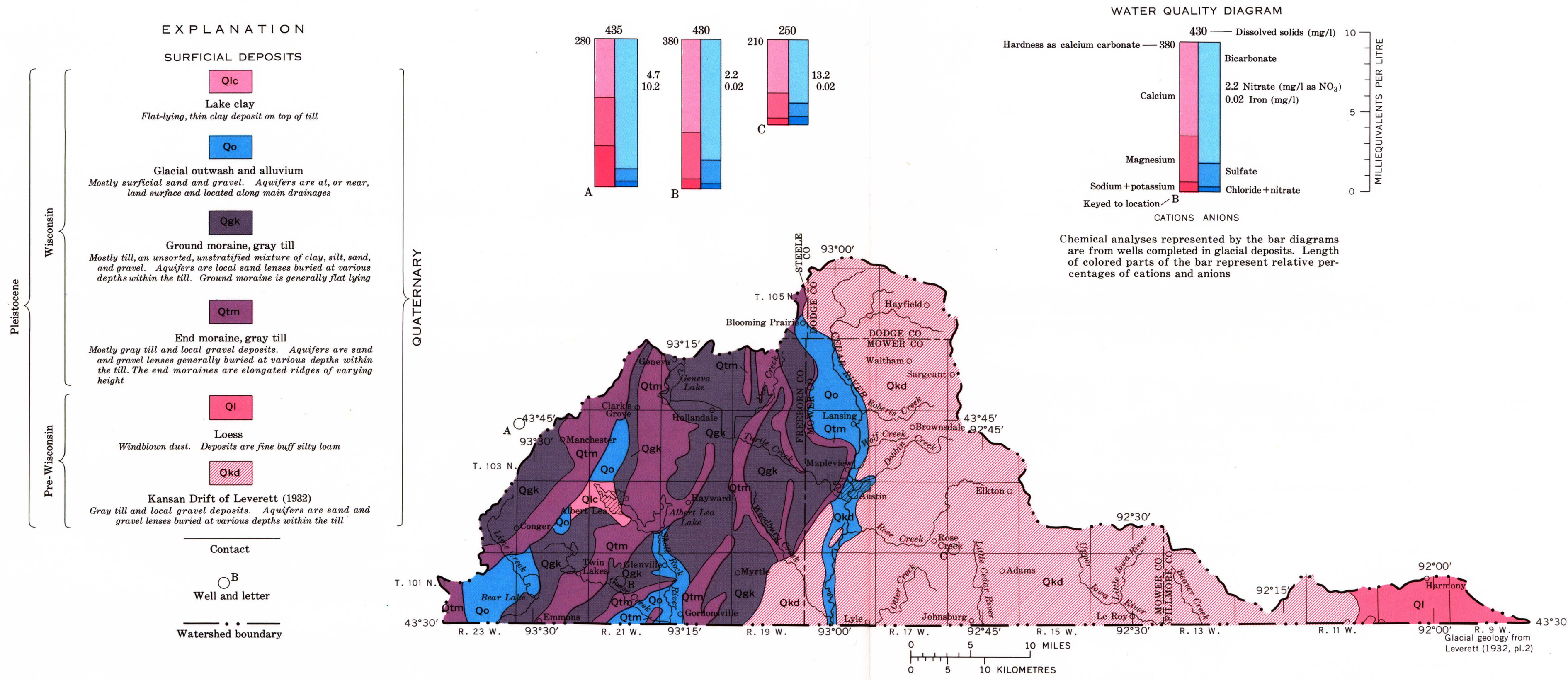
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

