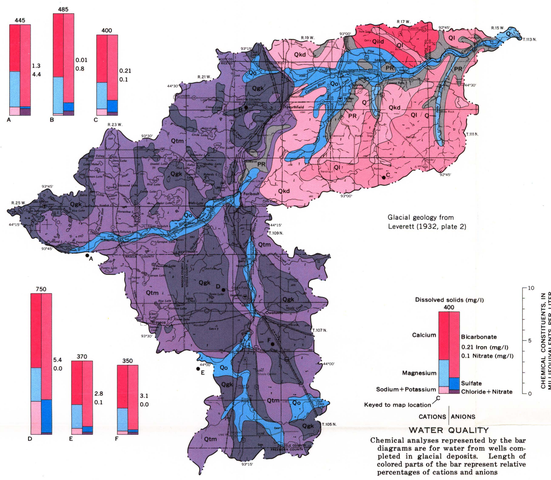
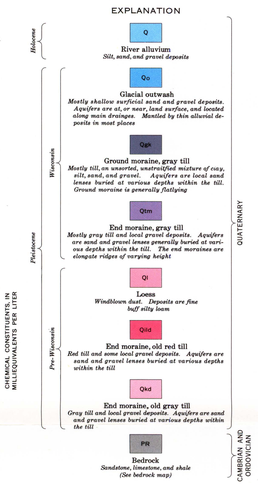
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

GROUND WATER

GLACIAL DEPOSITS



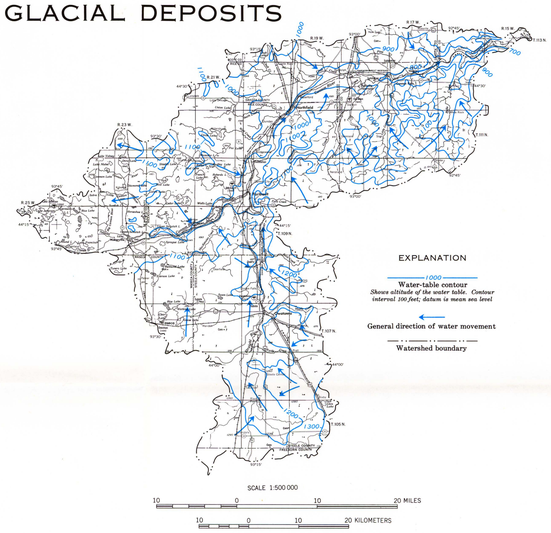


WATER QUALITY

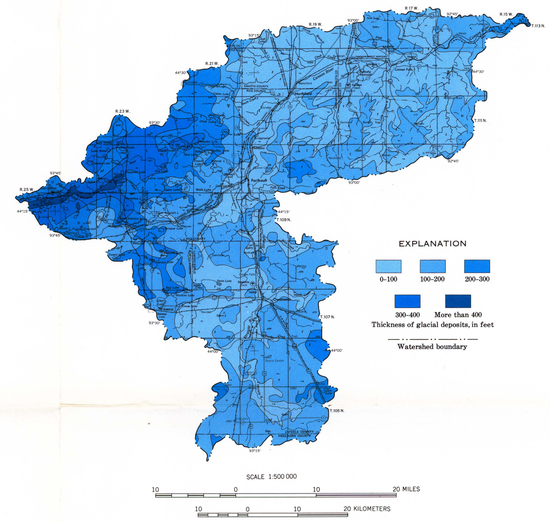
Chemical analyses represented by the bar diagrams are for water from wells completed in glacial deposits. Length of colored parts of the bar represent relative percentages of cations and anions

PLEISTOCENE GLACIAL DEPOSITS COVER MOST OF THE WATERSHED, BUT ONLY IN THE WESTERN AND SOUTHERN PARTS IS THERE ENOUGH SATURATED GLACIAL SAND AND GRAVEL TO BE WIDELY USED AS AQUIFERS.—*Many private domestic water supplies are obtained from glacial sediments of Wisconsin age. Eastward from the east edge of the Wisconsin end moraine, thin pre-Wisconsin deposits are deeply weathered and eroded. Few water supplies are obtained from drift in the eastern part of the watershed except from outwash in the Cannon River and Prairie Creek valleys. These valleys contain one of the largest outwash sand plains in southeastern Minnesota. Exploratory drilling may indicate the availability of adequate water for irrigation.*

Water from glacial deposits is a calcium bicarbonate type. In general, the dissolved-solids content is less than 500 mg/l (milligrams per liter). Water from sand lenses in poorly leached gray till contains higher dissolved solids and more sulfate than water from outwash, old gray till, and loess deposits. Water from all glacial deposits contain mainly carbonate type hardness, which usually exceeds 180 mg/l as calcium carbonate.

