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-286 (SHEET 2 OF 4)

GROUND WATER

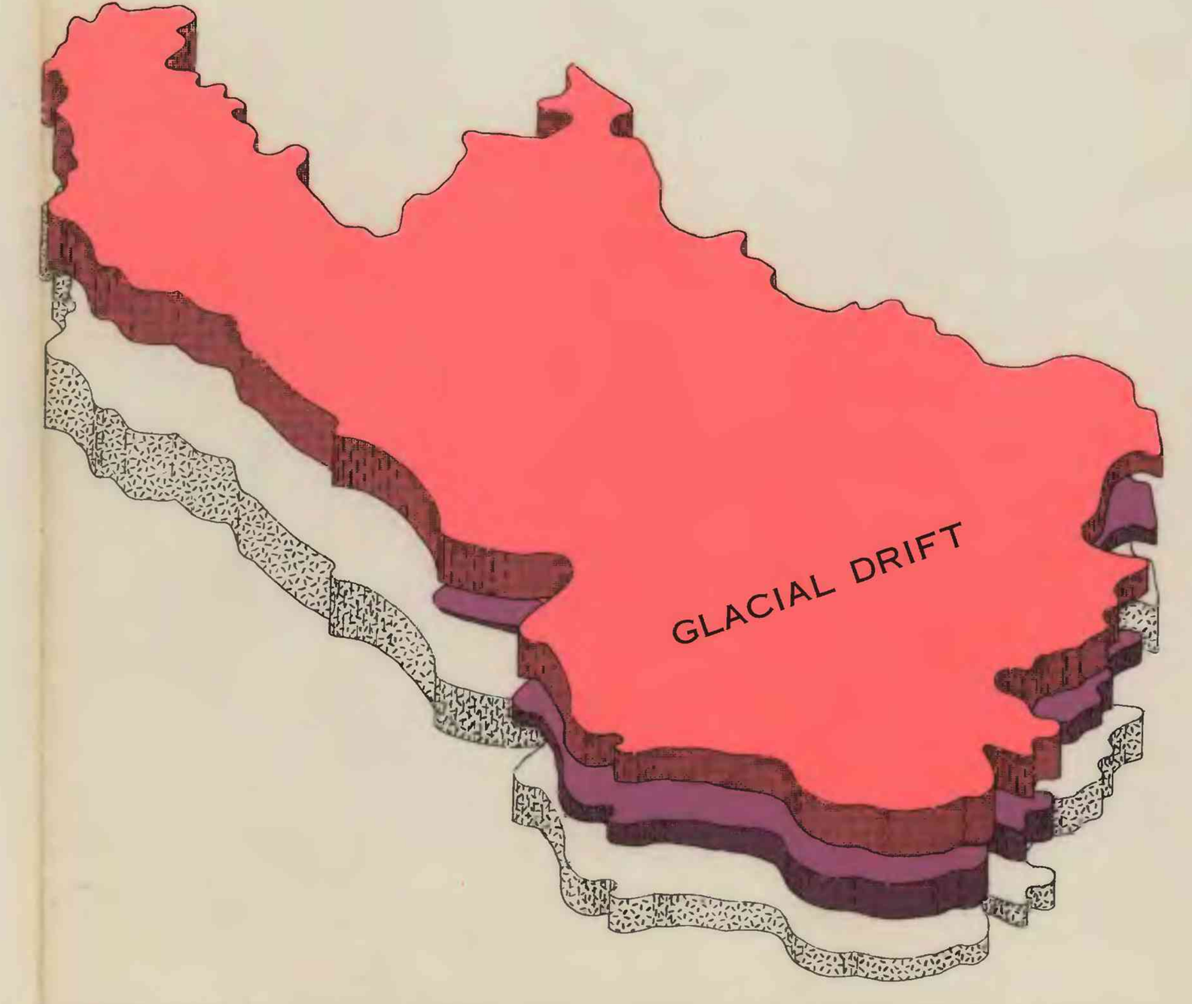
STORAGE, MOVEMENT, QUALITY, AND AVAILABILITY OF WATER WITHIN THE WATERSHED ARE RELATED TO THE GEOLOGY

THE OLDEST ROCKS IN THE WATERSHED ARE PRECAMBRIAN IN AGE

These hard crystalline rocks are granites and metamorphic rocks, having very low permeability except where their upper surface has been fractured or weathered.