GROUND WATER

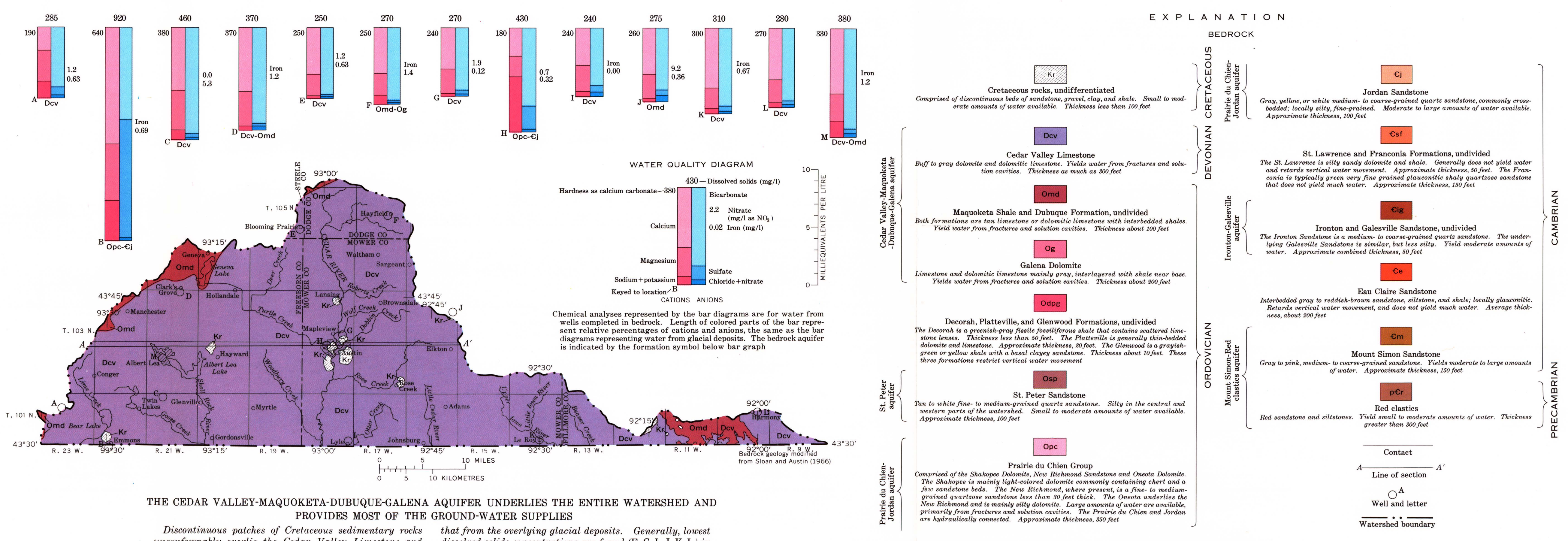
The ground-water system involves the interrelationships of water with the thickness, hydrologic characteristics, and areal extent of the geologic units. The system is continuously recharged in some places and discharged in others and is always tending to adjust, sometimes in minor degrees, to climatic variations and activities of man.



GLACIAL DEPOSITS UNDERLIE THE ENTIRE WATERSHED, BUT OF THOSE (284) WELLS FOR WHICH RECORDS ARE AVAILABLE, ONLY 6 PERCENT TAP GLACIAL AQUIFERS

The terminal moraine of Wisconsin Glaciation forms a north-south boundary across the watershed called the Bemis moraine. East of this moraine pre-Wisconsin Kansan Drift of Leverett (1932) underlies most of the surface. In the area of Wisconsin drift, about 8 percent of the wells tap glacial deposits. In the area of pre-Wisconsin Drift, less than 3 percent tap thin glacial deposits.

Water from glacial aquifers is of the calcium bicarbonate type and is very hard. The one water sample (C) from pre-Wisconsin Drift shows less dissolved-solids concentration than samples (A, just outside the watershed, B) from Wisconsin Drift. Base flow samples of streams (see surface-water sheet) also show less dissolved-solids concentration at the east end of the watershed. This may be due to leaching of the older drift, so that few soluble minerals remain.

