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

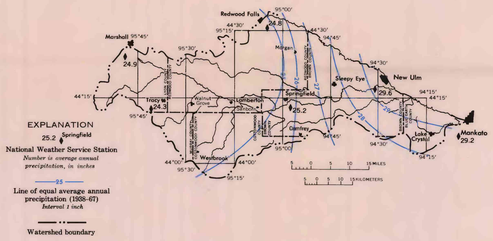
INTRODUCTION

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, assisted the interpretation of water quality.

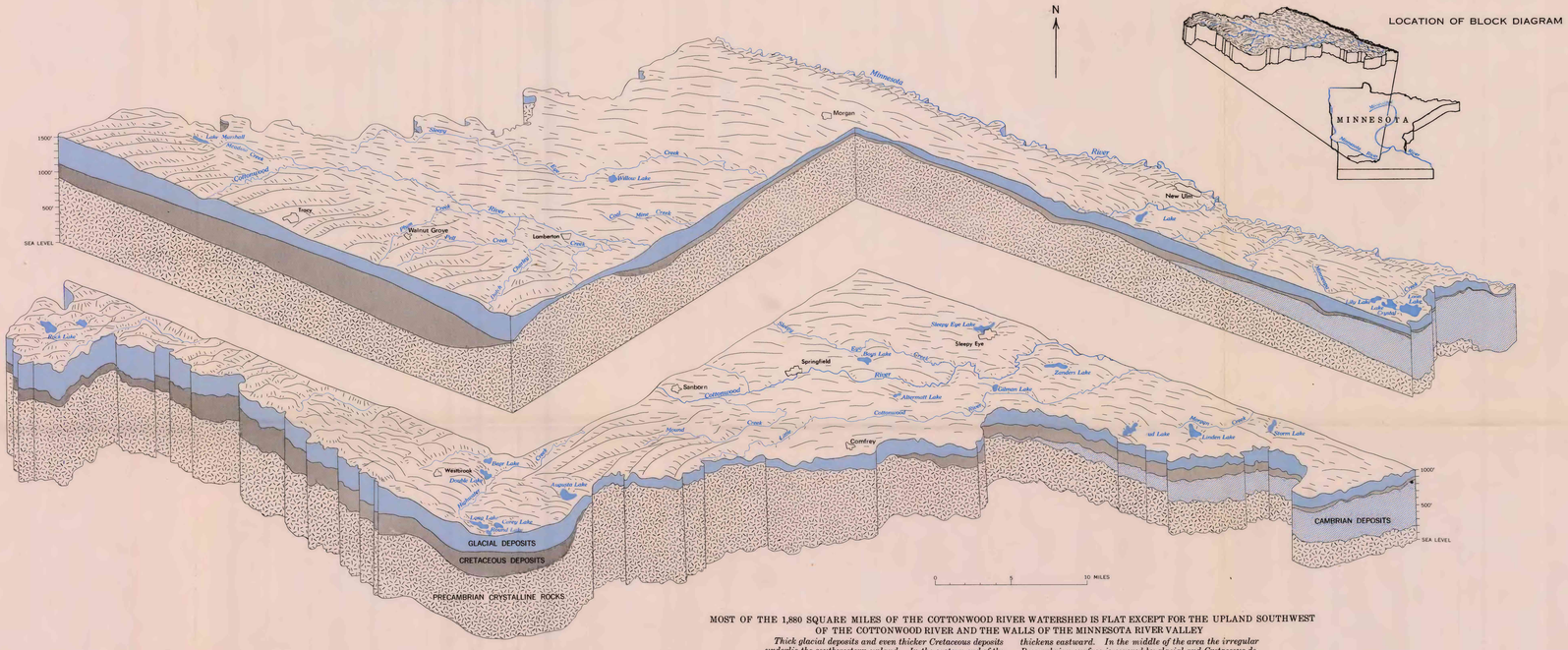
SELECTED REFERENCES

Interagency Task Force on Sedimentation, 1967, Fluvial sediment in the Upper Mississippi River Basin: Upper Mississippi River Basin Coordinating Committee, Comprehensive Basin Study, Appendix G, 139 p.
Leverett, Frank, 1932, Quaternary geology of Minnesota and parts of adjacent States: U.S. Geol. Survey Prof. Paper 161, 149 p.
Patterson, J. L., and Gamble, C. R., 1968, Magnitude and frequency of floods in the United States: U.S. Geol. Survey Water-Supply Paper 1678, 546 p.
Thiel, G. A., 1944, The geology and underground waters of southern Minnesota: Minnesota Geol. Survey Bull. 31, 506 p.
U.S. Department of Commerce, Weather Bureau, 1959, Technical Paper No. 37, Evaporation maps for United States: Washington, D. C., U.S. Govt. Printing Office, 12 p.
Wilcox, L. V., 1955, Classification and use of irrigation waters: U.S. Dept. of Agriculture Circ. 969, 19 p.



