GROUNDWATER RESOURCES

Hardin County

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Geological Survey Bureau

Introduction

Virtually all of the residents of Hardin County rely on groundwater as the source of their drinking water. Estimated use of groundwater in the county is approximately 1.2 billion gallons per year.

The users of groundwater in the county draw their supplies from several different geologic sources. Various factors must be considered in determining the availability of groundwater and the adequacy of a supply source:

distribution- having water where it is needed

accessibility- affects the costs for drilling wells and pumping water

yield- relates to the magnitude of the supply that can be sustained

quality- determines for what purposes the water can be used

In terms of these factors, there are few locations in Hardin County where the availability of groundwater is not limited to some degree. The most common limitation is poor water quality, that is, highly mineralized groundwater. Secondary limitations are generally related to poor accessibility due to the great depths to adequate sources.

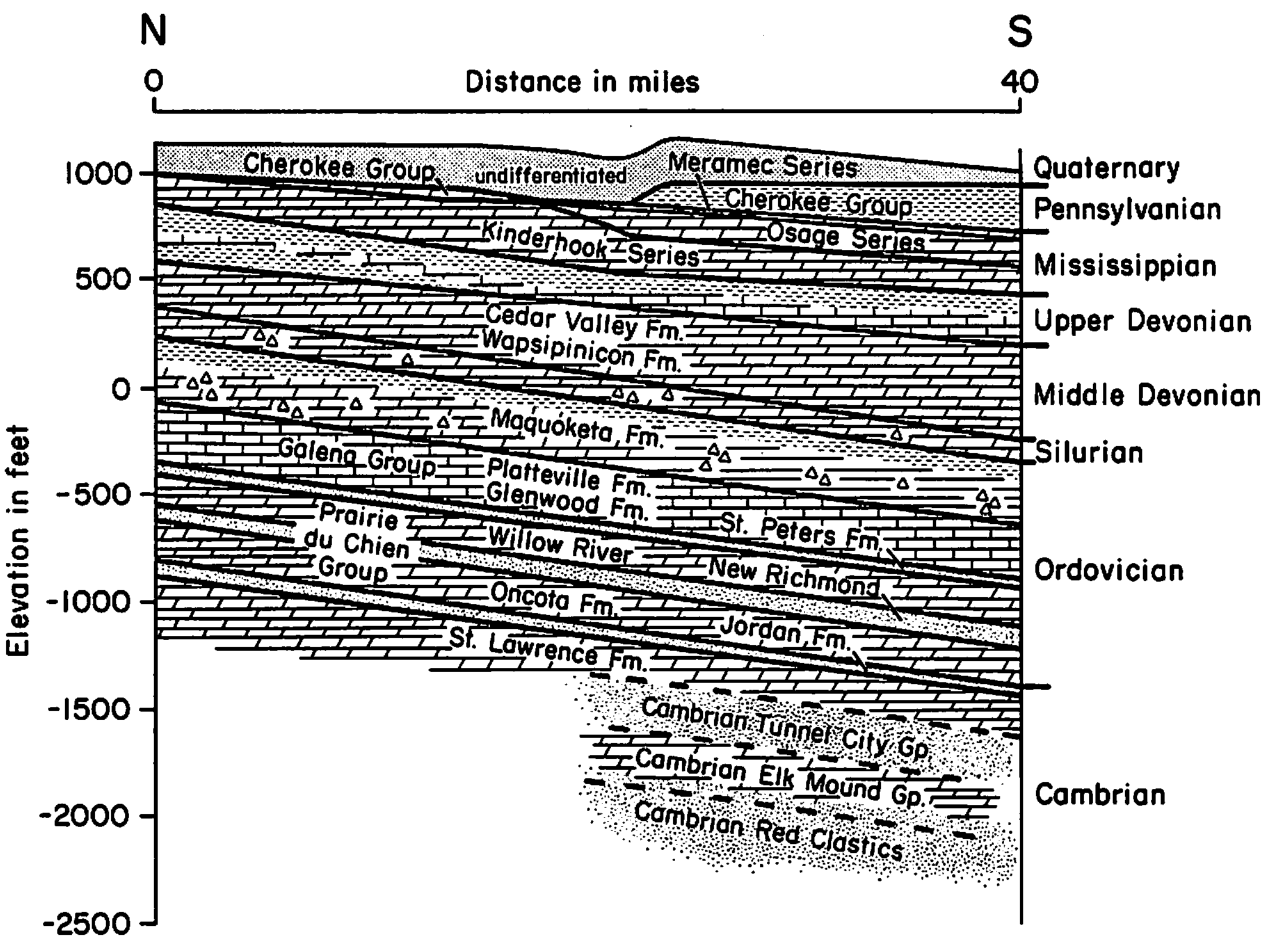
Occurrence of Groundwater in Hardin County

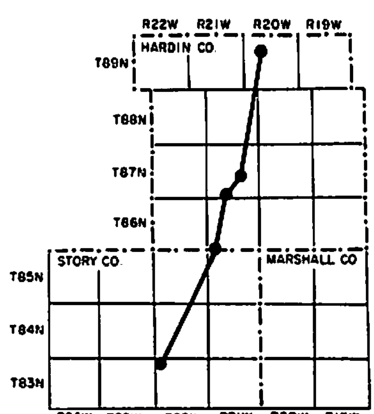
The occurrence of groundwater is influenced by geology -- the position and thickness of the rock units, their ability to store and transmit water, and their physical and chemical make-up. Geologic units that store and transmit water and yield appreciable amounts to wells are called aquifers. The most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

In Hamilton County, the principal sources from which users obtain water supplies are the loose, unconsolidated materials near the land surface that comprise the surficial aquifers, and several deep rock aquifers. Figure 1 is a cross section showing

Figure 1

GEOLOGIC CROSS-SECTION ACROSS HARDIN COUNTY





the geologic relations of aquifers beneath the county. Each aquifer has its own set of geologic, hydrologic, and water-quality characteristics which determine the amount and potability (suitability for drinking) of water it will yield. Table 1 lists the geologic and hydrogeologic characteristics of the aquifers underlying Hardin County.

Surficial Aquifers

Surficial deposits consist of mixtures of clay, silt, sand, gravel, and assorted boulders. The water-yielding potential of surficial deposits is greatest in units composed mostly of sand and/or gravel. In most Iowa counties, three types of surficial aquifers exist: alluvial, drift, and buried channel aquifers.

Alluvial aquifers (Fig. 2) consist mainly of sand and gravel deposited by streams and associated with the floodplains and terraces of major valleys. Alluvial deposits lie close to the land surface, and are generally less than 50-60 feet thick. Thus, alluvial aquifers are highly susceptible to contamination. Yields in alluvial systems are often quite variable due in part to the inhomogeneity of the sediment and to rapid lateral changes in thickness. Yields from 20-100 gallons per minute can be expected from the alluvial deposits in Hardin County. Higher yields may be possible in some locations.

Drift aquifers (Fig. 3) are found in the thick layer of clay-to-boulder-size material (till) deposited by glacial ice which invaded the county several times in the last two million years. The composition of the glacial drift varies considerably, and in many places does not yield much water. There are, however, lenses or beds of sand and gravel in the drift which are thick and widespread enough to serve as dependable water sources. Usually one or two sand layers can be found in most places that will yield minimum water supplies for domestic wells. Yields from glacial drift aquifers are generally low, often below 10 gallons per minute.

Buried channel aquifers consist of sand and gravels found in stream valleys that existed before the glacial period. The valleys were later overridden by the glaciers, and are now buried under the glacial drift. The former valleys may or may not coincide with present day stream valleys. No large buried channel aquifers are recognized in Hardin County.

The distribution and water-quality characteristics for the surficial aquifers are summarized in Figure 4 and Table 3,

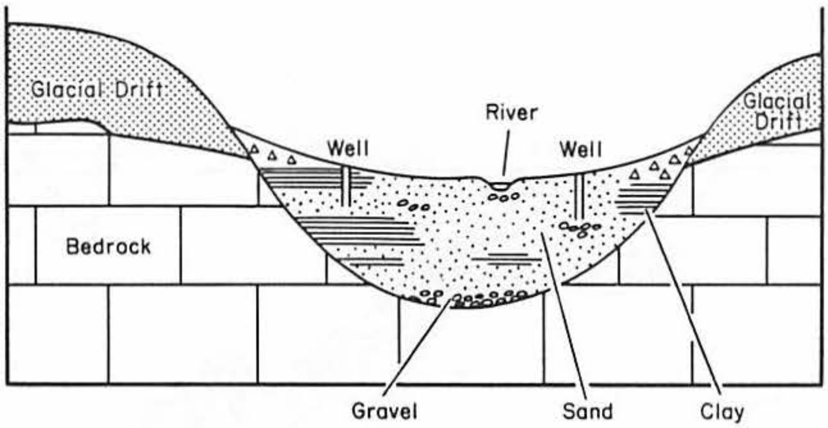
Table 1

GEOLOGIC AND HYDROLOGIC UNITS IN HARDIN COUNTY

GEOLOGIC AGE	SERIES	GROUP	FORMATION	DESCRIPTION	THICKNESS RANGE	HYDROGEOLOGIC UNIT	WATER BEARING CHARACTERISTICS
Quaternary	Pleistocene			alluvium (sand and gravel) glacial drift (clay, loess, sand and gravel)	0-30 5-350	alluvial aquifer glacial drift aquifer	moderate to high yields (50-1000 gpm) low yields (5-30 gpm)
Cretaceous			Dakota	sandstone	0-15	Dakota aquifer	
Pennsylvanian	Des Moines	Cherokee		shale, sandstone	5-130	aquiclude	
Mississippian	Meramec		St. Louis	limestone, dolomite	5-20	Mississippian aquifer	low to high yields (10-200 gpm)
	Osage		Warsaw Keokuk Burlington	shale, dolomite dolomite, shale, chert limestone, dolomite	20-110		
	Kinderhook		Gilmore City Hampton	limestone, dolomite limestone, dolomite	0-215		
		North Hill		dolomite, limestone, siltstone	235-360	aquiclude	
Devonian	Upper	Yellow Spring	English River Maple Mill Aplington Sheffield	shale, siltstone shale, siltstone dolomite shale			
			Lime Creek	shale, dolomite		Devonian aquifer	moderate to high yields (50-300 gpm)
	Middle		Cedar Valley Wapsipinicon	dolomite, limestone shale	100-350		
Silurian				dolomite, chert	0-190	Silurian aquifer	moderate to high yields
Ordovician			Maquoketa	shale, dolomite	215-280	aquiclude	
		Galena	Dubuque Wise Lake Dunleith	dolomite, shale dolomite, limestone dolomite, chert	290-310	Galena aquifer	low yields
			Decorah	shale, limestone		aquiclude	
			Platteville	limestone, shale			
		Ancell	Glenwood	sandstone			
			St. Peter	sandstone	30-55	Cambro-Ordovician aquifer	high yields (100-1000 gpm)
		Prairie du Chien	Shakopee Oneota	dolomite, chert sandstone	400-425		
Cambrian		Trempleau	Jordan	sandstone	50-85		
			St. Lawrence	dolomite	500*	(not known to produce potable water in Hardin County)	
		Tunnel City		sandstone, shale			
		Elk Mound	Mt. Simon	sandstone			
Precambrian				sandstone, quartzite, igneous and metamorphic rocks			

Figure 2

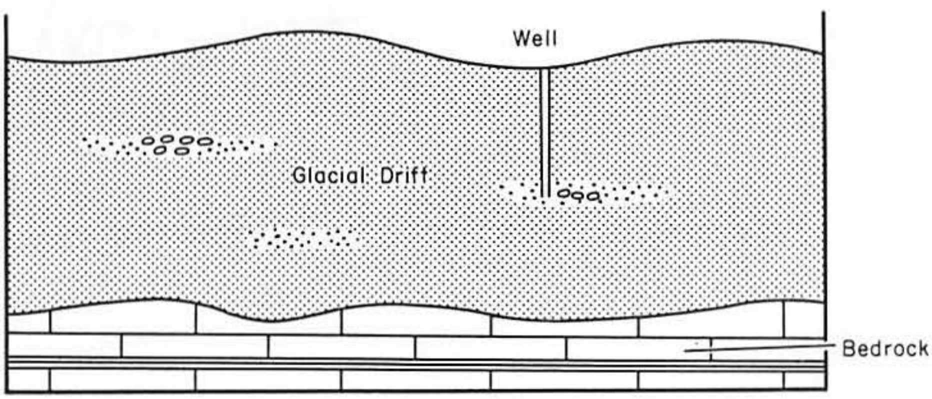
ALLUVIAL AQUIFER



An alluvial aquifer is a sand and gravel deposit which allows relatively free water movement.