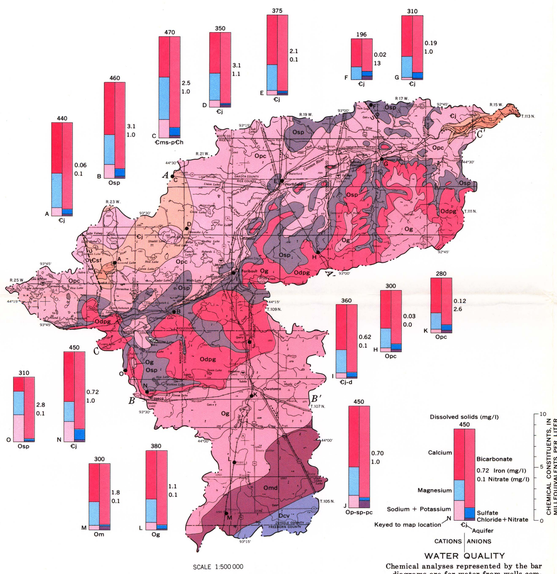


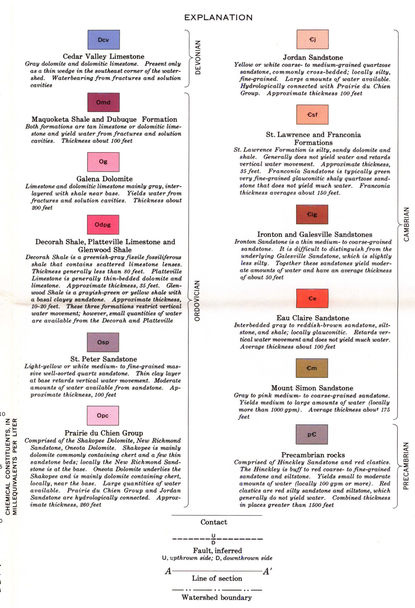
WATER MOVEMENT IN SHALLOW AQUIFERS IS LOCALLY TOWARD MAJOR DRAINAGE AND REGIONALLY TOWARD THE MOUTH OF THE CANNON RIVER.—*Direction of water movement is indicated by arrows on the map. Water in shallow aquifers moves nearly perpendicular to the contours, from upland areas to lowland areas. The ground-water divide approximately underlies the watershed boundary.*

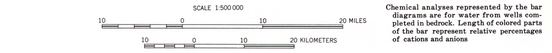


WATER FROM GLACIAL DRIFT SUPPLIES A LARGE NUMBER OF DOMESTIC WELLS IN THE SOUTHERN AND WESTERN PARTS OF THE WATERSHED.—*Glacial drift ranges in thickness from less than 100 feet to more than 400 feet. The greater the thickness, the greater the likelihood of penetrating a saturated sand lens and obtaining a water supply. Only a part of the available ground water is developed, and no areas of long-term ground-water decline are known. Because ground-water availability varies locally, additional exploration would be a valuable guide to resource development, especially for large supplies. In the northeast, water is obtained from glacial outwash sand in the river valleys, but little, if any, is obtained from glacial deposits outside the valleys.*

BEDROCK





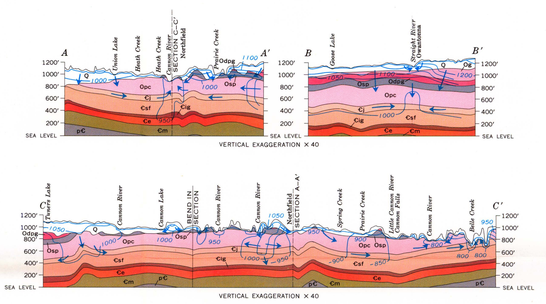


WATER QUALITY

Chemical analyses represented by the bar diagrams are for water from wells completed in bedrock. Length of colored parts of the bar represent relative percentages of cations and anions

THE DISTRIBUTION OF BEDROCK FORMATIONS INDICATES WHERE THE DIFFERENT AQUIFERS CAN BE ANTICIPATED. LITTLE VARIATION IS NOTED IN WATER QUALITY FROM DIFFERENT TYPES OF BEDROCK AQUIFERS.—*The bedrock formations underlying the glacial deposits dip regionally to the southeast. In the southern part of the watershed, most bedrock wells obtain water from Cedar Valley, Maquoketa, Dubuque, and Galena limestones and dolomites. Large supplies are available from the Jordan Sandstone everywhere in the watershed except from two small areas where the Jordan was removed by erosion. The Ironton-Galesville and Mount Simon aquifers could supply water anywhere in the watershed. The depth to these aquifers can be estimated by adding the thickness of the glacial deposits and the average thickness of bedrock formations overlying the aquifer at the point of interest.*

