GROUND WATER RESOURCES

Iowa County

Open File Report 86-48 WRD

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GROUNDWATER RESOURCES OF IOWA COUNTY

Introduction

Virtually all of the residents in Iowa County rely on groundwater as the source of their drinking water. Consumption of water in the county averages five-and-a-half million gallons of water per day, Table 1. Groundwater accounts for 81 percent of all consumption within the county, or 1.6 billion gallons per year. For comparison, this amount would provide each resident with 292 gallons of groundwater a day during the year.

The users of groundwater in the county draw their supplies from several geologic sources (Table 1). Several factors must be considered in determining the availability and adequacy of a supply source:

distribution--having the water where it is needed,

accessibility--affects costs for drilling and pumping,

yield--magnitude of supply,

quality--determines purpose of water use, and/or affects costs of water treatment.

In terms of these factors, the availability of groundwater in Iowa County is usually limited to some degree. The most common limitation is poor water quality, that is, highly mineralized groundwater. Secondary limitations are generally related to insufficient yields, limited accessibility due to the depths to adequate sources, and distribution of aquifers.

Projected growth trends through the year 2000 indicate a 6 percent increase over the 1980 population. This is roughly equivalent to adding another town the size of North English to the county. Groundwater resources will most probably be relied upon to fill the increasing demand for water throughout Iowa County.

Occurrence of groundwater in Iowa County

The occurrence of groundwater is influenced by geology--the position and thickness of the geologic units, their ability to store and transmit water, and their physical and chemical make-up. Geologic units that store and transmit water and yield appreciable amounts to wells are called aquifers. In Iowa, aquifers are composed of unconsolidated sand and gravel, porous sandstone, and porous or fractured limestone and dolostone. Other units such as clay, silt, shale, siltstone, mudstone, and impermeable carbonates yield little or no water to wells. These units are called aquicludes or aquitards and commonly separate one aquifer from another.

In Iowa County there are three principal unconsolidated aquifers and three major rock aquifers used extensively by municipal and rural users. Each of the aquifers has its own set of geologic, hydrologic, and chemical character-

Table 1.

Consumption of Water in Iowa County

	1980 Population	Avg. gallons/day	Max. gallons/day	Hydrogeologic sources
Amana	1,678	30,022	33,706	alluvium, Silurian
East Amana	1985 est. (126)	12,610	13,928	Devonian, Silurian
High Amana	1985 est. (325)	32,490	43,880	alluvium
Middle Amana	1985 est. (350)	35,000	40,000	alluvium
South Amana	1985 est. (581)	58,068	65,000	alluvium
West Amana	1985 est. (206)	20,640	25,713	alluvium
Homestead	1985 est. (125)	33,788	37,881	Devonian, Silurian
Conroy	1985 est. (280)	28,000	44,000	Devonian
Ladora	289	36,609	96,900	alluvium
Marengo	2,308	200,000	250,000	alluvium
Millersburg	184	17,000	30,000	glacial drift
North English	990	109,750	121,000	Cambrian-Ordovician (Jordan)
Parnell	234	est. (20,000)	est. (30,000)	buried channel
Victor	1,046	84,376	178,500	glacial drift
Williamsburg	2,033	254,000	425,000	glacial drift
Total Municipalities	70% 10,755	969,869	1,432,810	
Rural domestic	30% 4,674	467,400	701,100	groundwater
Permitted domestic		est. (20,000)	69,589	groundwater
Total domestic	15,429	1,457,269	2,203,499	
Permitted: industrial		est. (1,753,096)	2,062,466	64% groundwater
Permitted: irrigation		est. (148,150)	197,534	577 acres; 5% groundwater
Permitted: other		est. (151,836)	178,630	surface water
Livestock		est. (2,024,485)	est. (2,624,250)	95% groundwater
TOTAL Iowa County		5,534,836	7,266,379	

Table 2.

Geologic and Hydrogeologic Units in Iowa County

Geologic Age	Rock Units	Description	Water-Bearing Characteristics	Hydrogeologic Unit
Quaternary (unconsolidated)	alluvium	sand, gravel, silt, clay	fair to high yields (50-500 gpm)	alluvial aquifer
	glacial drift	till (sandy, pebbly, clay), sand, gravel, loess (silt)	low yields (5-20 gpm)	glacial drift aquifers
	buried channel deposits	sand, gravel, silt, clay	low to high yields (50->500 gpm)	buried channel aquifer
Pennsylvanian	Cherokee Group	shale, siltstone, coal, sandstone, limestone	low yields only from sandstone and limestone	aquiclude
Mississippian	St. Louis Formation	limestone, sandstone	low to fair yields (<10-50 gpm)	Mississippian aquifer
	Spergen Formation	dolostone, chert, shale		
	Keokuk Formation	dolostone, chert, limestone		
	Burlington Formation	dolostone, limestone		
	Hampton Formation	dolostone, limestone		
	North Hill Group	siltstone, shale	does not yeild water	aquiclude
Devonian	Maple Mill Formation	shale	does not yield water	Devonian aquiclude
	Sheffield Formation	shale, siltstone		
	Lime Creek Formation	shale, dolostone		
	Cedar Valley Formation	limestone, dolostone	fair to high yields (50-300 gpm)	Devonian aquifer
	Wapsipinicon Formation	limestone, dolostone, shale		
Silurian	undifferentiated	dolostone, chert	fair to large yields (100-300 gpm)	Silurian aquifer
Ordovician	Maquoketa Formation	shale, dolostone	does not yield water	aquiclude
	Galena Group	dolostone, chert	low yields	minor aquifer
	Platteville Formation	limestone, dolostone	does not yield water	aquiclude
	Glenwood Formation	shale, sandstone		
	St. Peter Formation	sandstone	fair yields	Cambrian-Ordovician aquifer
	Prairie du Chien Group	dolostone, chert, sandstone	high yields (100-1000 gpm)	
Cambrian	Jordan Formation	sandstone		
	St. Lawrence Formation	dolostone	low yields	aquitard
	Tunnel City Group	sandstone, shale, siltstone		
	Elk Mound Group	sandstone	low to high yields	aquifer
Precambrian	undifferentiated	coarse sandstones, igneous rocks	not known to yield water	base of groundwater reservoir

Figure 1
Cross Section of Iowa County

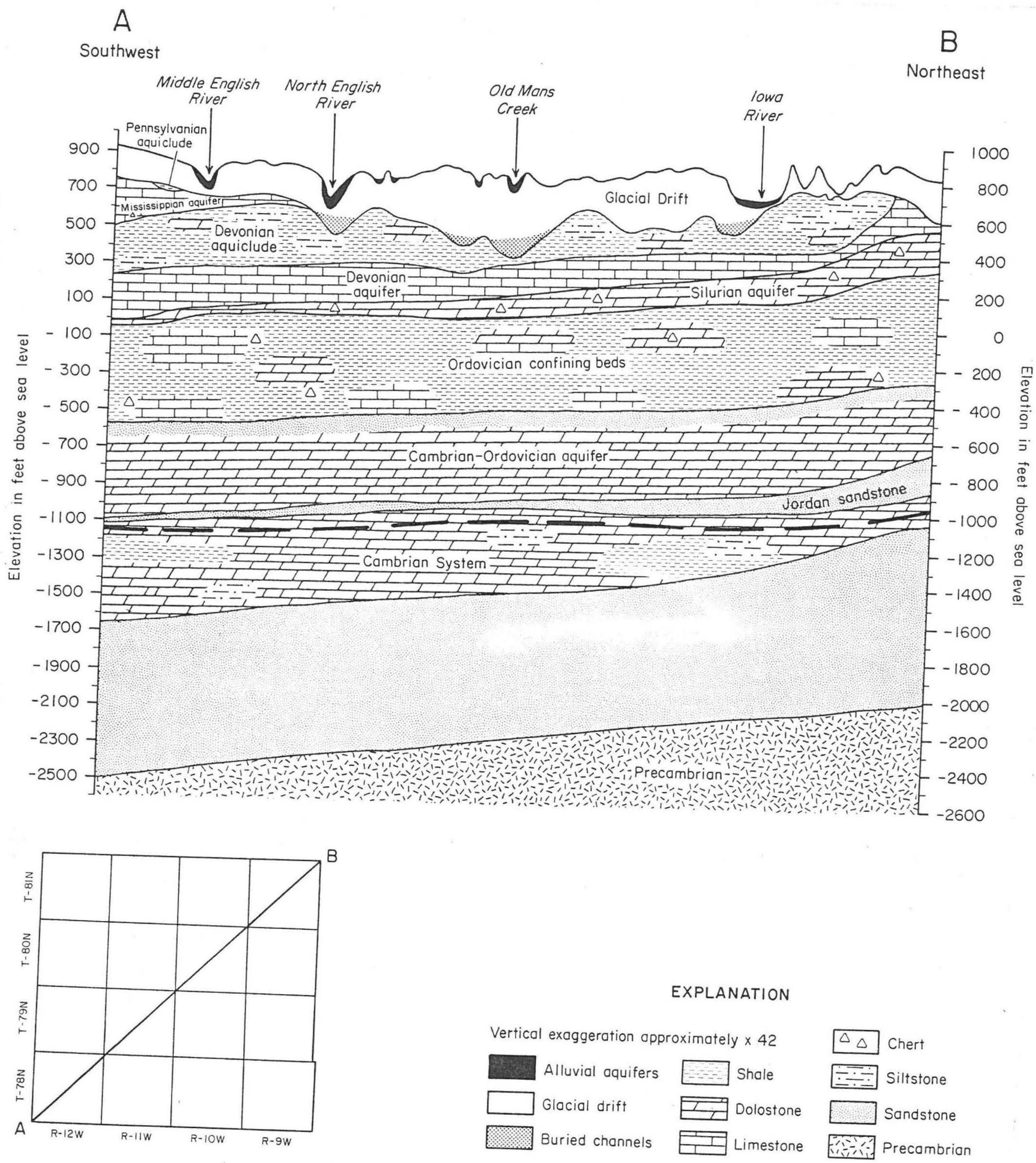
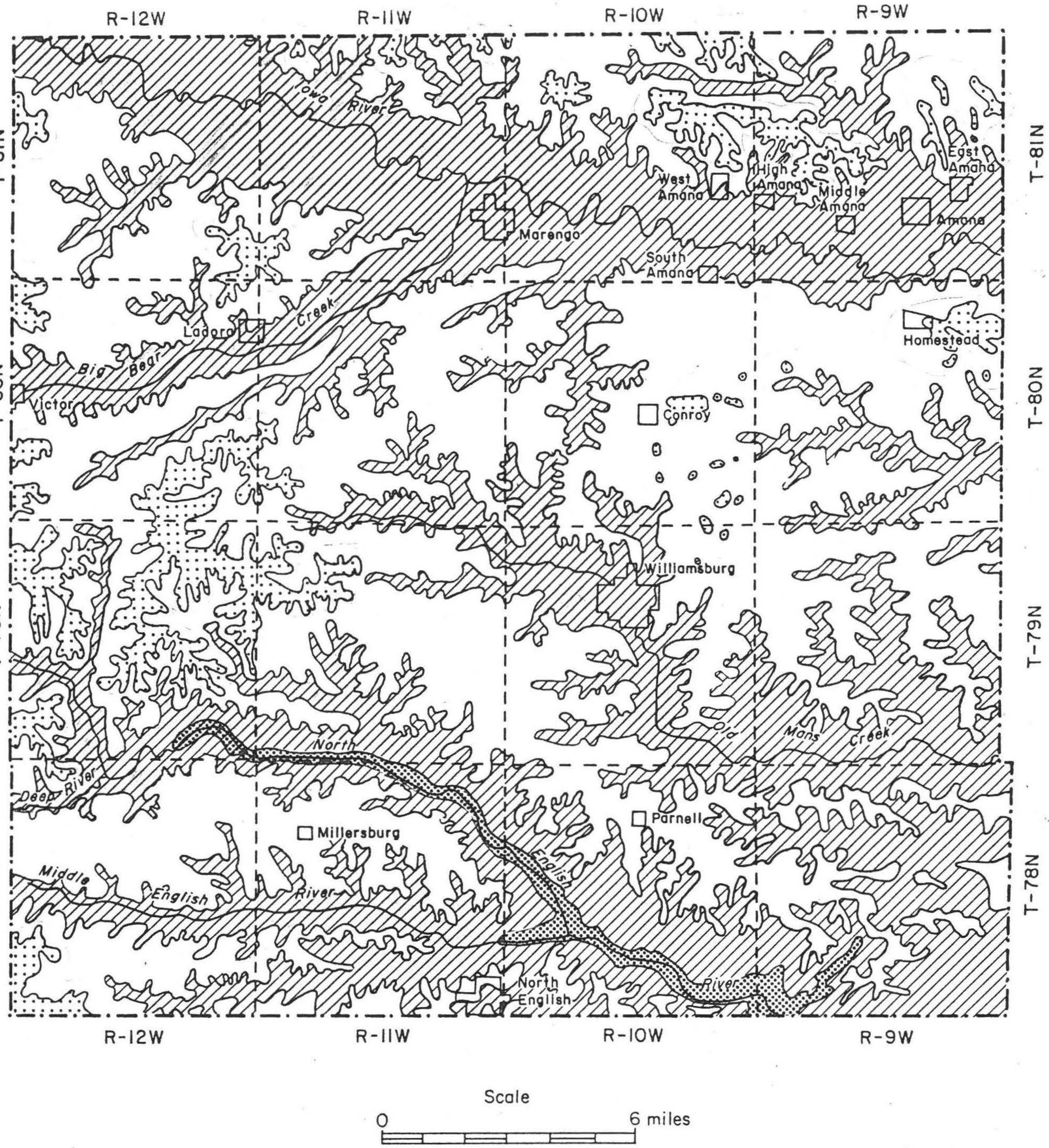


Figure 2

Elevation of Land Surface in Iowa County



Elevation in feet above mean sea level

Contour interval 100 feet

Dense stipple	<700
Diagonal hatching	700-800
Blank	800-900
Sparse dots	>900

istics which determine the accessibility, yield, and quality of water. Table 2 shows the geological and hydrological characteristics of the various earth materials in Iowa County. Figure 1 shows the geologic relationships of these units in cross section from the southwest corner to the northeast corner of the county, A-B.