AVERAGE ANNUAL PRECIPITATION RANGES FROM ABOUT 24 INCHES AT THE WESTERN END TO MORE THAN 29 INCHES AT THE EASTERN END OF THE WATERSHED

Wide variations in daily precipitation, caused by local summer thundershowers, are common in the area.



MOST OF THE 1,880 SQUARE MILES OF THE COTTONWOOD RIVER WATERSHED IS FLAT EXCEPT FOR THE UPLAND SOUTHWEST OF THE COTTONWOOD RIVER AND THE WALLS OF THE MINNESOTA RIVER VALLEY

Thick glacial deposits and even thicker Cretaceous deposits underlie the southwestern upland. In the eastern end of the watershed, thin discontinuous Cretaceous deposits and relatively thin glacial deposits cover Cambrian sandstone, which thickens eastward. In the middle of the area the irregular Precambrian surface is covered by glacial and Cretaceous deposits that are very thin over the Precambrian highs.

WATER BUDGET

ALL WATER IN AN AREA IS ACCOUNTED FOR IN A WATER BUDGET

For comparison, all water-quantity units in the water-budget equation are average inches per year, based on precipitation and runoff for the period 1938-69.

SUMMARY OF MUNICIPAL SUPPLIES AND DEVELOPMENT POTENTIAL

Municipality	Estimated population (1969)	Average daily pumpage (gallons)	Average use per person (gallons per day)	Data on wells: 1969 In use	1969 Standby	Depth (feet)	Diameter (inches)	Date drilled	Aquifer	Usual pumping rate (gpm)	Specific capacity (gpm per foot)	Available drawdown (feet)	Hardness (mg/l)	Iron content (mg/l)	Remarks	Potential additional supplies
Comfrey	640	20,000	31	2		63	–	1930's	Buried sand and gravel	60	6	25	–	–	Both wells obtain water from glacial deposits. An old well penetrated deep into quartzite under 175 feet of glacial deposits without obtaining a satisfactory supply.	Adequate water is available from glacial sand and gravel deposits.
						63	–	–	Buried sand and gravel	60	6	25	–	–		
Hanska	490	30,000	61	1		179	10	–	Buried sand and gravel	170	24	130	–	–	Wells enter Cretaceous sandstone, but water is obtained from coarse gravel at base of glacial deposits.	Additional supplies are available from basal glacial gravel which locally reaches 60 feet thickness.
					1	–	–	–		–	–	–	–	–		
Jeffers	525	45,000	86	3		715	–	–	Precambrian quartzite	25	–	–	–	–	Test wells indicate quartzite under 120 feet of glacial deposits.	Potential for ground water is poor.
						80	–	–	Buried sand and gravel	7.5	–	40	–	–		
						80	–	–	Buried sand and gravel	7.5	–	40	–	–		
Lake Crystal	1,650	135,000	76	2		737	–	1894	Cambrian sandstone	200	4.6	114	669	0.1	Both wells are open holes below 200 feet. Well on edge of village obtained 100 gpm with 12 feet drawdown from the Dresbach Sandstone. Surface water can be obtained from Lake Crystal.	More water could be obtained from Dresbach sandstone. Surface water can be obtained from Lake Crystal.
						625	10	1896	Cambrian sandstone	200	4.3	116	587	.1		
Lamberton	1,140	100,000	88	2		67	8	Before 1939	Buried gravel	180	180	45	–	–	Aquifer is glacial gravel about 20 feet thick.	A pumping test indicated more water is available from present wells.
						67	8	1939	Buried gravel	180	–	45	–	–		
Lucan	225	12,000	53	1		85	14	1957	Buried gravel	40	40	–	–	–	Aquifer is glacial gravel at base of glacial deposits. One well entered granite at 85 feet.	More water is available from present well.
					1	114	8	Before 1949		20	–	70	–	–		
Morgan	975	48,000	49	2		151	10	1951	Buried coarse gravel	250	83	89	–	–	Production wells are 12 feet apart in same glacial sand and gravel layer. Granite occurs about 200 feet below the land surface.	More water is available from present well.
					1	144	8	1940	Buried sand	–	–	88	–	–		
						–	8	–		30	–	–	–	–		