Water from Ordovician and Cambrian formations is calcium bicarbonate type. Dissolved-solids content of this water is generally less than 500 mg/l and sulfate less than 20 mg/l, but both may exceed these concentrations in formations receiving recharge from poorly leached gray till. Temporary (carbonate) hardness concentrations generally exceed 180 mg/l (as calcium carbonate). Iron concentrations are generally higher than the 0.3 mg/l recommended by the U.S. Public Health Service. High chloride and nitrate concentrations in water from shallow bedrock aquifers are indicative of pollution from surface sources.



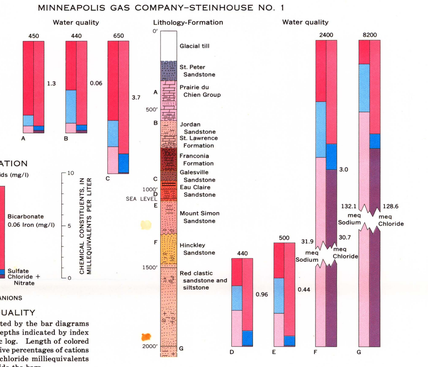
GLACIAL DRIFT AND SEDIMENTARY BEDROCK ARE PART OF A SINGLE HYDROLOGIC SYSTEM IN WHICH WATER MOVES VERTICALLY AND LATERALLY.—*The system is recharged primarily by infiltration of precipitation mainly in upland areas. Water moves downward and laterally toward discharge areas, where it moves toward the surface and discharges as stream base flow and evapotranspiration. Arrows on the hydrogeologic sections indicate ground-water movement from high to low hydraulic-potential areas. Water movement indicated on sections A-A′ and B-B′ is mainly downward from the uplands and laterally toward the Cannon and Straight Rivers, respectively. Section C-C′ shows shallow water circulation discharging locally to streams. Regional movement in the Jordan and deeper aquifers is generally toward the east in the direction of the Cannon River gradient. Locations of the lines of section are shown on the bedrock geology map.*

EXPLANATION

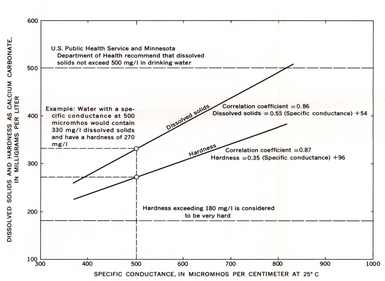
Q
Glacial deposits
Mostly till, some sand and gravel; outwash, and loess. Includes Holocene deposits
Contact
Water table
Approximately located
1050
Equipotential line
Line of equal hydraulic potential; interval 50 feet; datum is mean sea level
General direction of water movement

NOTE

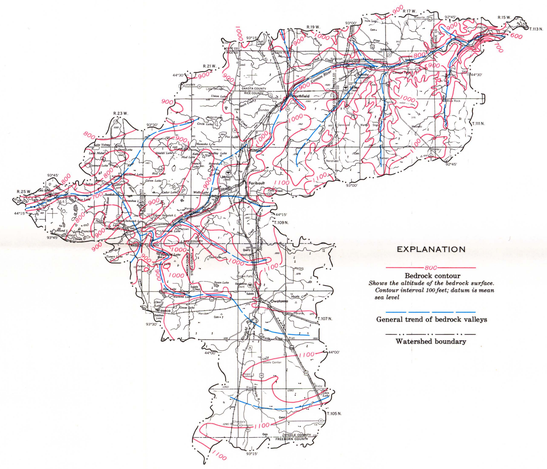
Refer to bedrock geology map for explanation of symbols



