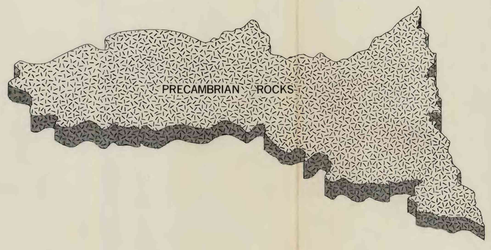
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

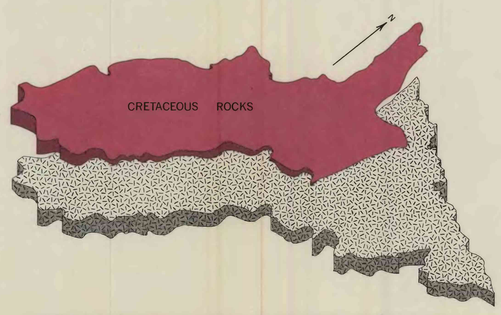
HYDROLOGIC INVESTIGATIONS
ATLAS HA-320 (SHEET 2 OF 3)

# GROUND WATER

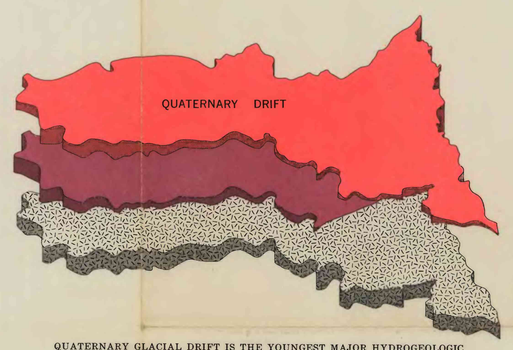
GROUND-WATER MOVEMENT, STORAGE, AND QUALITY ARE RELATED TO GEOLOGY. THREE MAJOR GEOLOGIC UNITS UNDERLIE THE YELLOW MEDICINE RIVER WATERSHED, EACH OF A DIFFERENT AGE, AND EACH HAVING DIFFERENT HYDROLOGIC CHARACTERISTICS. THE POSITION IN THE GEOLOGIC SECTION, THE THICKNESS, AND THE AREAL EXTENT OF EACH UNIT AFFECT THE GROUND-WATER SYSTEM.



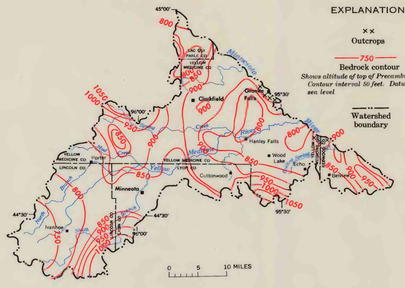

PRECAMBRIAN IGNEOUS AND METAMORPHIC ROCKS UNDERLIE THE ENTIRE WATERSHED.—*They are mostly granitic rocks comprising the oldest and lowermost hydrogeologic unit of the area.*



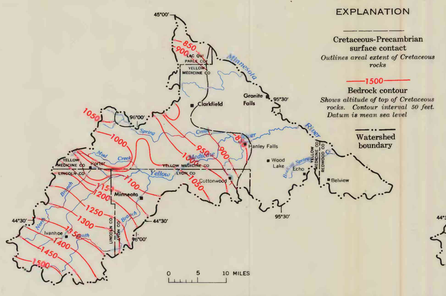

CRETACEOUS SEDIMENTARY ROCKS OF MARINE ORIGIN ARE PRESENT IN THE WESTERN TWO-THIRDS OF THE WATERSHED.—*They are mostly shale but contain some beds of sandstone, particularly at their base.*



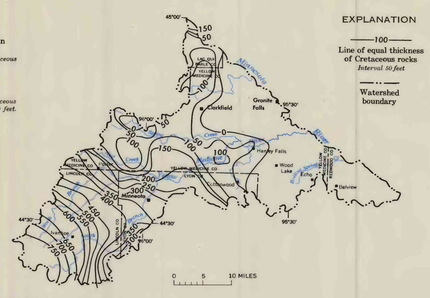

QUATERNARY GLACIAL DRIFT IS THE YOUNGEST MAJOR HYDROGEOLOGIC UNIT OF THE WATERSHED.—*It is present in the entire area and is composed mostly of clay till containing thin discontinuous deposits of sand and gravel. The drift forms the present topographic surface of the area.*