New Ulm	12,590	2,400,000	191	9		216	16	1969	Buried sand and gravel	750	11	121	–	–	In the late 1800's water was obtained from Cretaceous sandstone at depths between 150 and 200 feet. By the 1940's a group of wells 20 to 30 feet deep, dug on the alluvial terrace near the valley wall were supplying water from alluvial sand and gravel. The well data in this table is from the two most recently drilled wells. Both wells are outside of the Cottonwood watershed on the north side of the Minnesota River. Average daily pumpage is high because of industrial use.	Ground-water supplies within the city are extensively developed. Additional supplies are available from wells north of the Minnesota River.
					1	172	–	1969	Buried sand and gravel	1,000	25	120	–	–		
Revere	200	20,000	100	2		204	6	1948	Cretaceous sandstone	40	1.0	164	–	–	Wells flowed for more than 20 years under artesian pressure (Thiel, 1944, p. 373). At present pumps are used in both wells.	Additional supplies could probably be obtained from properly spaced and developed wells in the same Cretaceous sandstone aquifer.
						198	6	1923	Cretaceous sandstone	–	–	–	–	–		
Sanborn	520	30,000	58		1	315	12	–	Cretaceous sandstone	250	3.6	–	1,000	4.6	Test hole 1 (1957), south of school, penetrated Cretaceous rocks without obtaining a water supply and entered Precambrian quartzite at about 345 feet.	Test hole 2 (1957), in the northeast section of Sanborn, provides an adequate supply for the present and should be adequate for the immediate future.
					1	308	12	1957	Cretaceous sandstone	300	2.3	207	970	3.6		
Sleepy Eye	3,490	300,000	87	1		182	12	1964	Buried sand and gravel	–	–	–	–	–	Wells obtain water from basal glacial sand underlain by Precambrian granite. During summer, yield from main well drops from 600 to 200 gpm.	Test holes (1968) south of town penetrated buried gravel at or near the base of glacial deposits, which should provide additional supplies.
					1	191	–	1947	Buried sand and gravel	225	–	–	–	–		
Springfield	2,700	170,000	63		2	112	12	1953		250	–	32	–	–	Water supply is from glacial deposits.	Additional supplies might be available from glacial deposits. Surface water might be obtained from the Cottonwood River.
						94	12	1956		180	–	34	–	–		
					2	48	84	1928		150	–	15	–	–		
						124	12	1957	Buried sand and gravel	150	3.8	84	–	–		
Storden	400	50,000	125	1		190	–	1966		300	10.5[1]	–	–	–	Water is from glacial deposits. Precambrian Sioux Quartzite directly underlies these deposits.	Main potential is from glacial deposits
					1	323	8	–	Buried clayey gravel	85	–	–	–	–		
Tracy	2,860	300,000	105	2		638	12	1954	Cretaceous sandstone	600	7.8	370	–	–	Water supply is from Cretaceous sandstone.	Additional supplies are available from Cretaceous sandstone at a depth of about 600 feet.
						647	20	1966	Cretaceous sandstone	300	4.4	374	–	–		
Wabasso	790	45,000	57	2		99	8	1951	Buried sand	160	6.7	65	–	–	Water supply is from glacial deposits. Granite is about 100 feet below land surface.	Additional supplies probably are available from glacial deposits.
						75	8	After 1935	Buried fine sand	–	–	28	–	–		
Walnut Grove	885	78,000	88	2		320	10	–	Cretaceous sandstone	105	2.6	250	140	–	Water supply is from Cretaceous sandstone.	Additional supplies are available from Cretaceous sandstone.
						320	12	–	Cretaceous sandstone	125	–	–	140	–		
Wanda	160	30,000	188	2		185	6	Before 1930	Cretaceous sandstone	45	–	146	–	–	Aquifer is thin sandstone underlain by white marl and granite.	Cretaceous sandstone offers best potential for additional supplies.
						186	6	1939	Cretaceous sandstone	45	–	–	–	–		
Westbrook	1,010	86,000	85	2		650	–	1966	Cretaceous sandstone	–	–	–	–	7.5	Cretaceous sandstone aquifer overlies about 50 feet of weathered granite. Hard granite surface is 650 feet below land surface.	Best potential is from Cretaceous sandstone.
						571	6	1947	Cretaceous sandstone	125	–	–	–	–		