Unconsolidated aquifers

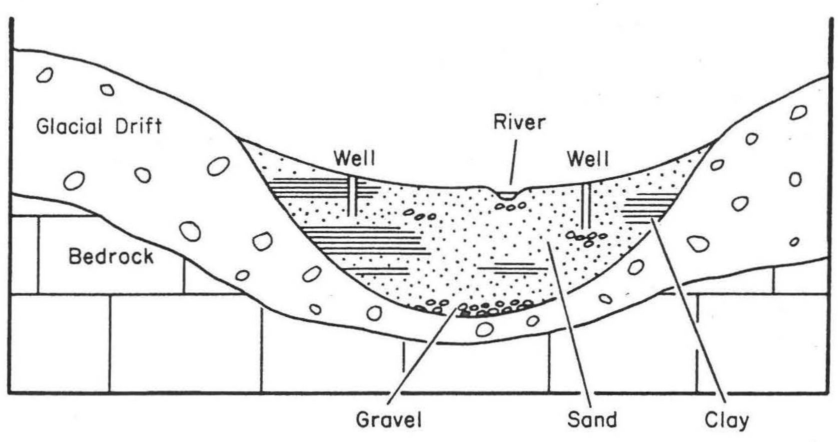
The three unconsolidated aquifers occur between the bedrock surface and the land surface. Figure 2 shows the elevation of the land surface as well as the major streams and communities within the county.

Alluvial aquifers

Alluvial aquifers consist mainly of sand and gravel deposited by streams along river channels, floodplains, and terraces in major stream valleys, Figure 3. Generally, alluvial deposits are near the surface and are usually less than 50 feet thick. The water table in alluvial aquifers slopes from high land areas toward the streams. The main influence on water levels is the stage (level) of the associated stream. Water levels in alluvial wells are commonly a few feet to tens of feet below the surface. The distribution of alluvial aquifers and yields that may be expected are summarized in Figure 4. Water-quality zones are shown in Figure 5.

Figure 3

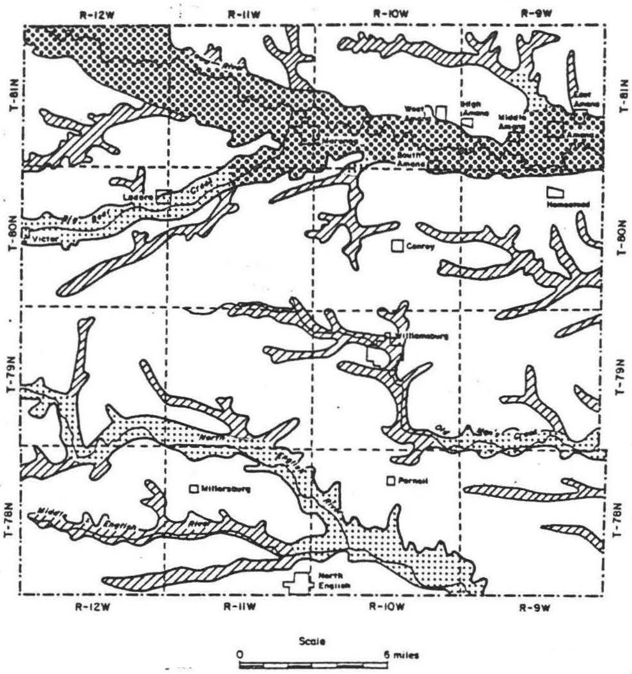
Alluvial Aquifer



Alluvial aquifers are sand and gravel deposits close to the surface, along major stream valleys.

Figure 4

Potential yields of Alluvial and Glacial-Drift Aquifers in Iowa County

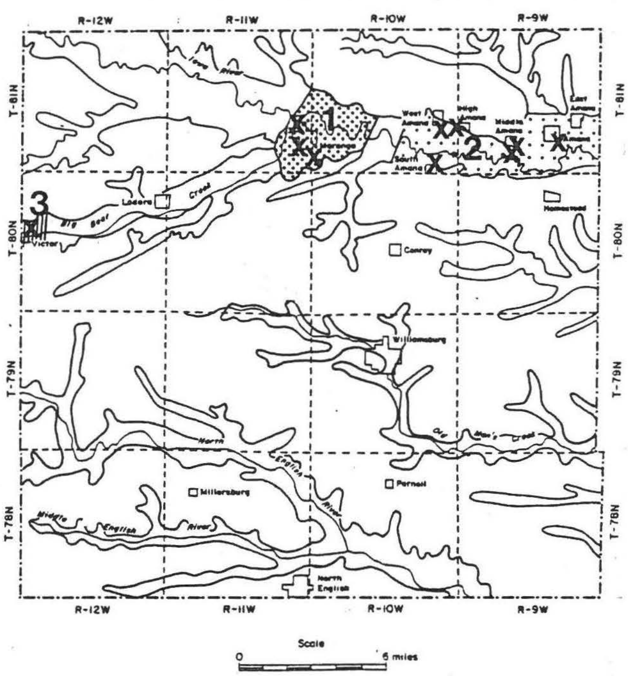


Potential yields in gallons per minute (gpm)

Glacial drift 5-20	Alluvium 50-100
Alluvium <50	Alluvium 100-500

Figure 5

Water-Quality Zones of Alluvial Aquifers in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

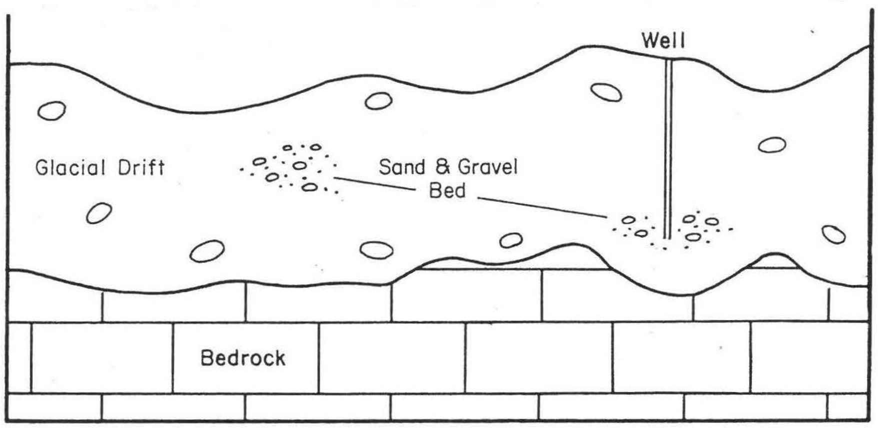
Zone 1	Zone 2
Zone 3	X Sample Locations

Glacial-drift aquifers

Glacial drift is the thick layer of unconsolidated material deposited above the bedrock surface by glaciers which covered the county several times in the last two million years, Figure 6. Glacial drift is composed of mixtures of clay, silt, sand, gravel, and boulders. Typically, the drift does not yield much water because of its high percentage of clay. However, there may be lenses or beds of sand and gravel within the drift which can serve as dependable water sources. These lenses are difficult to locate because they are discontinuous, irregular in shape, and buried within the drift. The water table in the shallow glacial-drift aquifer generally slopes from high land areas towards the streams. Water levels are commonly a few tens of feet below the land surface. The water table may change noticeably throughout the year in response to recharge from precipitation. Yields from suitable sand and gravel beds are generally low (Figure 4). Water-quality zones are shown in Figures 7 and 8.

Figure 6

Glacial-Drift Aquifer



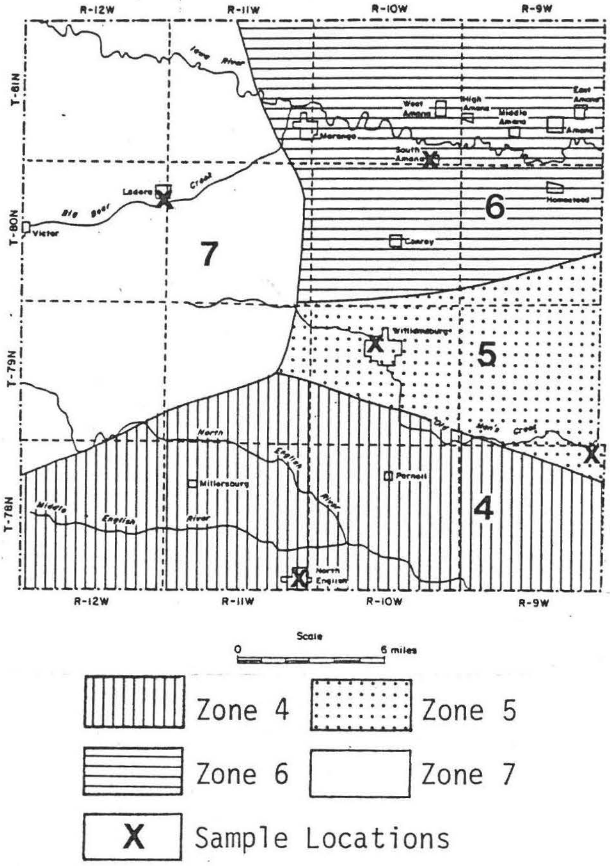
A glacial-drift aquifer is composed of thin, discontinuous sand and gravel zones within less permeable drift materials.

Buried-channel aquifer

The buried-channel aquifer consists of sand and gravel deposits in bedrock valleys which existed prior to the glacial period, Figure 9. These valleys, which were overridden by the glaciers, are now buried under glacial drift and recent alluvial deposits. Deposits of sand and gravel in the buried channels may range from 50 to 100 feet thick. Water levels in the buried-channel aquifers are generally unaffected by local recharge-discharge relationships and are generally under confined (artesian) conditions. The distribution of these buried channels and the yields that can be expected from them are summarized in Figure 10. Figure 11 shows the water-quality zone of the buried-channel aquifer.

Figure 7

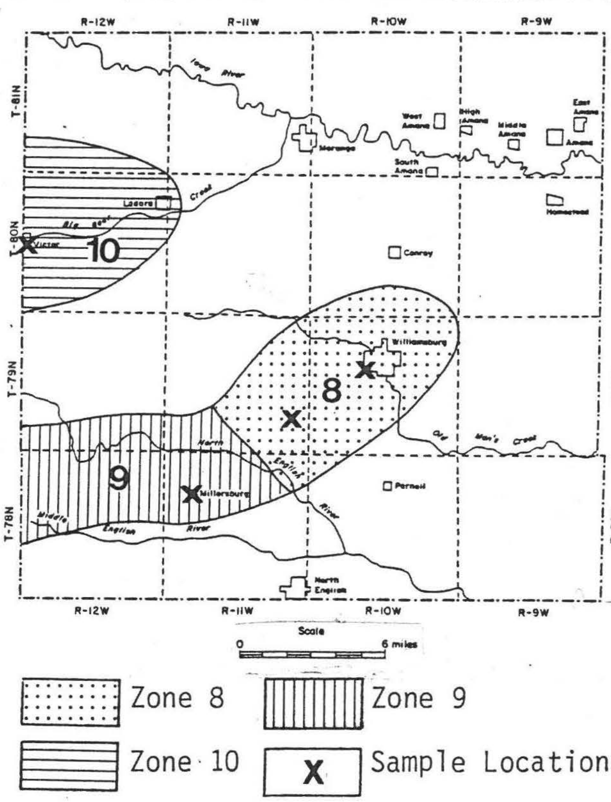
Water-Quality zones of Shallow (<125') Glacial-Drift Aquifers in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

Figure 8

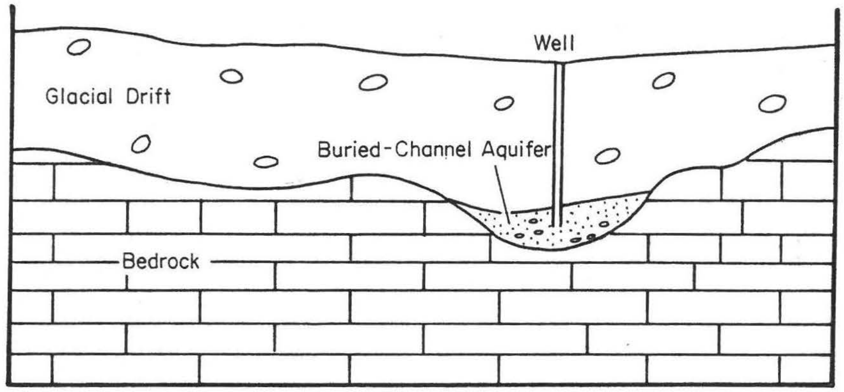
Water-Quality Zones of Deep (>125') Glacial-Drift Aquifers in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

Figure 9

Buried-Channel Aquifer



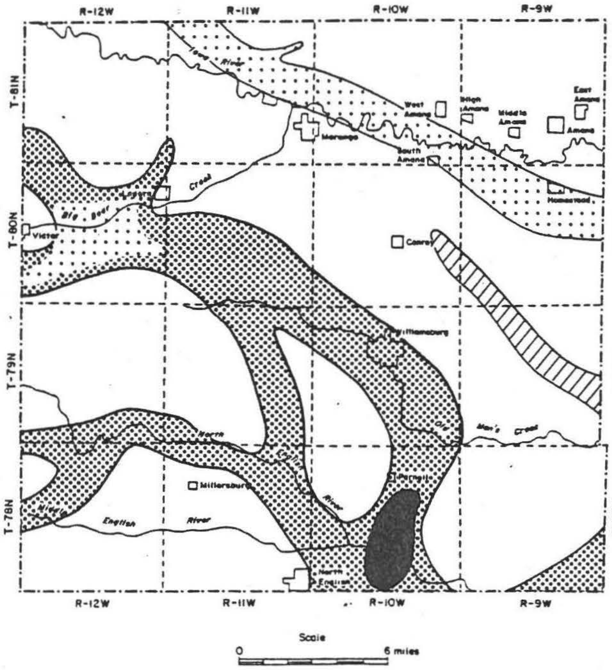
A pre-existing landscape was buried by the glacial drift. The buried channels may contain sand and gravel deposits which yield water.

