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MS #195

*Geol Survey*

**MAHOMET VALLEY AQUIFER  
STUDY PLANS and PROPOSALS  
(1980-1992)**

- A.) **ISWS & ISGS Spring of 1992 Study Plan**
- B.) **East Central Illinois Aquifer Study  
E.W.S. Memorandum, 2/5/90**
- C.) **Mahomet Valley Aquifer Study  
Mtg. Notes, 1/22/86**
- D.) **Preliminary Work Plan, ISGS & ISWS, 11/26/80**

**A.) ISWS & ISGS Spring of 1992 Study Plan**

GROUND-WATER RESOURCES OF THE MAHOMET BEDROCK VALLEY AQUIFERS  
EVALUATION FOR FUTURE DEVELOPMENT AND MANAGEMENT

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**GROUND-WATER RESOURCES OF THE MAHOMET BEDROCK VALLEY AQUIFERS  
EVALUATION FOR FUTURE DEVELOPMENT AND MANAGEMENT**

**INTRODUCTION**

Beneath the towns and villages and the corn and soybean fields of east-central Illinois lies an ancient river valley - the Mahomet Bedrock Valley (figure 1) which was carved into the rock long before the Pleistocene glaciers covered much of Illinois. The valley was filled by deposits left by the continental glaciers; today it is totally concealed beneath the present topography. The valley has been the subject of much interest since it was first defined by Horberg (1945). Scientists and the general public have expressed considerable interest in the origin of such buried valleys.

Of major interest to planners, city, state and local officials, agriculture, and industry are the highly productive sand and gravel aquifers that were deposited when melt waters from the great glaciers flowed within the valley system. It was estimated by Visocky and Schicht (1969) that the renewable ground-water resource of the sand and gravel aquifers within the Mahomet Bedrock Valley and its major tributaries in east-central Illinois, an area of about 3700 square miles, is about 445 million gallons per day (mgd). Kirk (1987) estimated that ground-water withdrawals from sand and gravel aquifers in 1986 in the counties shown in figure 2 were 59 mgd, or only about 13 percent of the renewable resource.

As a result of increased water use and recent drought periods, there is interest in the Mahomet aquifers by communities now dependent upon surface water resources. At one time only the Mason County area farms were irrigated; now irrigation wells can be found all along the valley. The region is also a major producer of ethanol as an energy alternative, a process that consumes large quantities of water. At the present time conflicts over ground-water use are developing. When ground-water use increases in the future as a result of increased municipal, industrial and irrigation use, conflicts will be more common and severe.

These conflicts can only be resolved by a complete understanding of the ground-water system within the Mahomet Bedrock Valley. This will allow the determination of the total resource potential of the aquifer and the location of the main resource areas. It will also allow the identification of the impacts of any proposed ground-water pumpage on the system and the assessments of options for future development that provides, hopefully, for equitable use of the resource. This document briefly summarizes our knowledge of the Mahomet Valley ground-water system, considers the developing conflicts over ground-water use, describes recognized ground-water management systems, and proposes a comprehensive hydrogeologic study that would result in a ground-water model that can predict the consequences of ground-water development and different options for development.

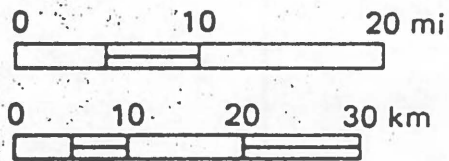
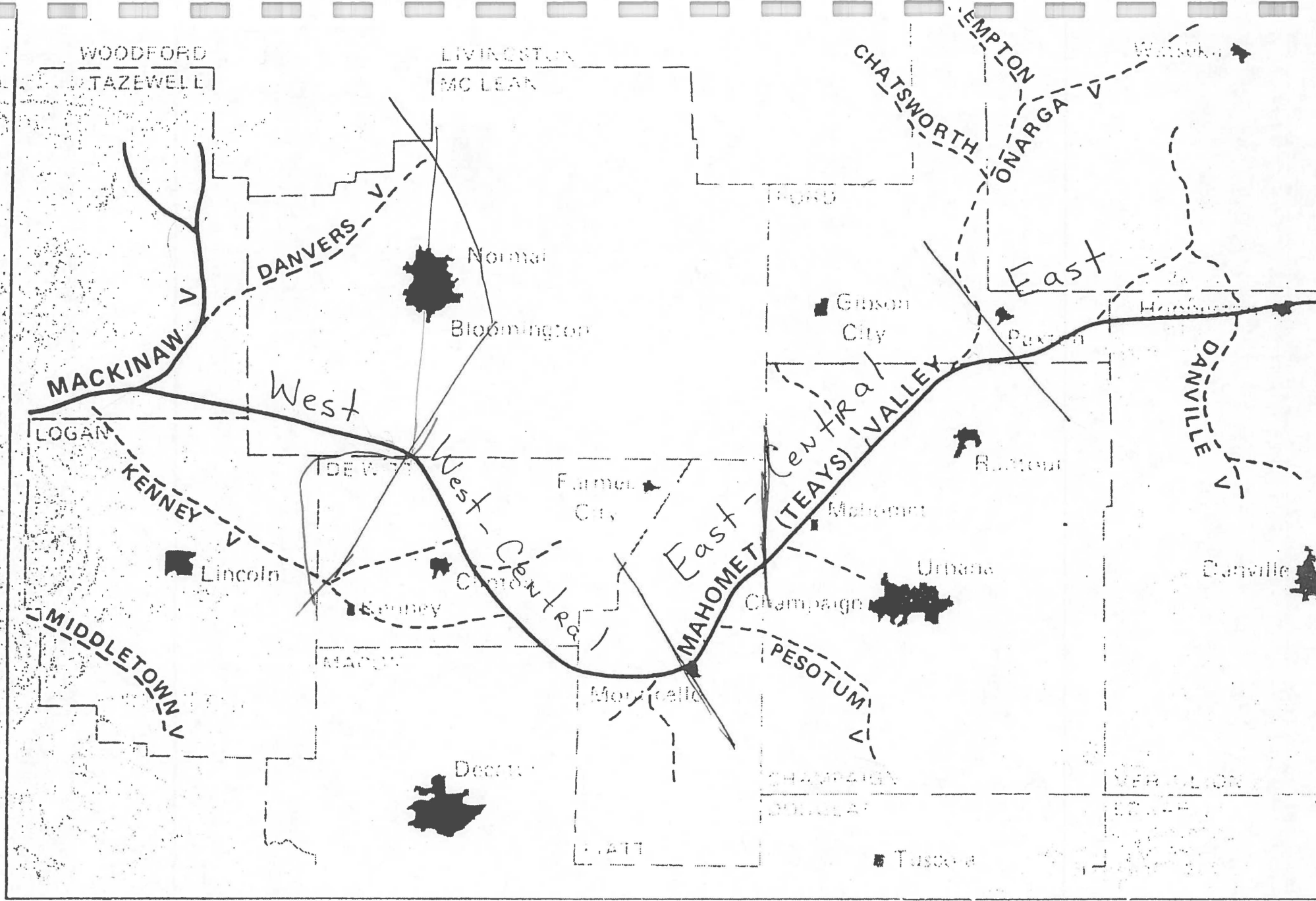


Figure 1. Thalwegs of the Mahomet Bedrock Valley and its principal tributaries.

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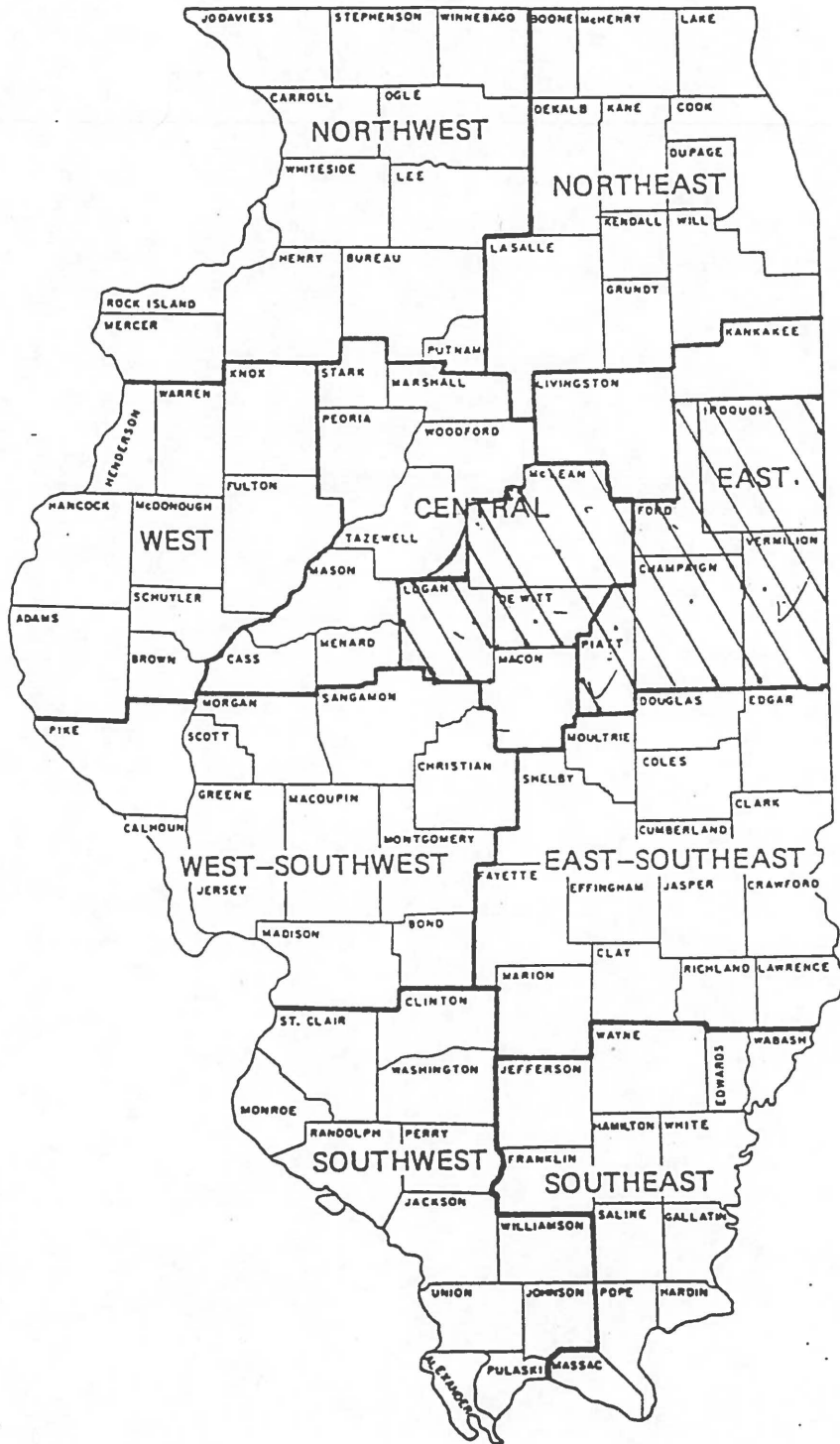


Figure 2. Location of the study area.

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## Background

By State statute the Illinois Scientific Surveys are mandated to conduct scientific research to identify, study and assist in the wise use and management of the natural resources of Illinois. Their recognition of the importance of the ground-water resources of the sand and gravel aquifers contained within the Mahomet Valley promoted data collection and research programs on the valley's resources. As a result of the programs, technical assistance has been provided to communities, industry, individuals, and agriculture to aid in locating ground-water supplies and to aid in determining yields of wells and well fields. These programs have been directed toward limited goals. Now is the time to study the system as a whole.

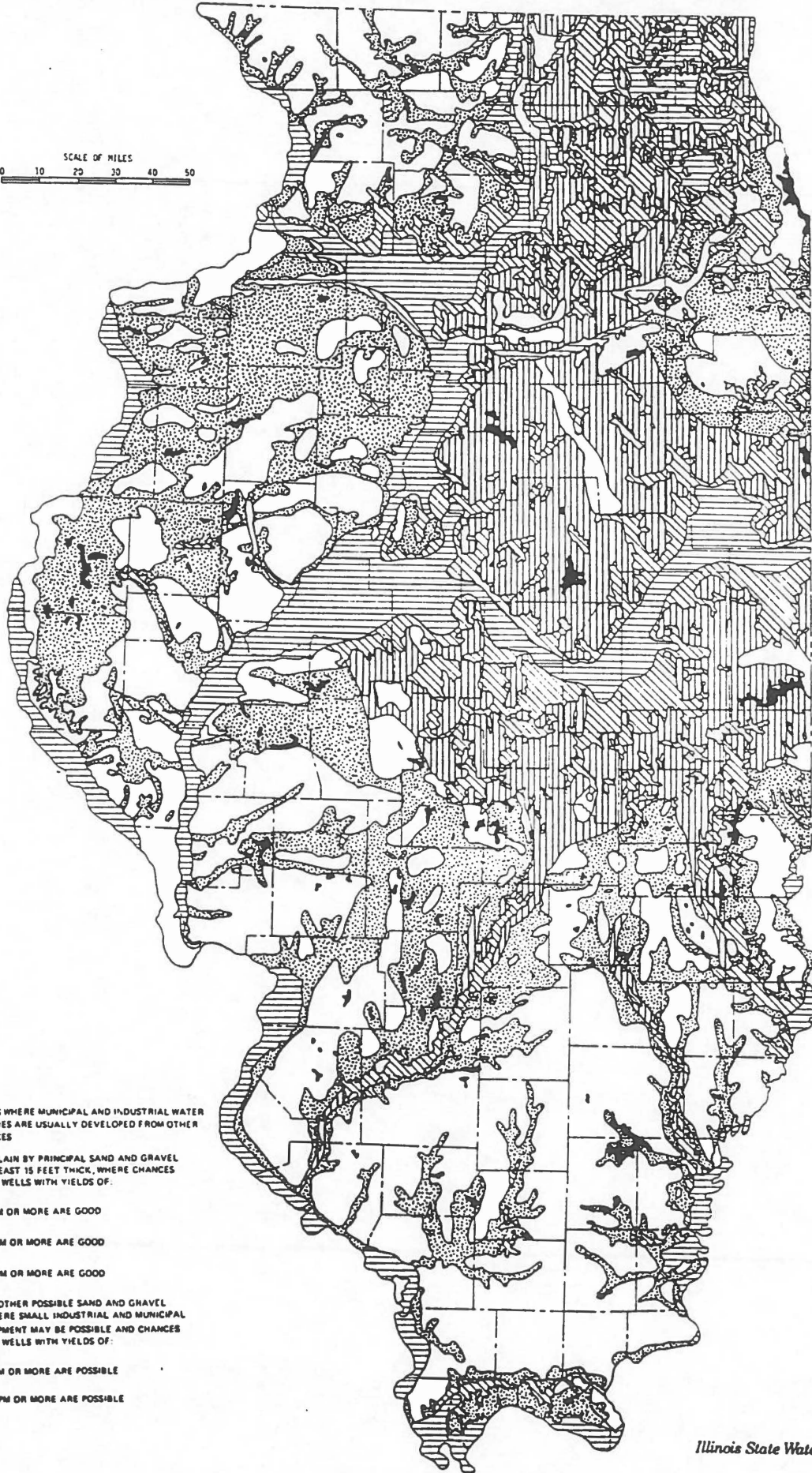
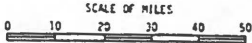
Past Illinois Geological Survey efforts have been directed toward mapping and delineating the Mahomet Valley and describing the sequence of deposits filling the valley. The first major effort made in mapping and delineating the valley was by Horberg (1945). He also described the general sequence of deposits filling the valley. Later, Horberg (1950, 1953) described more details of the stratigraphic sequence and outlined the general history of the bedrock surface and associated valley system. Subsequent work by the Geological Survey was concerned primarily with ground-water exploration and evaluation. These reports were cited by Kempton et al. (1991). Recently, study of the Mahomet Valley by the Geological Survey has been accelerated. A report by Kempton et al. (1991) described the first comprehensive geologic study of the Mahomet Valley since Horberg's work in the mid- to late-1940's. Work is also underway to understand recharge to the aquifer and the interaction of the valley aquifers with the surrounding bedrock.