OVERLYING THE PRECAMBRIAN ROCKS IN THE SOUTHERN PART OF THE WATERSHED ARE SHALES AND SANDSTONES OF CRETACEOUS AGE

The sandstones are moderately permeable, but are thin or absent over most of the area.



PLEISTOCENE GLACIAL DRIFT, INCLUDING TILL, CLAY, SILT, SAND AND GRAVEL COVERS THE ENTIRE WATERSHED

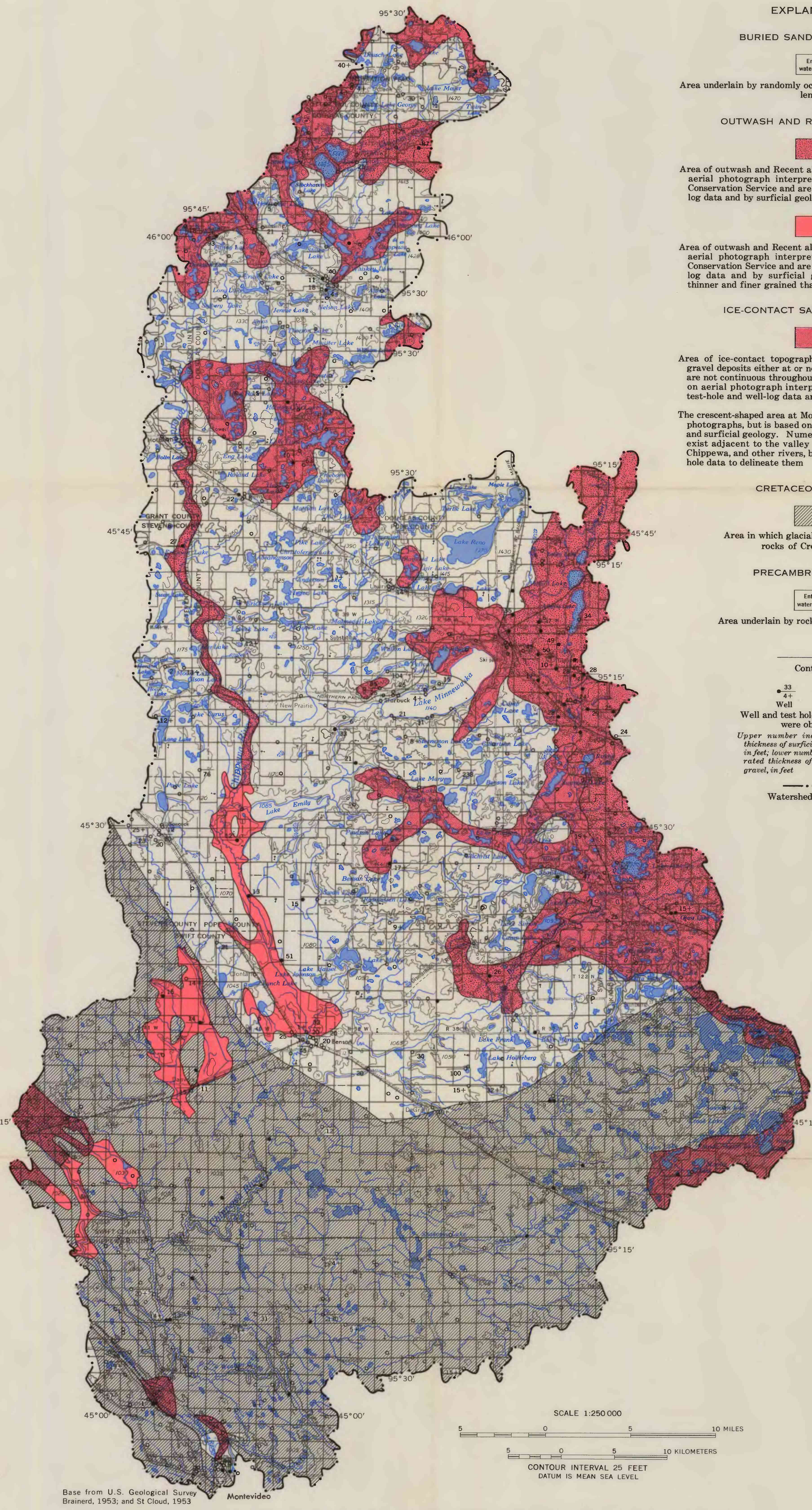
Sand and gravel are the only glacial deposits that are aquifers, and are grouped according to their mode of deposition.