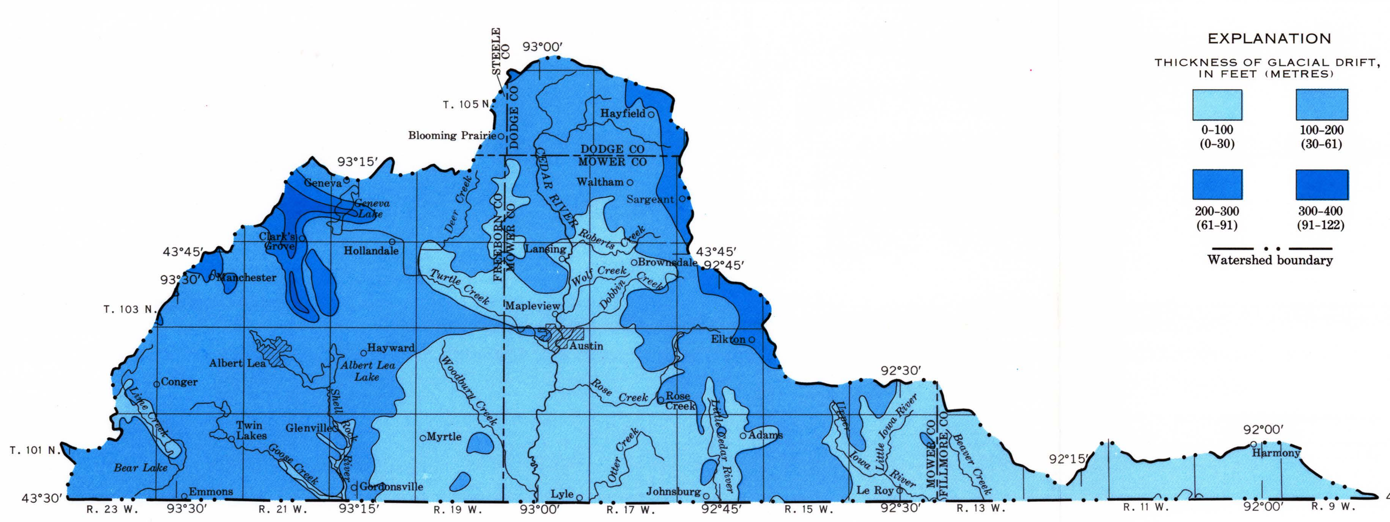


THE CEDAR VALLEY-MAQUOKETA-DUBUQUE-GALENA AQUIFER UNDERLIES THE ENTIRE WATERSHED AND PROVIDES MOST OF THE GROUND-WATER SUPPLIES

Discontinuous patches of Cretaceous sedimentary rocks unconformably overlie the Cedar Valley Limestone and Maquoketa Shale and locally provide water supplies from sandstone. The areal distribution of Cretaceous rocks is poorly known, and only major known areas are shown on the bedrock map. Few wells tap formations below the Cedar Valley-Maquoketa-Dubuque-Galena aquifer. Very fine sand often causes maintenance problems in wells completed in the St. Peter Sandstone. However, large supplies are available from the Prairie du Chien-Jordan, Ironton-Galesville, and Mount Simon-Red clastics aquifers, which underlie the entire watershed. The deeper aquifers (Mount Simon-Red clastics) may contain highly mineralized water.

Water from the shallow bedrock (Cedar Valley-Maquoketa-Dubuque-Galena) aquifer is similar in chemical quality to that from the overlying glacial deposits. Generally, lowest dissolved-solids concentrations are found (E, G, I, J, K, L) in the central and eastern parts of the watershed. Water from shallow bedrock (C, D, M) in the western part contains higher dissolved-solids concentrations than that in the central and the eastern parts. Samples A and J (outside the watershed) show water having low-dissolved-solids concentrations in shallow bedrock overlain by sand and gravel. Sample J also shows nitrate contamination in shallow bedrock. Dominant ions are calcium, magnesium, and bicarbonate.

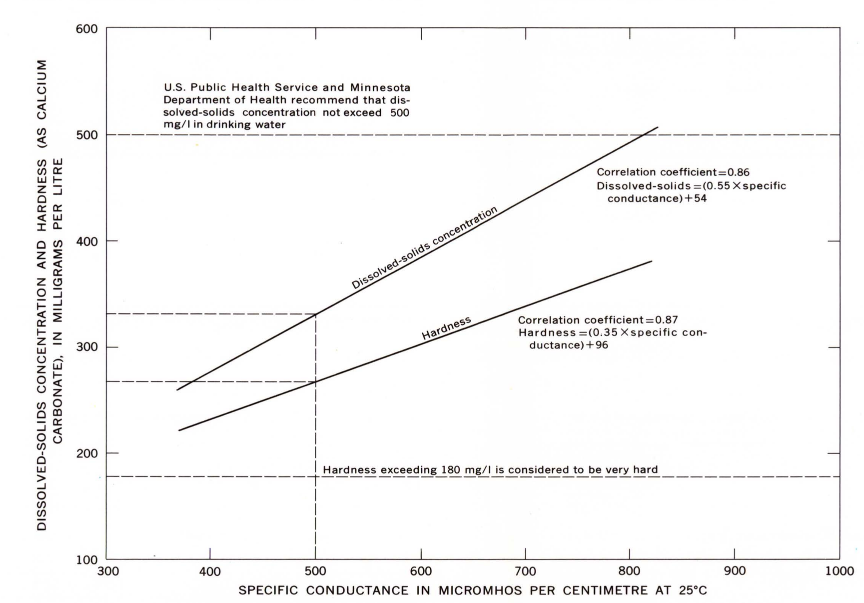
Water from the Prairie du Chien-Jordan aquifer at Emmons (B) and Austin (H) shows a higher percentage of sodium and sulfate and higher dissolved-solids concentrations than water from shallow bedrock and glacial deposits.