Water Survey efforts have been directed toward collecting data on aquifer hydraulic properties, making estimates of aquifer recharge, and determining yields of wells and well fields. A major report by Visocky and Schicht (1969) estimated the yield of the Champaign-Urbana west well field (the largest supply withdrawing ground-water from the Mahomet Valley aquifers), summarized data (including ground-water levels, ground-water withdrawals, aquifer hydraulic properties, and aquifer recharge), and estimated potential recharge to the Mahomet Aquifers under pumping conditions. Visocky and Schicht (1969) estimated that the potential yield of the Mahomet Valley aquifers is about 445 million gallons per day (mgd). They defined potential yield as the amount of ground-water that could be continuously withdrawn from a reasonable number of wells and well fields without exceeding recharge. According to Kirk (1987), ground-water pumpage in 1986 in the nine counties that are in part underlain by the Mahomet aquifers was about 66 mgd or only about 15 percent of the potential yield. Of the 66 mgd, about 28 mgd or 42 percent was concentrated in Champaign County. Yields of individual wells (figure 3) (Technical Advisory Committee on Water Resources, 1967) were estimated for the first State Water Plan--"Water for Illinois: A plan for action."

## Statement of Problem

Until about 1988 there was little concern that the ground-water resources of the valley region were not adequate to meet future demands and that the present pace of the Survey's investigative efforts could meet the need for information on the valley's ground-water resource. These efforts were not adequate because of the severe drought of 1988 and 1989, and the increased interest in development of ground-water resources in the Mahomet Valley. The drought impacted the yields of surface water reservoirs that supply the cities of Danville, Decatur and Bloomington. In response, the City of Decatur began a ground-water exploration program in the Mahomet Valley northeast of Decatur in 1988. Decatur's goal was to increase their ground-water capability (Decatur drilled two wells in the Mahomet Valley in the early 1950's) to

# ESTIMATED YIELDS OF WELLS IN SAND AND GRAVEL AQUIFERS



□ AREAS WHERE MUNICIPAL AND INDUSTRIAL WATER SUPPLIES ARE USUALLY DEVELOPED FROM OTHER SOURCES

AREAS UNDERLAIN BY PRINCIPAL SAND AND GRAVEL AQUIFER AT LEAST 15 FEET THICK, WHERE CHANCES OF OBTAINING WELLS WITH YIELDS OF:

- 20 GPM OR MORE ARE GOOD
- ▨ 100 GPM OR MORE ARE GOOD
- ▬ 500 GPM OR MORE ARE GOOD

LOCATION OF OTHER POSSIBLE SAND AND GRAVEL AQUIFERS, WHERE SMALL INDUSTRIAL AND MUNICIPAL WELL DEVELOPMENT MAY BE POSSIBLE AND CHANCES OF OBTAINING WELLS WITH YIELDS OF:

- ▨ 20 GPM OR MORE ARE POSSIBLE
- ▬ 100 GPM OR MORE ARE POSSIBLE

*skip*

supplement their supply from Lake Decatur. The City of Bloomington also began serious consideration of the aquifers in the confluence area of the Mahomet and Mackinaw Bedrock Valleys to supplement their surface water supplies. The Town of Normal developed a well field in the Mackinaw Valley in 1976. Danville also looked at the Mahomet Valley aquifer in 1978 as their reservoir. began to fill with silt.

There are other potential developments which will impact the ground-water resources in the Mahomet Valley. The number of irrigation systems outside the Mason-Tazewell County area increased from just a few in the 1960's to more than 30 in 1990. Uncertainty, however, surrounds any further significant increase in irrigation on the fertile "heavy soils" in the area. According to the Illinois State Climatologist, Wayne Wendland (personal communication), there is some evidence that the climate is becoming more variable and that droughts are occurring with greater frequency. Also, there is growing research evidence that a global climatic change or "greenhouse warming" could result in a significant "summer drying" in the Midwest in the foreseeable future. Climate changes, coupled with favorable economic conditions for agriculture, could result in significant increases in ground-water withdrawals for irrigation.

In addition to the current interest of Decatur and Bloomington in Mahomet Valley ground water as a long-term supplement to their present water supply systems, Lincoln, the Inter-State Water Company at Danville, and other smaller communities look to the valley aquifer for future needs. The Northern Illinois Water Corporation's (NIWC) Champaign-Urbana supply is presently the largest supply tapping the Mahomet Valley aquifers. NIWC is also currently supplying water to several small nearby communities, and appropriate public and private interests are negotiating with NIWC to supply water to Tuscola and Arcola. In addition, ground water from wells in the Mahomet Valley near Champaign is currently transported via the Kaskaskia River to Tuscola for industrial use during periods of low flow. While the total demand from these communities is small, the availability of a dependable supply of good quality water could benefit the economic health of these and potentially other communities. Continued economic growth, therefore, in the Champaign-Urbana area will result in increased future withdrawals by NIWC.

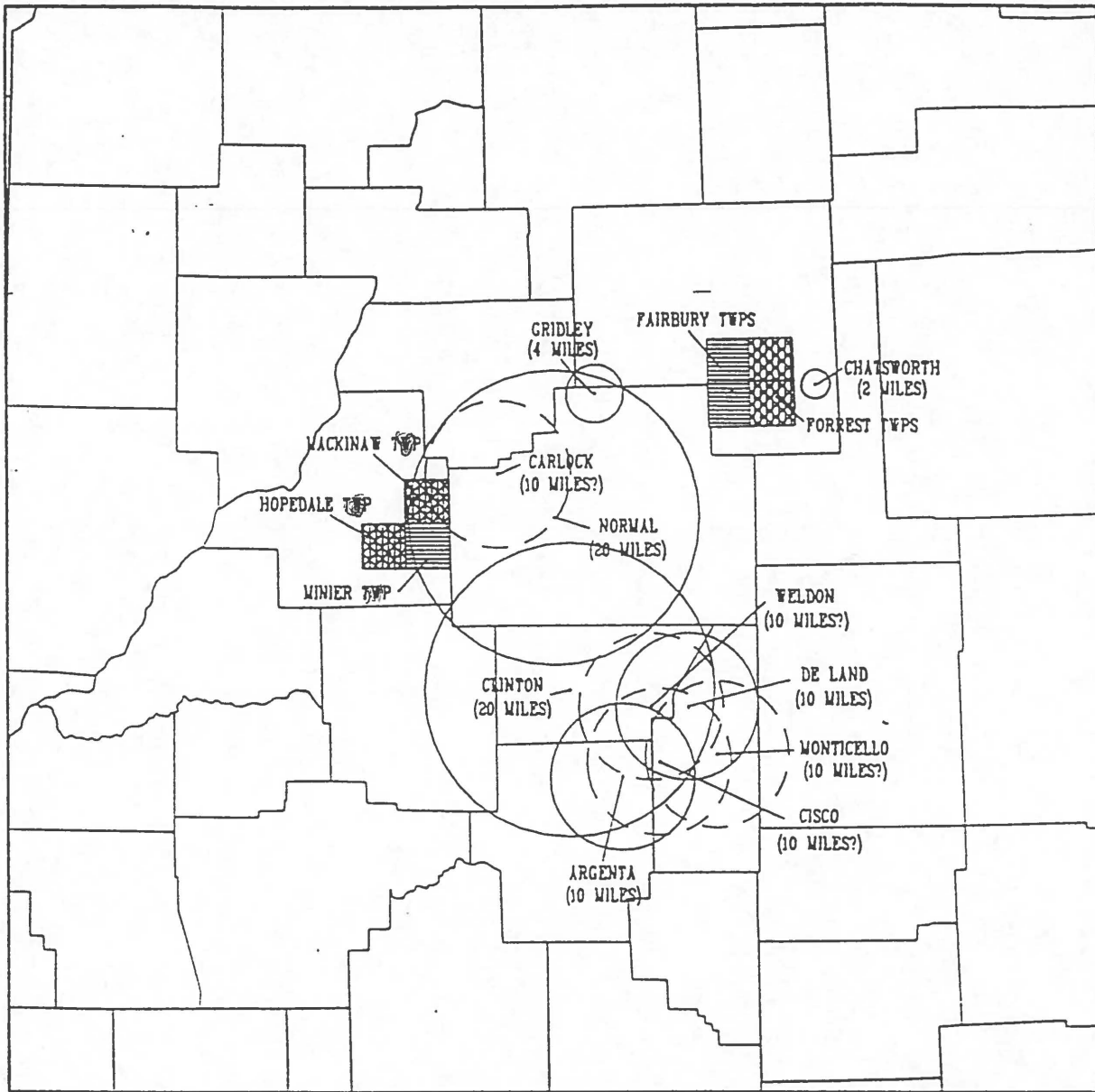
New demands on the ground-water resources in the Mahomet Valley will result from the increase in production of ethanol, a process requiring large quantities of water. Illinois is the top ethanol producing state in the United States with Decatur the center of production. Most of the ethanol is produced from corn, a crop Illinois farmers, of course, produce in large quantities.

Ethanol fuels also provide significant environmental advantages. Ethanol has been proposed as an alternative renewable energy resource dating back to the 1973 Middle-East oil embargo period. Continued political unrest in the Middle-East may result in increasing interest in ethanol as a significant energy source.

Currently, the main concerns about the valley water resources are the emergency well field development by Decatur and the long-range objective by Bloomington and Normal to further explore the ground-water resource potential in the western part of the valley in McLean and Tazewell Counties. Communities and individuals where these developments may take place have expressed concern that the developments will diminish their ground-water supplies. Because of this concern, more than 15 communities have used one of two paragraphs of the Illinois Municipal Code to try to establish control of the ground-water resource in the vicinity of their wells and well fields (see figure 4). Paragraph 11-125-2 of the Municipal Code provides for the extension of

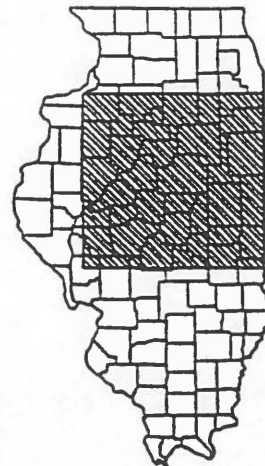
# Resource Protection Zones by Municipal Ordinance

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- City location
- ⊙ Mile limit delineation
- ⊙ (dashed) 10 mile limit (no information at time of mapping)
- ▨ Township limits



jurisdiction "to prevent or punish any pollution or injury to the stream or source of water, or to waterworks, extends 20 miles beyond its corporate limits, or so far as the waterworks may extend." Paragraph 11-126-3 provides for the extension of jurisdiction "to prevent or punish any pollution or injury to the stream or source of water for the supply of the waterworks extends 10 miles beyond its corporate limits." In the case of the present and possible resource developments, the perception by the municipalities is one of "injury" to their source of water. The challenge of this issue is to define injury with respect to resource quantity.

Local concern about the control of ground-water resource development also has prompted the formation of several Water Authorities (see figure 5). A 1951 statute defines the powers and duties of Water Authorities. In part, a Water Authority Board of Trustees has power to make inspection of wells, may require information from owners about withdrawal and use of water, may cause registration of wells, may require permits for wells, may require plugging of abandoned wells, can reasonably regulate the use of water, and, during any period of actual or threatened shortage, can establish limits upon or priorities as to the use of water. However, the provisions do not apply to water used for agricultural purposes, farm irrigation, or water used for domestic purposes. The challenge for the local interests is to develop a plan or management strategy that provides the degree of resource protection or reasonable regulation they desire while also providing access to the resource for any beneficial use by any user. They also must define an "actual or threatened shortage" and consider mitigating factors to be able to prioritize or restrict ground-water withdrawals. On a regional scale the quantity of water from the Mahomet Valley aquifer seems sufficient for the immediate future.

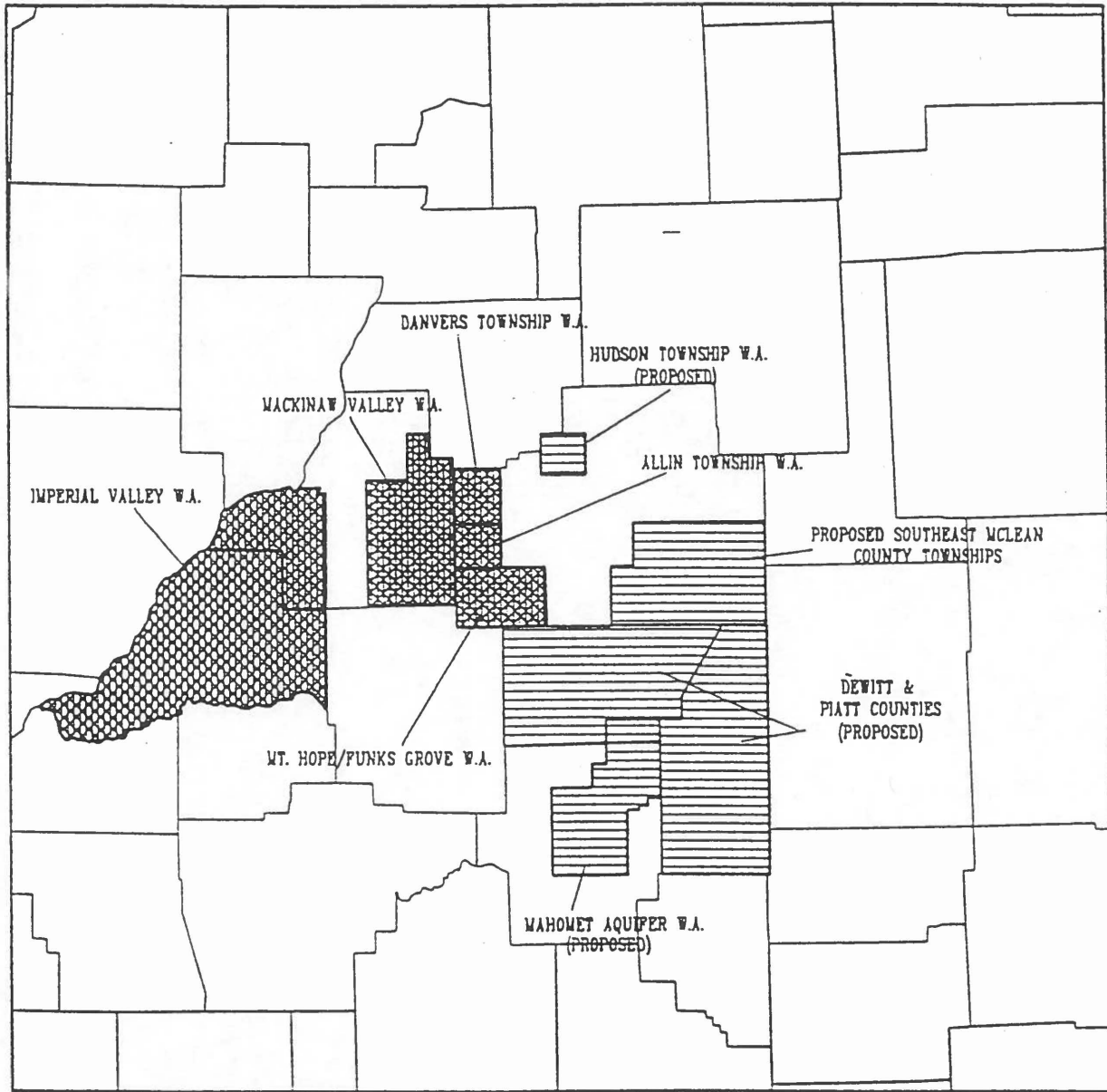
The desire of any interest to unduly or unfairly restrict or control ground-water resource development stems either from a lack of information about the resource or from a fear of becoming economically disadvantaged due to adverse impacts. The diverse and overlapping interests that are now involved in attempting to regulate or manage ground-water resources in the Mahomet Buried Bedrock Valley Region has now, for all practical purposes, created a "gridlock" for potential resource developers.