Bedrock aquifers

Below the unconsolidated materials is a thick sequence of sedimentary rocks formed from deposits within river systems and shallow seas which covered the state repeatedly during the last 600 million years, Figure 12. Uplift and erosion of these rocks produced the topography shown in Figure 13. The hydrogeologic map, Figure 14, shows the geologic units which occur at the top of the bedrock sequence.

Figure 10

Potential Yields of Buried-Channel Aquifers in Iowa County

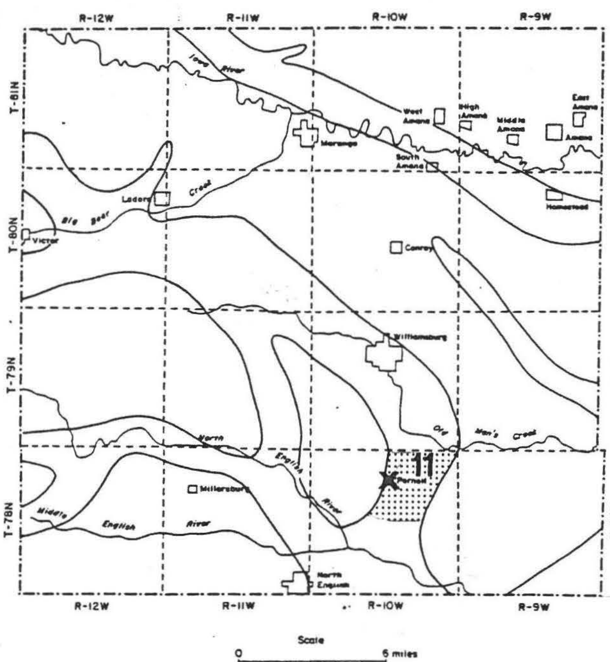


Potential yields in gallons per minute (gpm)

<50 | 100-500
50-100 | >500

Figure 11

Water-Quality Zone of Buried-Channel Aquifers in Iowa County

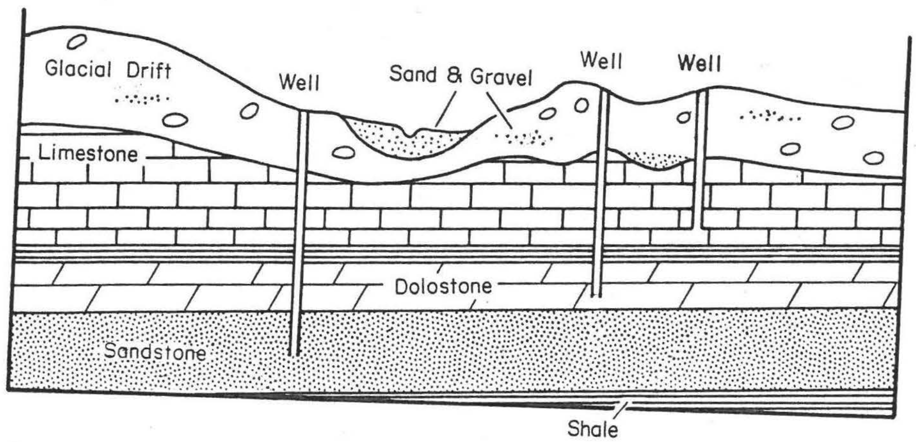


Chemical characteristics for each zone are in Table 4, p. 31.

Zone 11 | X Sample Locations

Figure 12

Bedrock Aquifers



Bedrock aquifers are water bearing rock formations which are often far below the land surface.

Pennsylvanian aquiclude

These rocks are quite discontinuous in Iowa County and are generally considered to act as an aquiclude. There are, however, local sandstone layers which may contribute water to some rural domestic wells. The yields from these restricted sandstone units are very low.

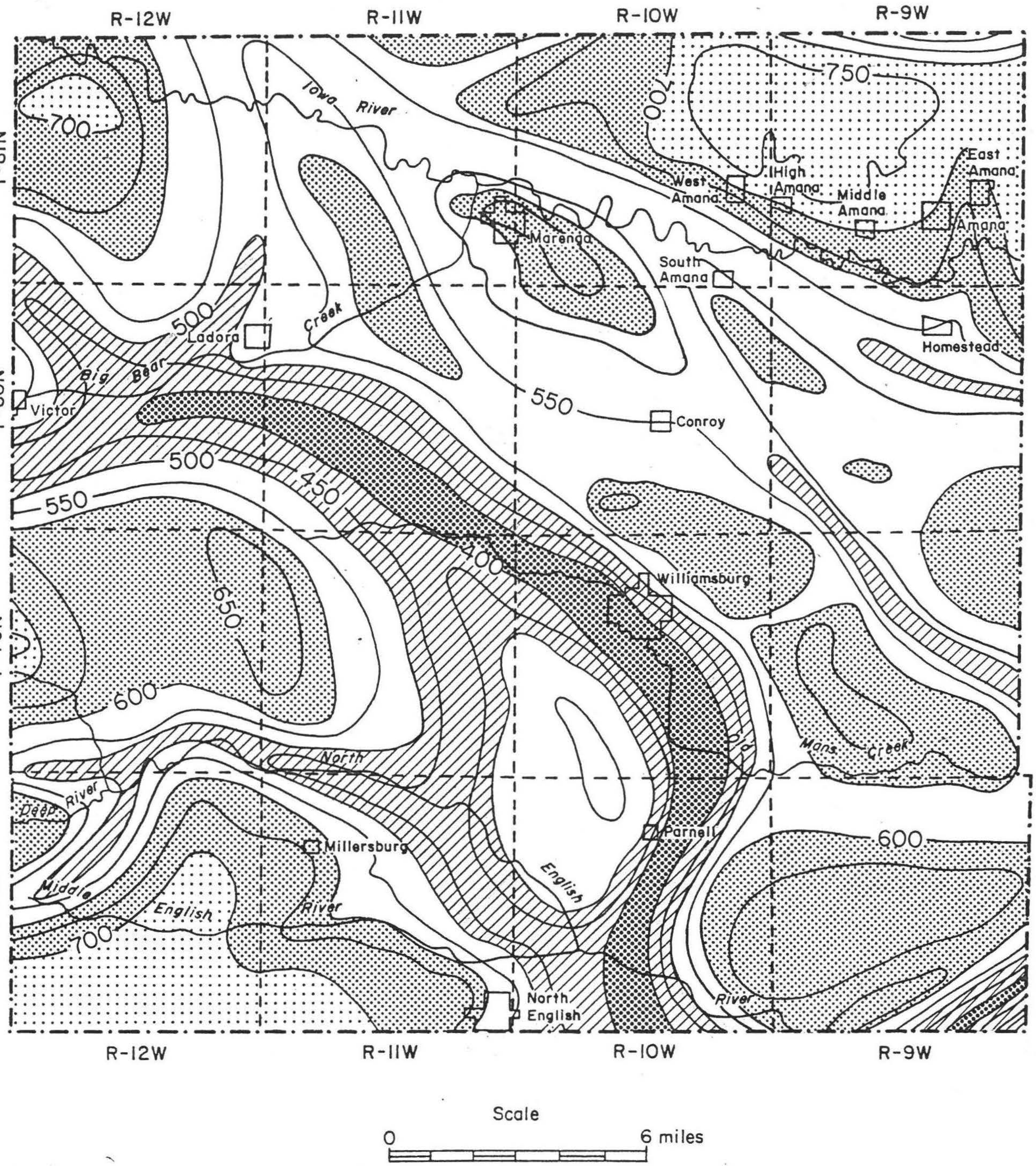
Mississippian aquifer

This aquifer is located primarily in the southwestern portion of the county. Its occurrence elsewhere, in the southern half of the county, is discontinuous. Figure 15 shows the elevation and aerial extent of the Mississippian aquifer.

The Mississippian aquifer is composed primarily of limestone. Its thickness is summarized on Figure 16. The elevation of static (non-pumping) water levels in a well completed into the Mississippian aquifer and potential yields are represented on Figure 17. For the major portion of the aquifer in T.78N., R.11 and 12W., the static water level in wells southwest of the 750 foot potentiometric contour (contour of the water level surface) will be higher than 750 feet while the static water level northeast of that contour will be lower than 750 feet. Water-quality zones are shown in Figure 18.

Figure 13

Elevation of Bedrock Surface in Iowa County



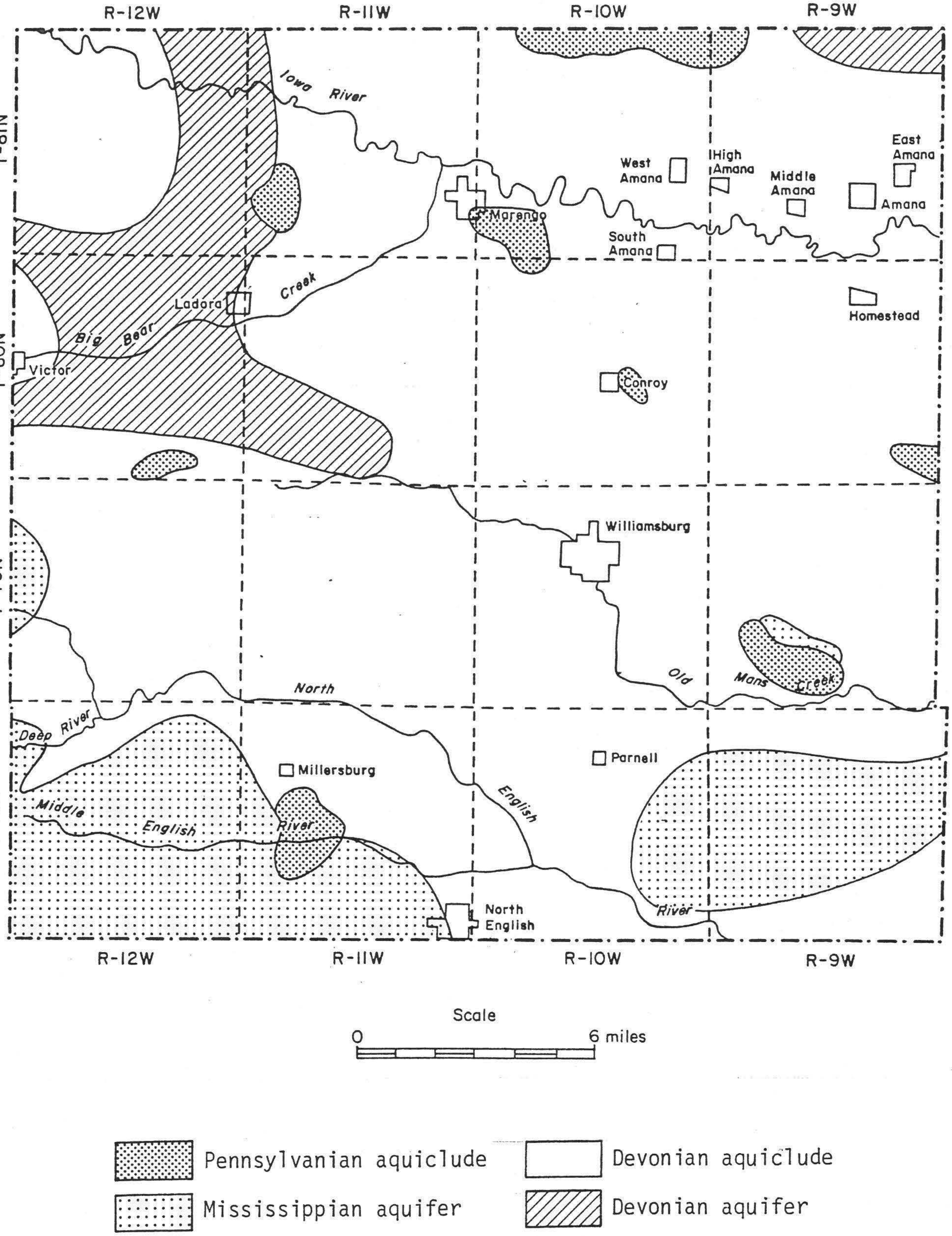
Elevation in feet above mean sea level

Contour interval 50 feet

<400 | 500 - 600 | >700
400 - 500 | 600 - 700

Figure 14

Hydrogeologic Bedrock Map of Iowa County



Devonian aquiclude

The majority of the uppermost bedrock in Iowa County belongs to the Devonian System (Figure 14). Most of these rocks are part of the Devonian aquiclude, and are primarily shales, siltstones, and dolostones which do not yield water.