Buried sand and gravel: Lenses or pods of sand and gravel deposited within the till by melt water as the ice melts in place; probably includes buried outwash and ice-contact sediments deposited during an earlier glaciatian. Some may be several miles in extent, but subsurface control is insufficient to outline them. These lenses or pods are contained within the till throughout the watershed.

Ice-contact sand and gravel: Pockets or hills of sand and gravel deposited against an active ice front. They may be overlain by thin glacial till and are located almost entirely within the moraine area.

The small area of sand and gravel near Montevideo was probably deposited between the valley wall and ice filling the valley.

Outwash and recent alluvium: Sand and gravel deposited by melt water beyond the ice front. High-velocity melt water within the central one-third of the Chippewa River valley carried off the fine-grained sediment leaving a permeable gravel. Where melt water spread over a flat area, the resultant deposits contain more fine-grained sediment. Elsewhere in the watershed, as around Benson, the surface is covered with fine sand too thin to be a potential water source.



EXPLANATION

BURIED SAND AND GRAVEL

Entire watershed

Area underlain by randomly occurring buried sand and gravel lenses

OUTWASH AND RECENT ALLUVIUM

Area of outwash and Recent alluvium. Outlines are based on aerial photograph interpretation and maps of the Soil Conservation Service and are modified by test-hole and well-log data and by surficial geology

Area of outwash and Recent alluvium. Outlines are based on aerial photograph interpretation and maps of the Soil Conservation Service and are modified by test-hole and well-log data and by surficial geology. These deposits are thinner and finer grained than the deposits described above

ICE-CONTACT SAND AND GRAVEL

Area of ice-contact topography likely to contain sand and gravel deposits either at or near the land surface. Deposits are not continuous throughout the area. Outlines are based on aerial photograph interpretation and are modified by test-hole and well-log data and by surficial geology

The crescent-shaped area at Montevideo was not outlined from photographs, but is based on data from Montevideo's wells and surficial geology. Numerous other deposits of this type exist adjacent to the valley walls of the Minnesota, lower Chippewa, and other rivers, but these deposits require test-hole data to delineate them