#### Solution

Chances are that this gridlock will not be broken unless a comprehensive study plan is presented to the public in a formal environment by state research agencies. The study plan is needed to address the information needs in the region of Illinois underlain by the Mahomet Bedrock Valley and its significant ground-water resources. The study results would provide an unbiased and common reference of geologic and hydrologic data and information and would serve as a foundation for resolving questions about specific ground-water developments and for creating future development strategies. The diverse local needs and interests in the region can be considered in developing resource management strategies.



In order to discuss the present knowledge of the valley's ground-water resources, it is useful to divide the valley into segments (see figure 1): an eastern segment from the state line near Hoopston west to about Paxton in Ford County; an east-central segment from Paxton southwest to near Monticello in Piatt County; a west-central segment from Monticello northwest to the DeWitt-McLean County line; and a western segment from the DeWitt-McLean County Line to the confluence of the Mahomet Valley with the Mackinaw Valley at the Havana Lowlands in Mason and eastern Tazewell Counties. Data on the water-level impact of large-scale, long-term ground-water withdrawals are limited to the

# Water Authorities - Active & Proposed

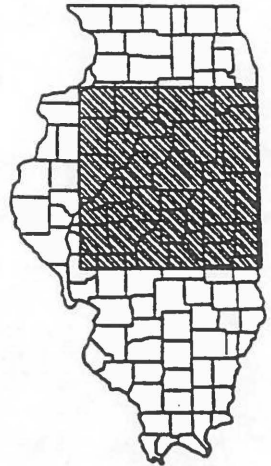


4/12/90

*Needs updating*

 PROPOSED WATER AUTHORITY  
 ACTIVE WATER AUTHORITY

Figures 2 and 3.  
 3 and 4.



Water Authorities as of 1/24/90

- 1) Mackinaw Valley Water Authority  
(seven townships - Deer Creek, Mackinaw, Little Mackinaw, Hittle, Boynton, Hopedale & Tremont)
- 2) Decatur Area (\*\*proposed\*\*)
- 3) Platt & De Witt Counties (\*\*proposed\*\*)
- 4) Mason Co. plus 4 townships  
In Tazewell Co. (Spring Lake, Malone, Cincinnati & Sand Prairie)
- 5) Danvers Township
- 6) Allin Township
- 7) Hudson Township (\*\*proposed\*\*)
- 8) Mount Hope & Funks Grove
- 9) Arrowsmith, Bellflower, Cheney's Grove, Dawson, East 1/2 of Downs, West & Empire (\*\*proposed\*\*)

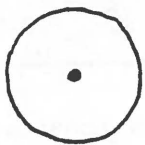
Municipalities - 20/10 mile limit

- 1) Normal - 20 miles
- 2) Clinton - 20 miles
- 3) Gridley - 4 miles
- 4) Fairbury - 2 townships
- 5) Minier - 1 township
- 6) Hopedale - 2 townships
- 7) Mackinaw - 1 township
- 8) Chatsworth - 2 miles
- 9) Argenta - 10 miles
- 10) Cisco
- 11) Hudson
- 12) Weldon
- 13) Monticello
- 14) De Land - 10 miles
- 15) Carlock
- 16) Danvers
- 17) Forrest - 2 townships

KEY



- CENTRAL ILLINOIS/  
MAHOMET AQUIFER



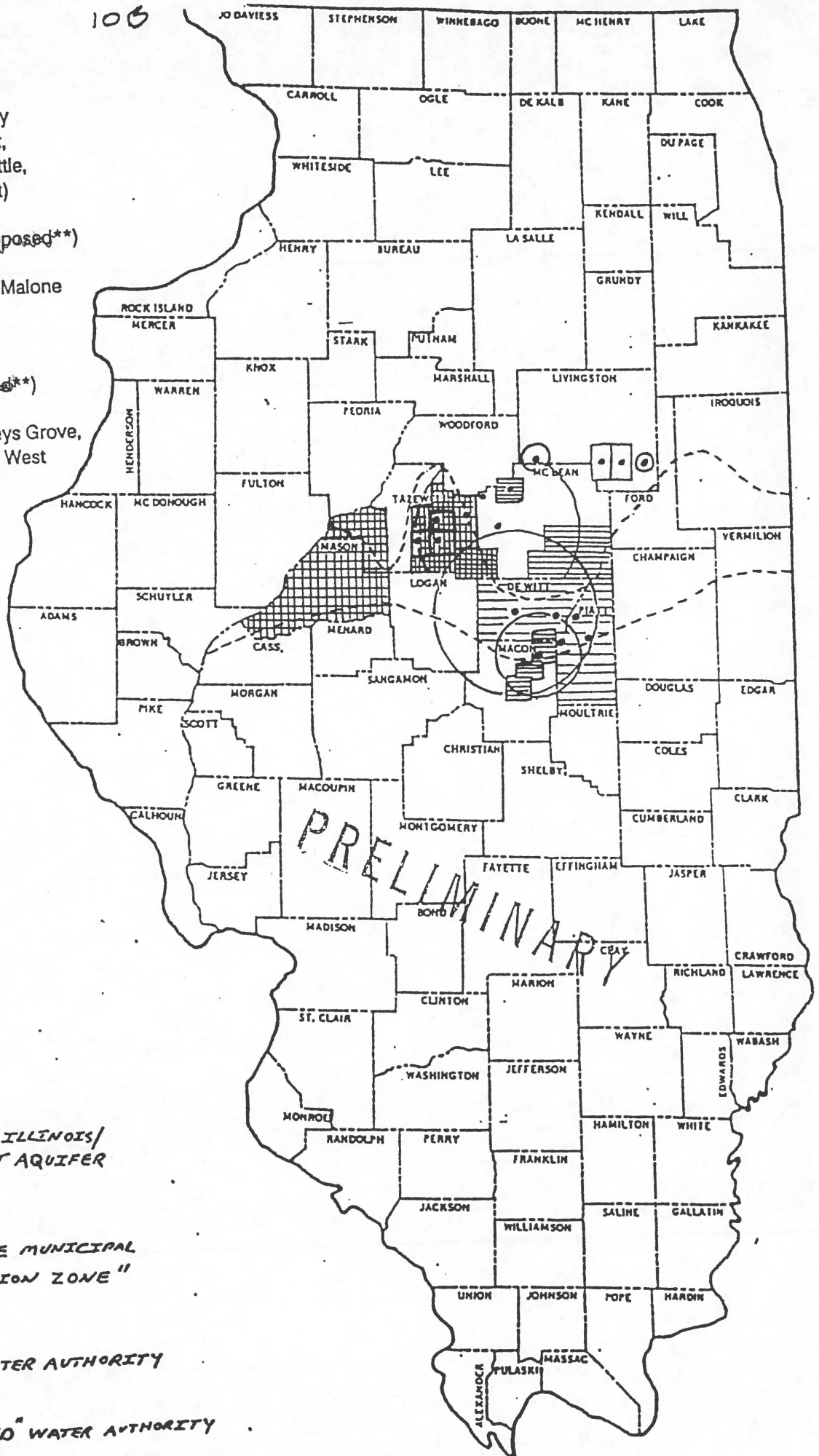
- 20 MILE MUNICIPAL  
"PROTECTION ZONE"



- NEW WATER AUTHORITY



- "PROPOSED" WATER AUTHORITY



Champaign-Urbana area in the east-central segment (Visocky and Schicht, 1969). Geologic and recent aquifer testing during the exploration program for the Decatur emergency well field indicate that in this part of the west-central segment of the valley, the aquifer yield may be less than in the Champaign-Urbana area. Little information is available on the potential yields of aquifers in the western and eastern segments of the valley. In no area are the data sufficient to undertake a modern, comprehensive analysis of the aquifer system.

In addition to questions concerning the aquifer potential yield, it is not possible with available information to predict with a reasonable degree of certainty the impacts of new ground-water developments on ground-water levels and water quality. Because of the artesian nature of the aquifer system, the impacts of large-scale resource developments on ground-water levels are widespread. However, these impacts do not necessarily mean a diminution of the ground-water resource.

#### **Summary**

Ground-water resource development in the Mahomet Valley is expected to increase significantly in the foreseeable future. It is anticipated that this increase will have at least some impact on the availability and quality of the resource in some localities over a period of time. Ongoing efforts to understand the aquifer system are not adequate to address conflicts and provide for the wise, equitable management and use of the system.

It is proposed to significantly accelerate the current data collection and study efforts of the Geological and Water Surveys to define the Mahomet Valley ground-water system so that the water-level and water quality impacts of increased development can be predicted and monitored and the tools needed to develop equitable management plans for the resource can be provided.

In subsequent sections of this report, the geology and the hydrology of the ground-water system is described to provide background data on what is currently known. Efforts to measure ground-water levels and ground-water withdrawals to monitor the water-level impact of withdrawals are described. Brief sections on ground-water quality and ground-water modeling are presented. Different options for future ground-water development are discussed.

The report concludes with a discussion on different plans for study and a recommended plan of study.

## II. GEOLOGIC AND HYDROLOGIC SETTING

### GEOLOGY

#### Background

To understand ground-water movement and ground-water availability in the Mahomet Valley requires knowledge of the details of its geologic history, bedrock topography, and the sequence, distribution, and character of its contained deposits. The most recent comprehensive study (Kempton et al. 1991) describes the Mahomet Bedrock Valley's history and provides regional interpretations of the bedrock topography and the glacial drift stratigraphy, utilizing data available at the time of the study. A subsequent study (Kempton and Visocky, 1991) updates information on the confluence area of the Mahomet and Mackinaw Bedrock Valleys. Most of the pertinent earlier studies are referenced in these reports.

Kempton et al. (1991) state that "During the more than 40 years since Horberg's original work defining the Mahomet Valley and describing its sediment fill, much new subsurface data have accumulated and numerous local and regional ground-water and related studies have yielded new insights into the configuration of the valley. In addition, the use of more sophisticated techniques, both geophysical and drilling and sampling has improved the quality of the data available."

Except for one recent project, just south of the Mahomet Valley (Kempton, Morse and Visocky, 1982), there have been no systematic studies incorporating controlled test drilling and sampling and test wells into an overall study of the distribution and characteristics of aquifers in the Mahomet Valley area. The most recent studies have been primarily compilations of existing data, although some test drilling at selected sites to determine aquifer occurrence and characteristics has been available (Kempton and Visocky, 1991). All of the studies since Horberg's work have built upon his original model, refining and revising as the available warranted. The studies by Kempton, et al. (1991) and Kempton and Visocky (1991) have carried the use of existing data to near the limit of its usefulness in defining the bedrock topography and sequence and distribution of the contained glacial sediments. Therefore, these studies represent the current state of knowledge of the regional geology of the Mahomet Valley region.

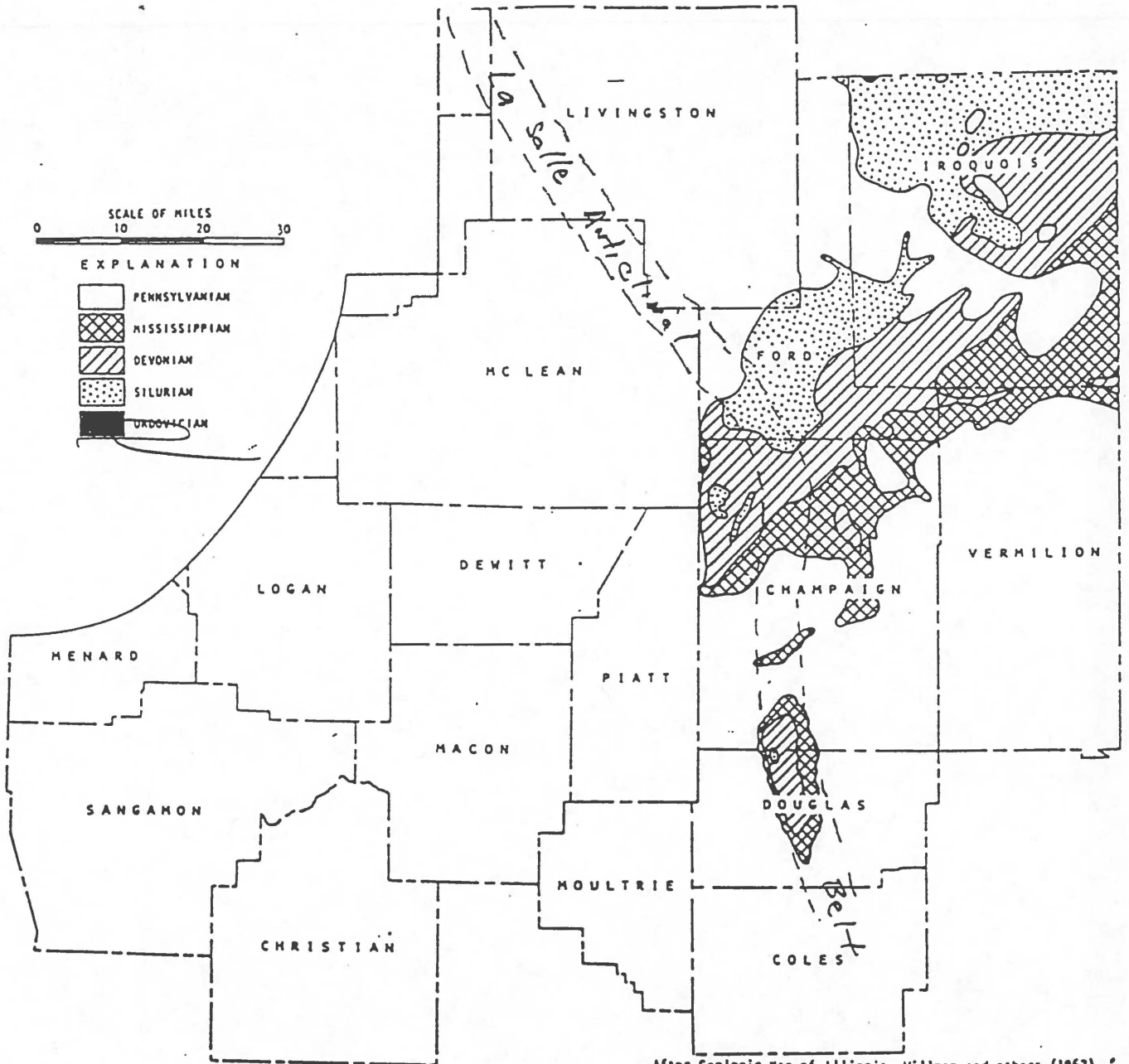
#### Summary of the Hydrogeologic Setting

##### *Bedrock Aquifers*

Rocks of Pennsylvanian age form the bedrock surface (figure 6) except where eroded in the northeastern part of the area and along the LaSalle anticlinal belt exposing older rocks of Mississippian, Devonian, and Silurian age.