DRIFT THICKNESS, IN THE AREA OF PRE-WISCONSIN DRIFT, IS GENERALLY LESS THAN 100 FEET (30 METRES) AND, IN THE AREA OF WISCONSIN DRIFT, RANGES FROM LESS THAN 100 FEET (30 METRES) TO MORE THAN 300 FEET (91 METRES)

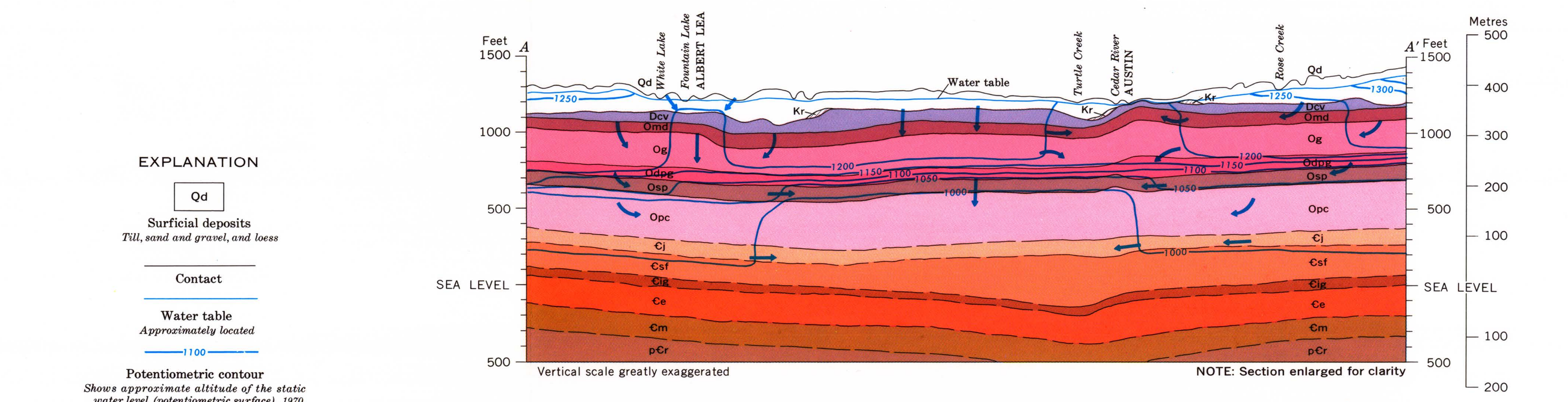
In areas of thick drift, saturated sand lenses were relied upon in the past for water supplies, but most new wells tap underlying bedrock aquifers. Carbonate bedrock, directly underlying areas of thin pre-Wisconsin Drift, is susceptible to formation of sinkholes. Water in the shallow bedrock aquifers is susceptible to contamination by seepage from the land surface. Drift is thick enough in the area of Wisconsin Drift to seal the bedrock aquifers effectively from direct surface contamination.

Glacial thickness is not always the same as unconsolidated thickness. Some unconsolidated sediments of probable Cretaceous age are mapped with bedrock, although their hydrologic and engineering properties relate more closely to the properties of glacial deposits.



DISSOLVED-SOLIDS CONCENTRATION AND HARDNESS OF GROUND WATER MAY BE ESTIMATED FROM MEASUREMENTS OF SPECIFIC CONDUCTANCE.

—Generally ground water in the Cedar River watershed with a specific conductance of 500 mhos/cm at 25° C (micromhos per centimetre at 25° Celsius) contains about 330 mg/l dissolved solids and has a hardness of about 270 mg/l.