Figure 3

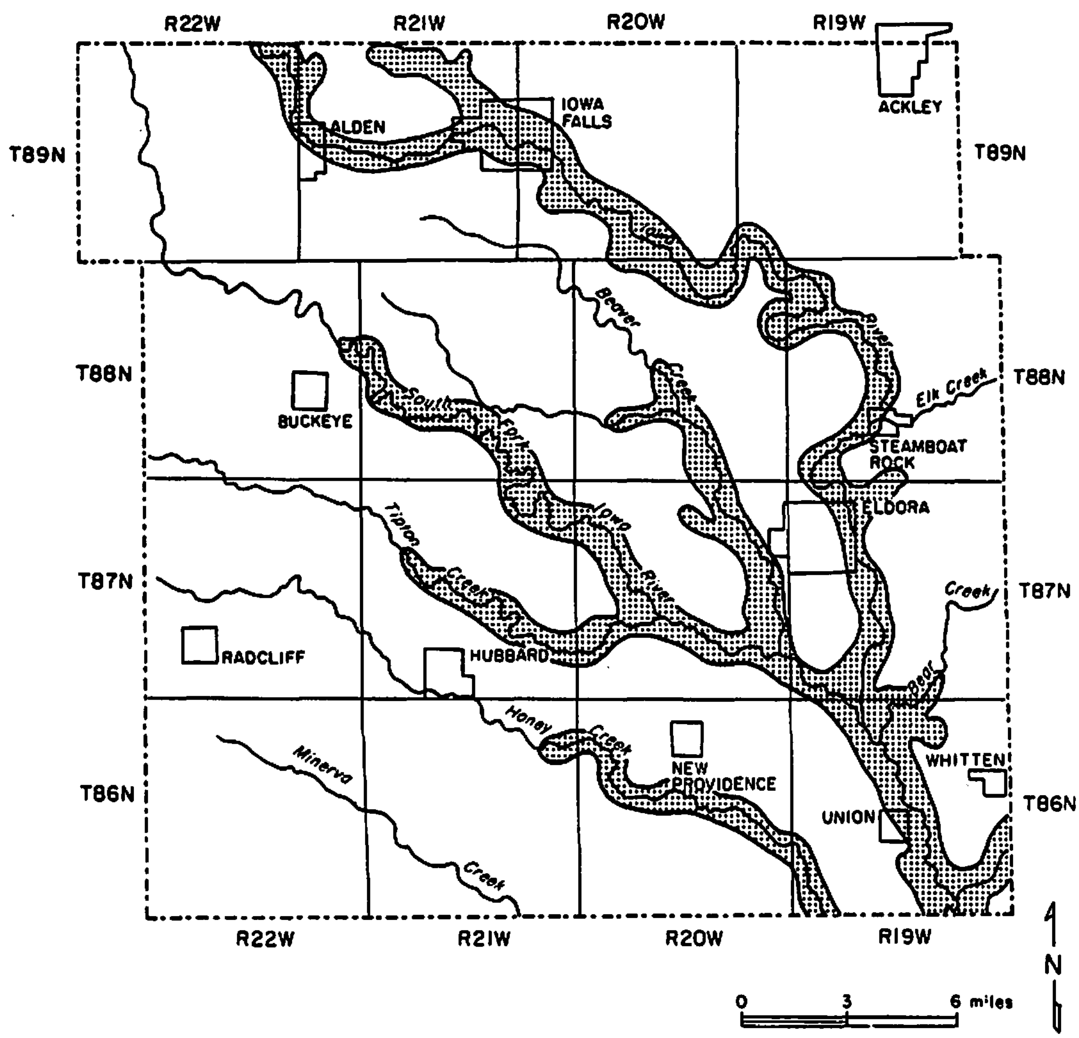
GLACIAL TILL AQUIFER



A drift aquifer is formed by thin discontinuous sand and gravel zones within less permeable drift materials.

Figure 4

DISTRIBUTION OF SURFICIAL AQUIFERS



Alluvial aquifer

Drift aquifer

respectively. An indication of the thickness of the drift can be obtained by comparing the elevations of the land surface with the bedrock surface in Figures 5 and 6, respectively.

Water levels in the surficial aquifers are difficult to analyze because water rises to different levels in wells drilled into alluvial and into drift aquifers. The water table in the alluvial aquifer generally slopes from high land areas toward the streams, although this can be reversed during high stream stages. The surface of the associated stream represents the water table at that location. The source of water in the alluvial system is precipitation which infiltrates the soil. Thus, groundwater levels change noticeably throughout the year in response to precipitation, and are highest in late spring and fall. Water levels in shallow drift aquifers fluctuate in the same way as those in alluvial aquifers. Deeper drift aquifers are under confined (artesian) conditions and are generally unaffected by local recharge-discharge relationships.

Levels in the drift aquifers are commonly from 10-50 feet below the land surface. The water levels in alluvial wells are from 4 to 20 feet below the land surface.

Rock Aquifers

Below the drift and other surficial materials is a thick sequence of layered rocks. These formed from sediments deposited in shallow seas that periodically inundated the state millions of years ago. The geologic map (Fig. 7) shows the geologic units which form the surface of this rock sequence. Two rock aquifers are shown schematically in Figure 8.

The relative accessiblity of groundwater in rock aquifers depends on the depth to the aquifer. The deeper a well must be, the greater the cost for well construction and pumping. The depths to units at specific sites will vary somewhat because of irregularities in the elevation of the land surface and in the elevation of the underlying rock units. Estimates of depths can be made by comparing Figure 6, the land surface elevation map, with the maps of aquifer elevations (Figs. 9,12,16).

A second factor affecting groundwater accessiblity is the level to which the water will rise in a well (the static water level). Throughout the county, water in the rock aquifers is under hydrostatic pressure, and rises in wells when an aquifer is penetrated. This can reduce the cost of pumping.

Rates of yield are also often an important consideration in determining groundwater availability. Yield can be quite variable throughout an aquifer, and in limestone and dolomite aquifers, it is often determined by the presence of fractures in the rock.