Devonian aquifer

The lower part of the Devonian System consists of the Cedar Valley and Wapsipinicon Formations, primarily limestone and dolostone, which contain numerous fractures and solution cavities. Figure 19 shows the elevation of the Devonian aquifer. Figure 20 summarizes the thickness and Figure 21 shows the potential yields and the elevation of static water level in wells finished in the Devonian aquifer. The dissolved-solids concentrations generally increase to the southwest and water-quality zones of the Devonian aquifer reflect this trend, Figure 22.

Silurian aquifer

The next geologic unit is the Silurian aquifer, composed mostly of fractured dolostone with abundant solution cavities. Because of the lack of an aquiclude between the Devonian aquifer and the Silurian aquifer, these two are often considered as one hydrologic unit.

The elevation of the Silurian aquifer is depicted in Figure 23. The thickness is summarized in Figure 24, while potential well yields and static water levels are summarized in Figure 25. Although static water levels are virtually unknown in the Silurian aquifer alone, static water levels for the combined Silurian-Devonian aquifers will be similar to those depicted for the Devonian aquifer (Figure 21). Similarly, yields from the combined Silurian-Devonian aquifer would be expected to be equal to or greater than the Devonian aquifer alone. Dissolved-solids concentrations also generally increase to the southwest in the Silurian aquifer, Figure 26. Water-quality zones of Silurian and Silurian-Devonian aquifers parallel this trend (Figure 26).

Ordovician confining beds

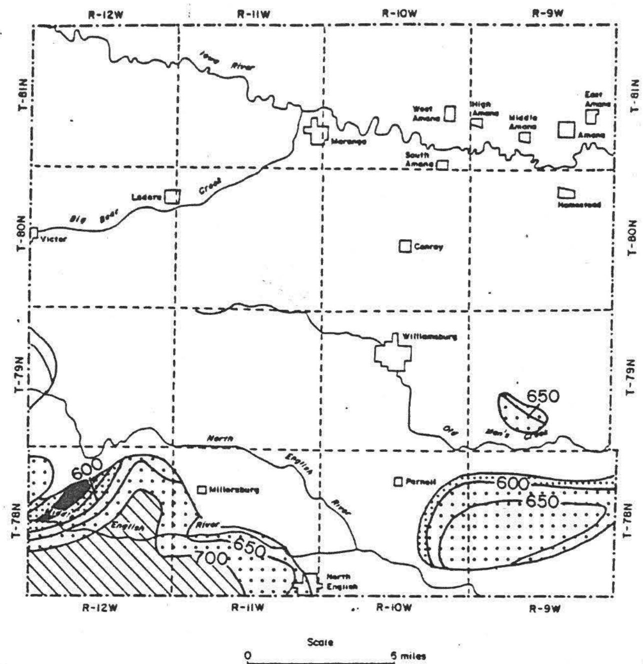
These beds are composed primarily of limestone, dolostone, and shale. Although minor yields may be possible in certain portions of this group, the depth of these units may make them uneconomical to develop. Most of these units are true aquicludes, and thus hydrologically separate the Silurian aquifer from the Cambrian-Ordovician aquifer.

Cambrian-Ordovician aquifer

Figure 27 depicts the elevation of the Cambrian-Ordovician aquifer. This aquifer is composed primarily of dolostones and sandstone, and it is relatively thick as shown on Figure 28. The high yields and the static water level

Figure 15

Elevation of Mississippian Aquifer in Iowa County



Elevation in feet above mean sea level
Contour interval 50 feet

400-500

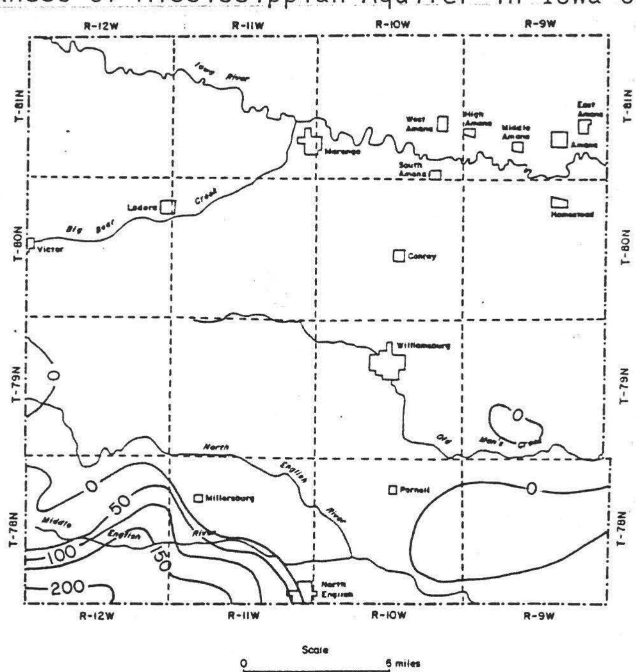
600-700

500-600

>700

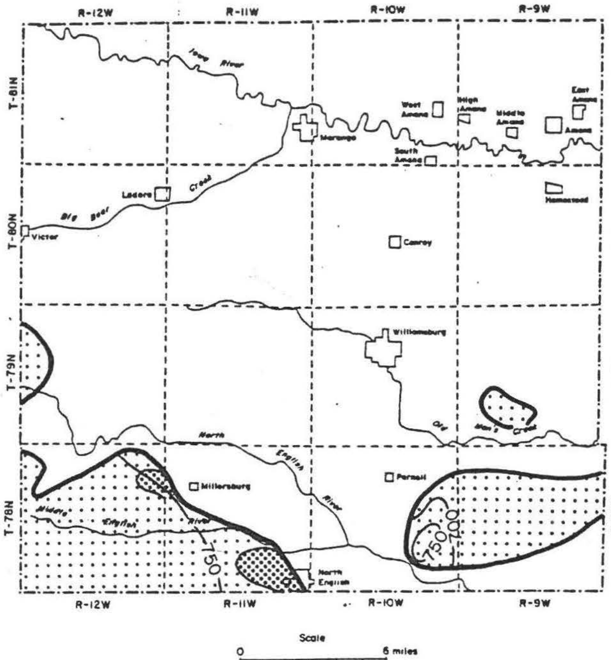
Figure 16

Thickness of Mississippian Aquifer in Iowa County



Contours of equal thickness
Contour interval 50 feet

Figure 17
Water Level, Potential Yields of Mississippian Aquifer in Iowa County



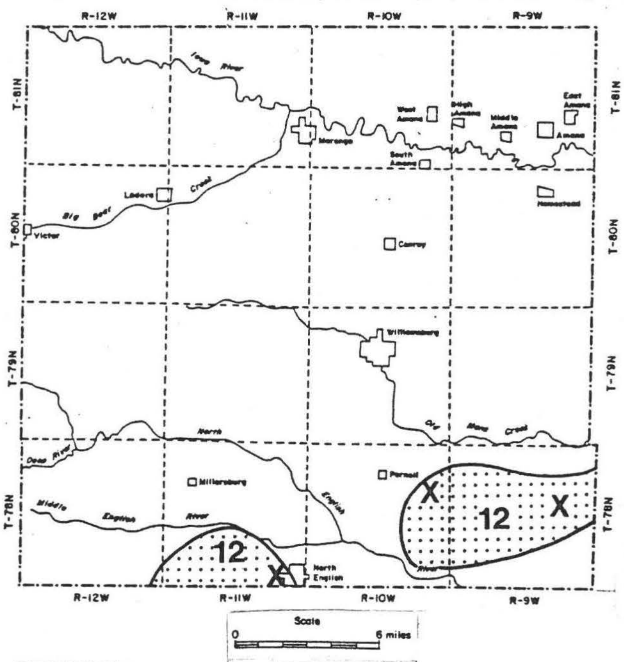
Potential yields in gallons per minute (gpm)

<10   10-50

—750— Potentiometric contour in feet above mean sea level

Contour interval 50 feet

Figure 18
Water-Quality Zones of Mississippian Aquifer in Iowa County

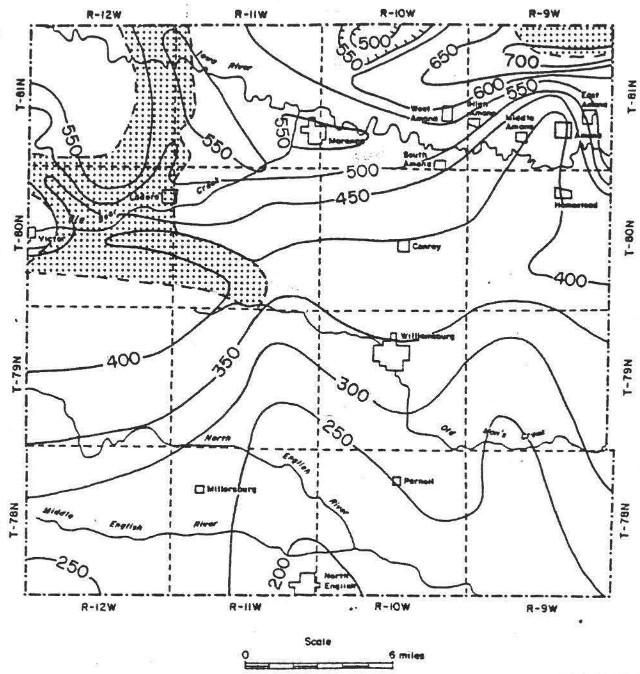


Chemical characteristics for each zone are in Table 4, p. 31.

Zone 12   X Sample Locations

Figure 19

Elevation of Devonian Aquifer in Iowa County



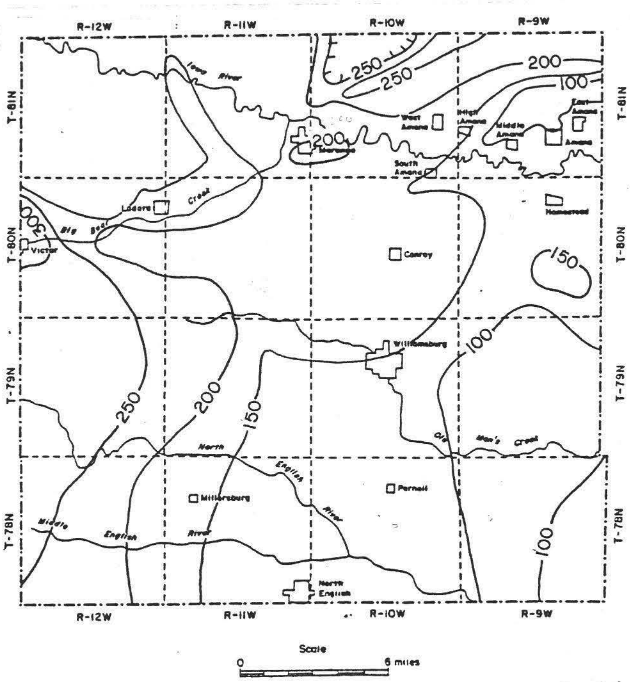
Elevation in feet above mean sea level

Contour interval 50 feet

Area where Devonian Aquifer is first bedrock

Figure 20

Thickness of Devonian Aquifer in Iowa County

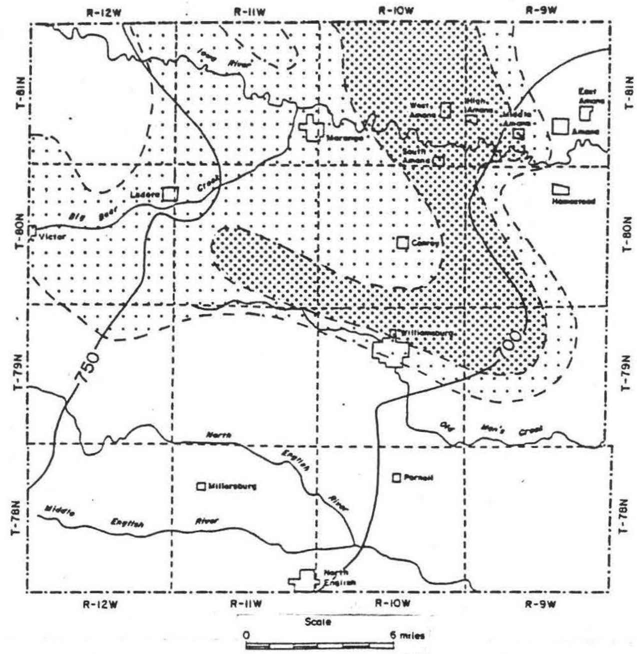


Contours of equal thickness

Contour interval 50 feet

Figure 21

Water Level, Potential Yields of Devonian Aquifer in Iowa County



Potential yields in gallons per minute (gpm)