SURFICIAL DEPOSITS AND SEDIMENTARY BEDROCK FORM A SINGLE INTERCONNECTED HYDROLOGIC SYSTEM IN WHICH WATER MOVES VERTICALLY AND HORIZONTALLY IN RESPONSE TO DIFFERENCES IN HYDRAULIC POTENTIAL

The system is recharged primarily by infiltrating precipitation in upland areas. Regionally, water moves generally downward through glacial drift at the water table and then laterally through bedrock toward discharge areas. The drift is largely composed of till of low permeability, so that water moves downward slowly. The limestone and dolomite underlying the drift are fractured and have solution channels of high permeability so that horizontal water movement is relatively rapid. Water from this upper limestone-dolomite aquifer discharges mainly to major drainageways—the Cedar, Shell Rock, and Upper Iowa Rivers. Some water also percolates downward from it into the underlying Prairie du Chien-Jordan aquifer, whose hydraulic potential (static water level) is about 200 feet (60 m) less than that of the upper aquifer.

The arrows on hydrogeologic section A-A′ show the general direction of ground-water movement—from areas of high to areas of low hydraulic potential. The potentiometric contours indicate the altitude to which water will rise in a well completed at the depth at which the contour is drawn. For example, at Austin, the static water level in a well open only to the Galena Dolomite would be at an altitude of about 1,200 feet (366 m). The water level in a well, at the same location, open only to the Jordan Sandstone would be at an altitude of about 1,000 feet (305 m).

Along the section, water in the upper limestone-dolomite aquifer moves toward Austin, where it discharges to the Cedar River and is withdrawn by pumping wells. Another part moves toward Albert Lea, where much ground water is pumped. Water in the Prairie du Chien-Jordan aquifer moves toward the center of the section and southward away from the line of section (toward the reader) into Iowa. (Location of the line of section A-A′ is shown on the bedrock geology map and on the Jordan Sandstone structure map.)