Rocks of Pennsylvanian and Mississippian age lie below the

Figure 5

ELEVATION OF LAND SURFACE IN FEET
ABOVE MEAN SEA LEVEL

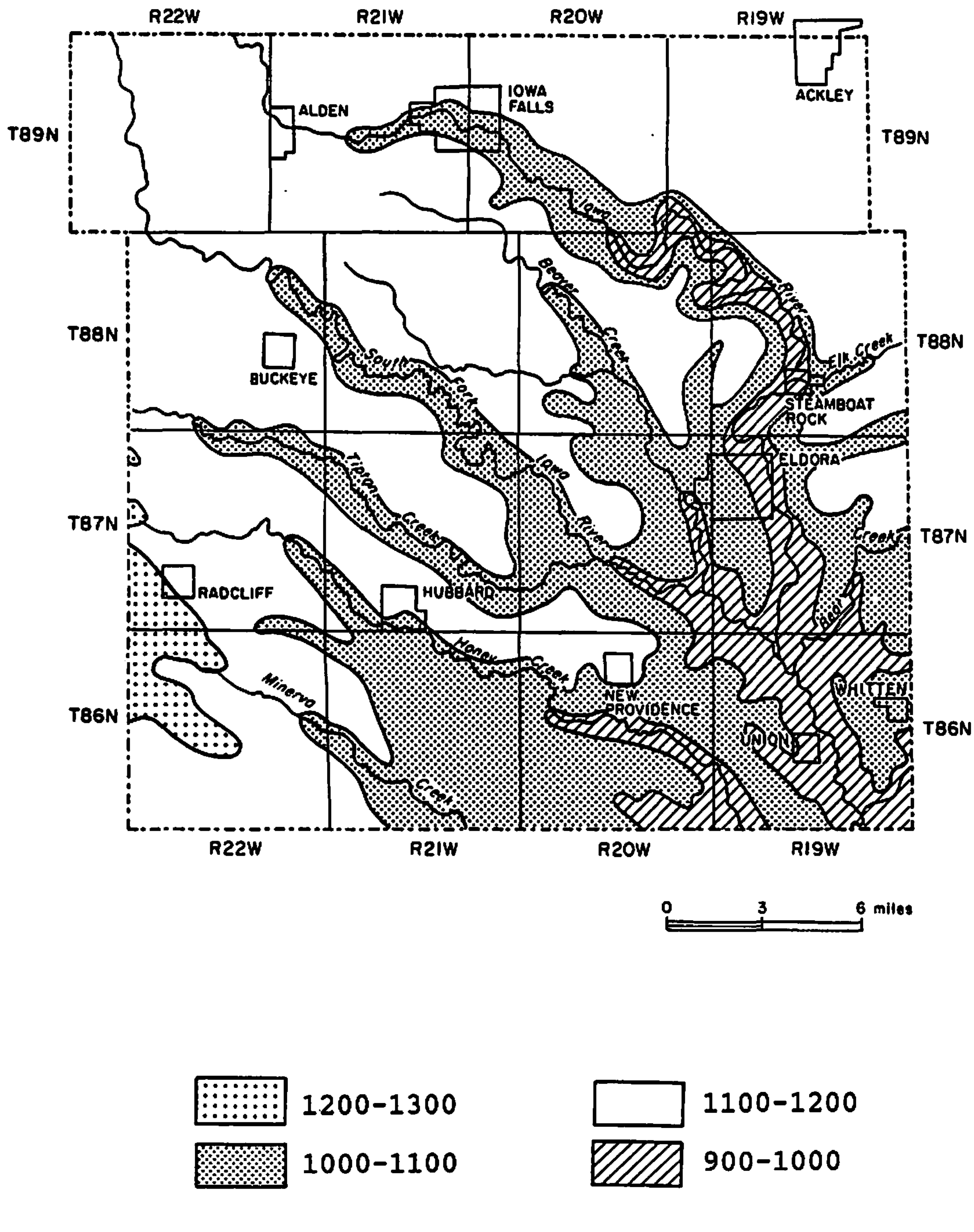


Figure 6

ELEVATION OF BEDROCK SURFACE IN FEET
ABOVE MEAN SEA LEVEL

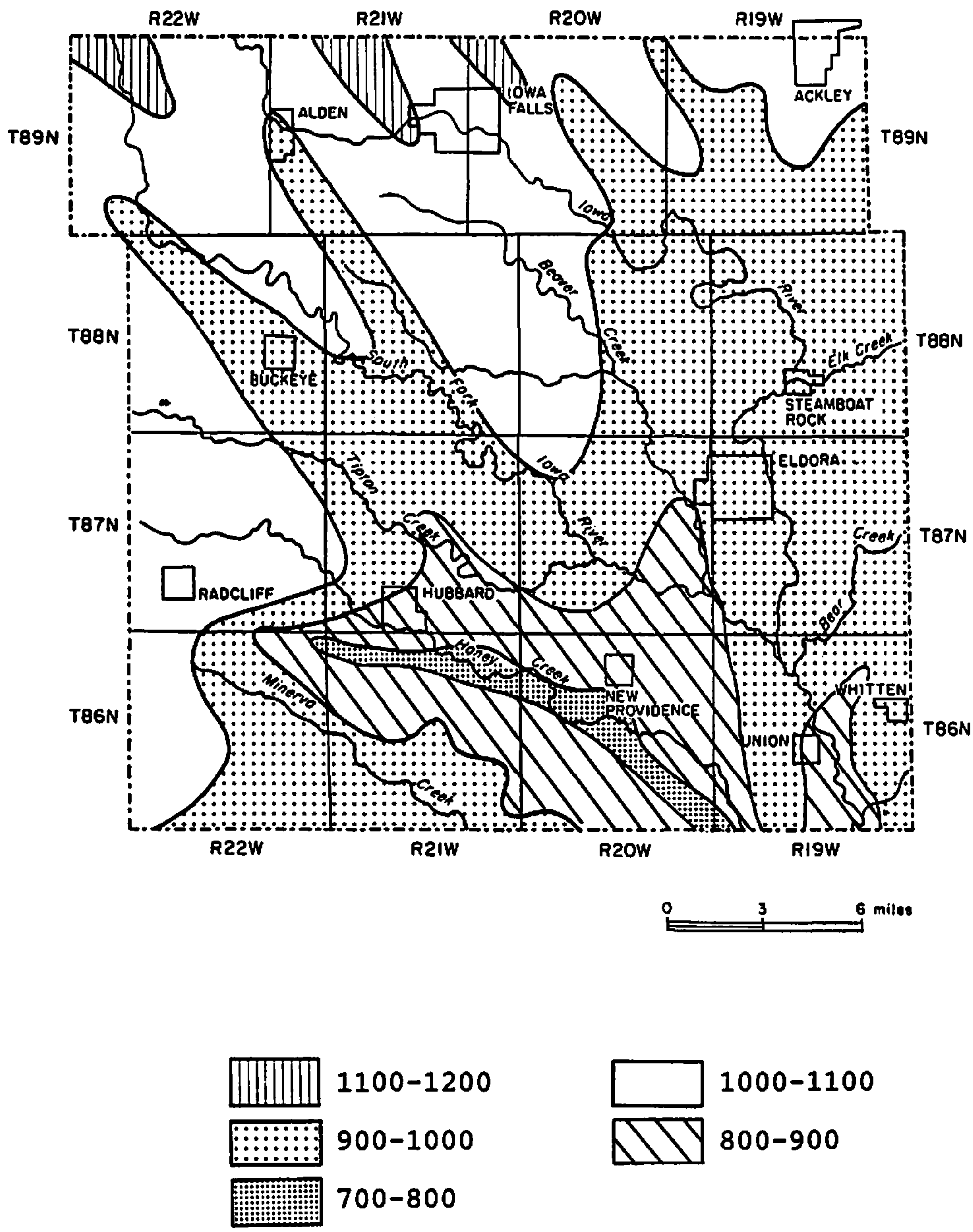
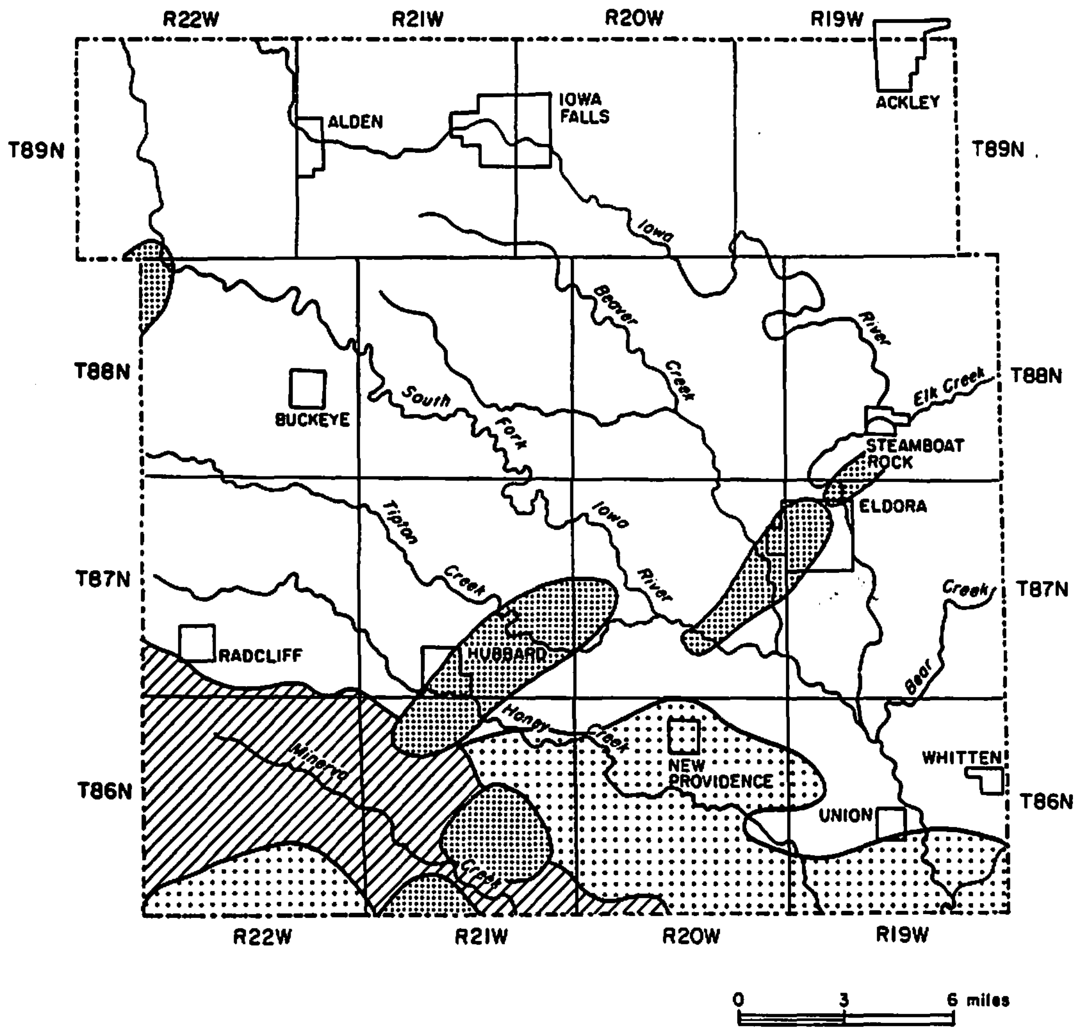


Figure 7

GEOLOGIC MAP



Pennsylvanian Cherokee Group

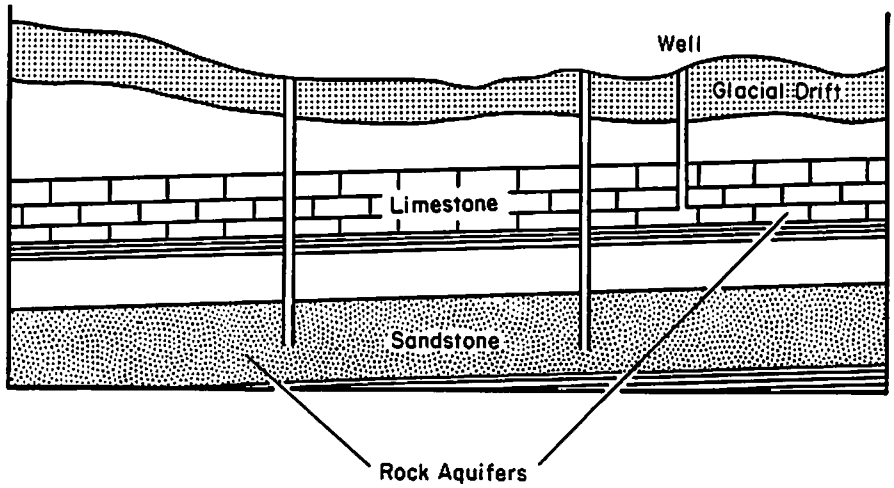
Mississippian Osage Series

Mississippian Meramac Series

Mississippian Kinderhook Series

Figure 8

ROCK AQUIFERS



Water-bearing rock aquifers occur at or below the land surface. Two different types of rock aquifers are shown: one composed of limestone, another of sandstone.

glacial materials in Hardin County. The Pennsylvanian rock sequence is primarily shale, siltstone, and sandstone. Because shales dominate, the Pennsylvanian section acts as an aquiclude.

The Mississippian aquifer is the most frequently utilized groundwater source in Hardin County, and consists of a series of limestones and dolomites. Figures 9, 10 and 11 show respectively the elevation, thickness, and water levels in the Mississippian aquifer. Pumping rates range from 50 to 650 gallons per minute for the municipalities using the Mississippian indicating the aquifer can be highly productive in some areas.

The Silurian-Devonian aquifer (Figs. 12-15) is not heavily utilized in Hardin County except for a few municipal wells which are open to both the Mississippian and parts of the Devonion. Adequate yields are expected from this aquifer as it is quite thick over much of the county; however, poor water quality precludes its use.

The Cambro-Ordovician aquifer is the major deep aquifer in the county, and includes the St. Peter Sandstone, the Prairie du Chien Group, and the Jordan Sandstone, the latter being the major water producer (Figs. 16-19). The St. Peter Sandstone is highly friable and is generally cased out in deep wells. The depth to the Cambro-Ordovician aquifer, which averages 2000 feet, precludes its use by most residents. However, it is the most