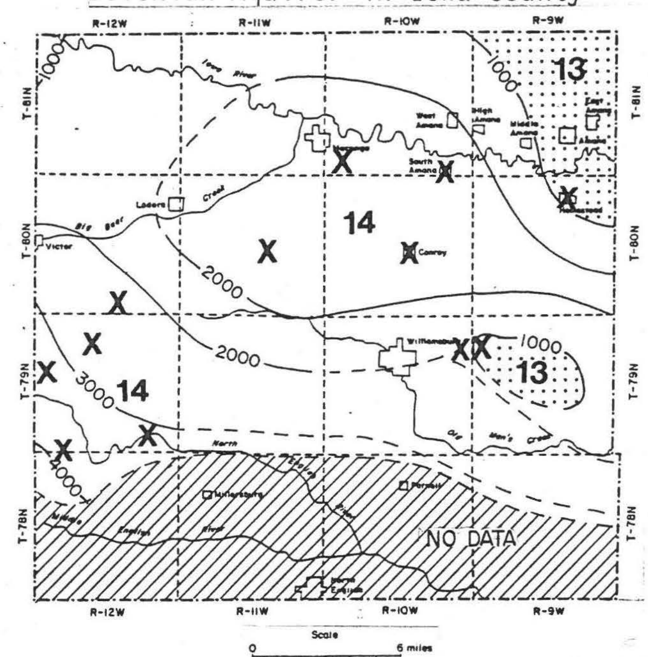
<50 | 50-100 | 100-300

—700— Potentiometric contour in feet above mean sea level

Contour interval 50 feet

Figure 22

Dissolved-solids Concentrations and Water-Quality Zones of Devonian Aquifer in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

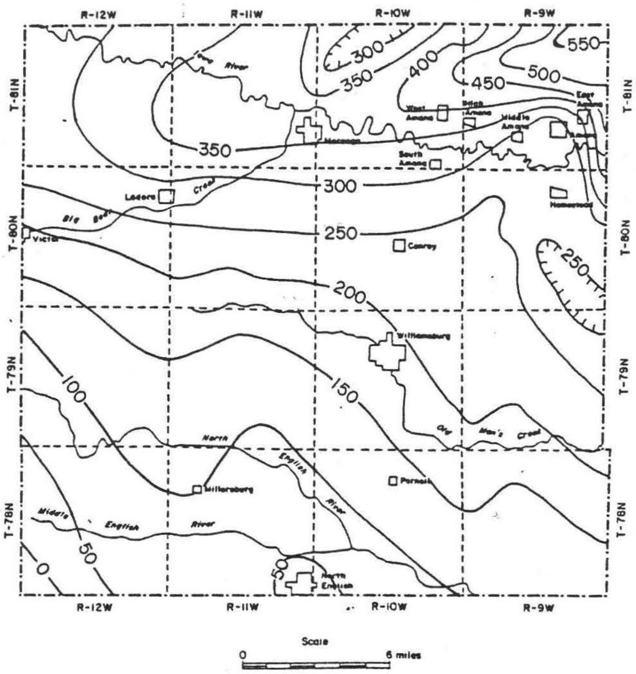
—4000— Dissolved-solids concentrations — — — Inferred

Zone 13 | Zone 14 | X Sample Locations

Contour interval 1000 mg/l

Figure 23

Elevation of Silurian Aquifer in Iowa County

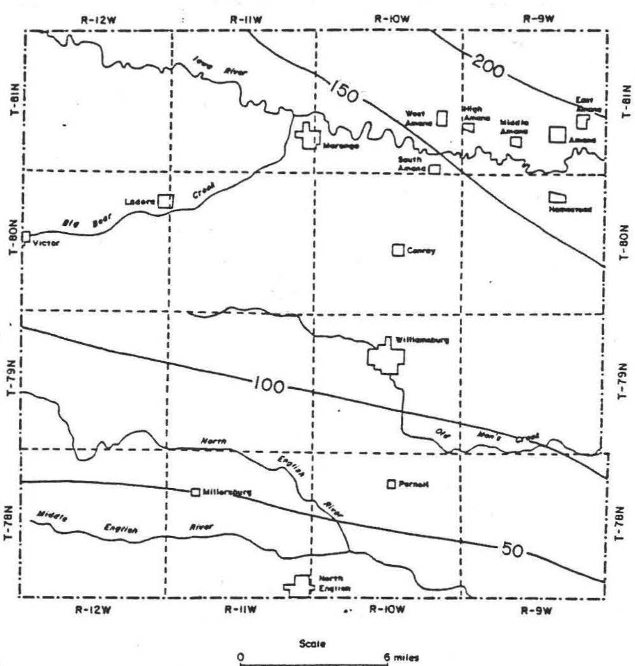


Elevation in feet above mean sea level

Contour interval 50 feet

Figure 24

Thickness of the Silurian Aquifer in Iowa County

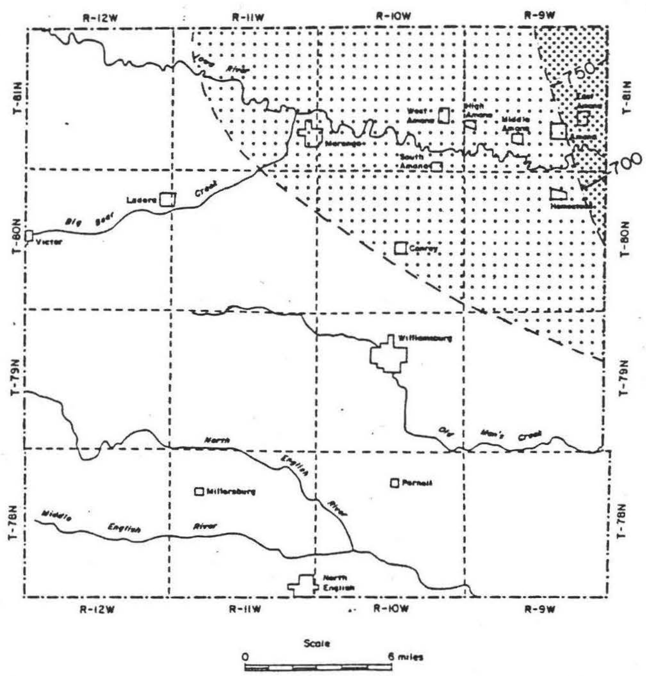


Contours of equal thickness

Contour interval 50 feet

Figure 25

Water Level, Potential Yields of Silurian Aquifer in Iowa County



Potential yields in gallons per minute (gpm)

100 - 300

Insufficient data

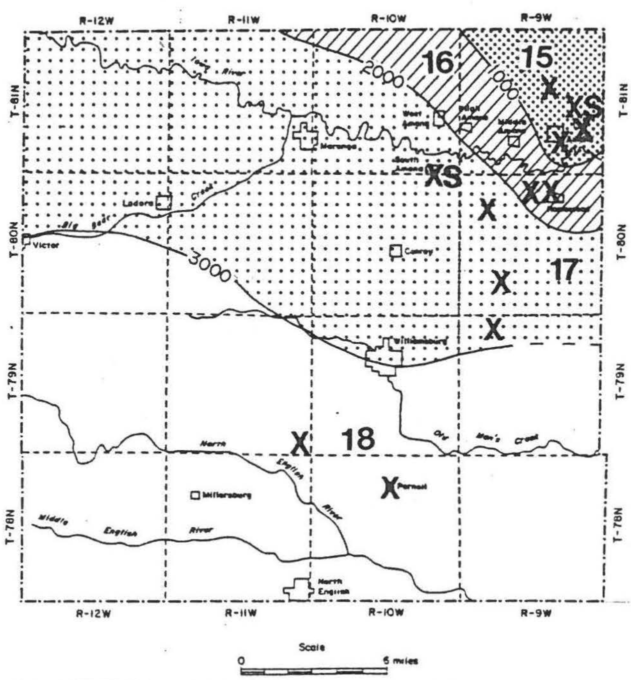
Only area of reliable data

—750— Potentiometric contour in feet above mean sea level

Contour interval 50 feet

Figure 26

Dissolved-Solids Concentrations of Silurian Aquifer and Water-Quality Zones of Silurian and Silurian-Devonian Aquifers in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

Contour interval 1000 mg/l

—3000— Dissolved-solids concentrations

- - - Inferred

Zone 15

Zone 16

Zone 17

Zone 18

X Sample Locations of the Silurian Aquifer

XS Sample Locations of the Silurian-Devonian Aquifer shown on Figure 29 are primarily attributed to the Jordan sandstone. Thus, wells developed in the Cambrian-Ordovician aquifers are usually finished in the Jordan sandstone. The static water level in the Cambrian-Ordovician aquifer decreases to the northeast. The dissolved-solids concentrations, Figure 30, increase to the southeast. The St. Peter sandstone, used elsewhere as an aquifer, generally has poor water quality, lower yields than the Jordan, and is friable (crumbles easily).

Jordan sandstone

The elevation of the Jordan sandstone is depicted on Figure 31. Thickness increases toward the east, Figure 32. Static water levels decrease toward the northeast, Figure 33. Dissolved-solids concentrations generally increase to the southeast, Figure 34.

Cambrian System, Tunnel City Group

These beds are considered aquitards. They are composed primarily of dolostone with some sandstone, siltstone, and shale. Their low yields and great depths do not make them economical to develop. They are 200 to 500 feet thick and hydrologically separate the Cambrian-Ordovician aquifer from the Elk Mound Group Sandstones.

Cambrian System, Elk Mound Group

There are no wells in Iowa County which tap the Elk Mound Group sandstones, primarily because of its great depth and unacceptable quality. Figure 35 gives the elevation of these rocks. It has been estimated that the potential yields to wells are less than 300 gallons per minute. However, yields of up to 1000 gallons per minute have been obtained in portions of Clinton, Jackson, Jones, and Scott Counties east-northeast of Iowa County. It remains to be seen what quantities of water are obtainable from these rocks in Iowa County.

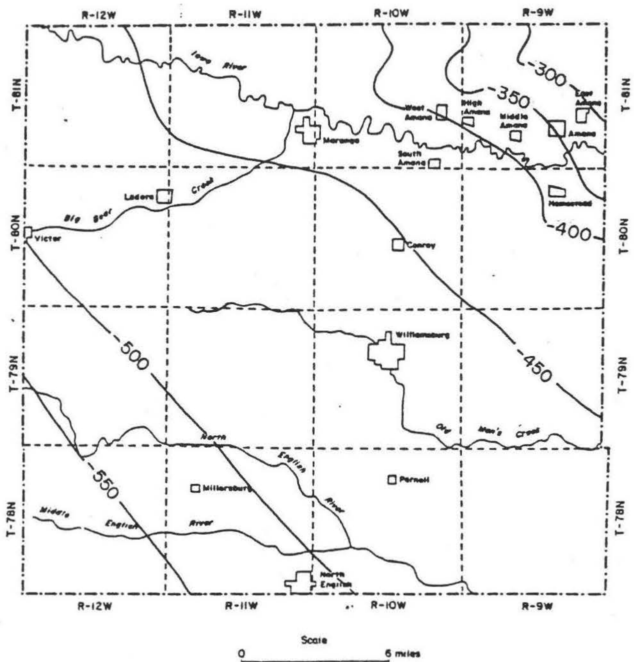
Chemical character of groundwater

To the user, the quality of groundwater is as important as the amount of water that an aquifer will yield. As groundwater moves through porous soil and rock materials, it dissolves some of the minerals which, in turn, affect water quality. In addition, impermeable soils and unconsolidated materials tend to protect groundwater from infiltrating surficial chemical and bacterial contamination.

Table 3 discusses the significance of several constituents of groundwater and gives the recommended maximum concentration for public drinking-water supplies. The maximum concentrations are those recommended by either the Iowa Department of Water, Air and Waste Management or the U.S. Environmental Protection Agency. There is also growing concern over the introduction of several man-made chemicals through poorly constructed wells and seepage into groundwater from pollution sources. Concentrations of some of these chemicals are listed in Table 3.