CRETACEOUS ROCKS

Area in which glacial drift is underlain by rocks of Cretaceous age

PRECAMBRIAN ROCKS

Entire watershed

Area underlain by rocks of Precambrian age

Contact

33 / 4+ Well — 85 / 25 Test hole

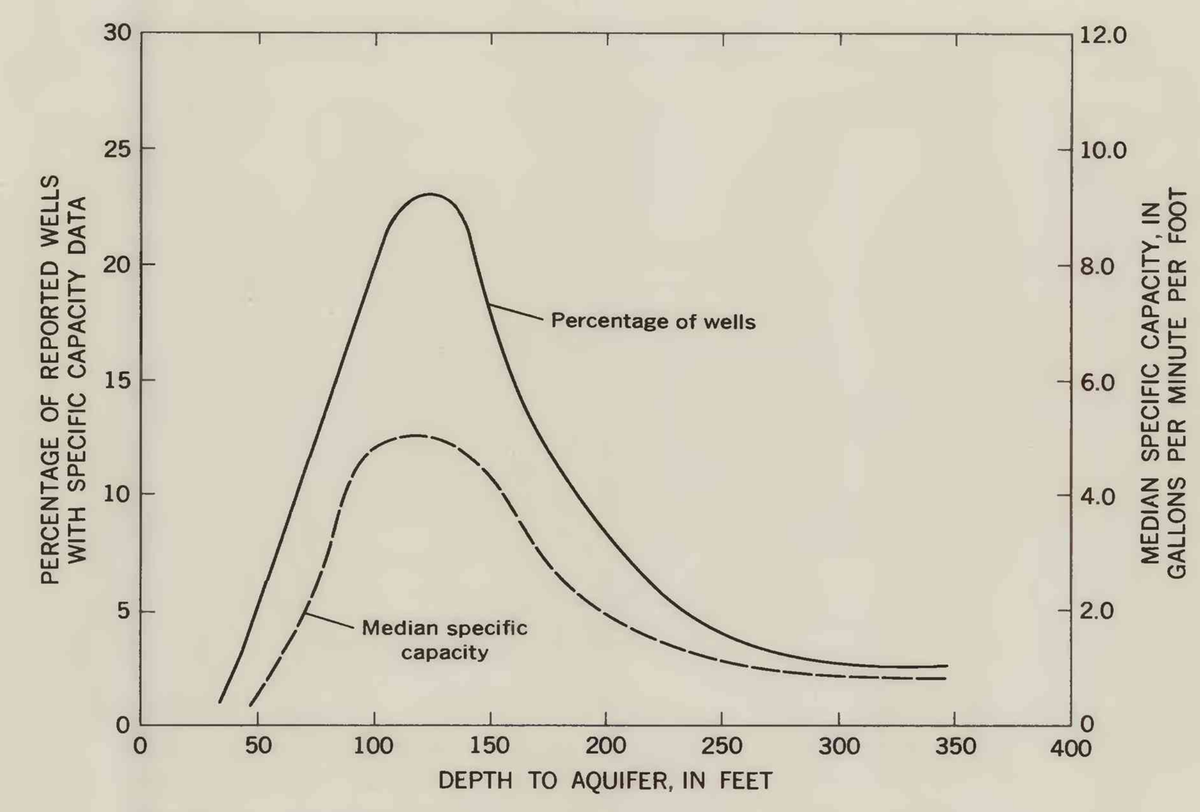
Well and test hole for which data were obtained

Upper number indicates saturated thickness of surficial sand and gravel, in feet; lower number indicates saturated thickness of buried sand and gravel, in feet

Watershed boundary

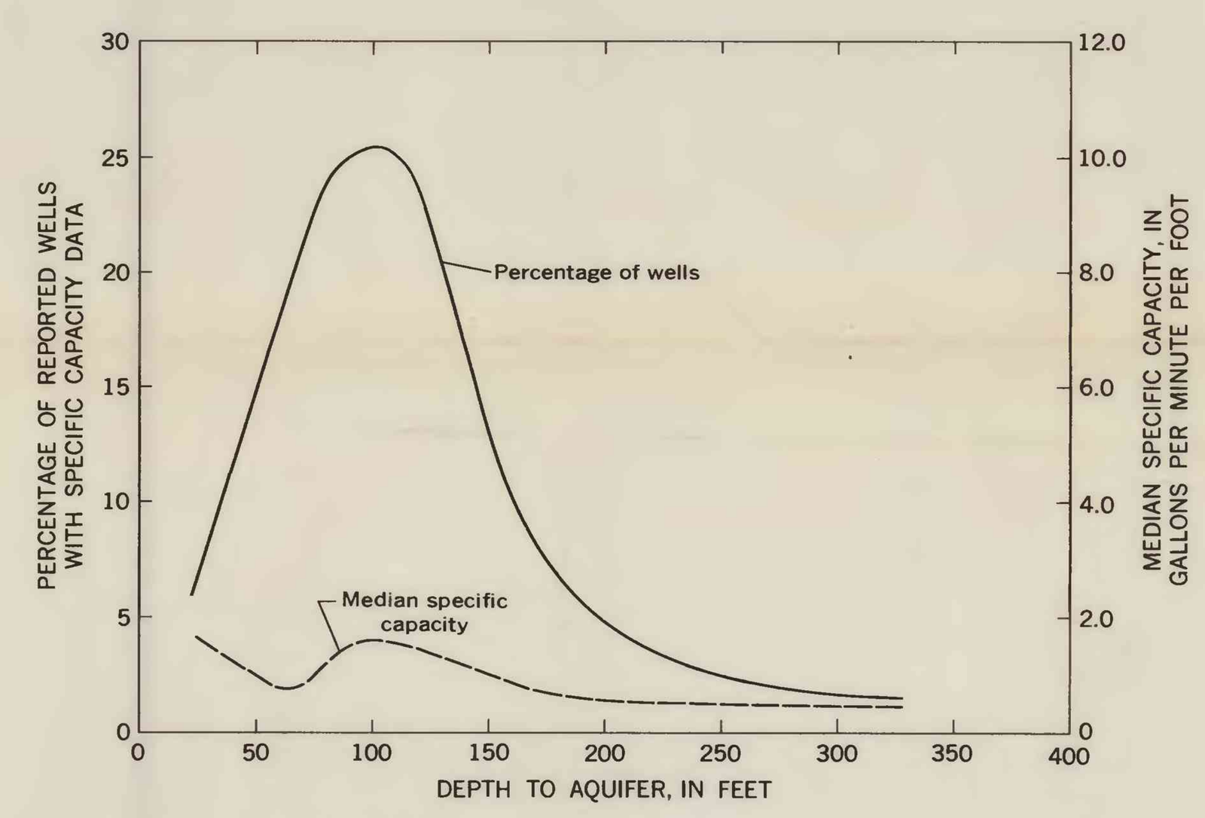
GROUND WATER IS AVAILABLE ALMOST ANYWHERE WITHIN THE WATERSHED, PRINCIPALLY FROM GLACIAL DRIFT, BUT TO A LIMITED EXTENT FROM CRETACEOUS AND PRECAMBRIAN ROCKS