SUMMARY OF WATER RESOURCES

Purpose	Considerations	Surface water: Cottonwood River	Surface water: Small streams	Surface water: Lakes and sloughs	Ground water: Pleistocene: Buried sand and gravel	Ground water: Pleistocene: Surficial sand and gravel	Ground water: Cretaceous sandstone	Ground water: Cambrian sandstone	Ground water: Precambrian crystalline rocks
Municipal and industrial supply	For a moderate supply, principal needs are: Quantity: Minimum available surface-water supply of 1 cfs or wells yielding 250 gpm. Quality: Dissolved solids less than 500 mg/l. Hardness less than 180 mg/l.	Adequate supply. Location favorable for some communities. Storage necessary. Few storage sites available. Treatment necessary. Dissolved solids, sulfate, and hardness are high.	Adequate supply for limited use. Storage necessary. Few storage sites available. Treatment necessary. Dissolved solids about 500 mg/l in east, higher in the west.	Adequate supply from some lakes for limited use. Shallow lakes and sloughs dry up during drought years. Treatment necessary. High dissolved solids in the west.	Adequate supply in most of the watershed. Widely distributed. Considerable local variation in yield. Thin or absent in some areas where Precambrian rocks are at or near the surface. Dissolved solids high. Nitrate high locally. Very hard in the western part of basin.	Generally adequate supply where present. Limited distribution. Subject to surface contamination. Bacteriologic treatment necessary. Nitrate high locally.	Generally adequate supply in western and central part of watershed. Generally inadequate in northern, southern, and eastern parts of watershed. Quality of water varies considerably. Water generally exceeds 500 mg/l of dissolved solids.	Generally adequate supply in extreme eastern tip of watershed. Water is very hard. Dissolved solids generally high.	Small yields available in some areas where no other ground-water supply is found. Inadequate yield, generally 25 gpm or less. Limited recharge. Dissolved solids high.
Rural domestic and stock supply	For an adequate farm supply, needs are: Quantity: Minimum of 5 gpm. Quality: Dissolved solids less than 1,000 mg/l.	Adequate supply. Suitable quality for stock. Available only to riparian lands. Treatment necessary for domestic use.	Adequate supply for limited use from some streams. Suitable quality for stock. Available only to riparian lands. Treatment necessary for domestic use.	Most are adequate supply for stock. Suitable quality for stock. Shallow lakes and sloughs dry up during drought years. Treatment necessary for domestic use.	Adequate supply in most of the watershed. Widely distributed. Quality suitable in ground-moraine areas. Thin or absent in some areas. Dissolved solids high in the southwest.	Adequate supply. Bacteriologic treatment necessary for domestic use. Nitrate high locally.	Adequate supply in western and central part of watershed. Locally too deep to be economical. Dissolved solids generally high.	Adequate supply in eastern tip of watershed. Quality generally suitable. Too deep; shallower supplies generally available.	Small yields available in some areas where other supplies are not. Yields may be inadequate. Dissolved solids high.
Irrigation supply	For an average farm, needs are: Quantity: Minimum available surface-water supply of 2 cfs during growing season or wells yielding 250 gpm. Quality: Dissolved solids less than 2,000 mg/l desirable. Suitability of water quality for irrigation as indicated by classification of U.S. Dept. of Agriculture (Wilcox, 1955).	Adequate supply for limited use. Quality suitable. Available only to riparian lands. Boron sometimes high.	Adequate supply for limited use from some streams. Quality suitable. Available only to riparian lands. Boron sometimes high.	Adequate supply for limited use from some lakes. Quality suitable. Available only to riparian lands. Shallow lakes and sloughs dry up during drought years.	Adequate supply in most of the watershed. Test drilling needed because of local variations in yield. Recharge may be limited. Dissolved solids high in end-moraine areas. Locally boron is high.	Generally adequate supply. Quality generally acceptable. Not widely distributed. Boron high locally.	Generally adequate supply in central and western part of watershed. Quality generally unsuitable. Boron generally high.	Generally adequate supply in eastern tip of watershed. Quality generally suitable. Generally greater than 200 feet in depth.	Insufficient yield. Inadequate recharge. High boron.
Fish and wildlife habitat	Adequate depth and quality of water for fish in lakes and streams. Adequate cover needed 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. Floods.	Suitable for wildlife along banks. Some suitable for fish. Floods. No flow during droughts.	Suitable for wildlife and water fowl. Some suitable for fish. Shallow lakes and sloughs dry up during droughts. Winter kill of fish common.					
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.	Suitable for hunting and fishing. Floods.	Suitable for hunting and some fishing. Floods. No flow during droughts.	Suitable for hunting and trapping. Some suitable for fishing. Some suitable for water sports. Shallow lakes and sloughs dry up during droughts.					

