The source of supply is divided into surface water, 11 percent, and ground water, 89 percent. Total usage is 1.1 percent of inflow (average annual precipitation); thus, quantity of water is not of great concern at this time. The Cedar Valley-Maquoketa-Dubuque-Galena aquifer underlies glacial drift throughout the watershed (see bedrock map, sheet 3), making water easily available in most areas. Quality of ground water, thus, is of greater concern than quantity, particularly in areas of thin drift and sinkholes.

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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. Data from test holes drilled by the Northern Natural Gas Company were helpful. Water analyses by Minnesota Department of Health, and soil maps by U.S. Soil Conservation Service, assisted the interpretation of water quality.

METRIC CONVERSION TABLE

in (inch)	× 25.4	= mm (millimetres)
ft (feet)	× 0.3048	= m (metres)
mi (mile)	× 1.609	= km (kilometres)
ft/mi (feet per mile)	× 0.1894	= m/km (metres per kilometre)
mi^2 (square mile)	× 2.590	= km^2 (square kilometres)
acre	× 0.4047	= hm^2 (square hectometre)
gal (gallon)	× 3.785	= l (litres)
million gallons	× 3.785×10^{-3}	= hm^3 (cubic hectometres)
gal/min (gallons per minute)	× 0.06309	= l/s (litres per second)
(gal/min)/ft (gallons per minute per foot)	× 0.207	= (l/s)/m (litres per second per metre)
ft^3/s (cubic feet per second)	× 0.2832	= m^3/s (cubic metres per second)
$(ft^3/s)/mi$ (cubic feet per second per mile)	× 0.01758	= $(m^3/s)/km$ (cubic metres per second per kilometre)

Interior—Geological Survey, Reston, Virginia—1975—W75060

WATER RESOURCES OF THE CEDAR RIVER WATERSHED, SOUTHEASTERN MINNESOTA

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1975

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