Figure 27

Elevation of Cambrian-Ordovician Aquifer in Iowa County

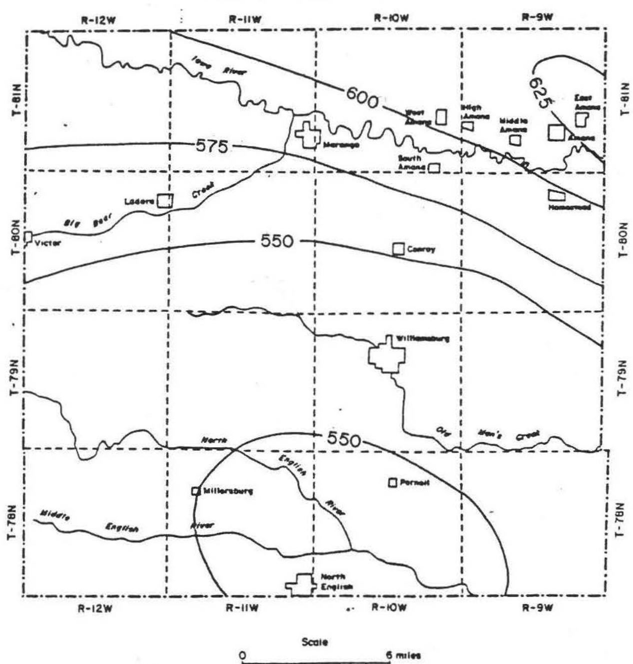


Elevation in feet above mean sea level

Contour interval 50 feet

Figure 28

Thickness of Cambrian-Ordovician Aquifer in Iowa County

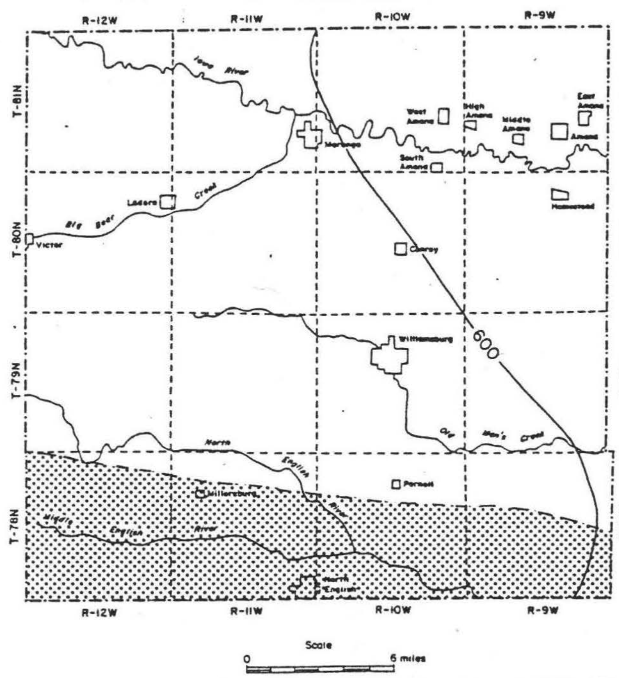


Contours of equal thickness

Contour interval 25 feet

Figure 29

Water Level, Potential Yields of Cambrian-Orodvician Aquifer in Iowa County



Potential yields in gallons per minute (gpm)

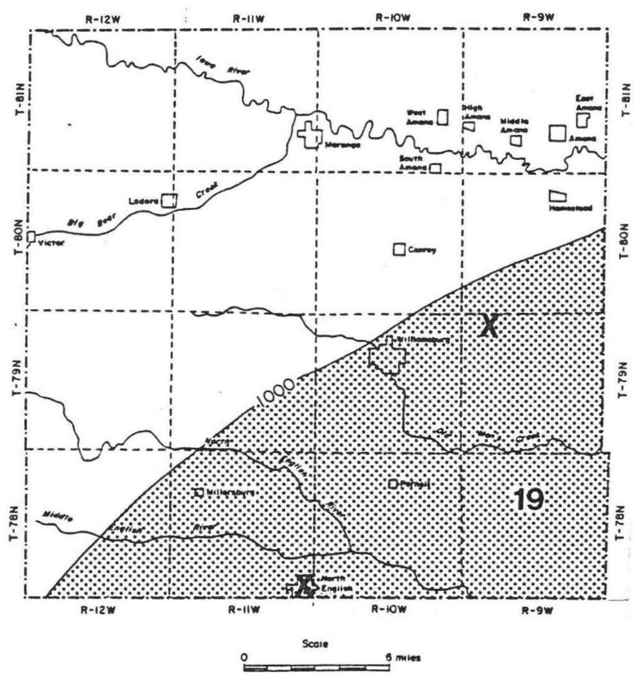
500-700 750-1000

—600— Potentiometric Contour for 1975-1976 in feet above mean sea level

Contour interval 50 feet

Figure 30

Dissolved-solids Concentrations and Water-Quality Zones
of Cambrian-Ordovician Aquifer in Iowa County



Chemical characteristics for each zone are in Table 4, p. 31.

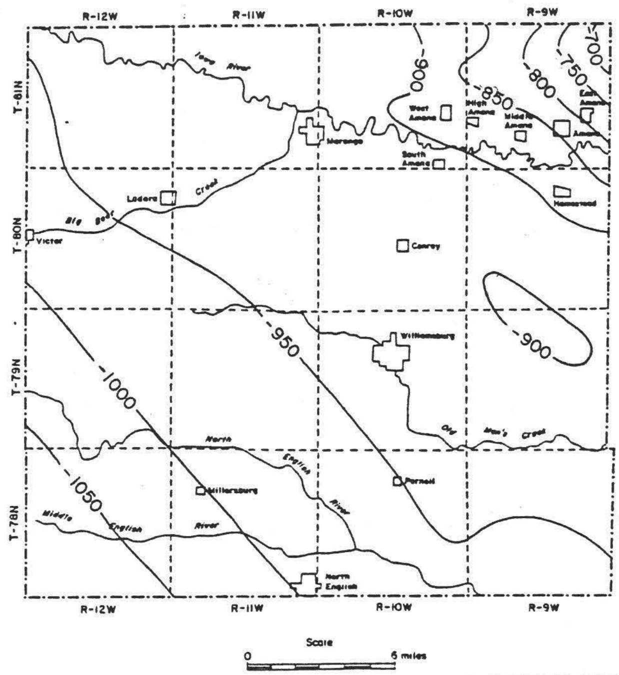
Contour interval 500 mg/l

—1000— Dissolved-solids concentrations

Zone 19   X Sample Locations

Figure 31

Elevation of Jordan Sandstone in Iowa County

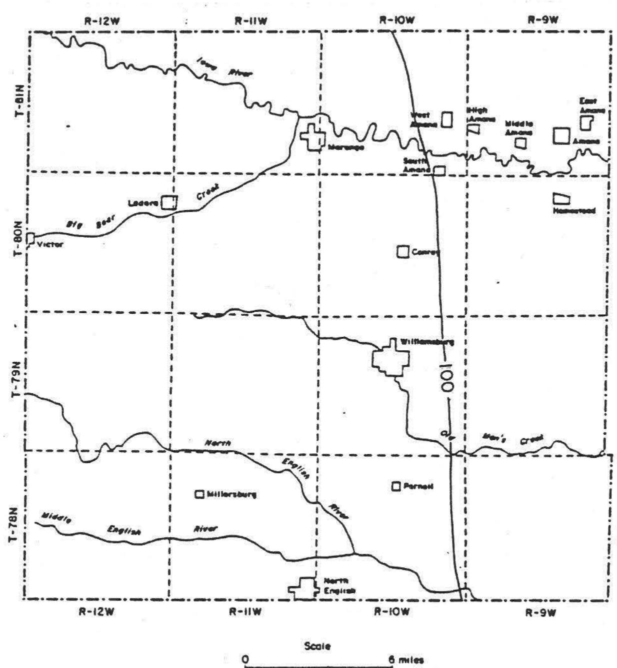


Elevation in feet above mean sea level

Contour interval 50 feet

Figure 32

Thickness of Jordan Sandstone in Iowa County

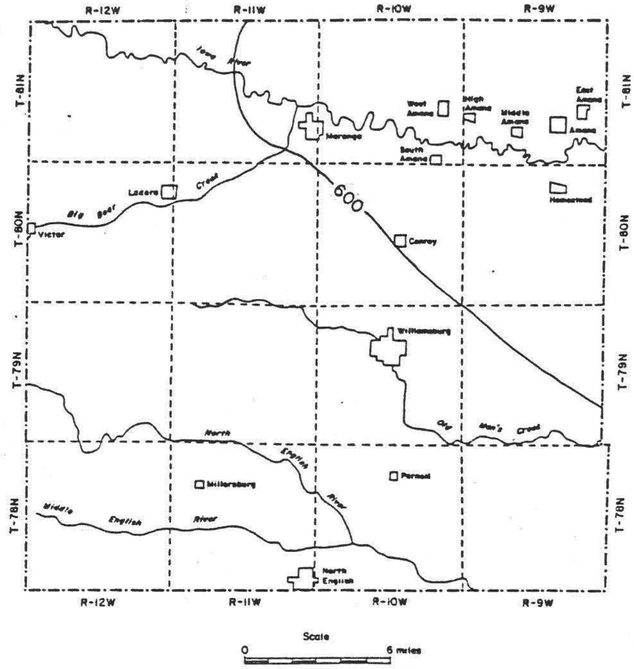


Contours of equal thickness

Contour interval 50 feet

Figure 33

Water Level of Jordan Sandstone in Iowa County

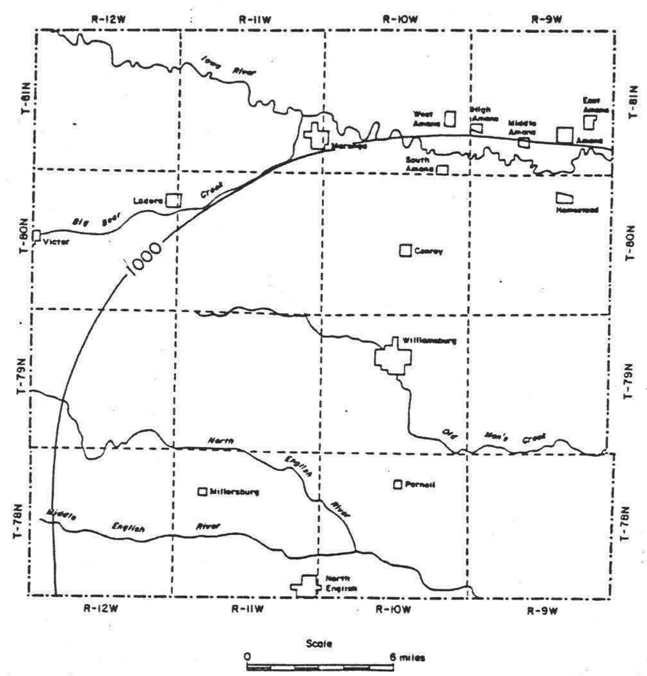


Contour interval 50 feet

—600— Potentiometric Contour for 1974-1975 in feet above mean sea level

Figure 34

Dissolved-Solids Concentrations of Jordan Sandstone in Iowa County

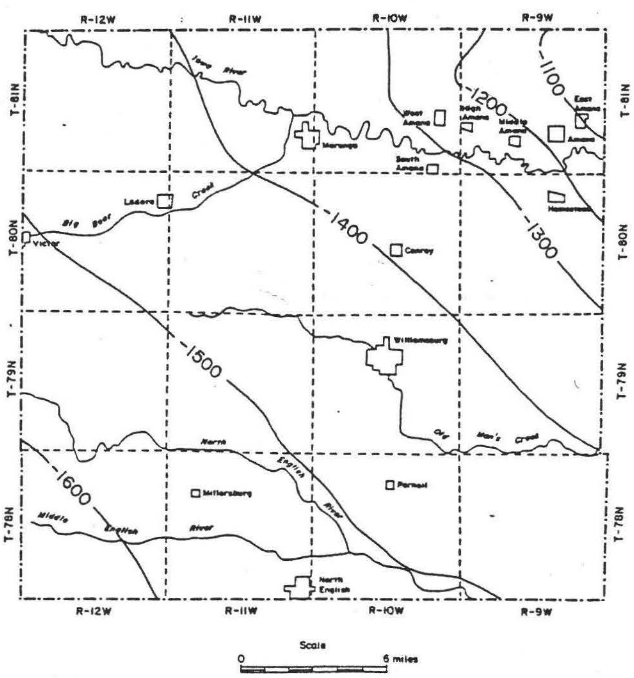


Contour interval 250 mg/l

—1000— Dissolved-Solids concentrations

Figure 35

Elevation of the Cambrian Elk Mound Group in Iowa County



Elevation in feet above mean sea level

Contour interval 100 feet

Table 3.

Significance of Chemical Constituents in Water

Constituent or Property	Maximum Recommended Concentration	Significance
Dissolved solids	500 mg/l	This refers to all material that is in solution. It affects the chemical and physical properties of water for many industrial uses. High concentrations will have a laxative effect and may cause an objectionable taste.
Hardness (as $CaCO_3$)		This affects the lathering ability of soap. Primarily caused by calcium and magnesium. Water is generally classified as: 0-100 mg/l as soft; 100-200 mg/l as moderate; anything above 200 mg/l as hard.
Iron (Fe)	0.3 mg/l	Iron is objectionable as it may impart an unpleasant taste and may cause discoloration of laundered goods and porcelain fixtures.
Manganese (Mn)	0.05 mg/l	Objectionable for the same reasons as iron.
Potassium (K) and Sodium (Na)		When combined with chloride, imparts a salty or brackish taste. In the presence of suspended matter, causes foaming in boilers. Important ingredients in human cell metabolism. Low sodium diets are prescribed in the treatment of certain types of heart disease and high blood pressure.
Calcium (Ca) and Magnesium (Mg)		Calcium and magnesium cause water hardness. They reduce the lathering ability of soap. They react with bicarbonate and sulfate to form scale in pipes.
Sulfate (SO_4)	250 mg/l	Commonly has a laxative effect and imparts a bitter taste when concentrations exceed 500 mg/l, particularly when combined with magnesium or sodium. The effect is less when combined with calcium. Persons may become acclimatized to the water, but concentrations above 750 mg/l generally affect everyone. Sulfate combined with calcium causes scale in boilers and water heaters.
Chloride (Cl)	250 mg/l	Imparts a salty taste, especially when combined with sodium and potassium.
Fluoride (F)	2.0 mg/l	Concentrations of 0.8--1.3 mg/l are effective in reduction of tooth decay, especially in children. Concentrations in excess of 2.0 mg/l will cause mottling of dental enamel.
Nitrate (NO_3)	45 mg/l	Concentrations of nitrate above the recommended limits may cause cyanosis or methemoglobinemia (blue baby syndrome) when used for feeding infants under one year of age. This disease reduces the ability of the blood to absorb oxygen and may be fatal unless properly treated. High concentrations suggest organic pollution from sewage, decaying organic matter, or fertilizers.
Radioactivity gross alpha Radium 226 (Ra^{226}) Radium 226 & 228 (RA ^{226}, Ra^{228}) Strontium 90 (Sr^{90}) gross beta (in absence of alpha emitters such as Sr^{90} and Ra^{226})	picocuries/l 15 3 5 10 1000	Groundwater may contain naturally occurring radioactivity. Human exposure to radiation is viewed as harmful, and unnecessary exposure should be avoided. Limits have been set insofar as is technically and economically feasible.