Because of their low permeability and poor water quality with depth, the Pennsylvanian rocks do not constitute an important aquifer in the area. On the bedrock uplands, however, where the glacial drift is thin and permeable sands and gravels are missing, they have been developed for domestic and small municipal supplies. Csallany (1966) summarized yields of wells in the Pennsylvanian rocks.

In the northern part of the area, wells finished in the Silurian dolomite and the Glenwood-St. Peter sandstone of Ordovician age may yield moderate to large quantities of ground water. According to Csallany and Walton (1963) yields of wells finished in the Silurian dolomite may exceed 500 gpm in parts of Iroquois and Livingston



After Geologic Map of Illinois, Willman and others (1967)

Figure 4. Areal geology of bedrock surface in east-central Illinois and location of La Salle anticlinal belt.

out

Counties. In northern Livingston, Ford, and Iroquois Counties wells finished in the Glenwood-St. Peter sandstone may yield up to 100 gpm (Technical Advisory Committee on Water Resources, 1967).

Along the LaSalle anticlinal belt in parts of Douglas, Champaign, and Ford Counties domestic and farm supplies can be developed in Silurian and Devonian limestone and dolomite where they are present just below the drift or are thinly covered by Pennsylvanian rocks.

These bedrock formations that yield potable ground water in the northern part of the area and along the LaSalle anticlinal belt where they are near the surface contain highly mineralized water in the remainder of the region where they are deeply buried.

Mississippian rocks are not an important aquifer in the area, because they are either too deeply buried or, where near the surface, are composed of shale.

#### *Bedrock Topography*

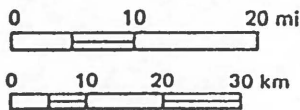
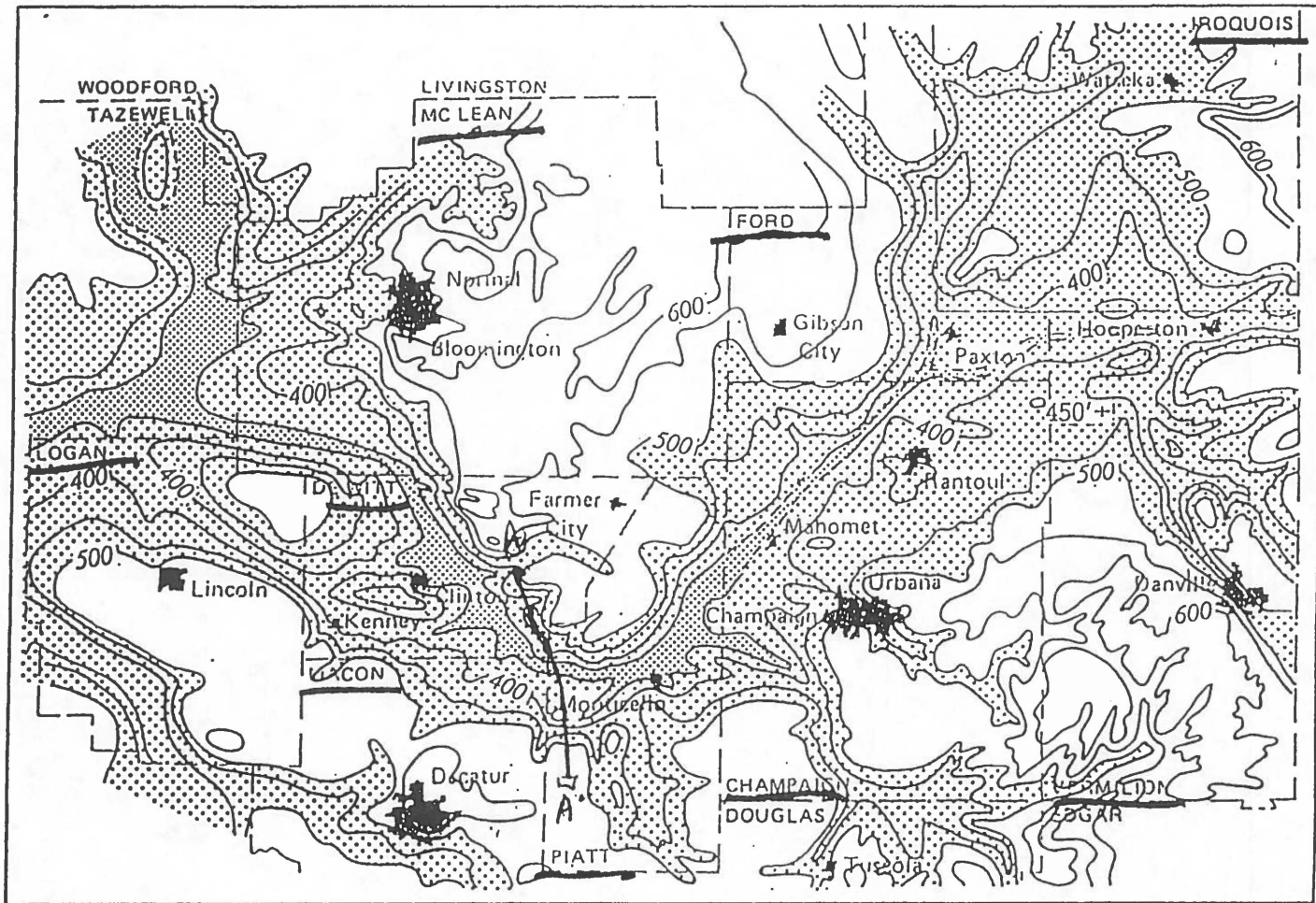
The bedrock topography of the Mahomet Valley was first defined by Horberg (1945). Kempton et al. (1991) provided a new perspective on the configuration of the Valley, confirming the essence of Horberg's map, but at the same time adding important changes in detail. A contour map of the bedrock surface from Kempton et al. (1991) is shown in figure 7. The main feature of the bedrock topography is the Mahomet Valley which enters the state from Indiana at about the county line of Iroquois and Vermilion Counties. The Valley continues westward to Ford County, then southwestward to Champaign County across the northwestern part of Champaign County to Piatt county where it turns northwestward continuing until joining the Mackinaw Bedrock Valley at the eastern end of the Havana Lowlands (see Walker and Bergstrom, 1965, for a description of the Havana Lowlands). Rock elevations along the valley are less than 400 feet above sea level, or about 200 to 300 feet below the adjoining uplands. The width of the valley varies from about 4 miles, as it enters the state, to about 14 miles in DeWitt County. The deeper part of the valley is entrenched below a broader outer valley, 400 to 500 feet above sea level. The main tributaries to the valley are also shown in figure 1.

#### *Glacial Drift*

The deposits covering the bedrock in east-central Illinois are a product of geologic events that occurred during the Pleistocene time. They range in thickness from a few feet to more than 400 feet (Piskin and Bergstrom, 1975). The thickest drift is found generally over bedrock valleys. The drift averages more than 150 feet throughout the east-central Illinois region. The cross-section in figure 8 illustrates the general nature of the glacial drift. Kempton et al. (1991) discuss in detail the stratigraphy and the history of the deposition and erosion of the glacial deposits.

It is not clear if the Mahomet Valley was entrenched to its maximum depth at the beginning of the ice age (Pleistocene) or during the early and middle Pleistocene. According to Kempton et al. (1991), the Mahomet Bedrock Valley was the major drainage way during the early and middle Pleistocene, and possibly earlier. It carried runoff, including large volumes of glacial meltwater, from eastern and northern Illinois, at least parts of northern Indiana, and possibly areas further east. It is from the sand and gravel, deposited by these meltwater streams, that large ground-water supplies are now obtained in east-central Illinois.

#### *Principal Sand and Gravel Aquifers*



< 350 ft above MSL  
 350-500 ft above MSL  
 > 500 ft above MSL

contour interval 50 ft

ISGS 1983

After Kerrison et al. (1991)

A-A' Geologic Cross-section

Figure 7. Bedrock topography of east-central Illinois

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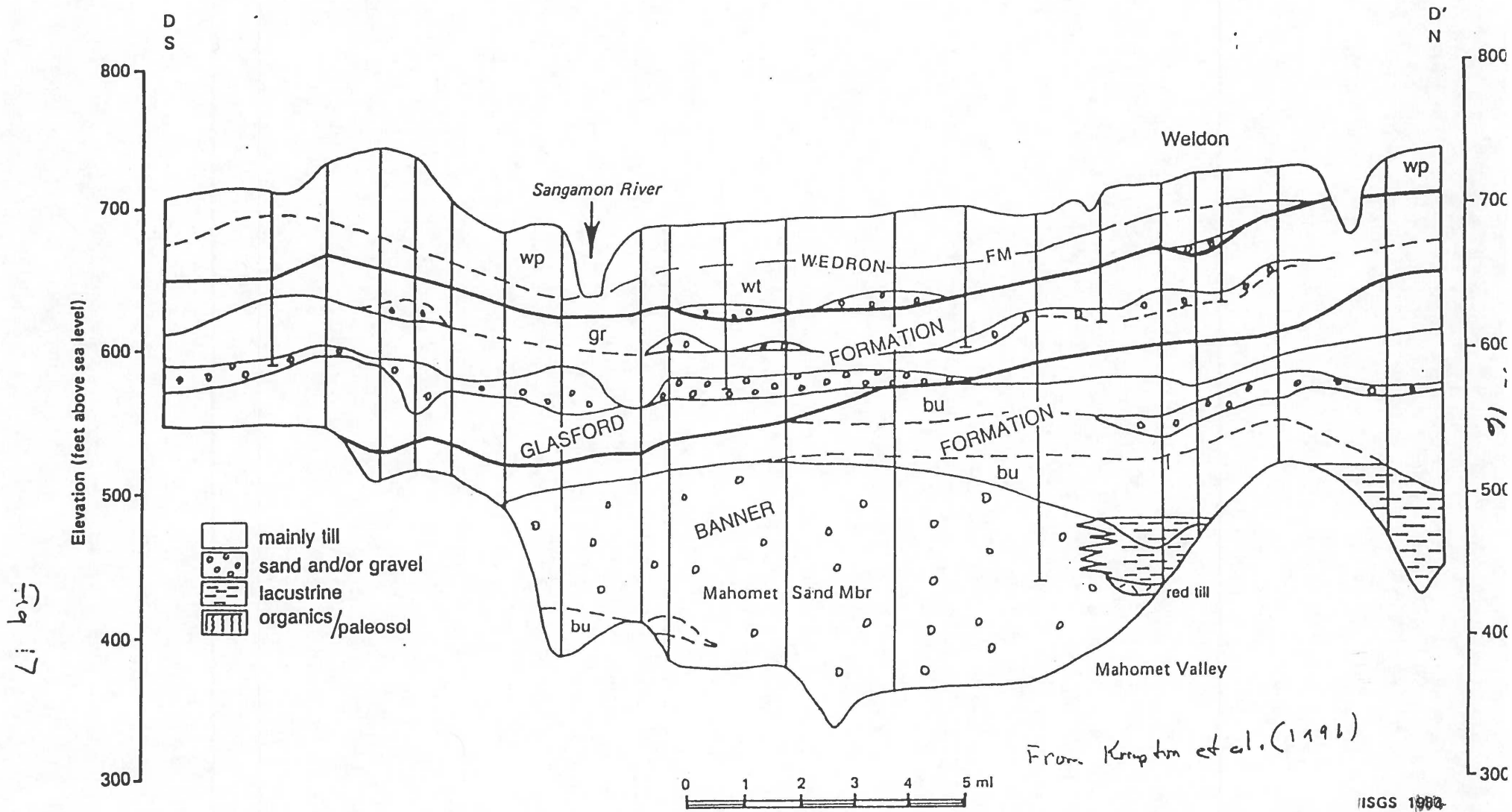


Figure 17.8 North-south cross section (A-A') across Mahomet Valley, south-eastern DeWitt County & southern Piatt County (see Figure 5 for location)

went clean copy

### **Mahomet Sand (Banner Formation)**

Kempton et al. (1991) briefly summarize aquifer characteristics in east-central Illinois. The Mahomet Sand of the Banner Formation is the most important aquifer in east-central Illinois. It fills the deeper parts of the Mahomet Valley throughout its length and in the tributary Onarga Valley and the Kenney Valley (figure 9). Its thickness and areal extent are controlled by the elevations of its upper surface and the configuration and elevation of the bedrock surface. Therefore, the Mahomet Sand is locally as much as 200 feet thick and averages close to 100 feet in thickness. The Mahomet Sand is composed primarily of clean sand and gravel with only minor amounts of fines. There is evidence that its productivity is greater in the eastern and east-central segments of the Valley.

### **Glasford Formation Aquifers**

The Glasford Formation aquifers lie above the Mahomet Sand and consist of sand and gravel formations interbedded within the glacial tills. As shown in figure 10, in the northwestern part of the Valley there are no widespread Glasford Formation aquifers. Throughout the stippled area shown in figure 10, these aquifers commonly range in thickness from 5 feet to more than 60 feet. They are coarsest and thickest (about 100 feet) just west of Champaign-Urbana. Although not as important as the Mahomet Sand, they are important sources of water-supply for many municipalities and industries along the Mahomet Valley. They also act as a holding tank for water to be gradually recharged into the Mahomet Valley Aquifer. Because of their closeness to the land surface and their importance as a recharge source, their protection must be a priority in any water resources study in this area.