Figure 9

ELEVATION AT THE MISSISSIPPIAN AQUIFER
IN FEET ABOVE MEAN SEA LEVEL

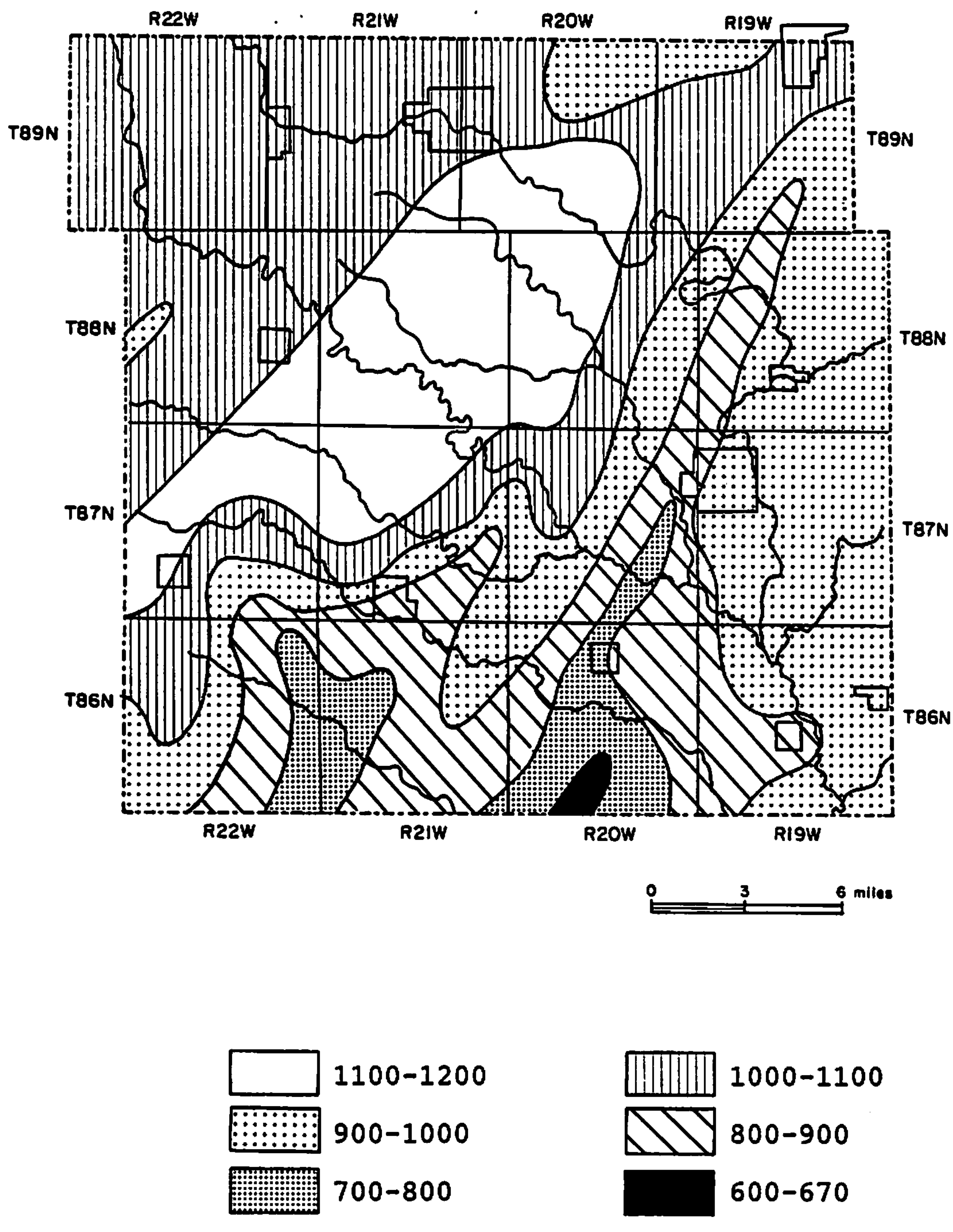


Figure 10

THICKNESS OF MISSISSIPPIAN AQUIFER IN FEET

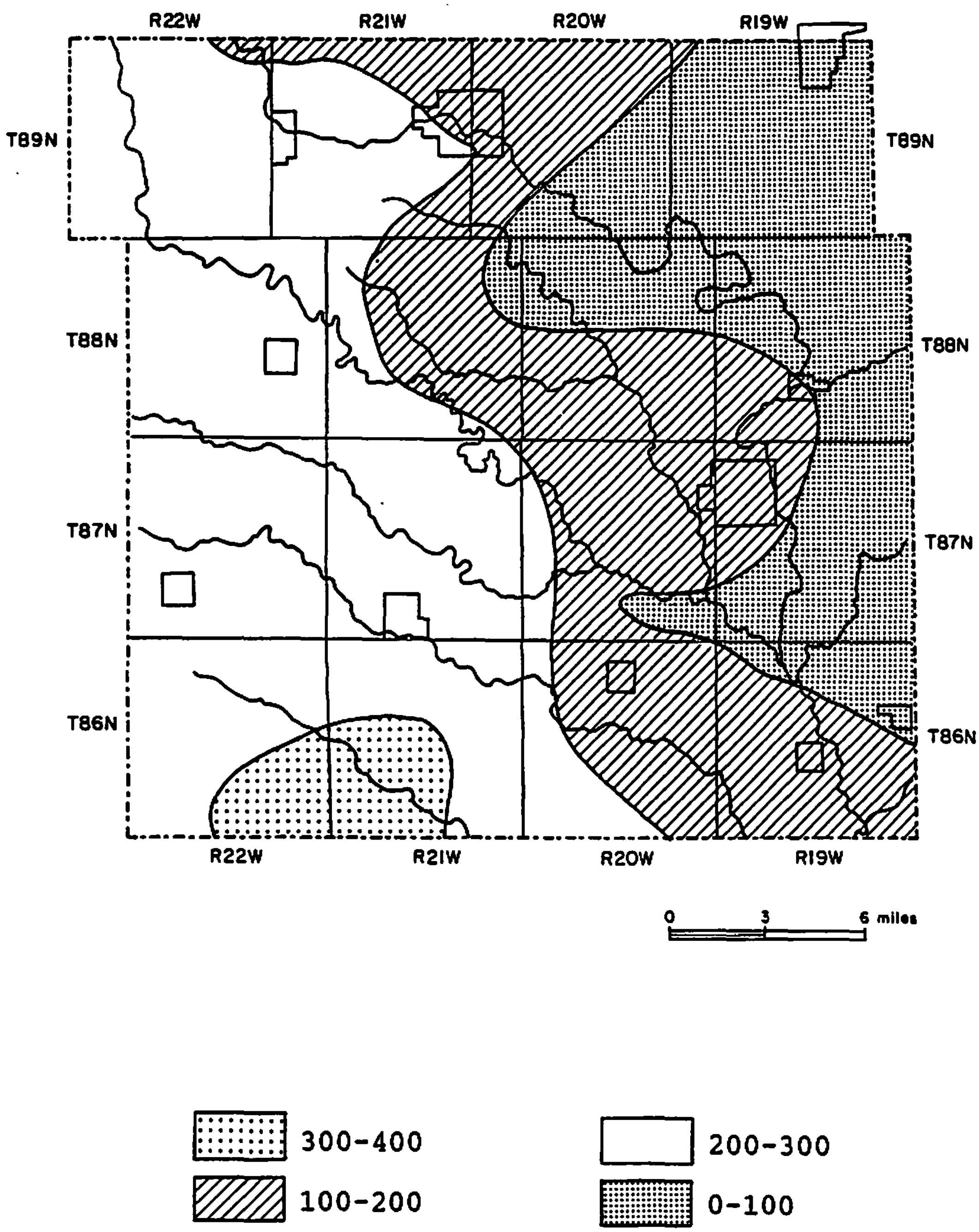


Figure 11

WATER LEVELS IN WELLS COMPLETED IN THE MISSISSIPPIAN AQUIFER IN FEET ABOVE MEAN SEA LEVEL

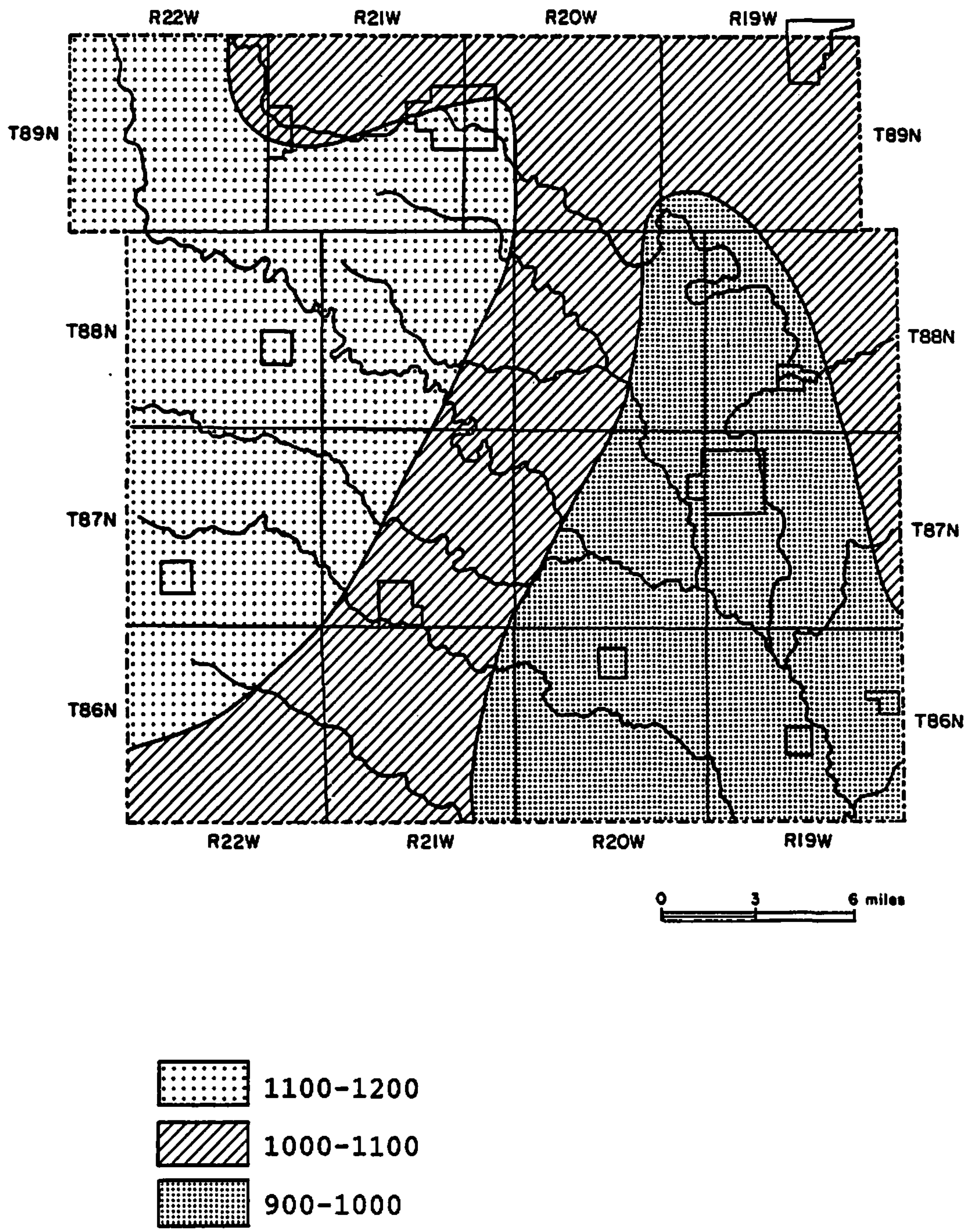


Figure 12

ELEVATION OF SILURIAN-DEVONIAN AQUIFER IN
FEET ABOVE MEAN SEA LEVEL