EXPLANATION

Good
Fair
Poor

Generally adequate supply. Quality generally acceptable. — Advantages
Not widely distributed. Boron high locally. — Disadvantages

Overall evaluation for purpose and considerations indicated.

CONCLUSIONS

GROUND WATER

Aquifers throughout the watershed serve two major functions in the hydraulic system; they are sources of water supplies, and they furnish a perennial base of streamflow by ground-water discharge.

Water supplies are obtained from wells tapping Pleistocene glacial deposits, Cretaceous sandstone, Cambrian sandstone, and Precambrian crystalline rocks. The most accessible and widely used aquifers are beds of sand and gravel buried in the glacial deposits.

Dominant regional ground-water flow is northeastward from the topographic high in the southwest toward the Minnesota River. Local flow patterns indicate ground water discharging into rivers and creeks.

Most of the Cottonwood River watershed is an area of ground-water recharge, indicated by a decrease in hydraulic potential as depth below land surface increases.

Only part of the available ground water has been developed, and no areas of significant ground-water decline are known. However, because ground-water availability varies locally, detailed studies will be necessary to guide resource development, especially where large ground-water supplies are needed.

SURFACE WATER

Average annual runoff from the watershed is about 3.0 inches.

Most of the annual runoff occurs in spring and early summer when evapotranspiration losses are low and soil conditions, such as frozen or saturated soil, are favorable for runoff.

Cottonwood River, Little Cottonwood River, and Sleepy Eye Creek are potential sources of water for moderate supplies if storage and transmission facilities are constructed.

Sites for large storage reservoirs are limited to lower reaches of the rivers. Evaporation of about 2.4 cubic feet per second per square mile of lake surface must be considered in the design of storage reservoirs.

Most of the smaller tributary streams have no natural storage; therefore, they cease to flow during droughts, and flood as the result of snowmelt and excessive precipitation.

The frequency of recurrence of the long periods of low flow during the severe drought of the 1930's cannot be adequately defined by the short length of streamflow records in the basin.

Generally, the most uniform daily discharge occurs just prior to spring breakup and, in contrast, the least uniform occurs during the summer.

WATER QUALITY

Ground water in the Cottonwood River watershed generally contains dissolved solids exceeding the U.S. Public Health Service recommended limit for drinking water (500 milligrams per liter). Most surface water also exceeds this limit during periods of low flow.

Thick glacial and Cretaceous deposits in the western part of the watershed contain soluble sulfates and chlorides. In the east, thinner glacial and Cretaceous deposits seem to be almost leached of these ions.

Ground water is mainly of two types: calcium magnesium sulfate type in the southern and western part of the watershed, and calcium magnesium bicarbonate type in the east.

Well drained end moraine areas have had less water infiltrate the soil (resulting in less leaching and higher dissolved solids) than in ground moraine areas where poor surface drainage results in greater infiltration and more leaching.

Dissolved-solids content during low flow, in both the Cottonwood and Little Cottonwood Rivers, decreases downstream as ground-water contributions to low flow increase downstream.

Sediment from soil erosion and discharge of municipal wastes into the Cottonwood River alters the natural quality of the riverwater, making it unsuitable for many uses.

Pollution of ground water results mainly from excessive use of fertilizers and from recharge water that has passed through livestock feedlots. Surface water is also affected by these sources of pollution and by municipal and industrial waste.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W72027

WATER RESOURCES OF THE COTTONWOOD RIVER WATERSHED, SOUTHWESTERN MINNESOTA

By
W. L. Broussard, H. W. Anderson, Jr., and D. F. Farrell

1973

For sale by U.S. Geological Survey, price $1.00 per set