### **Wedron and Henry Formation Aquifers**

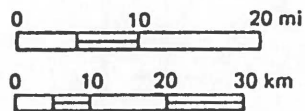
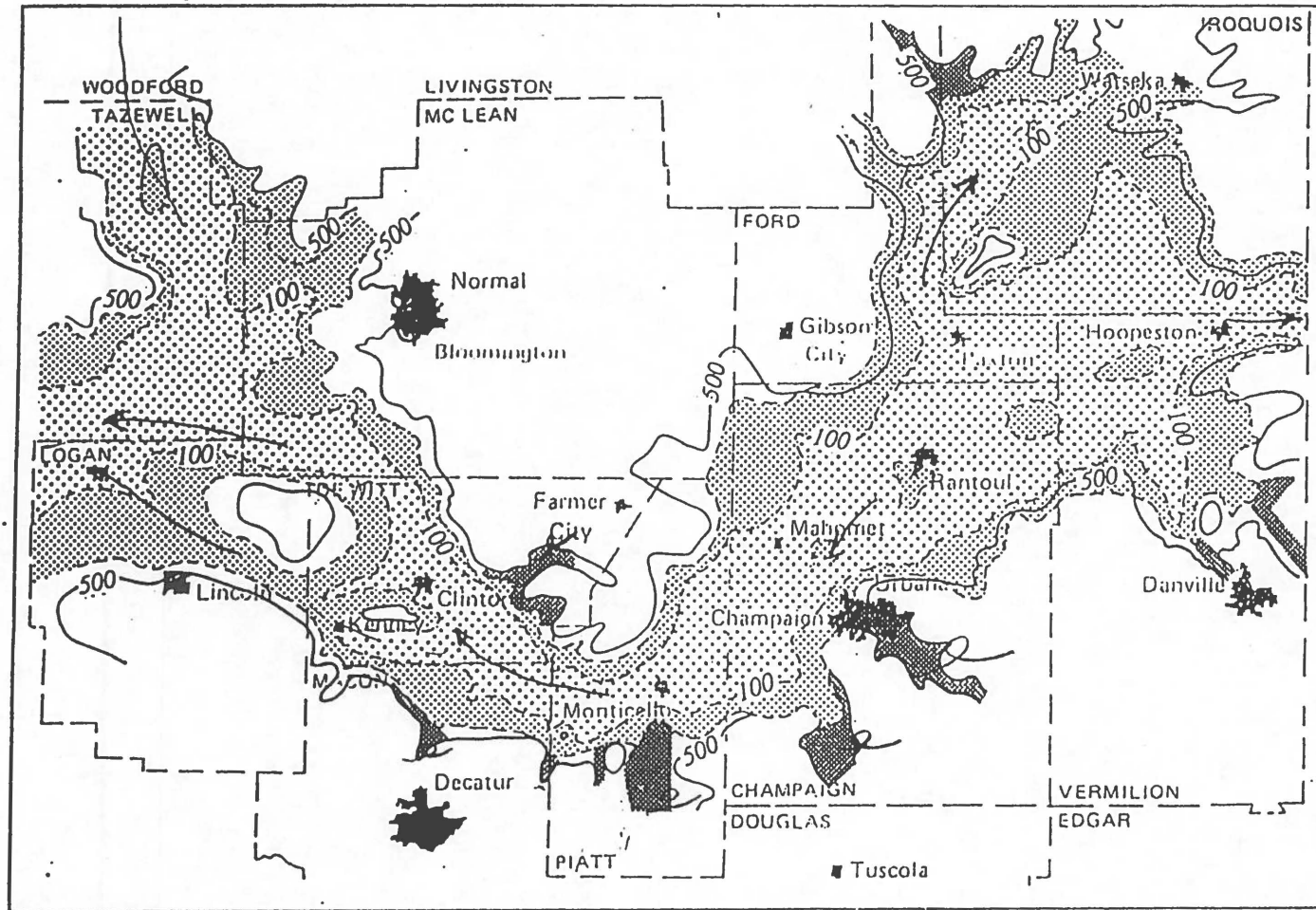
Above the Glasford Formation are aquifers associated with the most recent glaciation--the Wisconsinan. Locally, these aquifers may have importance, particularly those aquifers associated with present day stream valleys; for example, surficial sand and gravel aquifers associated with the Sangamon River lowlands (Henry Fm). Locally, sand and gravel layers are present at the base of or interbedded between till members of the Wedron Formation.

## **GROUND-WATER HYDROLOGY**

### **Ground-Water Occurrence and Movement**

Ground water in the unconsolidated glacial drift deposits in the Mahomet Valley occurs under leaky artesian and water-table conditions. Leaky artesian conditions exist where till or other fine-grained deposits overlie aquifers and impede or retard the vertical movement of ground water, thus confining the water in the aquifers under leaky artesian conditions. Leaky artesian conditions exist in the Glasford Formation aquifers and the Mahomet Sand aquifer. Water-table conditions exist in the Wisconsinan drift where the water is unconfined.

Ground water moves under the influence of gravity from areas of high head to low head that occur either naturally or are induced by pumpage. Under natural conditions ground water in the shallow deposits moves laterally and is either discharged into streams or percolates vertically to the deeper aquifers in the Valley region. Ground water in the shallow deposits is replenished by precipitation that percolates to the water table. Figure 11 provides a cross-section showing general ground-water movement in the shallow deposits. Under the leaky artesian conditions that exist in the deeper Glasford formation aquifers and the Mahomet Sand aquifer, a pressure difference between water above and below the till or fine-grained deposits that confine these aquifers allows water to move vertically through the confining beds from one aquifer to another. Leakage is possible in either direction. In places

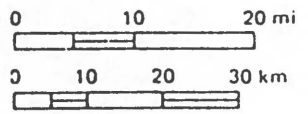
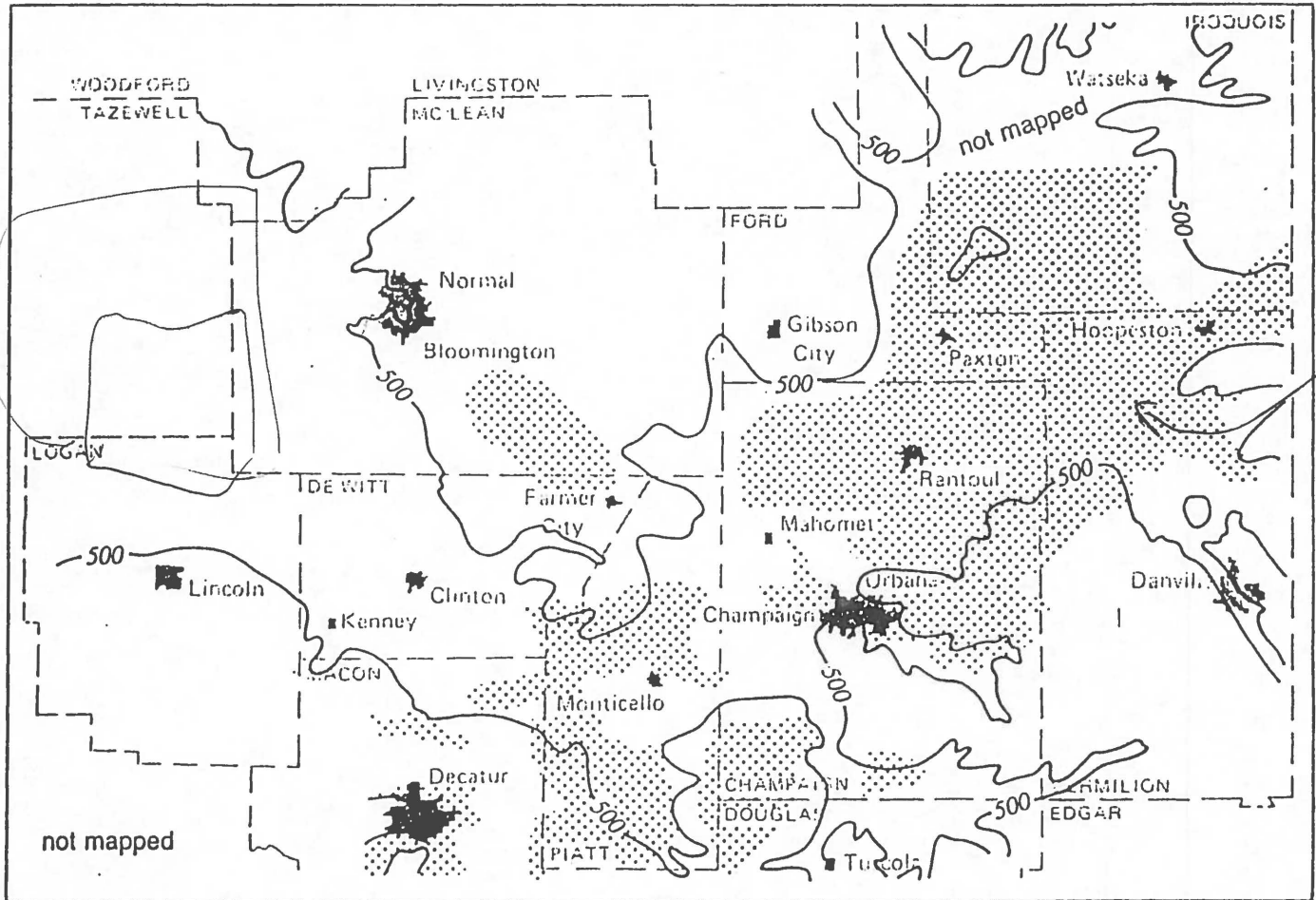


< 100 ft thickness  
 > 100 ft thickness  
 -500' bedrock elevation above MSL

silt facies ← Direction of groundwater flow  
 (modified from Kempton et al. (1991))  
 After Kempton et al. (1991)

Figure 9. Distribution and thickness of the Mahomet Sand Member.

loop



sand and gravel generally present > 20 ft thick  
 -500' bedrock elevation above MSL (outline of Mahomet Bedrock Valley)

From Kempton et al (1991)

<sup>10</sup>  
 Figure 8. Distribution of sand and gravel within Glasford Formation (Illinoian) in relation to the Mahomet Bedrock Valley.

Fig 20

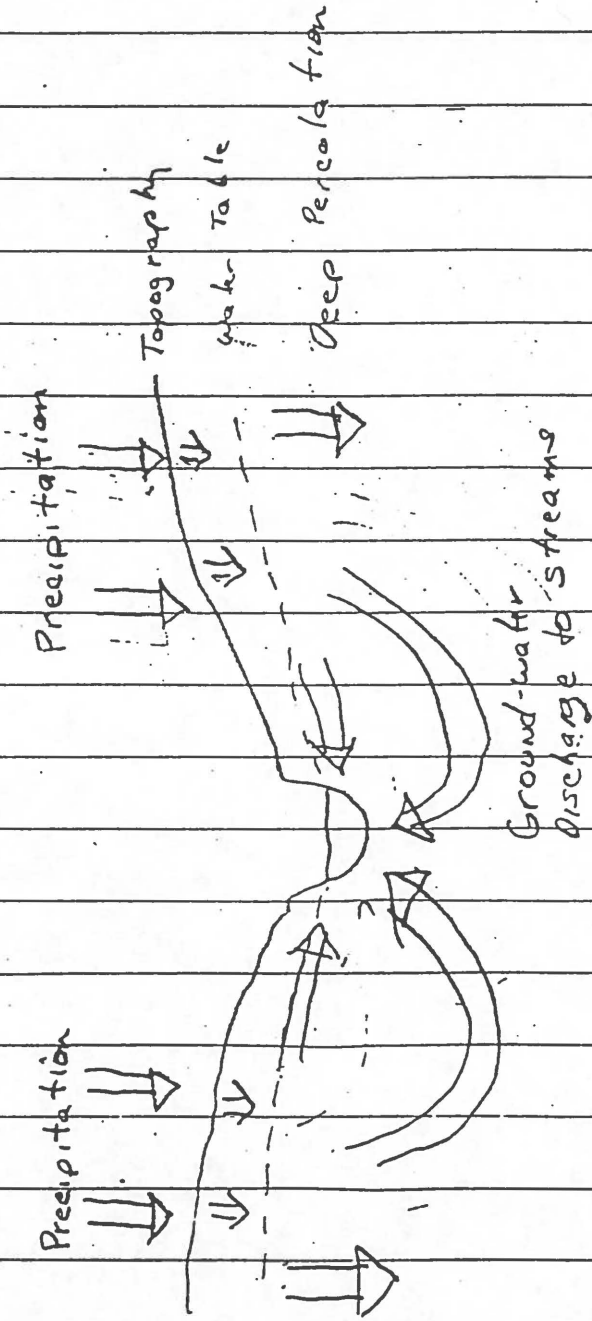
Bed > 20

19

98

deep

IGS 1963



21

Figure 11: Generalized ground-water movement in the shallow deposits.

Figure 11:

done

leakage may occur into the shallow deposits as shown generally in figure 12.

There is evidence that regional ground-water flow in the Mahomet Sand Aquifer in all but the eastern segment is westward (figure 8) with the ultimate discharge to the Illinois River Valley, west of the junction with the Mackinaw Bedrock Valley (Kempton et al., 1991). Discharge in the eastern segment of the Mahomet Valley may be toward the Iroquois River in central Iroquois County and eastward toward the Wabash River in east-central Indiana (Kempton et al., 1991).

#### Ground-Water Levels in Wells

Adequate knowledge of ground-water levels is critical to the success of any ground-water resource evaluation. The lowering of ground-water levels due to ground-water withdrawals is the main concern in developing ground-water conflicts. Ground-water level data are needed to make estimates of ground-water recharge and the direction of ground-water flow. Only with adequate information on ground-water levels can ground-water system models be calibrated.

To measure ground-water levels, the Illinois State Water Survey maintains networks of observation wells. A statewide network consisting of 19 shallow wells equipped with continuous water-level recorders and located remote from pumping centers is maintained to obtain data on seasonal fluctuations of the water table due to recharge and discharge phenomena and long-term trends of the water table due to climate change and land use changes such as improved drainage practices. Within the Mahomet Valley region shown in figure 13, shallow observation wells are located near Watseka in Iroquois County, near Bondville in Champaign County, near Galesville in Piatt County, and near Middletown in Logan County.

Other observation wells maintained by the State Water Survey are located near pumping centers mainly to monitor the impact of pumping on water levels. These water levels are useful in detecting aquifer overpumpage, in estimating ground-water recharge rates, and in calibrating ground-water models. Only in the vicinity of Champaign-Urbana (three wells) and between Decatur and Monticello, near Cisco and Cerro Gordo, are water levels near pumping centers in Mahomet Valley aquifers monitored by the State Water Survey.

Of particular interest has been the monitoring of water levels in the vicinity of Champaign-Urbana. Measurement of water levels in the vicinity of pumping centers began sporadically in the 1920's and 1930's and in earnest in the 1940's in the Champaign-Urbana area, primarily in municipal wells. These measurements documented the severe decline of water levels in the Glasford Formation aquifer caused by overpumpage by municipal, industrial, and University of Illinois wells. Systematic measurement of water levels west of Champaign-Urbana in the Mahomet Sand aquifer began in the 1950's to monitor the impacts of large industrial withdrawals on the municipal supply for Champaign-Urbana operated by Northern Illinois Water Company. Water levels from these wells were used to verify a ground-water model of aquifers in the vicinity of Champaign-Urbana described by Visocky and Schicht (1969).