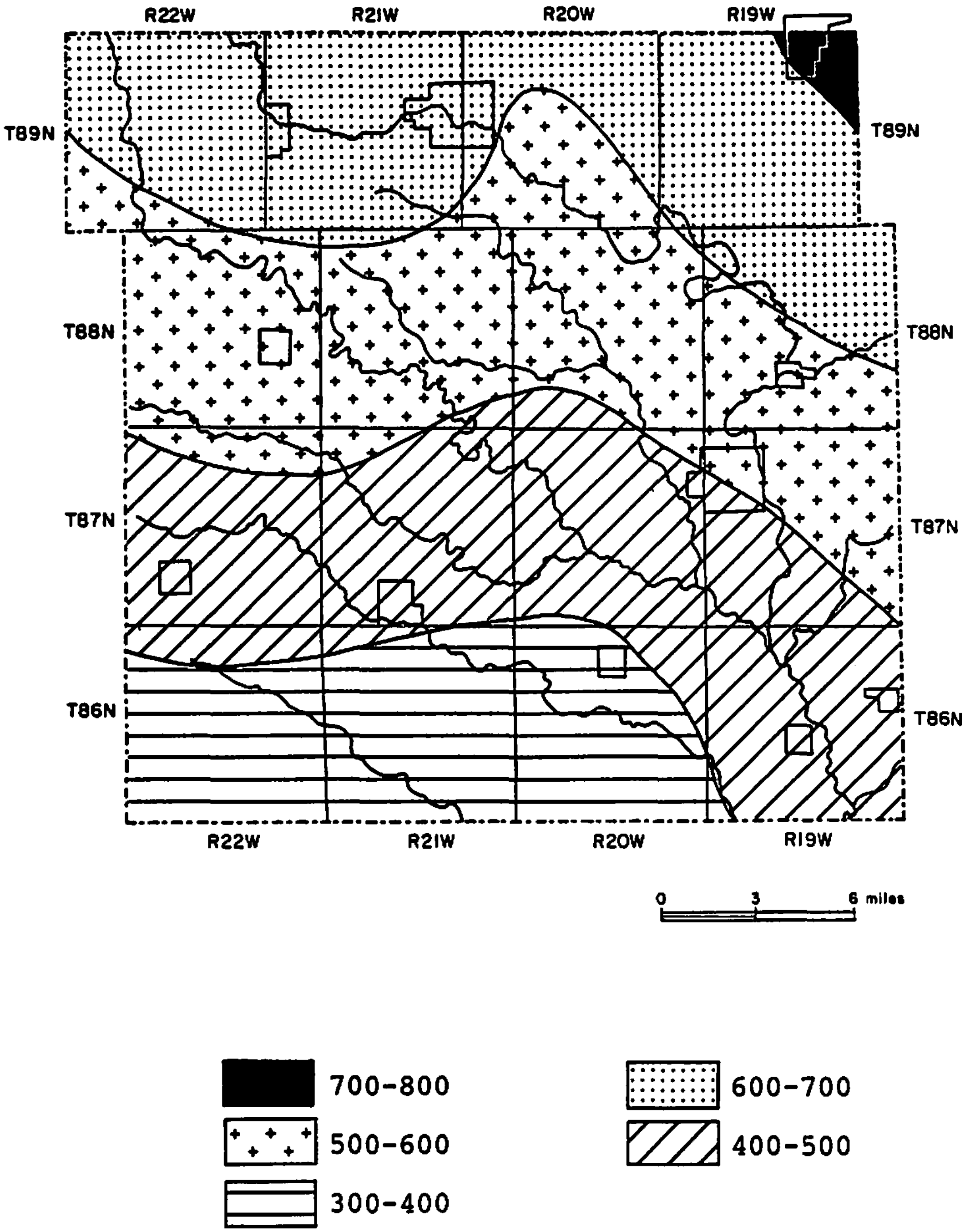


Figure 13

THICKNESS OF DEVONIAN ROCKS IN FEET

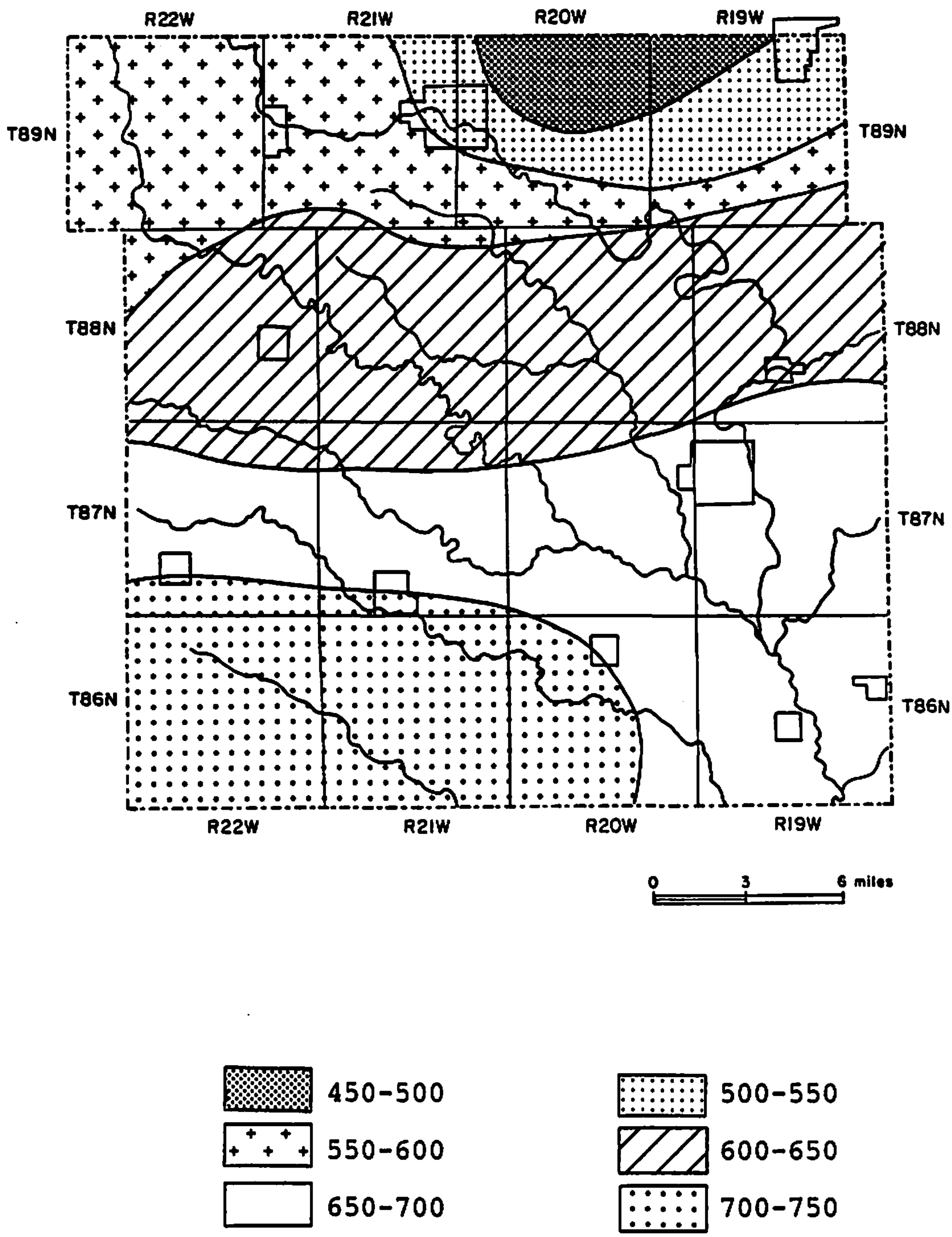


Figure 14

THICKNESS OF SILURIAN ROCKS IN FEET

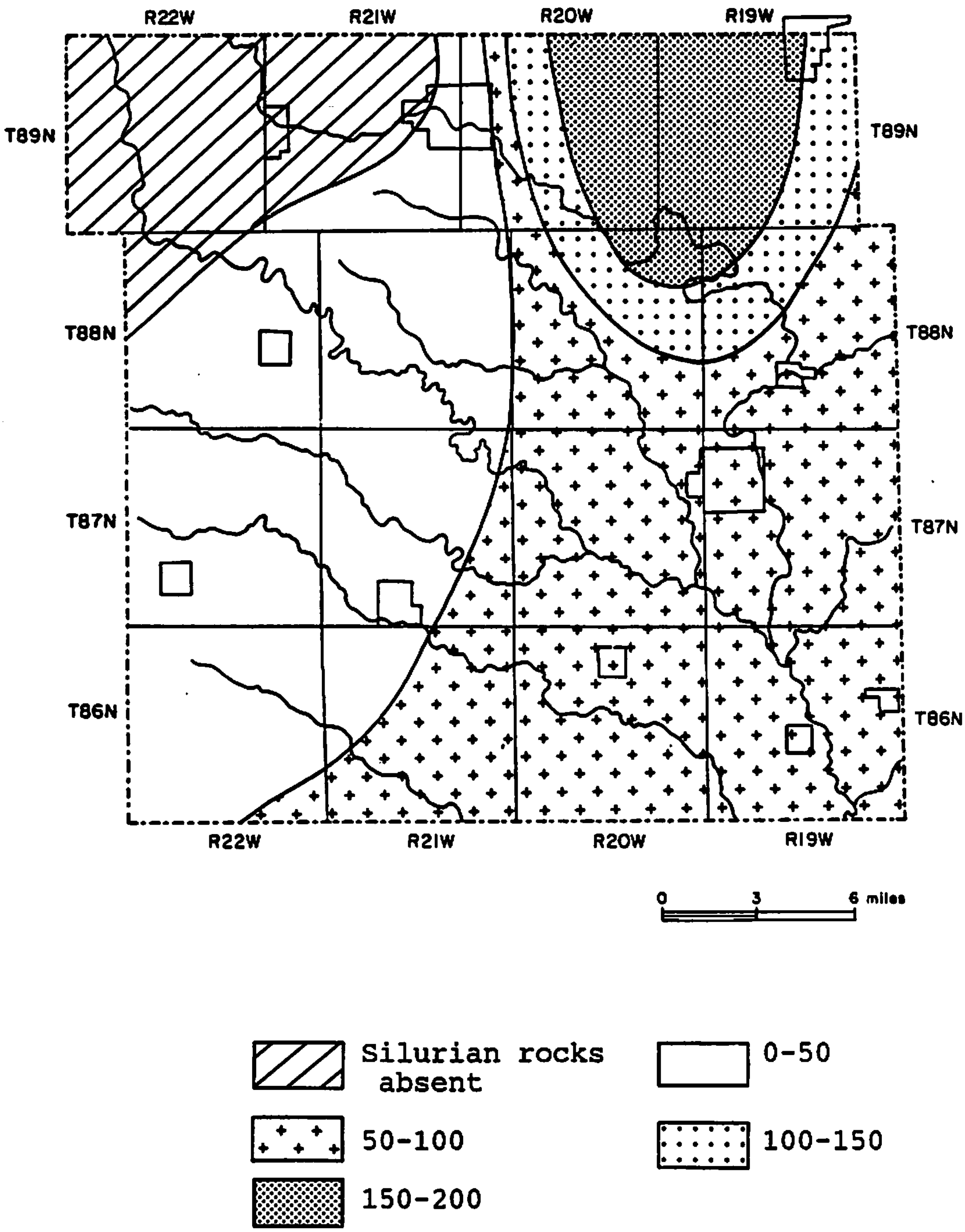


Figure 15

WATER LEVELS IN WELLS COMPLETED IN THE SILURIAN-DEVONIAN AQUIFER IN FEET ABOVE MEAN SEA LEVEL

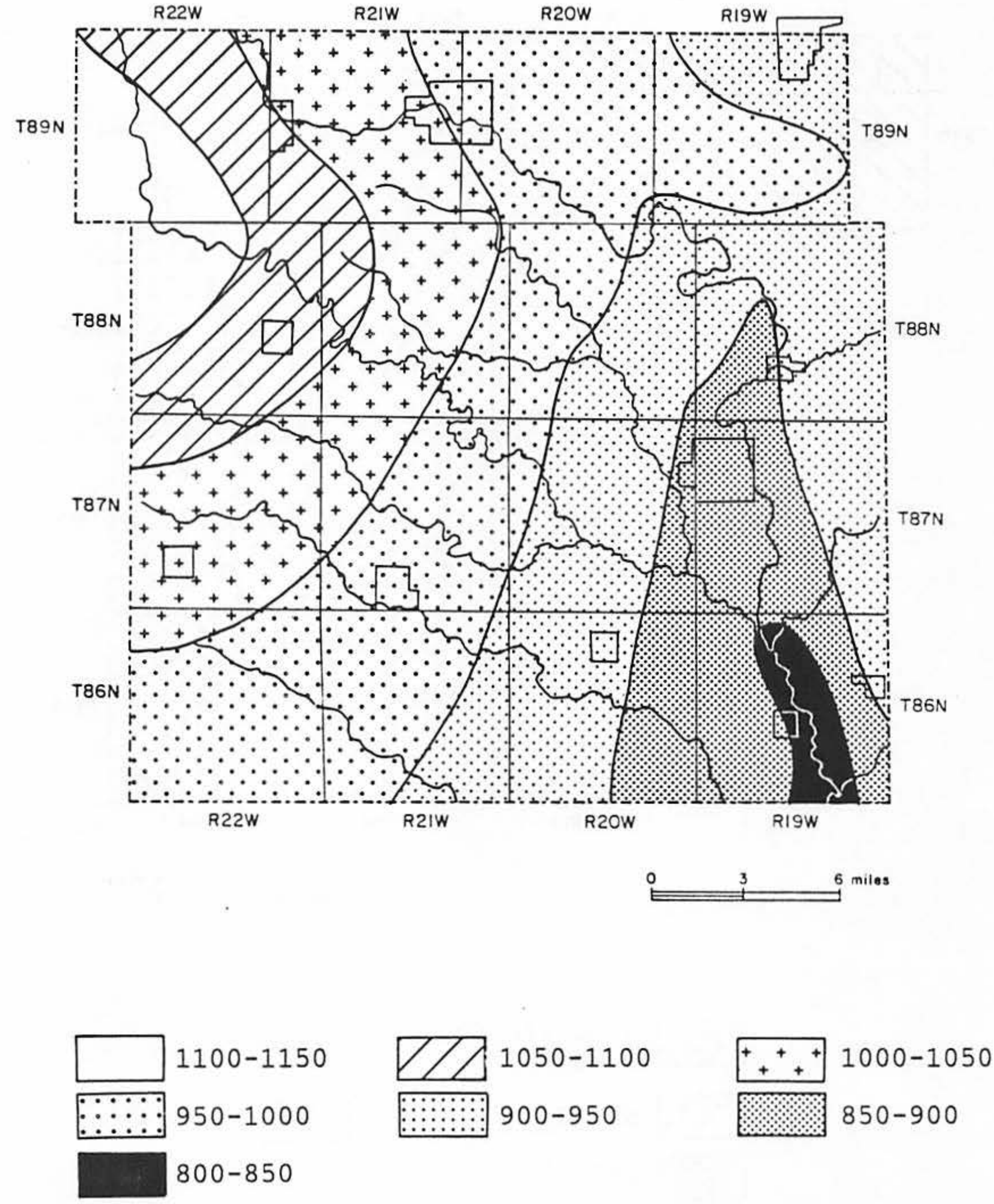


Figure 16

ELEVATION OF PRARIE DU CHIEN GROUP IN
FEET BELOW MEAN SEA LEVEL

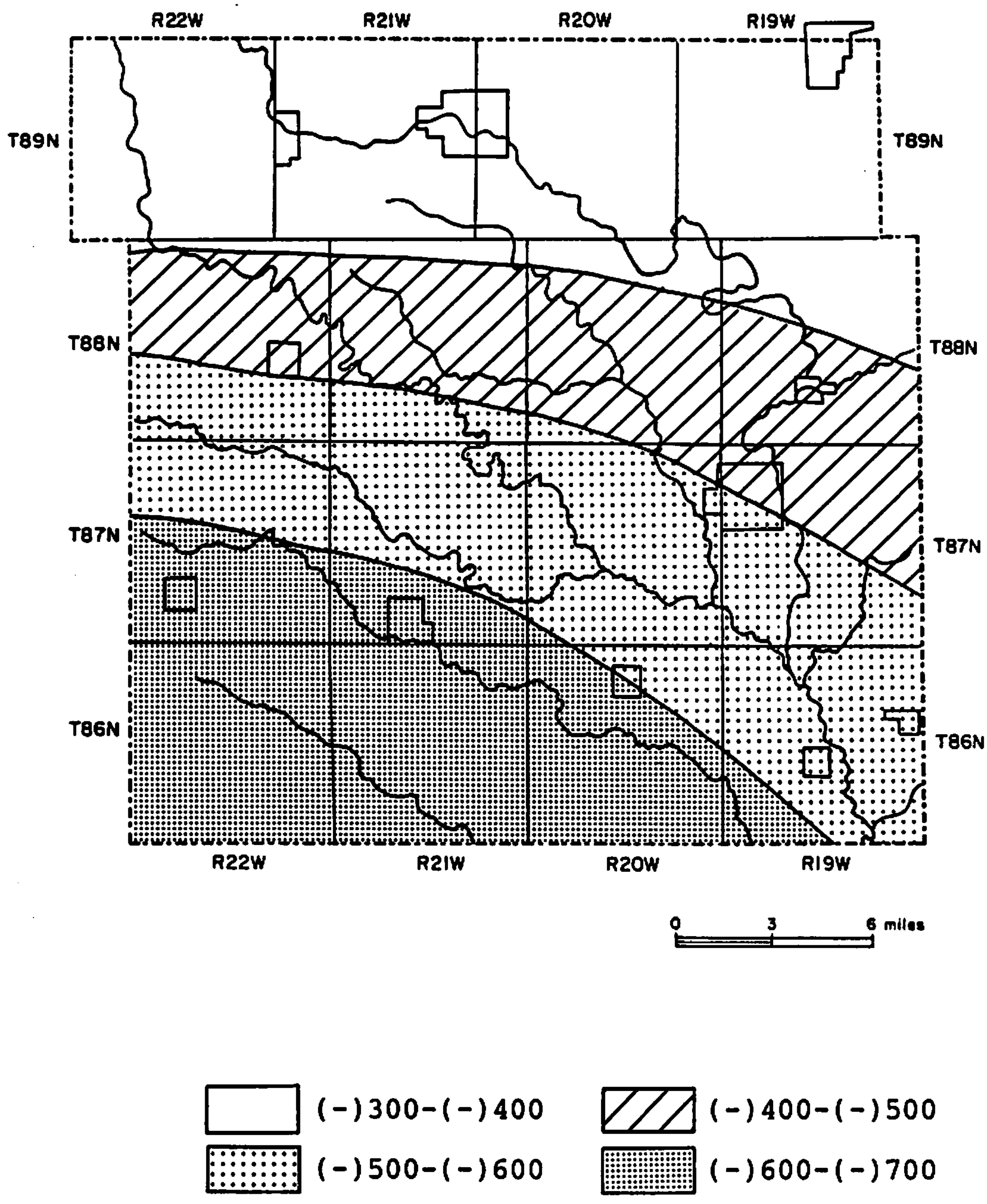