Buried lenses of sand and gravel yield small quantities of water throughout the entire watershed, and locally yield large supplies. Outwash and ice-contact sand and gravel commonly yield greater quantities and receive more rapid recharge than buried sand and gravel. Cretaceous and Precambrian rocks have the lowest rate of recharge and yield little water. Cretaceous rocks are present only in the southern part of the watershed.



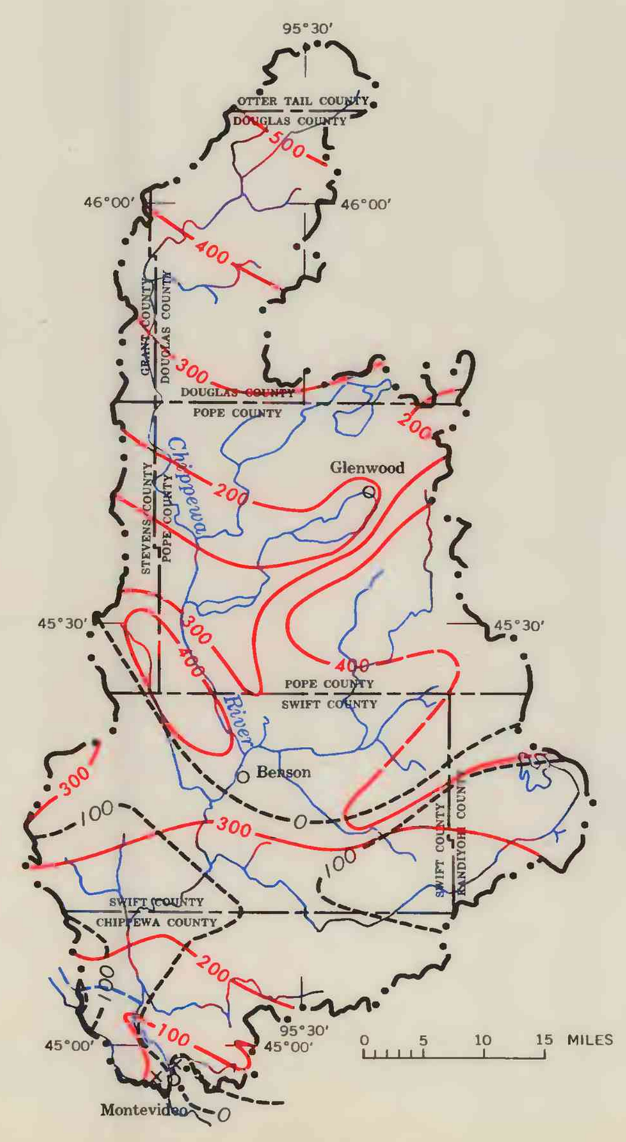
IN THE MORAINE AREA, MOST WELLS ARE FINISHED AT DEPTHS BETWEEN 75 AND 175 FEET