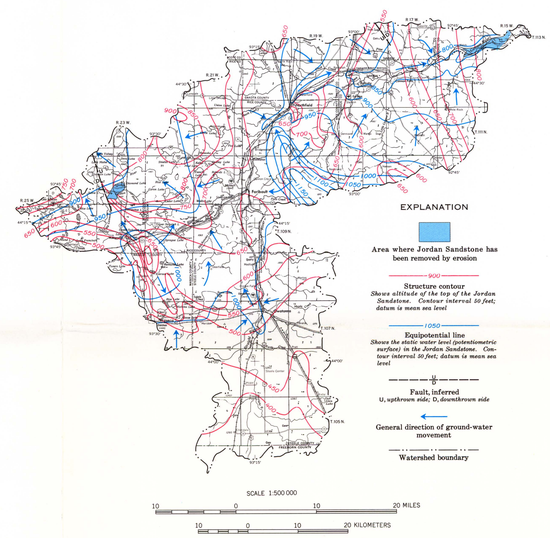
GROUND-WATER QUALITY IN THE GEOLOGIC COLUMN SHOWS A CHANGE FROM FRESH TO SALINE WATER.—*Water from the Prairie du Chien Group to the top of the Mount Simon Sandstone shows a dissolved solids range of 440 to 650 mg/l. This water is calcium magnesium bicarbonate type, with percentages of magnesium and sodium increasing with depth. Water from the Hinckley Sandstone and red clastic beds is sodium chloride type, with dissolved solids exceeding 2,000 mg/l.*



ESTIMATES OF DISSOLVED SOLIDS AND HARDNESS OF GROUND WATER MAY BE MADE BY MEASURING SPECIFIC CONDUCTANCE



BURIED BEDROCK VALLEYS ARE PROMISING AREAS FOR EXPLORATION FOR WATER-BEARING SAND AND GRAVEL DEPOSITS.—*The bedrock surface buried by glacial deposits reflects pre-glacial drainage patterns altered by glacial melt water. Some of these valleys were filled during subsequent glacial advances, with deposits including sand and gravel.*



THE REGIONAL DIP OF THE JORDAN SANDSTONE IS TO THE SOUTH, WHEREAS WATER MOVEMENT IN THE JORDAN AQUIFER IS GENERALLY TO THE NORTH.—*The Cannon River watershed is on the boundary between the bedrock basin to the north and a trough in the bedrock dipping south into Iowa. Several structural domes are identified in the watershed; the one at Waterville is used for underground gas storage in the Mount Simon Sandstone horizon. About 25 miles north of the watershed, the Jordan Sandstone is less than 500 feet above sea level in the center of the Twin Cities basin. In the south end of the watershed, the Jordan is less than 100 feet above sea level and more than 900 feet below the surface. Faulting in the Jordan Sandstone is indicated in T. 112 N., R. 18 W., by test drilling for underground gas storage sites. The fault shown in T. 110 N., R. 23 W., is either an extension of the Belle Plaine fault or a monoclinal fold. Structural identification is based on 200 feet of vertical displacement of Jordan Sandstone between wells about a mile apart.*

Water in the Jordan Sandstone moves perpendicular to the equipotential lines, from areas of high potential to areas of low potential. Two pronounced highs in the potentiometric surface are near Waterville and in the vicinity of the headwaters of Prairie Creek and Little Cannon River; thus, direction of ground-water flow is away from these places. Water in the western part of the aquifer moves to the north and west into the lower Minnesota River watershed. Water in the northeastern part moves to the northeast, discharging into the Cannon River.

AQUIFER DATA AND WATER QUALITY FROM MUNICIPAL RECORDS

Aquifer	Average thickness open to wells (feet)	Towns using aquifer	Municipal wells in aquifer	Well depth (feet)		Usual pumping rate (gpm)		Specific capacity (gpm/ft)		Iron (mg/l)		Sulfate (mg/l)		Chloride (mg/l)		Dissolved solids residue (mg/l)		Hardness as $CaCO_3$ (mg/l)	
				Range	Average	Range	Average	Range	Average	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median
Maquoketa Dubuque Galena	120	2	3	230-400	320	88-150	119	7.5	--------	1.1-1.8	------	< 5-18	------	0.3-3.0	------	330-380	------	290-330	------
St. Peter	104	3	3	184-300	231	170-250	223	10	--------	.7-3.1	2.6	0-33	< 1	< .5-4.4	1.2	460-500	------	270-420	390
Prairie du Chien Jordan	300	10	20	317-700	491	55-1200	557	7.6-46	29	< .02-.68	.18	18-40	28	<1-5.9	1.5	240-480	350	200-410	290
Ironton Galesville	100	2	3	750-760	755	215-1650	932	8.0-15	12	.62-3.7	------	25-85	------	<1-3.0	------	358-650	------	330-370	------

Base from U.S. Geological Survey
Saint Paul, 1953-63,
Mason City, 1953, 1:250,000

Interior—Geological Survey, Reston, Va.—1974

WATER RESOURCES OF THE CANNON RIVER WATERSHED, SOUTHEASTERN MINNESOTA

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

1974