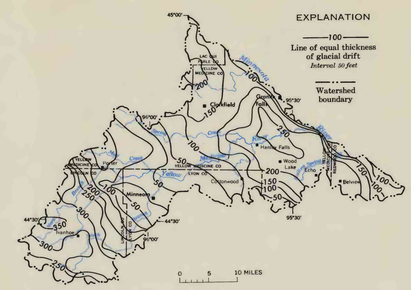



PRECAMBRIAN ROCKS YIELD WATER FROM WEATHERED OR FRACTURED ZONES AT THEIR SURFACE.—*This weathered surface is the lowermost water-bearing zone in the area. Relief of more than 300 feet results in a wide variation in the thicknesses of the younger overlying Cretaceous rocks and Quaternary drift.*

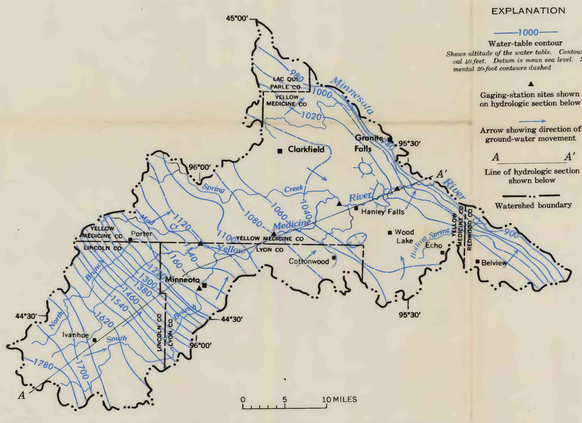



SANDSTONE BEDS IN THE CRETACEOUS ROCKS, PARTICULARLY NEAR THE BASE, LOCALLY PROVIDE ADEQUATE SUPPLIES FOR STOCK AND DOMESTIC NEEDS.—*The upper surface of the Cretaceous Section slopes eastward from altitudes of more than 1500 feet to less than 850 feet. The strata have a combined thickness of over 750 feet beneath the western end of the watershed.*



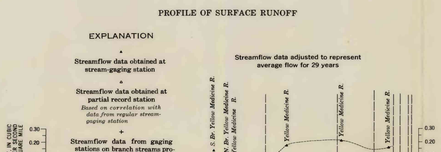




SAND AND GRAVEL DEPOSITS, BURIED AT DIFFERENT DEPTHS IN THE GLACIAL DRIFT, ARE THE MOST ACCESSIBLE AND WIDELY USED AQUIFERS OF THE WATERSHED.—*Thicker sections of the drift generally contain more sand and gravel deposits. The aquifers are generally thin and discontinuous but provide adequate water supplies for most uses.*

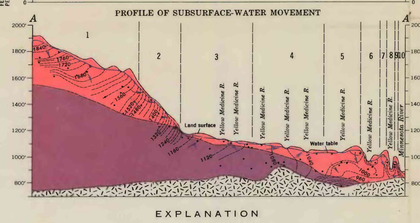



GROUND WATER MOVES GENERALLY NORTHEASTWARD, ULTIMATELY DISCHARGING TO THE MINNESOTA RIVER.—*The water table closely parallels the topography and is probably everywhere less than 100 feet below the land surface.*