Also, the highest specific capacities in the area are for wells in this depth range.



WELLS IN THE TILL PLAIN AREA ARE, ON THE AVERAGE, SHALLOWER THAN THOSE IN THE MORAINE AREA

Most wells are between 50 and 150 feet deep; however, wells having the highest specific capacities are not concentrated in this depth range.



EXPLANATION

Line of equal thickness of glacial drift
Dashed where approximately located. Interval 100 feet

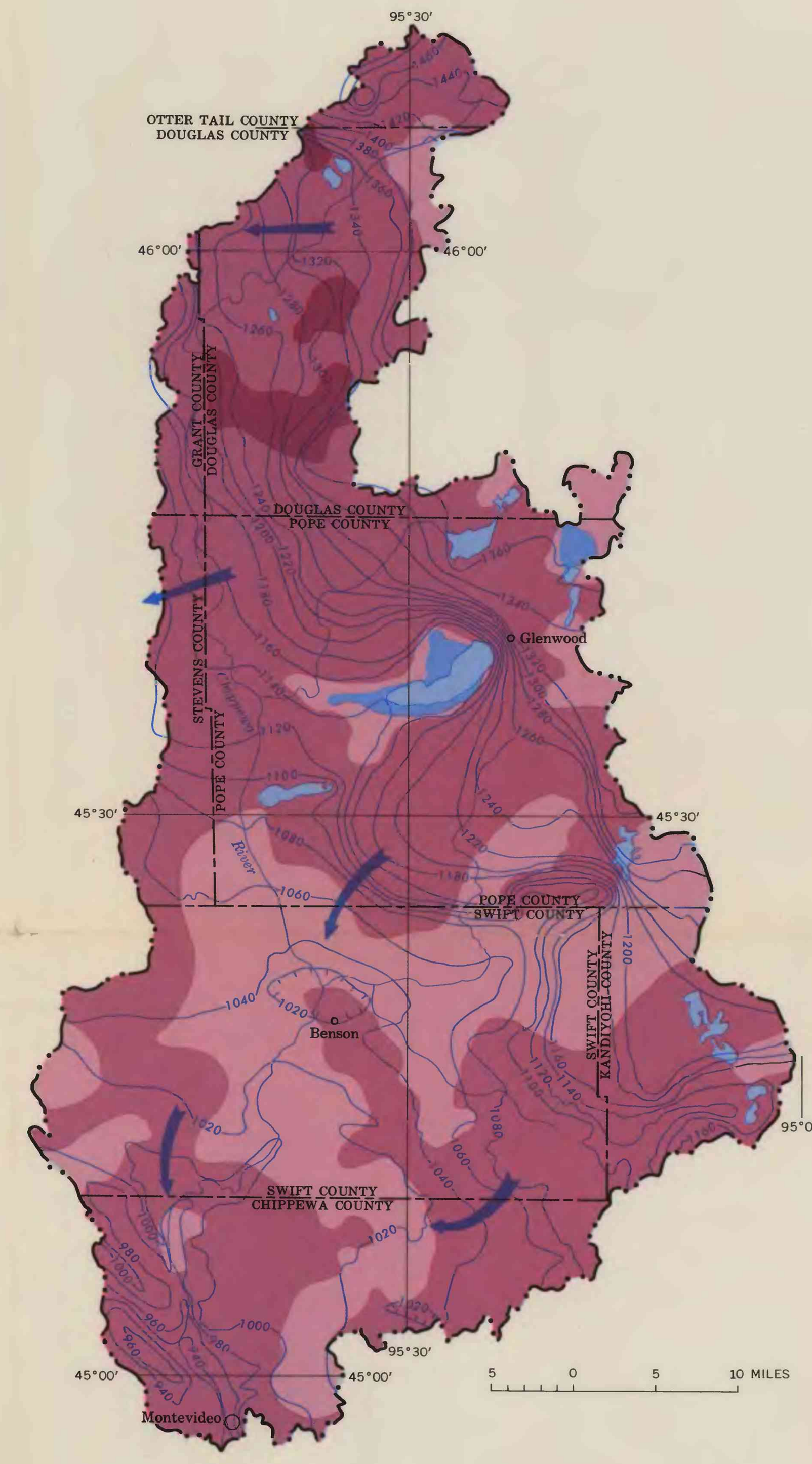
Line of equal thickness of Cretaceous rocks
Interval 100 feet