#### Aquifer and Confining Bed Hydraulic Properties

To aid in predicting water-level drawdowns in aquifers due to proposed pumping schemes, it is necessary to determine the capacity of aquifers and confining beds to transmit ground water and the capacity of aquifers to store water. The capacity of an aquifer to transmit ground-water is expressed by the transmissivity. The transmissivity is the

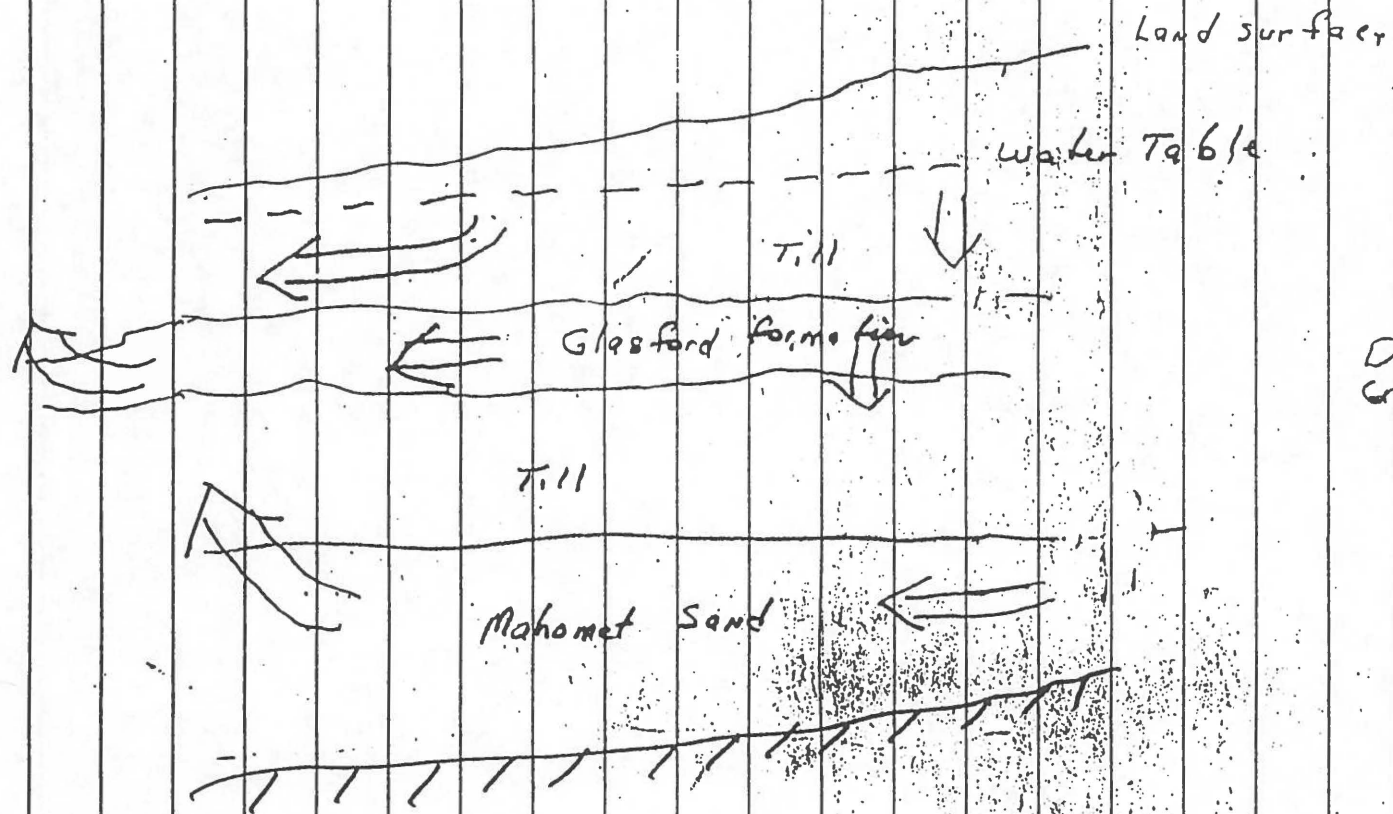


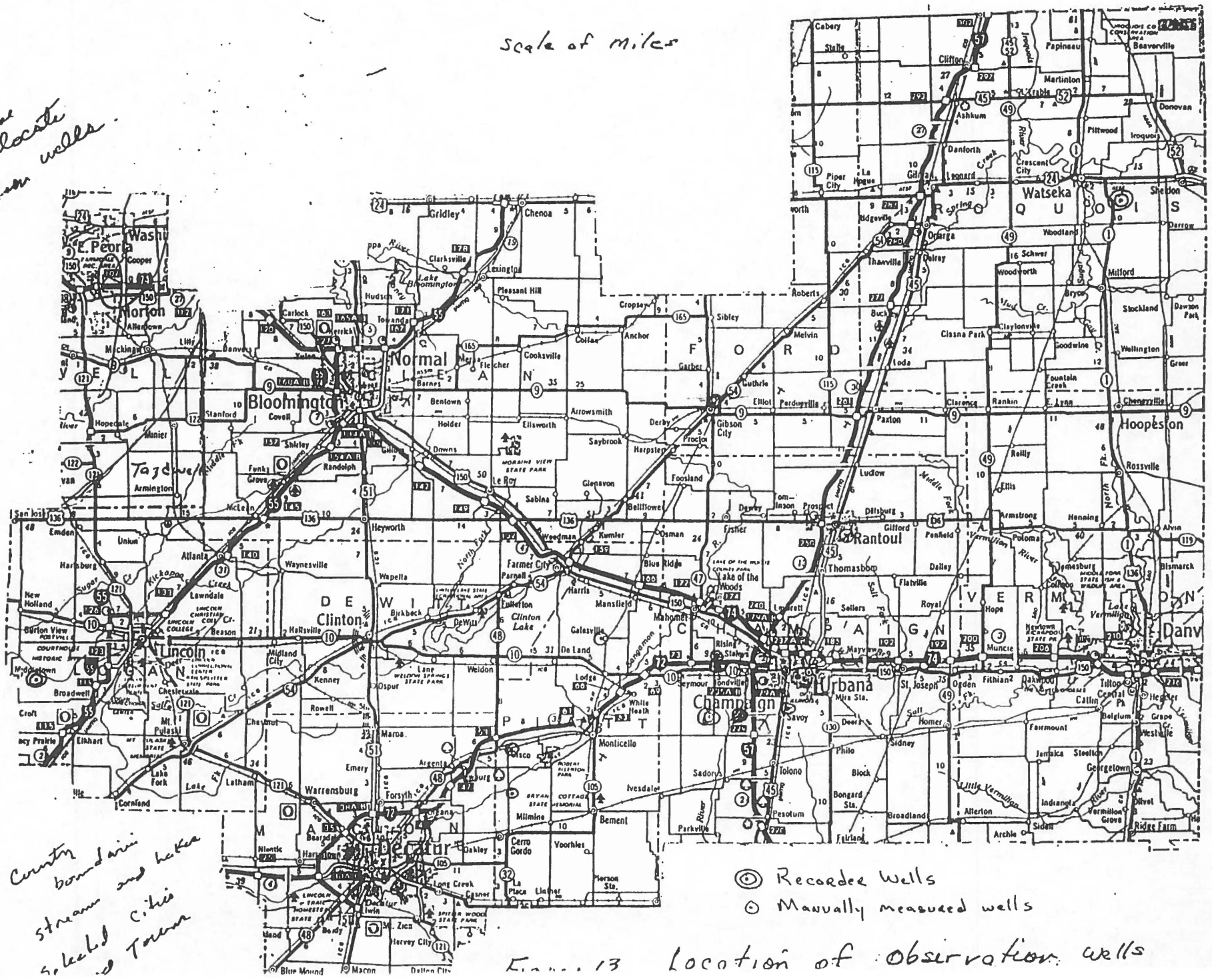
Figure 12. Cross-section showing direction of ground-water movement

22

delete

scale of miles

Need someone to help locate observation wells



County boundaries  
stream and lakes  
selected cities  
towns

⊙ Recorder wells  
○ Manually measured wells

Figure 13 Location of observation wells

55

product of the saturated aquifer thickness and the hydraulic conductivity of the aquifer.

The storage properties of an aquifer are expressed by the storage coefficient, the volume of water released from storage or taken into storage by a cubic foot of aquifer material per unit change in water level. For a confined or artesian aquifer such coefficients are usually very small--generally in the range of 0.00001 to 0.001. For unconfined or water-table aquifers, in which water levels are below the top of the aquifer, storage coefficients are much larger and typically range in value from about 0.05 to 0.3. See Freeze and Cherry (1979) for definitions of transmissivity, hydraulic conductivity (including the vertical hydraulic conductivity of confining beds), and storage coefficient.

Data from aquifer tests are commonly used to determine hydraulic properties for aquifers and confining beds. These tests consist of pumping a well at a constant pumping rate for a specified period of time and measuring the response of water levels in the pumped well and observation wells. Data from well production tests, where observation well data are not available, can be used to determine aquifer transmissivity. Methods of analysis are described by Walton (1962).

The Water Survey's ongoing aquifer and well production program has collected invaluable data to determine aquifer hydraulic properties in Illinois. Visocky and Schicht (1969) summarized aquifer hydraulic properties in east-central Illinois determined from tests conducted prior to 1967. They reported transmissivities ranging from 869 to 147,000 gallons per day per foot (gpd/ft) from well and aquifer tests in the Glasford Formation and from 5,130 to 325,000 gpd/ft for tests in the Mahomet Sand. More current information is contained in Water Survey files.

#### Ground-Water Recharge and Runoff

Knowledge of ground-water recharge is useful in evaluating the yield of ground-water resource systems. For example, the state-wide potential yield maps developed for planning purposes were partly based on recharge estimates (Technical Advisory Committee on Water Resources, 1967). Estimates of yields of wells and aquifers in many parts of Illinois have been based on previous recharge studies (see Walton, 1965, for a summary of analyses based on recharge).

The major source of ground-water recharge in the Mahomet Valley region is that portion of precipitation that percolates to the water table and shallow deposits. The amount of precipitation that reaches the water table is dependent upon several factors. Among these are the character and thickness of the soil and other deposits above and below the water table; the topography; vegetal cover; land use; soil-moisture content; the depth to the water table; the intensity, duration, and seasonal distribution of rainfall; the occurrence of precipitation as rain or snow; and the air temperature. Most recharge occurs during spring months when evapotranspiration demands on soil moisture are so great that little precipitation infiltrates to the ground-water table. Recharge during the late fall may be significant when evapotranspiration declines if precipitation is adequate to replenish soil-moisture. Recharge during the winter months may be negligible depending upon the length of time that the ground is frozen.

One of these recharge studies (Schicht and Walton, 1961) included the Goose Creek watershed located in the Mahomet Valley region in Piatt and DeWitt Counties. Estimates of recharge were made using a ground-water budget equation for the years 1955, 1956, and 1957. Recharge estimates to the ground-water table were about 310,000 gallons per day

per square mile (gpd/sq mi) and 170,000 gpd/sq mi for 1955 and 1956, respectively--years of below normal precipitation. During 1957, a year of above-normal precipitation, recharge was estimated to be about 500,000 gpd/sq mi.

The shallow deposits act as the recharge source for deeper aquifers in the Mahomet Valley region. This recharge to the deeper, buried aquifers involves the vertical movement of ground water from the shallow deposits under the influence of vertical head gradients. The quantity of recharge to the deep aquifers varies from place to place and is controlled by the vertical hydraulic conductivity and thickness of the deposits through which ground-water movement occurs, the head differential between sources of water and aquifer, and the area through which movement occurs. This movement of ground water through deposits is termed leakage and can be expressed mathematically by a form of Darcy's law (Walton, 1960).

Little quantitative data are available on recharge rates to the deeper aquifers in the Mahomet Valley region. Walton (1965) determined a recharge rate of 115,000 gpd/sq mi to the Glasford Formation aquifers in the immediate vicinity of Champaign-Urbana. Visocky and Schicht (1969) estimated the average annual recharge to the Banner Formation for the period 1953 through 1965 was about 107,000 gpd/sq mi. Richards and Visocky (1982) estimated recharge to the Banner Formation in the area of the Normal west well field to be about 88,000 gpd/sq mi.

If recharge estimates are to be used as a tool for ground-water management in the Mahomet Valley region, there is still much investigative work needed. Additional geologic mapping is needed to provide lithological characteristics of confining materials that can be related to the characteristics of other confining beds in Illinois for which vertical hydraulic conductivity data are available. By inference, a map of vertical hydraulic conductivities can be constructed. Additional data on conductivity must be determined from long-term aquifer tests. An expanded long-term program of water-level measurement will provide information that will aid in determining regional estimates of vertical hydraulic gradients.

Another source of recharge to shallow aquifers in the Mahomet Valley area is from infiltration of surface water during periods when stream stages are above adjacent ground-water levels. This is not considered a major source of recharge except along the Sangamon River, where shallow sand and gravel aquifers are in hydraulic connection with the river.

As described in the section on Ground-Water Occurrence and Movement, ground water is constantly moving either vertically downward to deeper aquifers or laterally to discharge to streams. Ground water that is discharged into streams is referred to as baseflow or ground-water runoff. Under pumping conditions, ground-water runoff is diverted toward cones of depression. Because the most productive aquifers in the Mahomet Valley region are deeply buried, not all ground-water runoff can be diverted into cones of depression. Even under heavy pumping conditions there is some lateral movement of ground water as well as vertical movement. Walton (1965) discussed the relation between recharge rates and ground-water runoff from other studies in Illinois and concluded that the average ratio between recharge to cones of depression in deeply buried aquifers and ground-water runoff was about 60 percent.

Ground-water runoff can be estimated from streamflow data using methods described by Freeze and Cherry (1979). Using the extensive long-term records of streamflow available for more than 100 drainage basins in Illinois, Walton (1965) made estimates of ground-water runoff.

Visocky and Schicht (1969) applied these studies to the Mahomet Valley region and estimated that during a year of normal precipitation that ground-water runoff is about 740 million gallons per day (mgd). Walton's ratio of recharge to cones of depression and ground-water runoff was then applied by Visocky and Schicht to arrive at the estimate of potential yield of about 445 mgd that could be developed from major aquifers in the Mahomet Valley region.

#### Ground-Water Pumpage

An accurate history of ground-water pumpage is critical in understanding the response of aquifers to pumping. Calibration of aquifer models is dependent on duplicating measured hydraulic-head drawdowns in response to pumpage history.

Within the Mahomet Valley area, the only comprehensive summary of ground-water use has been that reported by Visocky and Schicht (1969). They summarized ground-water withdrawals from 1890 to 1965 within the Mahomet Valley area as defined by the 500-foot bedrock contour. They estimated that 40.2 mgd were withdrawn from Mahomet Valley aquifers in 1965. The largest amount, 25.8 mgd or 64.2 percent of the total, was withdrawn by municipalities. They reported that 6.7 mgd, or 16.7 percent of the total, was withdrawn for industrial supplies; and rural pumpage accounted for 7.7 mgd, or 19.1 percent of the total. Over one-half of the withdrawals, 25.6 mgd or 55.4 percent of the total pumpage, were from municipal and industrial wells in the Champaign-Urbana area.