PROFILE OF SURFACE RUNOFF

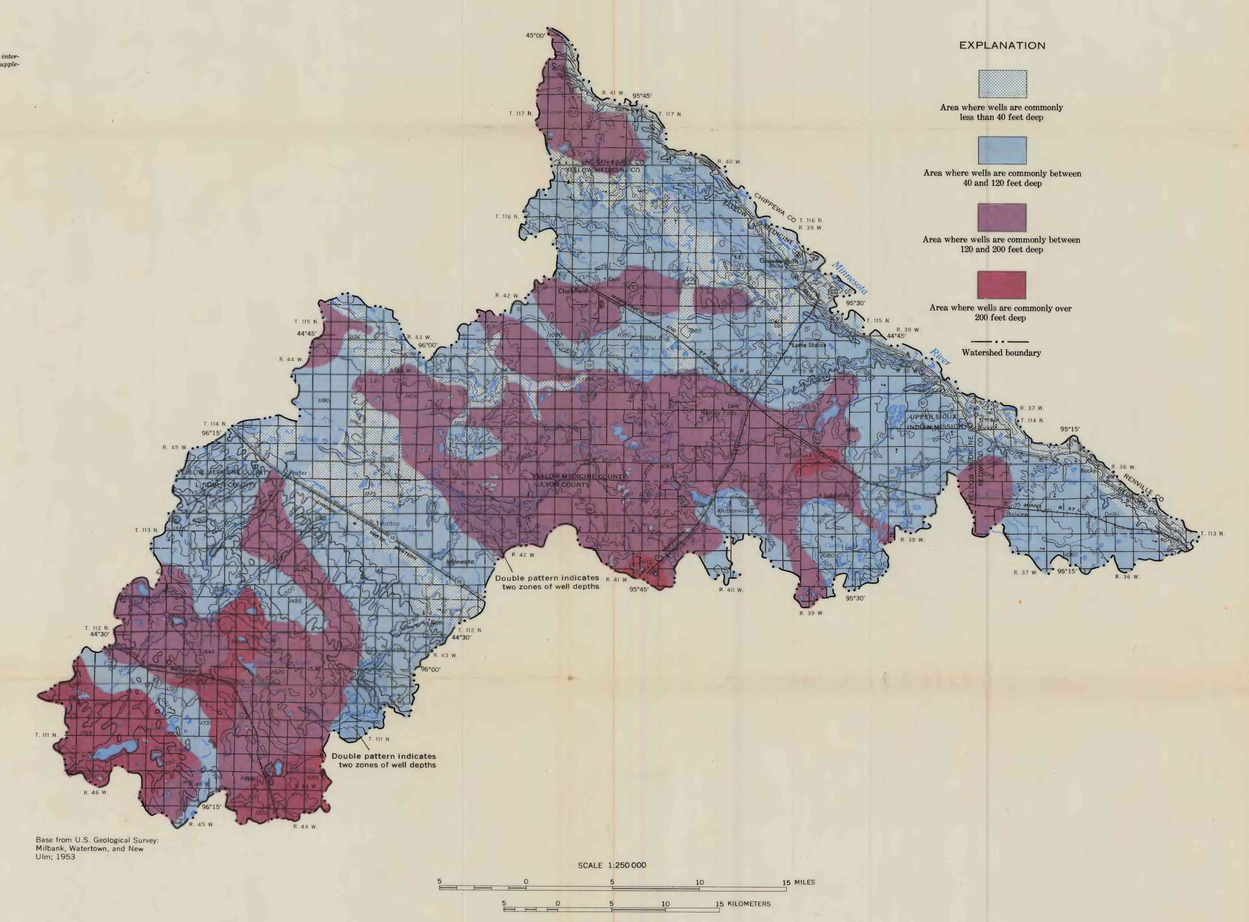



PROFILE OF SUBSURFACE-WATER MOVEMENT



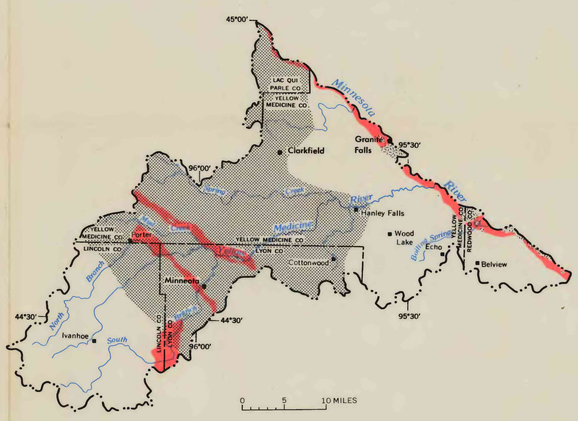


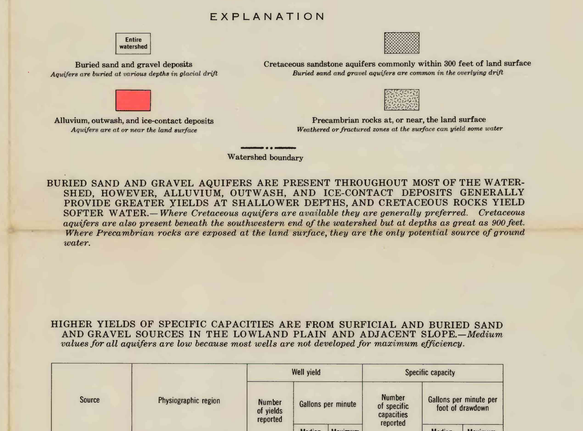
WATER MOVEMENT BETWEEN THE LAND SURFACE AND SUBSURFACE AND BETWEEN AQUIFERS IS CONTROLLED BY GEOLOGY AND TOPOGRAPHY.—*Alternating zones of ground-water recharge and discharge along the Yellow Medicine River are reflected in variations in surface-runoff patterns.*