Table 4.

Chemical Character of Groundwater In Aquifers

average value
(number of samples)
minimum - maximum

SOURCE	°C	concentrations in milligrams per liter												Hardness as $CaCO_3$				micromhos	picocuries per liter
	Temperature	TDS	Fe	Mn	Ca	Mg	K	Na	HCO_3	SO_4	Cl	F	NO_3	Total	Carb.	Non-Carb.	pH	Conductance	Ra^{226}
Zone 1 Alluvium (Figure 5)	11 (5) 10-13	347 (30) 198-409	1.3 (29) 0.14-8.7	0.5 (29) 0.01-1.2	77 (30) 66-93	16 (30) 6-20	2.6 (25) 0.4-7.4	12 (29) 6.9-17	212 (30) 115-261	78 (30) 40-103	17 (29) 3-38	0.2 (29) 0.1-0.3	7 (29) <0.1-20	260 (30) 126-311	174 (30) 94-214	86 (30)	7.5 (30) 7.3-7.8	518 (30) 279-640	
Zone 2 Alluvium (Figure 5)	12 (16) 10-17	466 (33) 332-647	0.5 (33) <0.01-4.4	0.8 (33) <0.01-5.3	93 (33) 74-120	34 (33) 22-48	3.3 (29) <0.01-14	17 (33) 7.0-32	333 (33) 242-449	73 (33) 27-150	28 (33) 8-52	0.3 (33) 01.-1.0	25 (33) 3-106	361 (33) 293-454	273 (33) 198-368	88 (33)	7.1 (33) 6.7-8.1	726 (33) 480-1000	0.4 (2) 0.3-0.4
Zone 3 Alluvium (Figure 5)		557 (1)	tr (1)	0.0 (1)	107 (1)	25 (1)		37 (1)	183 (1)	188 (1)	42 (1)	1.0 (1)	44 (1)	370 (1)	150 (1)	220 (1)	6.6 (1)		
Total Alluvium (calculated)	12 (21) 10-17	412 (64) 198-647	0.9 (62) <0.01-8.7	0.7 (63) <0.01-5.3	86 (64) 66-120	25 (64) 6-48	3.0 (54) <0.1-14	15 (63) 6.9-37	274 (64) 115-449	77 (64) 27-188	23 (63) 3-52	0.3 (63) 0.1-1.0	17 (63) <0.1-106	314 (64) 126-454	225 (64) 94-368	89 (64)	7.3 (64) 6.6-8.1	627 (63) 279-1000	0.4 (2) 0.3-0.4
Zone 4 Pleistocene (<125') (Figure 7)	12 (2) 11-12	338 (3) 311-358	0.4 (3) 0.2-0.5	tr (3) 0.0-tr	49 (3) 41-53	18 (3) 15-19		55 (3) 52-59	333 (3) 317-347	34 (3) 22-47	5 (3) 2-6	0.2 (3) 0.0-0.6	1 (3) 0.0-4	195 (3) 164-211	195 (3) 164-211	0 (3)	7.5 (3) 7.1-7.7		
Zone 5 Pleistocene (<125') (Figure 7)	11 (1)	379 (2) 270-488	3.0 (2) 2-4	0.0 (2)	57 (2) 54-59	22 (2) 19-25		67 (2) 31-102	417 (2) 285-549	8 (2) 5-10	7 (2) 3-11	0.7 (2) 0.3-1.0	tr (2) 0.0-tr	232 (2) 213-250	232 (2) 213-250	0 (2)	7.7 (2) 7.3-7.8		
Zone 6 Pleistocene (<125') (Figure 7)	12 (2) 10-14	529 (6) 451-741	1.7 (6) 0.6-2.8	0.07 (6) <0.05-0.09	110 (6) 90-146	37 (6) 30-51	3.3 (4) 3.0-3.5	32 (6) 20-35	475 (6) 418-547	86 (6) 13-199	4 (6) 1-9	0.5 (6) 0.3-1.2	2 (6) <0.1-8	424 (6) 348-576	376 (6) 343-448	48 (6)	7.4 (6) 7.0-7.6	814 (5) 733-1057	
Zone 7 Pleistocene (<125') (Figure 7)	12 (13)	634 (10) 566-684	1.7 (10) 1.0-4.0	0.04 (10) <0.01-0.24	85 (10) 79-91	31 (10) 28-34	3.7 (9) 2.7-4.4	100 (10) 96-110	460 (10) 432-481	164 (10) 130-190	5 (10) 3-11	0.6 (10) 0.5-0.6	2 (10) <0.1-9.7	341 (10) 330-357	341 (10) 330-357	0 (10)	7.7 (10) 7.3-8.0	964 (10) 811-1010	
Zone 8 Pleistocene (>125') (Figure 8)	12 (9) 12-13	444 (22) 397-565	2.1 (22) 0.4-9.6	0.06 (22) <0.01-0.17	58 (22) 42-114	20 (22) 11-49	2.8 (17) 1.9-5.3	86 (22) 20-100	488 (22) 295-576	21 (22) <0.1-191	1 (22) <0.5-7	0.7 (22) 0.3-1.0	2 (22) <0.1-27	227 (22) 184-486	226 (22) 184-472	1 (22)	7.8 (22) 7.3-8.2	725 (19) 630-800	
Zone 9 Pleistocene (>125') (Figure 8)	13 (2) 12-14	1007 (5) 970-1050	1.9 (5) 1.0-2.8	0.02 (5) <0.01-0.05	135 (5) 130-140	50 (5) 46-54	3.8 (5) 3.0-4.7	109 (5) 105-110	422 (5) 415-426	436 (5) 420-460	5 (5) 4-6	0.6 (5) 0.5-0.8	3 (5) <0.1-12	545 (5) 520-575	345 (5) 340-349	200 (5)	7.6 (5) 7.4-7.7	1380 (5) 1300-1400	
Zone 10 Pleistocene (>125') (Figure 8)	12 (2) 12-13	1558 (14) 1298-2444	2.6 (14) 1.2-15	0.5 (14) 0.04-0.11	144 (14) 84-160	73 (14) 53-171	7.9 (11) 7.6-8.3	194 (14) 146-222	289 (14) 237-343	808 (14) 703-940	7 (14) 4-12	0.5 (14) 0.3-2.0	3 (14) <0.1-30	661 (14) 573-913	237 (14) 194-281	424 (14)	7.7 (14) 7.1-7.9	1848 (13) 1600-2280	
Zone 11 Buried Channel (Figure 11)	13 (1)	1150 (6) 476-1694	5.6 (6) 0.9-28	0.2 (6) 0.1-0.3	114 (6) 56-145	47 (6) 21-56	5.8 (4) 5.4-6.4	183 (6) 89-387	335 (6) 266-464	567 (6) 12-887	7 (6) 3-15	0.4 (6) 0.3-0.6	2 (6) <0.1-7	473 (6) 226-567	248 (6) 218-318	225 (6)	7.5 (6) 7.0-7.8	1475 (6) 750-2000	
Total Pleistocene (calculated)	12 (22) 10-14	806 (68) 270-2444	2.4 (68) 0.2-28	0.06 (68) <0.01-0.3	94 (68) 41-160	39 (68) 11-171	4.5 (50) 1.9-8.3	114 (68) 20-387	414 (68) 237-576	289 (68) <0.1-940	4 (68) <0.5-15	0.6 (68) 0.0-2.0	2 (68) <0.1-30	394 (68) 164-913	268 (68) 164-472	126 (68)	7.7 (68) 7.0-8.2	1160 (58) 630-2280	
Zone 12 Mississippian (Figure 18)	12 (1)	1056 (3) 525-1577	1.2 (3) 0.3-2.5	0.03 (3) tr-0.07	95 (3) 46-181	46 (3) 24-90	4.0 (1)	164 (3) 78-252	350 (3) 246-493	473 (3) 22-865	12 (3) 2-29	0.4 (3) tr-1.0	1 (3) 0.0-3	424 (3) 214-822	231 (3) 202-254	193 (3)	7.3 (3) 7.0-7.7	750 (1)	
Zone 13 Devonian (Figure 22)	12 (1)	733 (2) 542-924	0.8 (2) 0.6-0.9	0.03 (2) 0.0-0.05	101 (2) 79-123	48 (2) 45-51	11 (1)	54 (2) 18-90	269 (2) 184-353	294 (2) 206-381	23 (2) 10-35	0.5 (1)	53 (1)	450 (2) 383-517	220 (2) 151-289	230 (2)	7.8 (2) 7.6-8.0	1055 (1)	
Zone 14 Devonian (Figure 22)	13 (9) 12-13	2399 (15) 868-3860	4.1 (14) 0.01-22.0	0.2 (15) <0.01-2.5	305 (15) 34-434	119 (15) 9.8-160	14 (7) 9.6-22	189 (15) 59-550	248 (15) 27-493	1288 (15) 233-1900	11 (15) 1-87	1.1 (15) 0.5-2.2	1 (15) <0.1-4	1242 (15) 125-1631	198 (15) 114-253	1044 (15)	7.4 (15) 7.1-8.0	2504 (9) 1250-3450	3.3 (1)
Zone 15 Silurian and Silurian-Devonian (Figure 26)	14 (8) 13-16	454 (24) 300-795	1.5 (24) 0.2-6.6	0.05 (24) <0.01-0.22	80 (24) 66-142	31 (24) 23-59	6.3 (22) 2.1-8.6	35 (24) 13-54	343 (24) 315-366	109 (24) 39-177	3 (23) <0.5-8	0.5 (24) 0.3-0.6	1 (24) <0.1-8	325 (24) 268-598	281 (24) 258-300	44 (24)	7.5 (24) 7.2-8.0	707 (24) 530-1316	1.7 (1)
Zone 16 Silurian-Devonian (Figure 26)	14 (3) 12-15	1477 (11) 1158-1630	1.0 (11) 0.06-2.7	0.05 (11) <0.01-0.14	202 (11) 125-244	84 (11) 57-110	13 (11) 10-15	102 (11) 88-140	310 (11) 294-344	753 (11) 403-950	9 (9) 4-17	0.4 (11) 0.3-0.5	0.3 (11) <0.1-1.1	848 (11) 547-1050	254 (11) 241-282	594 (11)	7.3 (11) 6.9-7.8	1725 (11) 1350-2100	5.6 (1)
Zone 17 Silurian and Silurian-Devonian (Figure 26)	13 (2) 12-13	2412 (5) 2030-2804	4.2 (5) 0.3-12	0.05 (5) 0-0.25	310 (5) 260-342	143 (5) 115-162	14 (5) 13-17	147 (5) 120-200	241 (5) 217-256	1424 (5) 1300-1561	13 (5) 11-14	0.7 (5) 0.4-0.8	1 (5) <0.1-5.3	1367 (5) 1140-1479	198 (5) 178-210	1169 (15)	7.4 (5) 7.1-7.8	2400 (5) 2230-2600	
Zone 18 Silurian-Devonian (Figure 26)	18 (1)	3357 (3) 3320-3389	2.8 (3) 0.2-6.5	0.06 (3) <0.05-0.08	403 (3) 352-491	139 (3) 131-146	22 (2)	322 (3) 231-380	252 (3) 249-259	1979 (3) 1968-2000	19 (3) 18-21	1.6 (3) 1.5-1.8	1 (3) <0.1-2.7	1582 (3) 1450-1827	207 (3) 204-212	1375 (3)	7.0 (3) 7.0-7.1	3695 (2) 3600-3790	
Zone 19 Cambrian-Ordovician (Figure 30)	22 (10) 16-24	1667 (23) 1090-3692	2.6 (23) 0.0-8.8	0.06 (21) <0.01-0.3	158 (23) 98-379	66 (23) 48-123	22 (13) 18-28	228 (23) 28-518	296 (23) 220-337	844 (23) 510-2224	42 (23) 33-60	1.0 (23) 0.2-1.4	1 (22) <0.1-5.8	662 (23) 449-1453	243 (23) 180-276	419 (23)	7.5 (23) 7.0-8.0	1985 (22) 1480-3920	6.1 (1)

Standards for uses other than drinking water often differ from these. Water which is unacceptable for drinking may be completely satisfactory as industrial cooling water. Conversely, drinking water may be unacceptable for certain industrial processes due to elevated concentrations of a critical parameter, such as calcium and sulfate which forms scale in boiler pipes.