*Ellis needs to update #1's*

In 1978, the Water Survey initiated a statewide water use inventory program. It was estimated from data given by Kirk et al. (1987)--the most recent statewide pumpage report--that about 59 mgd were withdrawn in 1986 from sand and gravel aquifers in the nine counties in east-central Illinois encompassing the Mahomet Valley area, considerably less than the 445 mgd estimated yield. Of the 59 mgd, about 36 mgd was for municipal use, 9 mgd for industrial use, and 14 mgd for rural use, including nearly 2 mgd for irrigation. Rural use also includes water for domestic and livestock use. Preliminary data indicate total pumpage in 1990 was about 58 mgd.

#### Ground-Water Quality

The quality--both chemical and biochemical--of ground water determines ground water's usefulness for industry, agriculture, and the home. Based on available information, the quality of ground water from sand and gravel aquifers in east-central Illinois is adequate for most general uses, particularly with treatment for hardness reduction and iron removal.

Studies at the Illinois State Geological Survey show that in the eastern half of the valley (east of Colfax Syncline and Osman Anticline) chloride concentration of the waters at the top of the aquifer is about 150 mg/l, and this concentration decreases with depth to about zero at a depth of about 120 m (about 395 ft). This trend is reversed for samples collected west of Coalfax Syncline and Osman Anticline. In this region the concentration of chloride increases from about 5 mg/l at the top of the aquifer to about 160 mg/l at a depth of about 120 m. This reversal in the pattern of chloride content is perhaps indicative of sodium chloride intrusion on the eastern half from surface sources, and brine intrusion from bedrock sources on the western half. If brine intrusion from bedrock sources is being held back by natural groundwater piezometric head in the aquifer, it is only natural that brine intrusion will be promoted by a decline in the piezometric head.

## GROUND-WATER RESOURCE EVALUATION

### General Approaches Available

There are three approaches to investigating and evaluating the ground-water resources of the Mahomet Valley area.

1. Continue to offer a technical assistance program to individuals, communities, and industries that are planning to develop ground water. Technical assistance programs range in scope from conducting pumping tests on individual wells to designing and conducting a full-scale ground-water investigation, concluding with the design of a well-field configuration, well construction features, and long-term well and well-field yields.

Depending upon the magnitude of the investigation, the developer may be requested to provide financial support. The successful conclusion of each study adds another building block to our understanding of ground-water conditions in the Mahomet Valley area. It is unlikely that with this approach ground-water conditions in the Valley would be adequately understood to resolve ground-water conflicts or determine the water-level impacts of large-scale ground-water development in the foreseeable future, if ever.

2. Supplement the technical assistance program with a modest continuing geologic exploration and aquifer testing program supplemented with long-term support for the Illinois State Water Survey Water Use and Ground-Water Level Monitoring Programs. It is estimated that a period of 20 to 30 years may be needed at this level to understand the Mahomet Valley system adequately for conflict resolution and understanding the impacts of development on the environment.
3. Supplement the technical assistance program with an intensive geologic exploration and aquifer testing program of seven years duration supplemented with long-term support for water-use and water-level programs. It is estimated that after the seven-year study period, the understanding of the ground-water system would be adequate to make management decisions, to resolve conflicts, and to make reasonable predictions on the water-level impacts of resource development.

### Ground-Water Modeling for Planning for Development

The ultimate goal of an intensive geological and hydrological investigation of the Mahomet Valley region is to form a model of the ground-water flow system within the valley or within different valley study segments. The definition of a model that follows is excerpted from Anderson and Woessner (1992). Models are devices that represent field situations. Physical models like sand tank models can simulate ground-water flow directly. For a system as complex as the Mahomet Valley system a mathematical model that simulates ground-water flow indirectly by means of a governing equation that represents the physical processes that occur in the system, together with equations that describe heads or flow along the boundaries of the system, is necessary. Since the flow system is time-dependent, an equation describing the initial distribution of water-levels is also needed. For a simple model, a mathematical solution may be all that is required. For a system as complex as the Mahomet Valley system, a numerical analysis, involving a computer, is necessary. The general use of the model will be to determine ground-water-level changes caused by changes in pumpage and recharge.

The need for detailed and reliable data from intensive field studies for a successful model cannot be overemphasized. For example, an important step in the modeling exercise is the calibration of the model against historical records of ground-water levels and ground-water withdrawals. Calibration is a trial and error procedure that may require many adjustments in the model parameters before a close match is obtained between model output - water levels - and observed ground-water levels. It should be noted that to remain useful the model must be updated, as warranted, with newly acquired data and refined interpretations.

The model would have many uses, including locating well fields to minimize water-level impacts and evaluating various development scenarios on regional water levels. Development scenarios might include limiting withdrawals in order to balance recharge, allowing withdrawals to exceed recharge (mining), or allowing environmental, social, or economic considerations to dictate ground-water development.

Many different models are available, including those developed by Prickett and Lonquist (1971). Modeling protocol described by Anderson and Woessner (1992) is also available.

#### Assessment of Options for Future Ground-Water Development

To reduce conflicts and to plan for the wise development of the ground-water resource, it is important to develop a ground-water management philosophy before intensive development of the ground-water resource occurs.

Three management philosophies based on yield concepts can be considered for the Mahomet Valley. They are:

- Practical sustained yield
- Safe yield
- Optimum yield

The practical sustained yield concept is used in most ground-water evaluation studies conducted by the State Water Survey. Todd (1959) discusses the safe yield concept and Freeze and Cherry (1979) summarize the concept of optimum yield.

Practical sustained yield is defined as the maximum amount of ground water that can continuously be withdrawn from a reasonable number of wells without creating critically low water levels or exceeding recharge.

- Advantages

1. Satisfies the concept of water as a renewable natural resource.
2. Yields maximum sustainable resource quantity.

- Disadvantages

1. Does not consider the possible impact of withdrawals on water quality.
2. Does not consider the likely impacts of withdrawals on base-flow to streams.
3. Does not consider legal constraints.
4. Neglects pumping costs.
5. May limit economic development.

Safe yield can be defined as the amount of ground water that can be withdrawn from a reasonable number of wells and well fields without creating critically low water levels or exceeding recharge or producing any other undesirable results.

- Advantages

1. Satisfies the renewable natural resource concept.
2. Considers the possible impact of withdrawals on water quality.
3. Considers the likely impacts of withdrawals on baseflow.
4. Considers legal constraints.
5. Considers pumping costs.

- Disadvantages

1. May limit economic development.

Optimum yield, in addition to yield and environmental objectives, considers sets of economic and/or social objectives associated with the uses to which the water is put. Analysis may lead to optimal yields that involve mining ground water or reflect the need for complete conservation.

- Advantages

1. Considers social and economic objectives.

- Disadvantages

1. Abstract concepts may be difficult to define and to understand.

The following should be considered in developing a management philosophy:

- Aquifer conditions (water table, leaky artesian, areal extent, thickness, etc.)
- Available information
- Projected demand
- Types of use
- Environmental concerns
- Economic considerations

### III. PROPOSAL FOR SYSTEMATIC STUDY AND EVALUATION

#### STUDY PROPOSAL

Because of the regional extent and complexities of the Mahomet Valley ground-water system, a multi-year (seven years) study is proposed. The main goals of the study are to develop a detailed geologic and hydrologic framework of the ground-water system and an intensive ground-water level monitoring system so that a ground-water model can be developed and calibrated. An ongoing ground-water use program will continue to be maintained. The understanding of the ground-water system should be adequate so that ground-water models can be developed in the future to study the impacts of different schemes of ground-water development for different resource management philosophies. The first year of the study will consist of staff selection, study design, and initial compilation of existing data. At the start of the second year a five-year Geologic and Hydrologic Field Study will begin.

The Geologic Study will determine aquifer and confining bed dimensions and lithology for model development. The study will build on the work by Kempton et al. (1991) and consist of intensive surface and subsurface geological and geophysical programs. The Geologic study will provide input for design of the Hydrologic study and will provide data to aid in determining ground-water recharge and aquifer and confining bed properties, and aquifer geometry data.

The main objectives of the Hydrologic study are to determine hydraulic properties of aquifers and confining beds and recharge characteristics sufficiently for future model development. The Hydrologic study will include an inventory of existing water use and the design and construction of a ground-water level monitoring system for monitoring the impacts of pumpage and for future model calibration.

For study purposes it is anticipated that the Valley will be subdivided into four segments (figure 1). The segments in their likely order of study priority are given below. The order of priority may, of course, change based on local input and unforeseen exigencies.

- 1) West segment: The confluence area of the Mahomet Valley and the Havana Lowlands.
- 2) West-central segment: Monticello northwestward to the southeast edge of the confluence area.
- 3) East segment: The area from near Paxton eastward to the state line.
- 4) East-central segment: The area from near Paxton southwestward to Monticello.

A more accurate definition of the study segments will be made during the first-year study design phase.

A schedule for completion of the project studies is given below.

Year 1 - Geologic and Hydrologic Studies  
Staffing and study design  
Compilation of existing data  
Database development design

Year 2 - Geologic Study  
West segment:  
Surface geophysical study  
Enter geologic data into database  
Hydrologic Study  
West segment:

Enter hydrologic data database  
Collect data on current water use  
Inventory wells  
Design aquifer tests and select sites

Year 3 - Geologic Study

West segment:

Drill and log test holes  
Sieve analyses for test holes  
Geologic maps and cross sections  
Interim report

West-central segment:

Surface geophysical study  
Enter geologic data into database

Hydrologic Study

West segment:

Well and aquifer tests  
Mass water-level measurements  
Interim report

West-central segment:

Enter hydrologic data into database  
Collect data on current water use  
Inventory wells  
Design aquifer tests and select sites

Year 4 - Geologic Study

West-central segment:

Drill and log test holes  
Sieve analyses for test holes  
Geologic maps and cross sections  
Interim report

East segment:

Surface geophysical study  
Enter geologic data into database

Hydrologic Study

West-central segment:

Well and aquifer tests  
Mass water-level measurements  
Interim report

East segment:

Enter hydrologic data into database  
Collect data on current water use  
Inventory wells  
Design aquifer tests and select sites

Year 5 - Geologic Study

East segment:

Drill and log test holes  
Sieve analyses for test holes  
Geologic maps and cross sections  
Interim report

East-central segment:

Surface geophysical study  
Enter geologic data into database

Hydrologic Study

East segment:

Well and aquifer tests  
Mass water-level measurements  
Interim report

East-central segment:

Enter hydrologic data into database  
Collect data on current water use  
Inventory wells  
Design aquifer tests and select sites

Year 6 - Geologic Study

East-central segment:

Drill and log test holes

Sieve analyses for test holes

Geologic maps and cross sections

Interim report

Hydrologic Study

East-central segment:

Well and aquifer tests

Mass water-level measurements

Interim report

Year 7 - Geologic and Hydrologic Studies

Mass water-level measurement in entire valley

Compile final report for Mahomet Valley

Public Participation

Along with the Geologic and Hydrologic Studies, it is proposed to conduct public meetings to describe study objectives, report study progress, and describe different resource management philosophies. During the first year of the study, four meetings will be held; one at a convenient location in each study segment. In following years, one meeting will be scheduled after the conclusion of a study segment to report on progress. After the final report in Year 7 is completed, four public meetings will be held to report on the conclusions of the final report; one in each study segment.

ESTIMATED COST

It is estimated that a representative annual cost would be about 1.353 million dollars. The following shows the breakdown of costs into personnel, other direct (travel, communications, computer, equipment, publication, etc.), outside contractual (test drilling, aquifer testing, and some geophysical work), and indirect costs for each Survey.

	<u>Geological Survey</u>	<u>Water Survey</u>	<u>Total</u>
Personnel	\$150K	\$120K	\$ 270K
Other Direct	75	60	135
Outside Contractual	325	500	825
Total Direct	\$550K	\$680K	\$1230K
Indirect (10% of Direct)	55	68	123
TOTAL	\$605K	\$748K	\$1353K

Significant costs are shown for outside contractual costs for the study. These costs are based on early estimates that the geologic study would require about 30 test borings averaging 400 feet in depth (@ \$20/ft) for each segment to confirm and correlate geologic data. The hydrologic study for each segment would require determination of aquifer and confining bed hydraulic properties by conducting controlled aquifer tests with high-capacity production test wells (with observation wells) at 5-10 sites. The estimated cost for each site is about \$60K-\$75K. All drilling work and portions of the production tests would be under contract with drilling contractors.

These cost estimates are intended to provide only guidance as to the probable annual study costs. Improved cost estimates will be made as the scope of the study is further defined and as sponsorship interests and needs are evaluated. The cost of the first and last year of the study will reflect reduced contractual costs.

#### IV. REFERENCES

- Burch, Stephen L. 1991. The new Chicago model: A reassessment of the impacts of the Lake Michigan allocations on the Cambrian-Ordovician Aquifer System in northeastern Illinois. Illinois State Water Research Report No. 119.
- Csallany, Sandor. 1966. Yields of wells in Pennsylvanian and Mississippian rocks in Illinois. Illinois State Water Survey Report of Investigation 55.
- Csallany, Sandor, and W. C. Walton. 1963. Yields of shallow dolomite wells in northern Illinois. Illinois State Water Survey Report of Investigation 46.
- Freeze, R. Allan, and John Cherry. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
- Horberg, L. 1945. A major buried valley in east-central Illinois and its regional relationships. Geology, v. 53. No. 5, p. 349-359. Illinois State Geological Survey Reports of Investigation 106.
- Horberg, L. 1950. Bedrock topography of Illinois. Illinois State Geological Survey Bulletin 73.
- Horberg, L. 1953. Pleistocene deposits below the Wisconsin drift in northeastern Illinois. Illinois State Geological Survey Reports of Investigation 165.
- Kempton, J. P., W. H. Johnson, P. C. Heigold, and K. Cartwright. 1991. Mahomet Bedrock Valley in east-central Illinois; Topography, glacial drift stratigraphy, and hydrogeology. Geological Society of America Special Paper 258.
- Kirk, James R. 1987. Water withdrawals in Illinois, 1986. Illinois State Water Survey Circular 167.
- Piskin, K., and R. E. Bergstrom. 1975. Glacial drift in Illinois: thickness and character. Illinois State Geological Survey Circular 490.
- Prickett, T. A., and G. C. Lonquist. 1971. Selected digital computer techniques for ground-water resource evaluation. Illinois State Geological Survey Bulletin 55.
- Richards, Susan S., and Adrian P. Visocky. 1982. A reassessment of aquifer conditions west of Normal, Illinois. Illinois State Water Survey Circular 153.
- Schicht, Richard J., and W. C. Walton. 1961. Hydrologic budgets for three small watersheds in Illinois. Illinois State Water Survey Report of Investigation 40.
- Technical Advisory Committee on Water Resources. 1967. Water for Illinois: a plan for action. Springfield, Illinois.
- Todd, David K. 1959. Ground Water Hydrology. John Wiley and Sons, Inc., New York, New York.
- Visocky, A. P., and R. J. Schicht. 1969. Ground-water resources of the buried Mahomet Bedrock Valley. Illinois State Water Survey Report of Investigation 62.
- Walker, W. H., R. E. Bergstrom, and W. C. Walton. 1965. Ground-water resources of the Havana Region in west-central Illinois. Illinois

State Water Survey and State Geological Survey Cooperative Ground-water Report 3.