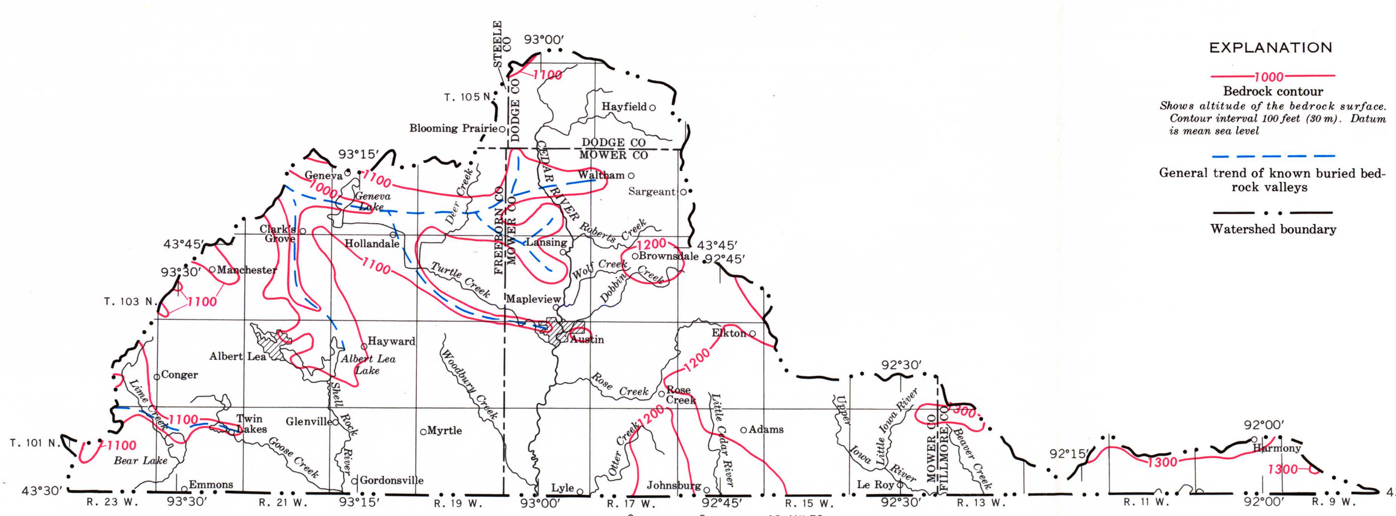
AQUIFER AND WATER-QUALITY DATA FROM MUNICIPAL RECORDS

Aquifer	Towns using aquifer	Municipal wells tapping aquifer	Well depth (feet)		Thickness open to wells (feet)		Normal pumping rate (gal/min)		Specific capacity of wells [(gal/min)/ft]		Iron (mg/l)		Sulfate (mg/l)		Chloride (mg/l)		Dissolved solids, residue (mg/l)		Hardness as $CaCO_3$ (mg/l)	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median
Glacial sand	1	1	179	—	60	—	100	—	10	—	.22	—	8.8	—	1.0	—	—	—	250	—
Cedar Valley	10	12	171–350	229	23–127	75	60–500	221	2.1–83	36	<.02–2.0	.7	2.4–25	9.5	<1–12	2.0	240–360	300	180–370	255
Cedar Valley-Maquoketa-Dubuque	7	9	250–423	331	81–273	193	50–280	141	1.7–55	21	.39–3.1	.8	<5–44	6.2	.8–7.7	1.9	240–340	315	200–400	295
Cedar Valley to Galena	4	7	320–720	459	175–470	314	110–1500	546	6.0–89	55	.14–1.6	1.1	5.5–35	14	<1–3.0	2.0	250–420	315	200–370	265
Maquoketa-Dubuque	1	3	60–132	101	12–41	26	800–1500	1270	60–188	124	.03	—	14–18	16	1.0–1.7	1.4	—	—	230–240	235
Maquoketa-Dubuque-Galena	3	3	340–575	449	209–435	285	150–1000	460	7.2–125	60	.03–1.4	1.0	<1–19	<5	<.5–.8	.6	290–300	295	230–260	250
St. Peter	1	1	558	—	53	—	600	—	6.7	—	.14	—	33	—	1.2	—	—	—	230	—
Prairie du Chien-Jordan	4	7	748–1167	994	315–367	342	250–1500	642	14–75	39	<.02–1.5	.7	1.3–340	15	.5–8.8	.7	830	—	250–400	300

MUNICIPAL WATER SUPPLIES RELY MAINLY ON THE CEDAR VALLEY-MAQUOKETA-DUBUQUE-GALENA AQUIFER

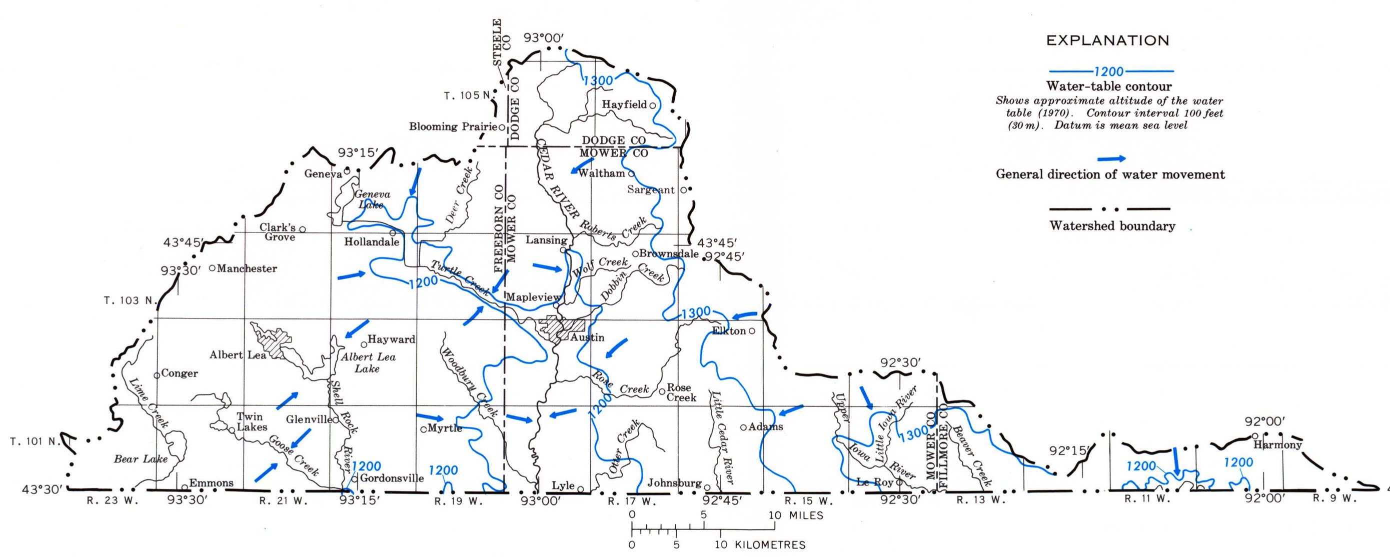
Most towns have wells that tap part of this aquifer, as indicated in the table. The formations that make up the aquifer are hydraulically interconnected; although, in some places a slight change occurs in hydrostatic head with depth. The water contains dissolved-solids concentrations ranging from 240 to 420 mg/l, which indicates water of good chemical quality that is very hard.