Figure 17

ELEVATION OF JORDAN SANDSTONE IN
FEET BELOW MEAN SEA LEVEL

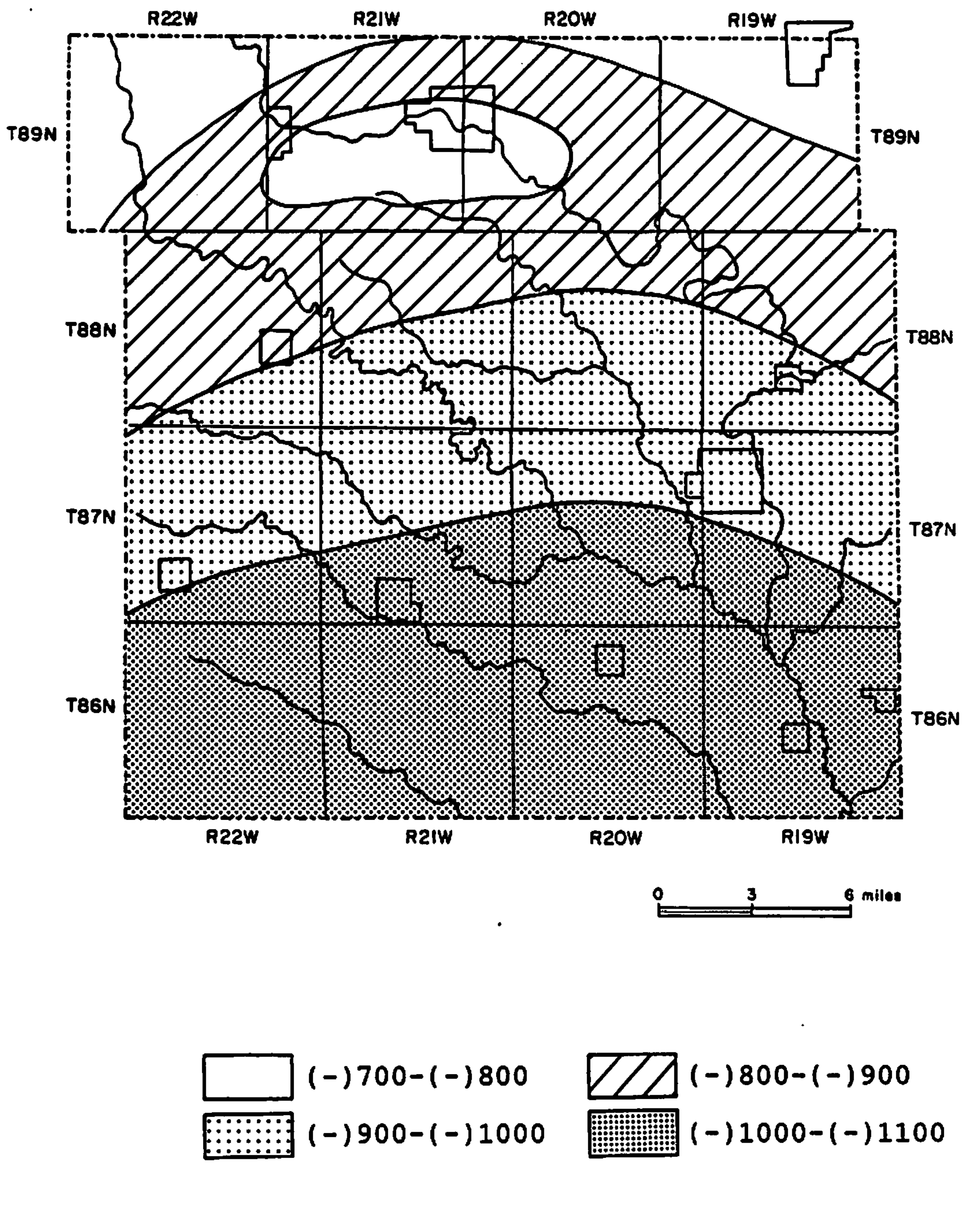


Figure 18

THICKNESS OF JORDAN SANDSTONE IN FEET

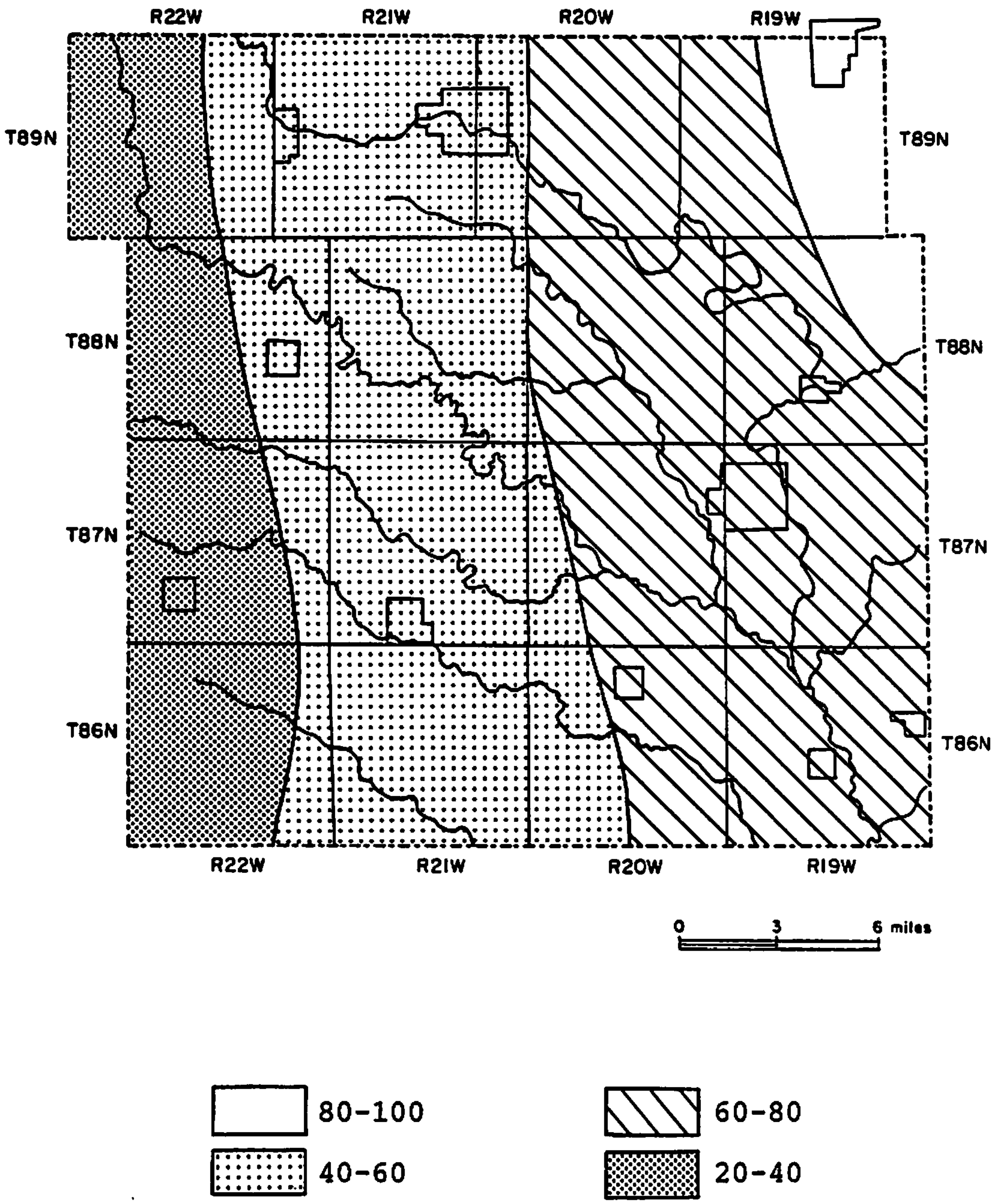
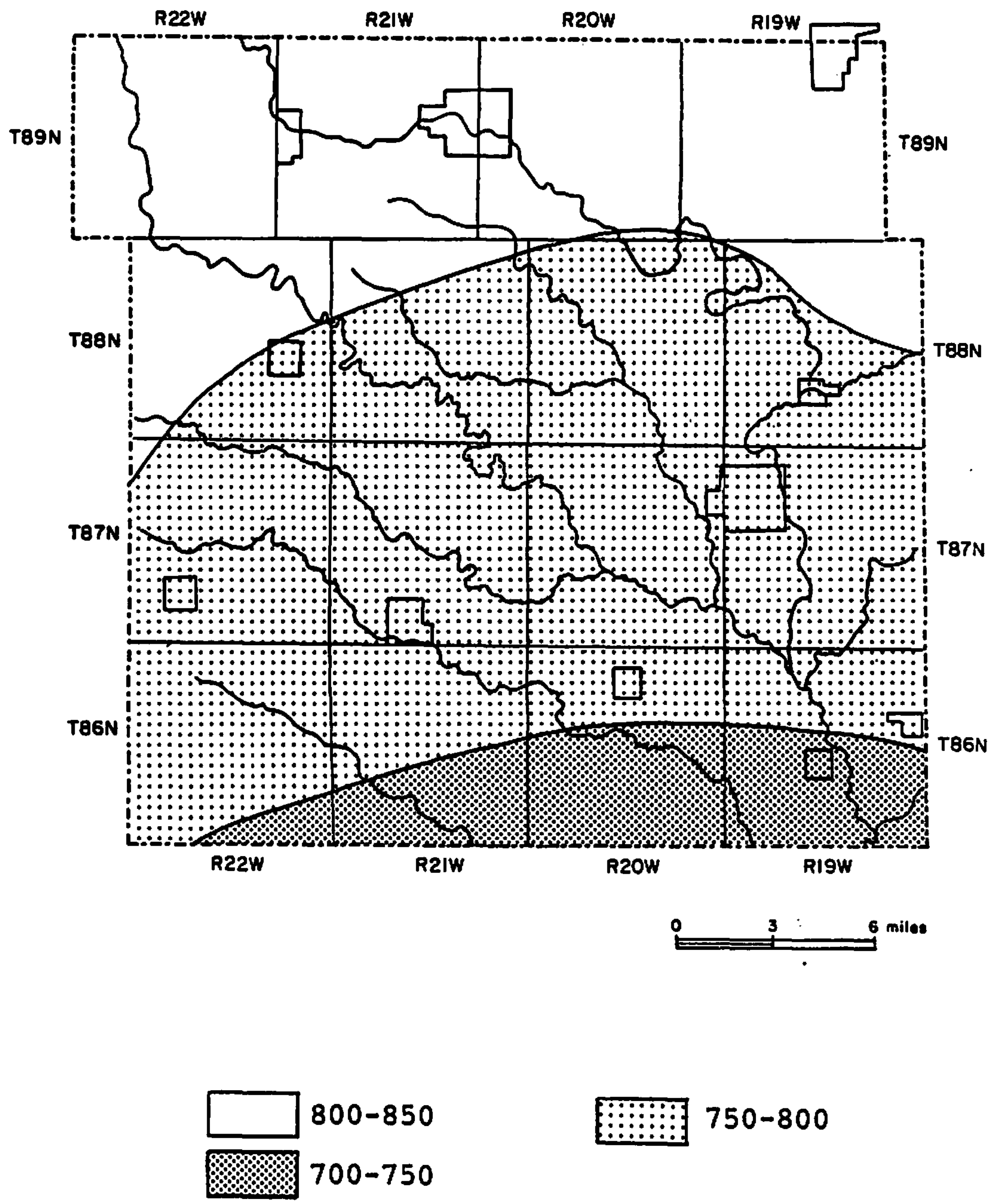


Figure 19

WATER LEVELS IN WELLS COMPLETED IN THE CAMBRO-ORDOVICIAN AQUIFER IN FEET ABOVE MEAN SEA LEVEL



productive rock aquifer in the state producing high yields of adequate quality water.