MOST WATER SUPPLIES IN THE WATERSHED HAVE BEEN FOUND AT DEPTHS OF LESS THAN 200 FEET

*The well-depth map, based on data from over 1,400 wells, shows that most of the deeper wells are on the Upland Plain and that most of the shallower wells are on the Slope, Lowland Plain, and Minnesota River Flood Plain.*



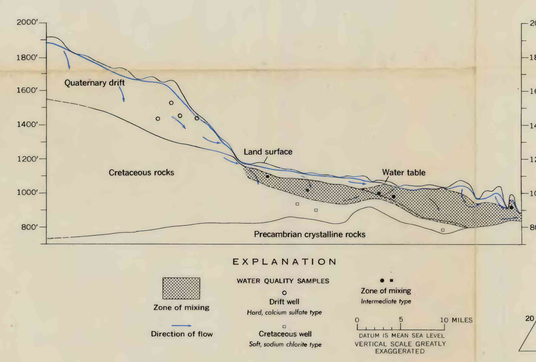



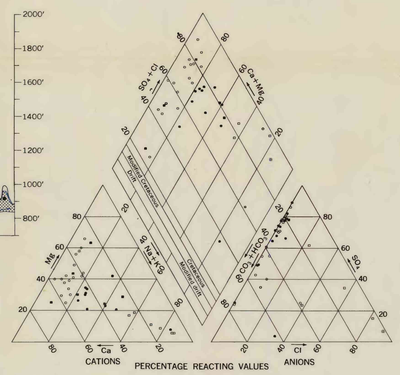

BURIED SAND AND GRAVEL AQUIFERS ARE PRESENT THROUGHOUT MOST OF THE WATERSHED, HOWEVER, ALLUVIUM, OUTWASH, AND ICE-CONTACT DEPOSITS GENERALLY PROVIDE GREATER YIELDS AT SHALLOWER DEPTHS, AND CRETACEOUS ROCKS YIELD SOFTER WATER.—*Where Cretaceous aquifers are available they are generally preferred. Cretaceous aquifers are also present beneath the southwestern end of the watershed but at depths as great as 900 feet. Where Precambrian rocks are exposed at the land surface, they are the only potential source of ground water.*

HIGHER YIELDS OF SPECIFIC CAPACITIES ARE FROM SURFICIAL AND BURIED SAND AND GRAVEL SOURCES IN THE LOWLAND PLAIN AND ADJACENT SLOPE.—*Median values for all aquifers are low because most wells are not developed for maximum efficiency.*

| Source | Physiographic region | Well yield: Number of yields reported | Well yield: Gallons per minute: Median | Well yield: Gallons per minute: Maximum | Specific capacity: Number of specific capacities reported | Specific capacity: Gallons per minute per foot of drawdown: Median | Specific capacity: Gallons per minute per foot of drawdown: Maximum |
|---|---|---|---|---|---|---|---|
| Alluvium, surficial outwash and ice-contact deposits | Minnesota River Flood Plain | 11 | 10 | 20 | 4 | 3 | 10 |
| | Lowland Plain | 148 | 5 | 120 | 36 | 2 | 120 |
| | Slope | 27 | 5 | 500 | 7 | Less than one | 144 |
| | Upland Plain | 12 | 6 | 40 | 4 | 4 | 20 |
| Buried sand and gravel deposits | Minnesota River Flood Plain | 3 | 8 | 30 | 2 | 22 | 30 |
| | Lowland Plain | 44 | 6 | 60 | 15 | 2 | 42 |
| | Slope | 17 | 7 | 30 | 3 | 1 | 4 |
| | Upland Plain | 36 | 5 | 90 | 5 | 3 | 10 |
| Cretaceous rocks | Minnesota River Flood Plain | 1 | 8 | 8 | 1 | 8 | 8 |
| | Lowland Plain | 135 | 4 | 300 | 16 | 2 | 12 |
| | Slope | 7 | 5 | 100 | — | — | — |
| | Upland Plain | 2 | 2 | 3 | — | — | — |
| Precambrian rocks | Minnesota River Flood Plain | 5 | 10 | 45 | 2 | 5 | 5 |
| | Lowland Plain | 44 | 6 | 60 | 12 | Less than one | 6 |
| | Slope | — | — | — | — | — | — |
| | Upland Plain | — | — | — | — | — | — |