× Outcrop of bedrock

Watershed boundary

THE GLACIAL DRIFT IS SEVERAL HUNDRED FEET THICK IN MOST OF THE WATERSHED, BUT IS ABSENT AT BEDROCK OUTCROPS ALONG THE CHIPPEWA AND MINNESOTA RIVERS

Thicker sections of drift commonly contain more sand and gravel lenses. Cretaceous rocks are present in the southern part of the watershed and are less than 200 feet thick.



EXPLANATION

Depth to water, in feet below land surface

Above land surface (flowing well zone)

0-20

20-100

over 100

Piezometric contour
Shows altitude to which water will rise in a well drilled in glacial drift. Contour interval 20 feet. Datum is mean sea level

Direction of ground-water movement in the glacial drift

Watershed boundary

GROUND-WATER MOVEMENT WITHIN THE GLACIAL DRIFT IS MAINLY ACROSS THE WATERSHED FROM NORTHEAST TO SOUTHWEST AND DEPTH TO WATER IS QUITE VARIABLE

The ground-water divides do not follow the watershed boundaries. In the two shallow zones, water can be withdrawn by a centrifugal pump, but in some areas in the moraine, it is over 100 feet below land surface. Evapotranspiration is high where the piezometric surface is at or near land surface.

THE HIGHEST YIELDS AND SPECIFIC CAPACITIES ARE FOR WELLS DEVELOPED IN THE QUATERNARY AQUIFERS

In contrast wells in Cretaceous and Precambrian rocks have low yields and specific capacities. In all cases the development of maximum yield requires test drilling and careful well construction.

Geologic age	Aquifer	Well yield				Specific capacity			Aquifer tests			Water yielding potential
		Number of wells	Average depth of wells, in feet	Maximum (Gallons per minute)	Average (Gallons per minute)	Number of wells	Maximum (Gallons per minute per foot of drawdown)	Average (Gallons per minute per foot of drawdown)	Number of tests	Average transmissibility, in gallons per day per foot	Average coefficient of storage	
Quaternary	Outwash and Recent alluvium	34	49	600	112	23	75	13.7	1	10,000	0.002	Good, although limited in areal extent. Rapid recharge rate means that it is easily contaminated by surface water.
	Ice-contact sand and gravel	28	82	450	51	8	29	13.0	3	25,000	.0004	Good. Artesian conditions are common. Thicker but less extensive areally than the other two types. Where these deposits form hills, the upper unsaturated section is thick.
	Buried sand and gravel	312	131	1,000	31	160	63	4.0	3	15,000	.001	Good. Buried lenses are present throughout the entire watershed. Recharge rate slower than the above two.
Cretaceous	Shale, sand, and sandstone	12	250	100	28	7	8	1.4	-	-	-	Poor, although some good wells can be made at relatively shallow depths in the southwestern part of the watershed.
Precambrian	Crystalline rocks	2	298	50	28	1	.4	.4	-	-	-	Poor. Some small farm wells can be developed in the southwestern part of the watershed.

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WATER RESOURCES OF THE CHIPPEWA RIVER WATERSHED, WEST-CENTRAL MINNESOTA

By
R. D. Cotter, L. E. Bidwell, W. A. VanVoast, and R. P. Novitzki
1968