Water Quality

To the user, the quality of groundwater is as important as the amount of water that an aquifer will yield. As groundwater moves through soil and rock materials it dissolves some of the minerals which, in turn, affect water quality. In addition to mineral content, bacterial and chemical contamination may be introduced through poorly constructed wells and seepage from other pollution sources.

Recommended maximum concentrations for the common mineral constituents in water are described in Table 2. These are accepted as standards for drinking water supplies. Limits for uses other than drinking often differ from these. For instance, water that is unacceptable for drinking and household use may be completely satisfactory for industrial cooling.

From past analyses of groundwater, the averages (A) and ranges (R) of values in milligrams per liter (mg/l) for several constituents are summarized in Table 3 for the surficial and bedrock aquifers in Hardin County. Figures 20-22 show the distribution of dissolved solids for each of the rock aquifers. Water-quality analyses for individual wells should be obtained to determine if concentrations of constituents affecting health are exceeded.

Although available information on water quality from alluvial aquifers in Hardin County is limited, alluvial sources generally yield the least mineralized groundwater in central Iowa. However, alluvial aquifers are the most susceptible to contamination.

The only analysis available for the drift aquifer is similar to typical analyses for alluvial aquifers. Water from the drift aquifer is hard and contains high concentrations of iron, manganese, and sulfate. The water in the drift aquifer is usually acceptable for most purposes if wells are constructed properly and located suitable distances from sources of contamination. Nitrate content should be checked carefully in shallow wells, and any water supply containing over 45 mg/l should not be used for infant feeding.

The Mississippian aquifer is the most extensively used of the bedrock aquifers in Hardin County with dissolved solids content averaging less than 1000 mg/l. Other consitutents are also within acceptable limits.

No data is available for the Devonian aquifer in Hardin County. The water is of poor quality in central Iowa with high concentrations of total dissolved solids, iron, sulfate and fluoride.

Figure 20

DISSOLVED SOLIDS CONCENTRATION IN THE MISSISSIPPIAN AQUIFER IN MILLIGRAMS PER LITER (mg/l)

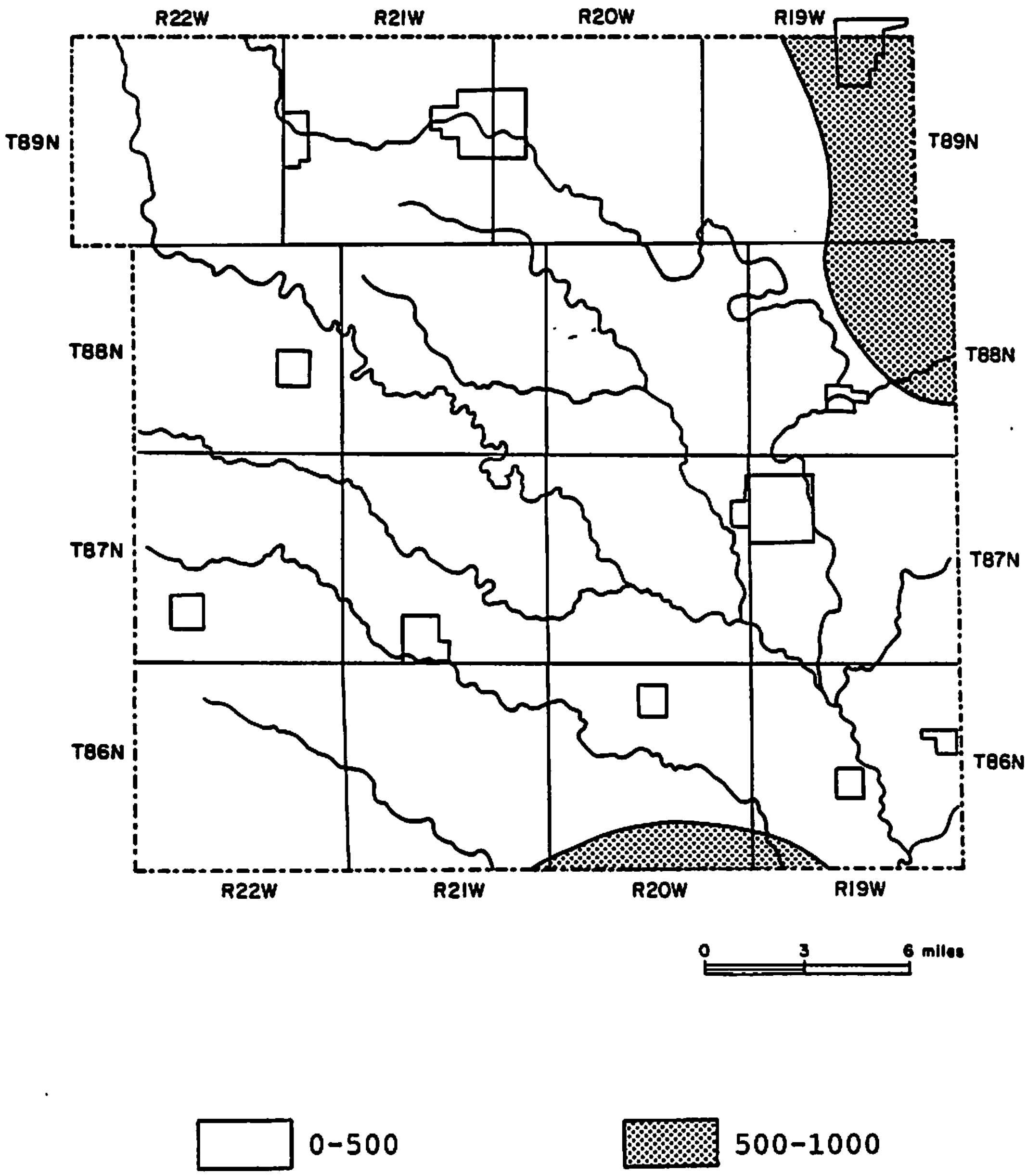


Figure 21

DISSOLVED SOLIDS CONCENTRATION IN THE SILURIAN-DEVONIAN AQUIFER IN MILLIGRAMS PER LITER (mg/l)

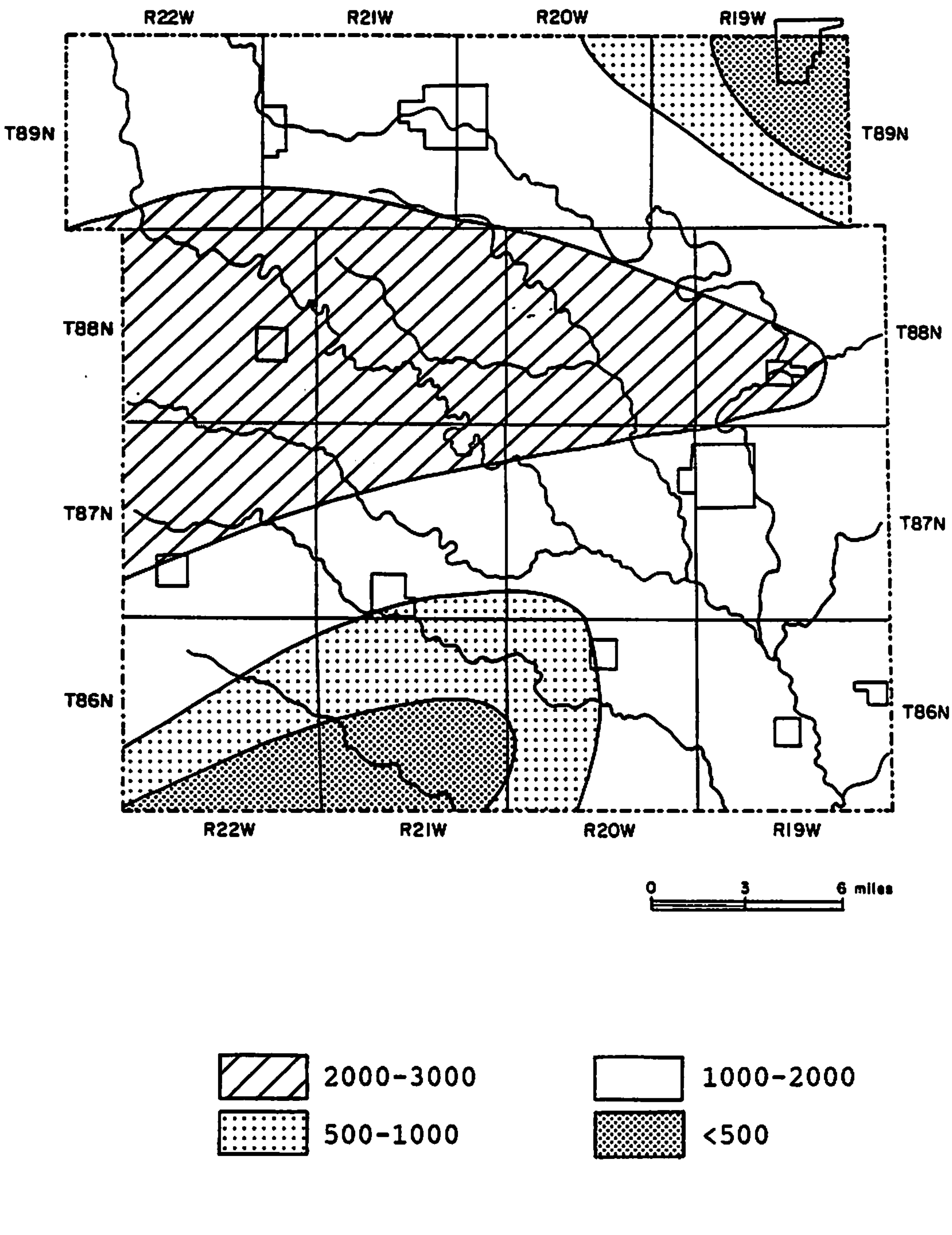


Figure 22

DISSOLVED SOLIDS CONCENTRATION IN THE CAMBRO-ORDOVICIAN AQUIFER IN MILLIGRAMS PER LITER (mg/l)