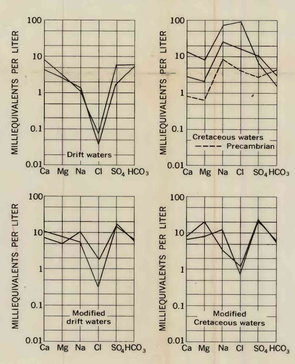
# QUALITY OF WATER



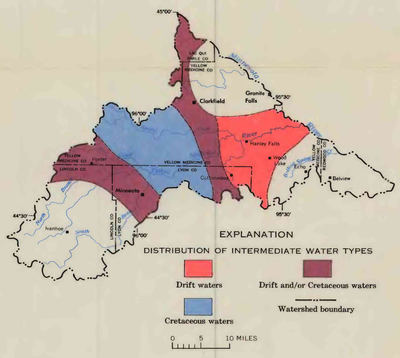




GROUND-WATER QUALITY IS RELATED TO THE SUBSURFACE FLOW SYSTEM

*Typical glacial drift waters contain high percentages of $Ca^{++}$, $Mg^{++}$, and $SO_4^{--}$ ions. Waters typical of the Cretaceous aquifers contain high percentages of $Na^+$, $K^+$, and $Cl^-$ ions. Intermediate water types, the result of inter-aquifer water movement, have compositions between these extremes.*




TWO MAIN WATER TYPES OCCUR IN THE WATERSHED; CALCIUM SULFATE TYPE DRIFT WATERS AND SODIUM CHLORIDE TYPE CRETACEOUS WATERS.—*Intermediate water qualities result when the main water types are modified by mixing.*




WATER OF INTERMEDIATE QUALITY MAY BE OBTAINED IN PARTICULAR AREAS OF THE WATERSHED FROM WELLS FINISHED WITHIN THE ZONE OF MIXING.—*The boundaries shown are approximately located and are based on random samples including 39 complete chemical analyses and more than 500 hardness analyses.*

GROUND-WATER QUALITY IS DEPENDENT UPON THE AQUIFER FROM WHICH THE WATER IS OBTAINED, AND UPON THE SUBSURFACE FLOW SYSTEM.—*Water from the surficial and buried aquifers in the calcareous glacial drift is generally of the calcium sulfate type; however, as the result of water movement between aquifers, water of intermediate quality may be obtained from either source. The water throughout the watershed is generally very hard, with high concentrations of dissolved solids; an exception being the sodium chloride water type, which is obtained from the sandstone aquifers and is usually softer. Concentrations of iron are high throughout most of the watershed, and boron concentrations exceed 1 mg/l in waters from, or affected by, the sandstone aquifers.*

| Aquifer | Water type | General quality |
|---|---|---|
| Alluvium, outwash, and ice-contact deposits (Quaternary) | Calcium sulfate—intermediate water quality where mixing with sodium chloride type water occurs. | Hardness varies between 100 and 1000 milligrams per liter, mg/l (approximately 6 to 60 grains per gallon). Softer waters are those of the intermediate type and those obtained in areas of ground-water recharge. Concentrations of dissolved solids range from 700 to 3500 mg/l (median-about 1200 mg/l). High concentrations of nitrate occur as a result of contamination from the surface. Iron concentration is generally less than 2 mg/l. Boron concentration is less than 1 mg/l except in waters of the intermediate type. |
| Buried sand and gravel (Quaternary) | Calcium sulfate—intermediate water quality where mixing with sodium chloride type water occurs. | Hardness varies between 500 and 1200 mg/l (approximately 29 to 70 grains per gallon). Softer waters are those of the intermediate type. Concentrations of dissolved solids range from 500 to 2200 mg/l (median-about 1500 mg/l). Iron concentration is generally higher, exceeding 20 mg/l locally. Boron concentration is less than 1 mg/l except in waters of the intermediate type. |
| Sandstone (Cretaceous) | Sodium chloride—intermediate water quality where mixing with calcium sulfate type water occurs. | Hardness varies between 50 and 1000 mg/l (approximately 3 to 60 grains per gallon). Harder waters are those of the intermediate type. Concentrations of dissolved solids range from 1000 to 6000 mg/l (median-about 2000 mg/l). Iron concentration is generally less than 5 mg/l. Boron concentration is greater than 1 mg/l. |
| Decomposed granite (Precambrian) | Water type similar to that in overlying aquifer. May be calcium sulfate, sodium chloride, or intermediate type. | Water quality is generally the same as that of water in the overlying aquifer. |

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# WATER RESOURCES OF THE YELLOW MEDICINE RIVER WATERSHED, SOUTHWESTERN MINNESOTA

By
R. P. Novitzki, W. A. Van Voast, and L. A. Jerabek

1969