Specific capacity of wells may be defined as yield, in gallons per minute, per foot of drawdown of water level in the well caused by pumping.



THE SUB-GLACIAL BEDROCK SURFACE IS HIGH IN THE EAST END OF THE WATERSHED, INDICATING PRE-GLACIAL DRAINAGE TOWARD THE WEST

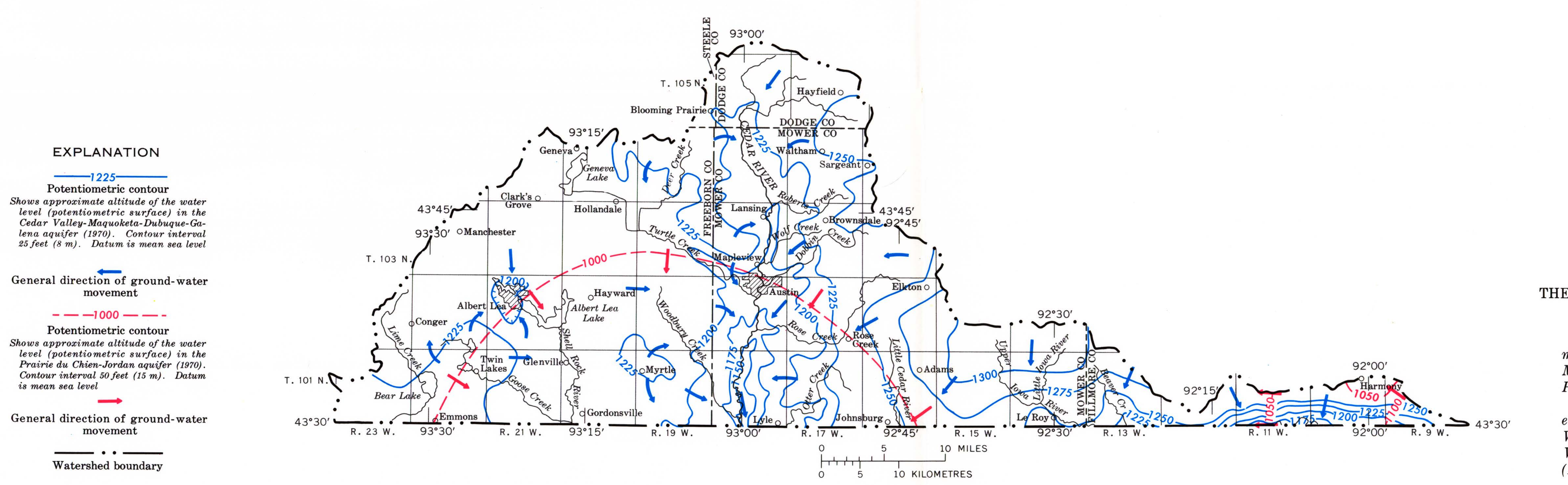
Drainage patterns were altered significantly by glaciation, principally in the western part of the watershed. Bedrock valleys were filled with sediments (including sand and gravel) and are now buried under a blanket of drift. Exploration for saturated sand and gravel deposits in the buried bedrock valleys may reveal locally valuable aquifers.



WATER MOVEMENT IN SURFICIAL DEPOSITS IS TOWARD LOCAL DRAINAGE AND REGIONALLY TOWARD THE CEDAR RIVER

The general direction of water movement is indicated by arrows on the water-table map and is at right angles to the contours, from upland areas to lowland areas. The water-table divide approximately underlies the watershed boundary.

The water table in the western part of the watershed is generally higher than the hydraulic potential in the underlying bedrock aquifer. Locally along stream valleys the bedrock potential is greater and water moves upward from bedrock to discharge into streams.