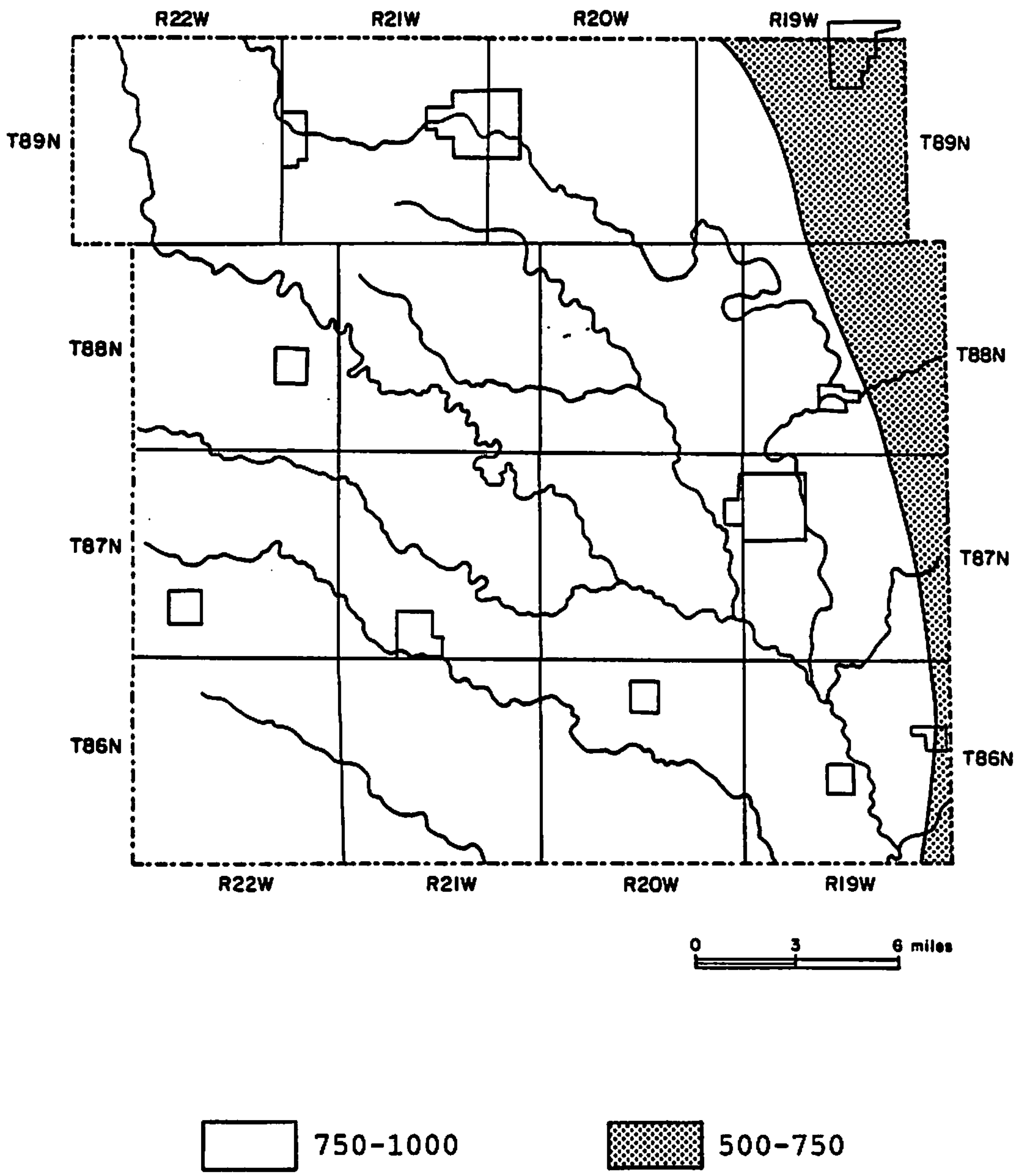


Table 2

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 3

CHEMICAL CHARACTER OF GROUNDWATER

	Diss Solids	Fe	Hardness as $CaCO_3$	K	Na	Ca	Mg	Mn	NO_3	F	Cl	SO_4	HCO_3	Cond	pH
Alluvial Aquifer (1 sample)	465	Tr.	385			98.0	340	0.0	18.0	0.0	14.0	57.0	368		7.0
Mississippian	363	1.1	326	2.6	15.5	76	20	0.8	3.6	0.6	8.4	33.1	316	595	7.3
Aquifer	170-550	.01	108	0.3	6.1	22	10.7	.01	.01	.15	0.5	0.1	215	330	7.0
(49 samples,		4.4	460	5.0	40.0	120	47	.34	36.0	2.2	51	.01	500	860	7.9
Silurian-Devonian Aquifer	(No information available)														
Cambro-Ordovician	959	0.7	574			131	62	0.01	0.26	1.4	12.5	392	343		7.3
Aquifer	576	0.3	342			82	.33	0.0	10.0	0.0	7.0	36.0	327		7.2
(8 samples,	1213	1.0	693			167	77	0.1	1.8	2.0	20.0	477	371		7.6
2 well)															

All analyses in mg/l except for pit (standard pH units) and conductivity (micromohs/cm)

The Cambro-Ordovican aquifer has the highest potential yield of the bedrock aquifers but is also highly mineralized. Total dissolved solids average over 750 mg/l. Sulfate concentrations increase to the southwest and are higher than recommended limits, but the water is acceptable because most users can adapt. Radium concentrations can be high in the Jordan aquifer; however, high concentrations can be reduced by certain methods of water softening.

RECOMMENDATIONS FOR PRIVATE WATER WELLS

Well Location

A well should be located where it will be least subject to contamination from nearby sources of pollution. Table 4 lists the minimum distances recommended between wells and sources of contamination. Greater distances should be provided where possible. Often county health departments will have additional guidelines.

The well location should not be subject to flooding or surfacewater contamination. Select a well-drained site, extend the well casing a few feet above the ground, and mound earth around it. Diversion terraces or ditches may be necessary on slopes above a well to divert surface runoff around the well site.

In the construction of all wells, care should be taken to seal or grout the area between the well bore and the well casing (the annulus) as appropriate, so surfacewater and pollutants cannot seep into the well and contaminate the aquifer.

Water Treatment

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

Chlorination or other forms of oxidation, followed by

Table 4

MINIMAL LATERAL DISTANCES BETWEEN WELLS
AND COMMON SOURCES OF CONTAMINATION
(From Iowa Administrative Code)

Source of Contamination	Minimum Lateral Distance (in ft)
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, 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

filtration, will remove most forms of iron. Iron can cause an unpleasant taste and odor, and is usually the cause of "red water." If the problem persists, iron-removal equipment can be used.

A black or dark brown slimy coating on water fixtures may indicate an iron bacteria problem. Iron bacteria are not known to affect human health, but they will plug wells, pumping and treatment equipment, and distribution lines. A three step procedure is commonly used for removal of iron bacteria. The first step is chlorination, followed by an acid treatment and then another chlorination. Because iron bacteria are so difficult to remove, a regular maintenance program is necessary to control the problem.

Since groundwater in Hardin 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, filtration, distillation, ion exchange, reverse osmosis, absorption, oxidation, 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. Other types of softening equipment are available that do not create a sodium problem.

Water Testing

Ideally, water taken from a private well should be tested every six months. Studies have shown that wells less than 50 feet deep are subject to contamination by nitrate and bacteria. The University of Iowa Hygienic Laboratory will test water supply samples for coliform bacteria, nitrate, iron, hardness, and iron bacteria. Special bottles must be used for collecting and sending water samples to the laboratory. A sample kit can be obtained by writing to the University Hygienic Laboratory, University of Iowa, Oakdale Campus, Iowa City, Iowa 52242. Indicate whether your water has been treated with chlorine, iodine, or bromine, as different sample bottles must be used for treated and untreated water. The current charge for a bacterial test is $6; iron bacteria or hardness, $5; and nitrate or iron, $9. If your well is determined to be unsafe, advice for correcting the problem can be obtained from your county or state Department of Health. Several certified private laboratories also perform water analyses.

Concern is currently being expressed related to pesticides in groundwater. Testing for these compounds is comparatively expensive; however, it may be advisable especially for shallow wells. If a well is located in an area with a past history of high chemical usage, near a mixing or formulation area, or near an area where a spill has occurred, then it should be tested for suspected contaminants. Currently, the test for common agricultural herbicides is $100. If orthophosphate insecticides are included, the cost is $160.

Well Abandonment

Old, poorly maintained wells which are no longer used provide easy access for pollution to enter aquifers supplying water to other wells in the vicinity. Unprotected wells may also cause personal injury. Proper abandonment procedures should be followed to restore the natural conditions that existed before well construction and prevent any future contamintion. Permanent abandonment requires careful sealing. Wells require different sealing techniques depending on the depth and type of well. Contact your local health department, a well contractor, or the Geological Survey Bureau for specifics.

Temporary abandonment procedures ensure that surface water will not enter the well, thus protecting the aquifer. A tight well cap should be maintained over the well. 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 protect your investment and guarantee satisfactory well completion, it is a good idea to have a written agreement with the well driller. The agreement should specify in detail:

- size of well, casing specifications, and types of screen and well seal
- methods of eliminating surface and subsurface contamination
- disinfection procedures to be used
- type of well development
- test-pumping procedure to be used
- date for completion

- itemized cost list including charges for drilling per foot, for materials per unit, and for other operations such as developing and test pumping

- guarantee of materials, workmanship, and that all work will comply with current recommended methods

- liability insurance for owner and driller

For a statewide listing of water well drillers, contact the Iowa Water Well Driller's Association, 900 Des Moines St., Des Moines, Iowa, 50309, (515) 266-2189.

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 communites, protection of surface and underground reservoirs, allocates water use, permits water use of 25,000 or more gallons per day)

Environmental Protection Division (515) 653-2135
Regional Office No. 5
Wallace Building
Des Moines, IA 50319
(Routine sanitary inspections of municipal water supplies and wastewater treatment , local pollution problems, assistance to communities)

Energy and Geological Resources Division
Geological Survey Bureau (319) 335-1575
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
Lucas Building (515) 281-4942
Des Moines, IA 50319
(Encourages public health, hygiene and sanitation; programs of health education, quality of health care)

University of Iowa Hygienic Laboratory
University of Iowa (319) 335-4500
Oakdale Campus
Iowa City, IA 52242
(Water Analyses)

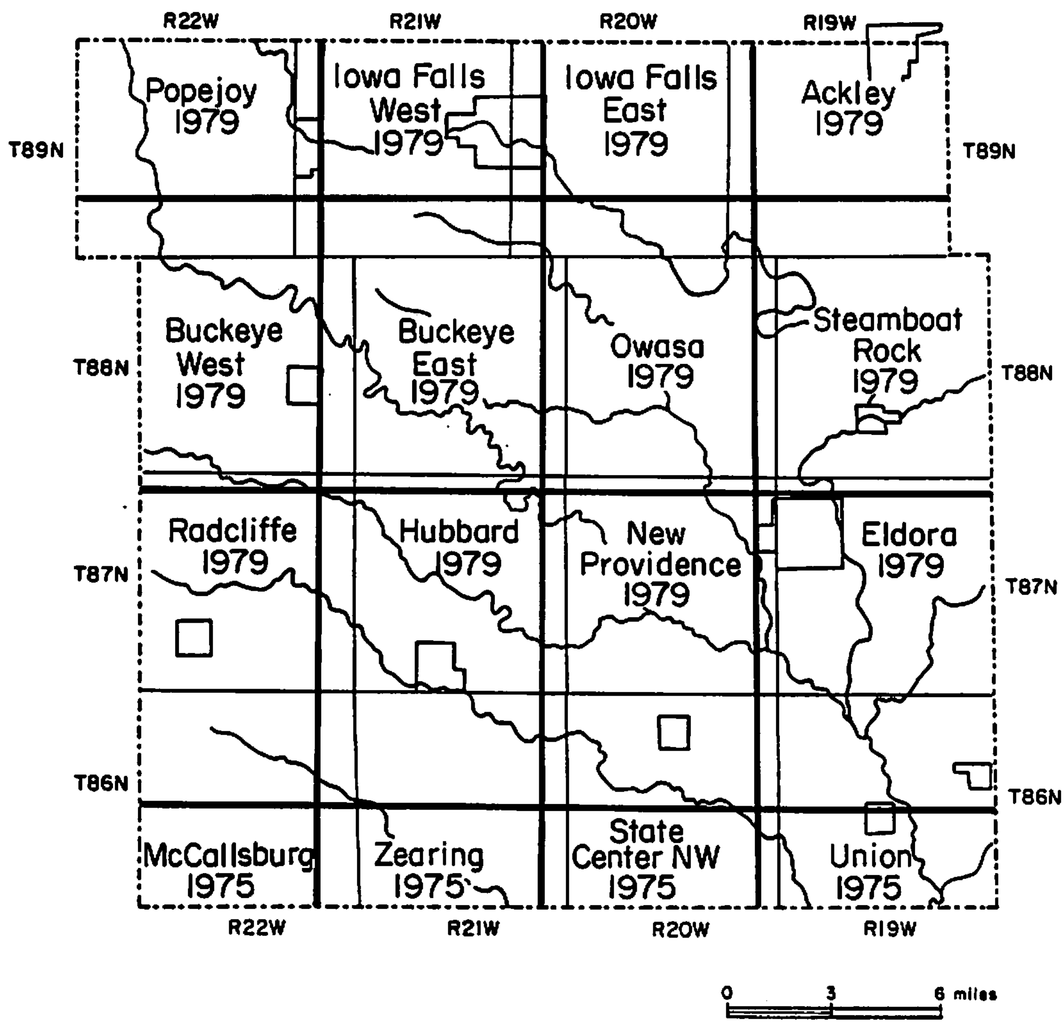
Cooperative Extension Service
Iowa State University (515) 294-4569
Ames, IA 50011
(Advice on water system design and maintenance)

Topographic Maps

Figure 23 shows the 7 1/2 minute quadrangle maps which cover Hardin 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 Department of Natural Resources, Geological Survey Bureau, 123 North Capitol Street, Iowa City, Iowa 52242, for $2.50 each plus postage and handling charges.

Figure 23

TOPOGRAPHIC MAPS FOR HARDIN COUNTY



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