Alluvial aquifer

Alluvial aquifers collectively provide the best quality water in the county, Table 4. Total dissolved solids are about 412 mg/l, which is less than the recommended maximum. Hardness averages 314 mg/l which is technically classified as hard water. The sulfate content averages 77 mg/l.

The highly variable nitrate concentrations reflects the fact that alluvial deposits are susceptible to contamination by infiltration of surface water. Great care should be taken when developing a well in an alluvial source. Potential pollution sources should be identified and the well located or constructed to eliminate problems caused by surficial contaminants.

Glacial-drift and buried-channel aquifers

Deeper sources of groundwater generally are more highly mineralized. The total dissolved solids content, the indicator of amount of mineralization of water, ranges from 270 mg/l to 2444 mg/l while hardness and sulfate (SO_4) also vary widely. This is attributed to both depth and individual characteristics of the aquifer (Table 4).

Mississippian aquifer

There are only three water analyses available from the Mississippian aquifer in Iowa County. In general, water from the Mississippian aquifer is more highly mineralized than water from the most of the glacial drift aquifer Table 4.

Devonian, Silurian, and Silurian-Devonian aquifers

Water quality in the Devonian, Silurian, and Silurian-Devonian aquifers becomes more highly mineralized towards the southwest. The best water quality for these aquifers is in the northeast corner of the county where total dissolved solids concentrations are less than 1000 mg/l, hardness is less than 500 mg/l, and sulfate is usually less than 250 mg/l (Table 4).

Cambrian-Ordovician aquifer

The Cambrian-Ordovician aquifer, primarily the Jordan Sandstone, provides water which is generally intermediate in quality (Table 4).

Cambrian System, Elk Mound Group

Since there are no wells which utilize water from these rocks units, it is difficult to determine water quality. Data from counties to the east-northeast of Iowa County, indicate that the total dissolved solids in Iowa County are probably greater than 5000 mg/l. This is classified as brackish or moderately saline water, making it unsuitable as drinking water.

Recommendations for Private Water Wells

Well Location

When the criteria for water availability, yield, and quantity have been satisfied, the problem of distribution of water from the well becomes paramount. First, it is important that the well is located where it will be least subject to local contamination. For a new well, leave a sufficient distance between the well and any potential contamination sources, Table 5. Protect an existing well by observing minimum separation distances when locating new facilities which may be potential sources of contamination. Greater distances should be maintained wherever possible.

The use of a well pit is no longer recommended as such pits are easily contaminated. The well site should not be subject to flooding or surface water drainage. Select a well-drained site and extend the well casing a few feet above the ground. Mound earth around the casing and divert surface runoff around the well site by the use of diversion terraces or ditches. Care should be taken to grout the area between the well casing and the bore hole so that surface water cannot seep down on the outside of the casing and contaminate the aquifer as well as the well. To prevent the seepage of shallow groundwater into the well, the casing should be watertight.

Water Treatment

Following well construction, repair, or maintenance, disinfection of the well and distribution system is recommended. Shock chlorination is a convenient method to combat nuisance and disease-causing organisms which remain in the water system. Shock chlorination is a one-time use of a strong chlorine solution which will disinfect the surfaces with which it comes in contact. Shock chlorination should be repeated if the first treatment does not rid the system of bacteria. If repeated treatments do not solve the problem of disinfection, the water should be continously disinfected with the proper chlorination equipment, or the well should be abandoned.

Since the groundwater of Iowa County is mineralized to varying degrees, water treatment may make the water more palatable and pleasant to use. There are many treatments available for specific desired results. Some common treatments are: disinfection (mentioned above), filtration, distillation, ionic exchange, reverse osmosis, adsorbtion, oxydation, and softening.

Commonly, softened water increases the sodium content of the treated water. If you are on a sodium-restricted diet, you should consult your physician before using this type of water softener.

Table 5

Minimum lateral distances between wells and common sources of contamination. (From Iowa Administrative Code)

Source of Contamination	Minimum Lateral Distance (in feet)
Lagoons or waste treatment facilities and sanitary landfills ...	1000
Cesspools	150
Preparation or storage area for spray materials, commercial fertilizers or chemicals that may result in groundwater contamination	150
Drainage or improperly abandoned wells	100
Soil absorption field, pit privy, or similar disposal unit	100
Confined feeding operations	100
Septic tank, concrete vault privy, sewer, or tightly jointed tile or equivalent material, sewer-connected foundation drain, or sewers under pressure	50
Ditches, streams, or lakes	25
Sewer of cast iron with leaded or mechanical joints, independent clear water drains, or cisterns	10
Pumphouse floor drain draining to ground surface (Drains must not be connected to any sewer or drainage system)	5

Chlorination followed by filtration will remove most forms of iron and iron bacteria. Iron bacteria is not known to have an effect on human health, but it will plug wells, pumping and treatment equipment, and distribution lines. It can cause unpleasant taste and odor. It is usually the cause of "red water." If the problem persists, shock chlorination or iron-removal equipment can be used.

Water Testing

Many contaminants, like nitrate or bacteria, are undetectable by taste, sight, or smell. Therefore, water analysis is essential in identifying contaminants in your water supply. Biological quality should be of primary concern since this type of contamination is most likely to affect health. Water from a private well should be tested once or twice a year. Your water supply should also be tested after shock chlorination, or any other time the distribution system, including the well, has been opened for repairs or maintenance.

The University of Iowa State Hygienic Laboratory will run tests for coliform bacteria, nitrate, iron, hardness, and iron bacteria in drinking water for private individuals. Special sample bottles used for collecting the supplies are obtainable from the State Hygienic Laboratory, University of Iowa, Oakdale Campus, Iowa City, Iowa 52242. Indicate the number of water supplies to be tested, the materials you wish the sample analyzed for, and whether the water supply is being treated with disinfecting chemicals such as chlorine, bromine, or iodine because different sample bottles must be used for treated and untreated water. The 1985 charges from the State Hygienic Laboratory are: bacterial analysis only--\$6; nitrate only--\$9; nitrate and bacteria--\$10; iron bacteria only--\$10; iron bacteria, calcium hardness, nitrate--\$10. . There are also several certified private laboratories which run water analyses.

Analysis for naturally occurring minerals should be performed any time water-conditioning equipment is being considered as the performance of the equipment may be affected by the minerals which are not being treated. Tests for organic or man-made chemicals need only be made if a spill has occurred into or near a water supply, as these tests are quite expensive. If a spill has occurred, every attempt should be made to flush the chemical from the well and distribution system before testing.

Well Abandonment

Wells taken out of service provide easy access for pollutants to enter the groundwater aquifers supplying water to other wells in the vicinity. Proper abandonment procedures should be followed. Piping or other obstructions should be removed, the uppermost 10 feet (at least) of casing should be removed, and the entire length of the well should be completely filled with cement grout, or sealing clays. A cement cap for the upper few feet is strongly recommended. The site can then be completely filled with compacted earth.

Temporary abandonment procedures ensure that surface water will not enter the well, thus protecting the aquifer. This is not an alternative for proper plugging techniques. Abandoned wells should never be used for disposal of sewage or other waste materials.

Contracting for Well Construction

To obtain a good well and protect your investment may require contacting more than one drilling contractor. Dealing with a reputable contractor, who is familiar with the geology and incorporates basic sanitary construction features, should guarantee satisfactory well completion. It is best to obtain a written contract which protects both the contractor and the owner. The contract should specify:

well size, casing specifications, type of well screen and well seal; well log of materials encountered during drilling; depth to water; type of well development; test-pumping procedures; depth and type of grouting materials; disinfection procedures to be used; date of completion; itemized cost list including drilling charges per foot, materials used per foot, construction operations such as well development and test pumping, guarantee of materials, workmanship, and that all work complies with current recommended standards; liability insurance for owner as well as contractor.

Well Drillers and Contractors

These selected drillers and contractors are within an approximate radius of 50 miles from Iowa County. For a statewide listing, contact the Iowa Water Well Driller's Association, 4350 Hopewell Avenue, Bettendorf, Iowa 51712, (319) 355-7528 or the Iowa Geological Survey, 123 North Capitol Street, Iowa City, Iowa 52242, (319) 338-1173.

Kringle Well Drilling
Cascade, IA 52033

Gingerich Well Co.
R.R. #2
Kalona, IA 52247

R. E. Novotny
Route 2,
Indian Creek Rd.
Marion, IA 52302

Novotny & Son Well Drilling
R.R. #2
Shueyville, IA 52338

McBurney Well Co.
R.R. #1
Toddville, IA 52341

Ralston Well Drilling
1915 Bever Ave. SE
Cedar Rapids, IA 52403

Schlicher Well Co.
P.O. Box 207
Donnellson, IA 52625

Southeast Iowa Well Drilling
East Main
New London, IA 52645

Brockhouse Well
518 Adams
Muscatine, IA 52761

Dwayne Bruinekool
R.R. #3
Oskaloosa, IA 52577

Clair Nikkel Well Drilling
R.R. #1, Box 64
Laurel, IA 50141

Marengo Plumbing and Heating
699 Eastern Ave.
Marengo, IA 52301

Latta Well & Pump
Rural Route
Wilton, IA 52778

Latta & Sons
Riverside, IA 52327

Shilanek Well Drilling
310 E 7th Street
Tama, IA 52339

Speidel Well Co.
Box 174
Vinton, IA 52349

Kaldenberg Well Service
Reasnor, IA 50232

Chuck Andries
2122 Independence
Waterloo, IA 50707

Ellison Well Drilling
Box 13
Mountpelier, IA 52759

Dwayne Bruinekool
Route 3
Oskaloosa, IA 52577

Detrick Well Co.
RR #1
New London, IA 52645

Neal Lyon Well Co.
P.O. Box 112
Salem, IA 52649

H M White & Son
P.O. Box H
Lincoln, IA 50652

Wilford Denison Well Drilling
208 W. Oak
North English, IA 52316

Winslow Well Co.
P.O. Box 222, Rt. 1
Maysville, IA

Schlicher Bros. Well Co.
R.R. 2, Box 43
Hwy. 34 West
Fairfield, IA 52556

Jack Kremer
R.R. #3
Mt. Pleasant, IA 52641

Wayne Smith Well Drilling
Box 195
West Liberty, IA 52776

Additional Information

In planning the development of a groundwater supply or contracting for the drilling of a new well, additional information is often required. This section lists several types and sources of information.

State Agencies

Iowa Department of Natural Resources (515) 281-8666
Environmental Protection Division
Wallace Building
Des Moines, IA 50319-0034
(Pollution problems, public drinking water, wastewater treatment, water quality, assistance to local communities, protection of surface and underground reservoirs, allocates water use, permits water use of 25,000 or more gallons per day)

Environmental Protection Division (319) 653-2135
Regional Office No. 6
117 N. 2nd Avenue
Washington, IA 52343
(Municipal water supplies and waste water treatment routine sanitary inspections, local pollution problems, assitance to communities)

Energy and Geological Resources Division
Geological Survey Bureau (319) 338-1173
123 North Capitol Street
Iowa City, IA 52242
(Geologic and groundwater data repository, consultant for well problems, well forecasting, hydrogeologic research, and related services)

Iowa Department of Public Health (515) 281-4942
Lucas Building
Des Moines, IA 50319
(Promotes public health, hygiene and sanitation; programs of health education, quality of health care)

University of Iowa Hygienic Laboratory (319) 353-5990
University of Iowa
Oakdale Campus
Iowa City, IA 52242
(Water analyses)

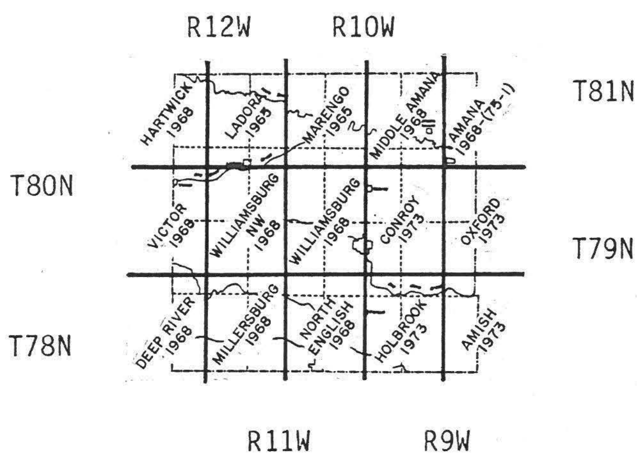
Cooperative Extension Service (515) 294-4569
Iowa State University
Ames, IA 50011
(Advice on water system design and maintenance)

Topographic Maps

Figure 31 shows the 7 1/2 minute quadrangle maps which cover Iowa County. The map names are followed by the date of publication. All these maps are at the same scale, 1:24,000, and have a contour interval of 10 feet. They are all available from the Iowa Geological Survey, 123 North Capitol Street, Iowa City, Iowa 52242, for $2.50 each (1986 price) plus postage and handling charges.

Figure 31.

Topographic Maps for Iowa County



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