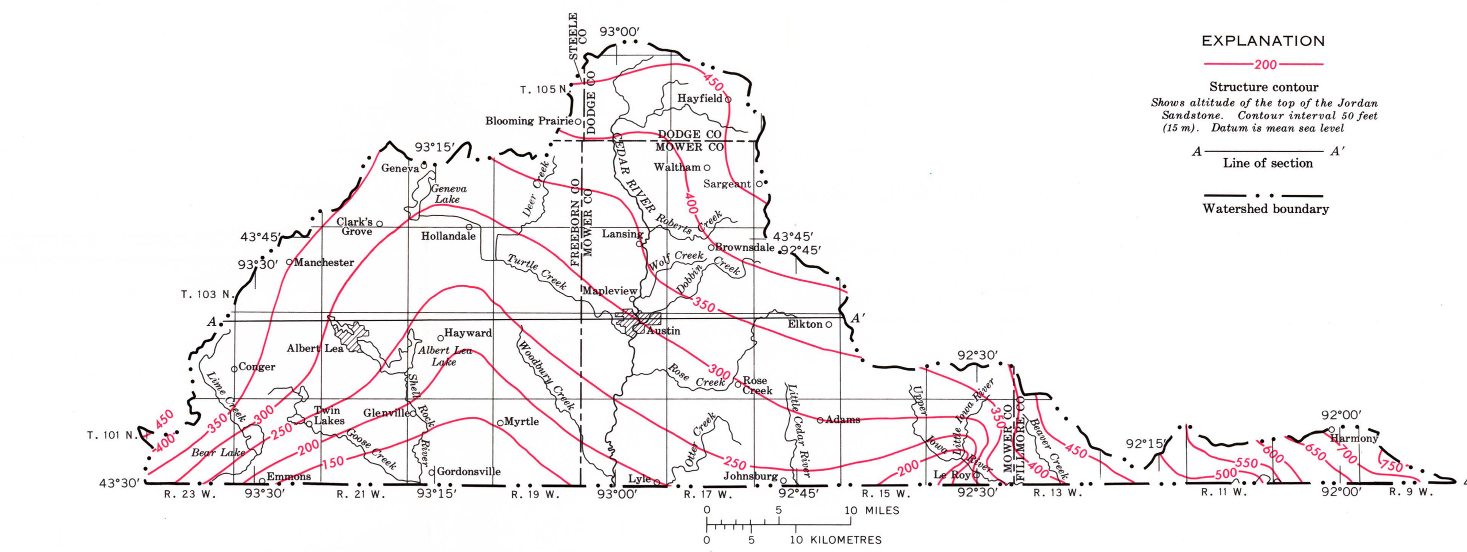


THE REGIONAL DIRECTION OF GROUND-WATER MOVEMENT IS SOUTHWARD INTO IOWA IN BOTH THE CEDAR VALLEY-MAQUOKETA-DUBUQUE-GALENA AQUIFER AND THE PRAIRIE DU CHIEN-JORDAN AQUIFER

Water moves from areas of high to areas of low potentiometric head, as indicated by blue arrows for the Cedar Valley-Maquoketa-Dubuque-Galena aquifer and red arrows for the Prairie du Chien-Jordan aquifer.

Water levels in the Cedar Valley-Galena aquifer are generally coincident with the water table in the area of pre-Wisconsin Drift in the eastern part of the watershed. In the Wisconsin Drift area the water table is as much as 50 feet (15 m) above the potentiometric surface in the Cedar Valley-Galena aquifer. The potentiometric head in the Prairie du Chien-Jordan aquifer is about 200 feet (60 m) less than in the Cedar Valley-Galena aquifer, indicating downward movement of water.

The depression contour around Albert Lea is caused by pumping municipal and industrial wells, which probably induces recharge into the shallow bedrock aquifer from Albert Lea Lake. Water levels in wells in Austin also have declined in recent years (1971).



THE REGIONAL DIP OF THE JORDAN SANDSTONE IS ABOUT 12 FEET PER MILE (2.3 METRES PER KILOMETRE) TO THE SOUTH

Contours drawn on the top of the Jordan Sandstone in southeastern Minnesota indicate that the watershed is centered on a structural basin, which dips south into Iowa. The contours are approximately located because of sparse data. Comparison of the Jordan structure map with the topography map (see sheet 1, introduction) shows that the top of the Jordan Sandstone ranges from 600 to 1,100 feet (183 to 335 m) in depth below land surface.

Interior—Geological Survey, Reston, Virginia—1975—

WATER RESOURCES OF THE CEDAR RIVER WATERSHED, SOUTHEASTERN MINNESOTA

By
D. F. Farrell, W. L. Broussard, H.W. Anderson, Jr., and M. F. Hult
1975