- Walton, W. C. 1960. **Leaky aquifer conditions in Illinois.** Illinois State Water Survey Report of Investigation 39.
- Walton, W. C. 1962. **Selected analytical methods for well and aquifer evaluation.** Illinois State Water Survey Bulletin 40.
- Walton, W. C. 1965. **Ground-water recharge and runoff in Illinois.** Illinois State Water Survey Report of Investigation 48.
- Willman, H. B., and others. 1967. **Geologic Map of Illinois.** Illinois State Geological Survey.

**B.) East Central Illinois Aquifer Study  
E.W.S. Memorandum, 2/5/90**



GROUND-WATER SECTION • MEMORANDUM

TO: Visocky, Schicht, and Kempton (ISGS)  
FROM: Ellis Sanderson  
DATE: February 5, 1990  
RE: East Central Illinois Aquifer Study  
(Mahomet Valley Aquifer Study)

RECEIVED  
DIVISION OF WATER RESOURCES  
Springfield, Illinois

DRV \_\_\_\_\_

AUG 29 1990

PCM D  C/O \_\_\_\_\_  
D/LR \_\_\_\_\_ RM \_\_\_\_\_  
PLNG \_\_\_\_\_ AS \_\_\_\_\_

This follows up on our discussion of 2/2/90 regarding an appropriate funding level for a study of the Buried Mahomet Valley Aquifer system. During this discussion we considered the four segments of the system we had determined at our recent meeting on 1/26/90 on the same general topic:

- 1) Valley western confluence area (MCL, TAZ, DWT)
- 2) Monticello-Decatur-Clinton
- 3) Champaign-Rantoul
- 4) Paxton-Hoopeston (Valley eastern confluence area) (FRD, IRO, VER)

The conceptual approach to the study was:

- 1st Year -- Assemble data, establish common database, study framework, etc.
- 2nd Year -- Begin field study - 1st segment
- 3rd Year -- Complete field study - 1st segment. Begin 2nd segment.
- 4th Year -- Complete field study - 2nd segment. Begin 3rd segment.
- 5th Year -- Complete 3rd segment. Begin 4th segment.
- 6th Year -- Complete 4th segment.
- 7th Year -- Complete data analysis/interpretation. Prepare joint final report.

The estimated funding level was based on staff requirements, outside contractual, and other direct costs. Fringe benefits and IC, if applicable, are imbedded in the estimate. Project staff needs at the ISGS was estimated to average 4 FTE and at the ISWS 3 FTE. Outside contractual costs were estimated based on an average of 30 test borings/segment (400 ft x \$20/ft) and a total of 30 high capacity test wells (10, 5, 5, 10 for segments 1, 2, 3, and 4, respectively, at \$60 K/site). Included in the contractual costs for test wells is sophisticated logging by Schlumberger (\$75 K/yr).

C.) Mahomet Valley Aquifer Study Mtg. Notes, 1/22/86

# MAHOMET VALLEY AQUIFER STUDY MTG.

1/22/86 GARY CLARK, ELLI SANDERSON, BOB ~~STREIBER~~  
GILKESON

"GOAL IS A FRAMEWORK FOR MANAGEMENT!"

## KEY POINTS

- 1) ALOT OF MONEY TO DO IT RIGHT!
- 2) MUST DO MAIN VALLEY AND NUMEROUS TRIES.  
BY SETTING A DEMAND BASIS SCHEDULE!
- 3.) COSTLY TO DRILL HOLES AND DO PUMP TESTS  
SO WE MUST CUT COSTS BY APPLYING GEOPHYSICS.
- 4.) ISWS AND ISGS WANTS DOWN TO "LEAD THE CHARGE"  
FILTER OUT THE B.S. AND MANAGE FUNDING
- 5) WE MUST DO A SCOPING STUDY OF ALL  
EXISTING INFO. AND NEEDED STUDIES, TYPE, NATURE,  
LOCATION
- 6.) FY '87 SEPT. - DEC ≈ 12 mos. \$40,000 FINAL REPORT IF  
FY '88 GO FOR A 9 MONTH EXTENSION @ \$40,000 NEEDED
- 7) HAVE DRAFT PROPOSAL IN 2 MONTHS
- 8) " FINAL PROPOSAL BY JULY 1<sup>ST</sup>

**D.) Preliminary Work Plan, ISGS & ISWS, 11/26/80**

**State Geological Survey Division**

██████████ Natural Resources Building  
615 East Peabody Drive  
217/344-1481 Champaign, IL 61820

RECEIVED  
DIVISION OF WATER RESOURCES  
Springfield, Illinois

November 26, 1980

Mr. Sam Mastoufi  
Division of Water Resources  
Illinois Department of Transportation  
2300 South Dirksen Parkway  
Springfield, IL 62764

P.K. \_\_\_\_\_ DRV \_\_\_\_\_  
DEC 02 1980 NS \_\_\_\_\_  
JAG \_\_\_\_\_ RM \_\_\_\_\_  
FI \_\_\_\_\_ LA \_\_\_\_\_  
PD \_\_\_\_\_ PGM D. \_\_\_\_\_

Dear Sam:

Enclosed is a tentative work plan for the Mahomet Valley study we talked about. Also enclosed is a short article written on the Mahomet, "A Hidden Valley: Our Region's Most Important Resource," written for a newspaper.

As I envisage the project, Part I can be accomplished in two years. Part II would only be undertaken if drilling funds become available.

Very truly yours,

*Keros Cartwright*  
(24)

Keros Cartwright  
Geologist and Head  
Hydrogeology and Geophysics Section

Enclosures

cc: Ellis Sanderson - State Water Survey

Preliminary Work Plan for Joint Agency Study on Regional  
Assessment of Major Aquifers (Mahomet Valley)

By

Keros Cartwright and Ellis W. Sanderson

Purpose

Subsurface investigations are necessary to determine the hydrogeologic setting for numerous communities mainly in central Illinois. Such investigations require evaluation of existing subsurface data supplemented, where needed, by controlled drilling and sampling to identify, characterize and map the extent of aquifers present within the buried preglacial buried Mahomet Bedrock Valley. This is Phase I of a 5-year proposed study of the glacial drift aquifers in the buried Mahomet Bedrock Valley.

Justification

An assessment of public ground-water supplies was undertaken jointly by the Division of Water Resources, Illinois Department of Transportation, and the State Geological Survey and State Water Survey Divisions, Illinois Institute of Natural Resources. The assessment, begun in 1977 and continuing through the present time, has focused on community water supplies which suffered water shortages during the 1976-77 drought. Two regional aquifer assessments in central and east-central Illinois, where there was a concentration of water-short communities, are underway and will be completed in 1980.

The Mahomet Valley is a broad, deep valley carved by a large river into the preglacial landscape of Illinois. Sand and gravel deposited in this valley constitute the largest, and potentially the most productive in the southern three-quarters of Illinois. In most of the area it constitutes the only aquifer capable of large industrial and municipal development, and will be increasingly utilized for this purpose.

We propose to evaluate the potential yield of the aquifer. To do this, it will be necessary to determine the extent of the aquifer, its hydrologic properties, and how the aquifer properties vary. This will be accomplished by utilizing existing geologic and hydrologic information, geophysical exploration, test drilling, logging existing water wells, and testing existing water wells.

Work Plan - Part I  
(2 years)

Tasks

1. Study, evaluate and plot subsurface data currently available for the central Illinois area focusing on stratigraphic position, distribution, continuity of potential sand and gravel aquifers, yield, hydrologic properties, and present use.
2. Outline areas of significant aquifer potential and areas where data are lacking, but where the aquifer is likely to be present.
3. Perform geophysical studies (surface electrical earth resistivity, seismic refraction, and downhole logging) in selected areas.

4. Perform hydrologic tests on existing wells where possible.
5. Prepare an interim report on the progress of the project.

Work Plan - Part II  
(2 or 3 years)

6. Conduct a test drilling program at sites selected during Part I.
7. Map the distribution of potential aquifers for the entire region on a series of maps, showing thickness and general properties.
8. Evaluate hydrologic characteristics of the aquifers as related to municipal ground-water sources, and determine resource availability.
9. Evaluate other hydrogeologic regions containing groups of selected communities for possible future study, or if resources permit include in this study by repeating steps 1 through 6 for each region.
10. Compilation of the data for a report to the Division of Water Resources.

Task Responsibility

<u>Task</u>	<u>Agency</u>
1	Geological Survey, Water Survey
2	Geological Survey
3	Geological Survey
4	Water Survey
5	Geological Survey, Water Survey
6	Geological Survey, Water Survey
7	Geological Survey
8	Water Survey
9	Geological Survey, Water Survey
10	Geological Survey, Water Survey

*Funding:*

*Part I - \$ 20 - 30 K Per Year for 2 years  
with 20K as the absolute Min.*

*Part II - \$ 300,000 for drilling Program.*

## A HIDDEN VALLEY: OUR REGION'S MOST IMPORTANT RESOURCE

A hidden valley the size of the Mississippi Valley crosses southernmost Iroquois, Ford, Champaign, Piatt and De Witt Counties. From it comes the most valuable natural resource taken from the ground in these counties. Inhabitants of Hoopeston, Paxton, Mahomet, Champaign and Urbana, Monticello, and Clinton live beside the valley, but none of them have seen it, even though most of them continually use the resource extracted from it.

As many in this region know, the hidden valley is the buried Mahomet Valley and the valuable resource is water. In places the Mahomet Valley is about half full of water-bearing sand and gravel layers, which are called aquifers because they readily yield water to many hundreds of private home, farm, city and industry wells. The records of the Northern Illinois Water Corporation show that in 1975 alone the communities of Champaign and Urbana used approximately 5 billion gallons of water pumped entirely from the Mahomet Valley.

The Mahomet Valley and its aquifers are extraordinary geologic features. Even though out-of-sight and underfoot, they are a frequently discussed topic. They inspire questions that geologists at the Illinois Geological Survey are often asked and that I want to answer in this space: Where is the valley? How was it formed? How big is it? How does water get in it?

But to explain what the Mahomet Valley aquifers are, one point needs to be made clear.

### The Aquifers of the Mahomet Valley Are Not an Underground River

The Mahomet Valley aquifers and similar ones throughout the state are frequently referred to as "underground rivers" and thought of as streams running in caves through solid rock. In fact, an aquifer in the Mahomet Valley is not one but innumerable millions of streams. These streams are tiny, intertwining seeps

and films of water. They do not flow in caves but in the microscopic spaces between the grains of sand and gravel that make up the water-bearing layers buried in the Mahomet Valley. In truth, "rivers" of water are pumped from the valley, but its aquifers are in no way similar to the streams that can be seen in limestone caves in southern and western Illinois and in southern Indiana, particularly at Spring Mill State Park.

### Early History

The Mahomet Valley was in existence at least one million years ago, just before the beginning of the Ice Age. Then the landscape of Illinois was more rolling than it is today, with deeper stream valleys cut into bedrock. In large part, the streams and rivers followed different courses across the midwest than they do today. At this time the Mahomet Valley was the principal valley of east-central Illinois and with its tributaries drained much of the east-central portion of the region now in our state.

The Mahomet Valley was broad and deep, carved by a large river that flowed from West Virginia, across Ohio and Indiana to central Illinois where it joined the Ancient Mississippi River in Tazewell County. At that time, the Ancient Mississippi flowed southeastward from near Rock Island to Hennepin, then southward in a valley now closely followed by the Illinois River from Hennepin to near Alton. After the Mahomet Valley was completely buried by debris from the Ice Age glaciers, drainage off its watershed was ultimately diverted into the present-day rivers, and their valleys now form a part of the present landscape.

### Effects of Glaciation

At least four times within the past million years the Earth's climate has cooled for long periods. During each of these cooler times, or glacial stages, more winter snow fell in the northern latitudes around the world than melted in

the summers. Because the glacial stages lasted tens of thousands of years, snow and ice fields perhaps 5 to 10 thousand feet thick accumulated. Like the Antarctic and Greenland ice caps today, the ancient snow and ice fields flowed outward in pulses from their edges as they thickened.

In North America, the continental glaciers flowed southward into the lowland between the Appalachians and the Rocky Mountains. The Illinois region lay near the center of this flow, and the southernmost point reached by glaciers in the whole northern hemisphere is in southern Illinois, near Goreville in Johnson County.

When glaciers entered the drainage basin of the Mahomet Valley and its tributaries, floods of meltwater from the ice carried sand and gravel into the valleys where it was deposited. These deposits of sand and gravel are now the porous, water-yielding aquifers found in the Mahomet Valley. In places they are as much as 200 feet thick.

When the glaciers themselves reached the valley and flowed across it, they deposited layers of gray, pebbly, sandy clay which geologists call "till" and well drillers and excavators call "blue boulder clay." The succession of glaciations filled the Mahomet Valley full of alternating layers of till and layers of sand and gravel, hiding it from sight and finally creating the present slightly rolling and level plains in our area.

#### How Discovered

After the Mahomet Valley was completely buried by debris from the Ice Age glaciers, drainage off its watershed was ultimately diverted into the present-day rivers, and their valleys now form a part of the present landscape. The only parts of the old valley visible at the surface now are found south of Chillicothe, in south-central Ohio, and in West Virginia. It was in this area, south of the

glaciated region, that the existence of the valley was first recognized. The westward continuation of the valley was discovered and traced by geologists studying the records and samples of wells drilled through the whole thickness of glacial deposits down to the old bedrock surface in which the valley was cut. The information furnished by drilling companies making foundation tests and seeking water, oil and gas and coal has enabled us to map the course of the valley, the aquifers, and the ancient landscape under the glacial deposits. Using such data, new aquifers can be found, often with less cost for exploratory drilling, and the flow of ground water into and out of the aquifers can be monitored.

### The Valley in Illinois

The Mahomet Valley covers a distance of about 120 miles in Illinois and has many tributaries that are also buried. It enters our state near Hoopston and runs west to Paxton in Ford County, southwest through Mahomet and Monticello across Champaign and Piatt Counties. There the valley turns northwest across De Witt County and passes just east of Clinton into southwestern McLean County. From here it is traced along the Tazewell-Logan County line to its junction with the Ancient Mississippi Valley near San Jose.

In Illinois the valley is named after the Village of Mahomet which is located over the deepest part of the buried channel. East of Illinois, the valley is generally called the Teays Valley, and so the whole valley system from our state to West Virginia is sometimes referred to as the Mahomet-Teays Valley.

In Illinois the average depth from the present land surface to the deepest part of the Mahomet Valley is somewhat more than 300 feet. Before the glaciers buried the valley, the uplands on each side were 200 feet and more above the valley floor--about the height of the Mississippi Palisades above that river now. The Mahomet Valley in Illinois averages about 12 miles in width, actually wider than the present day Mississippi River Valley.

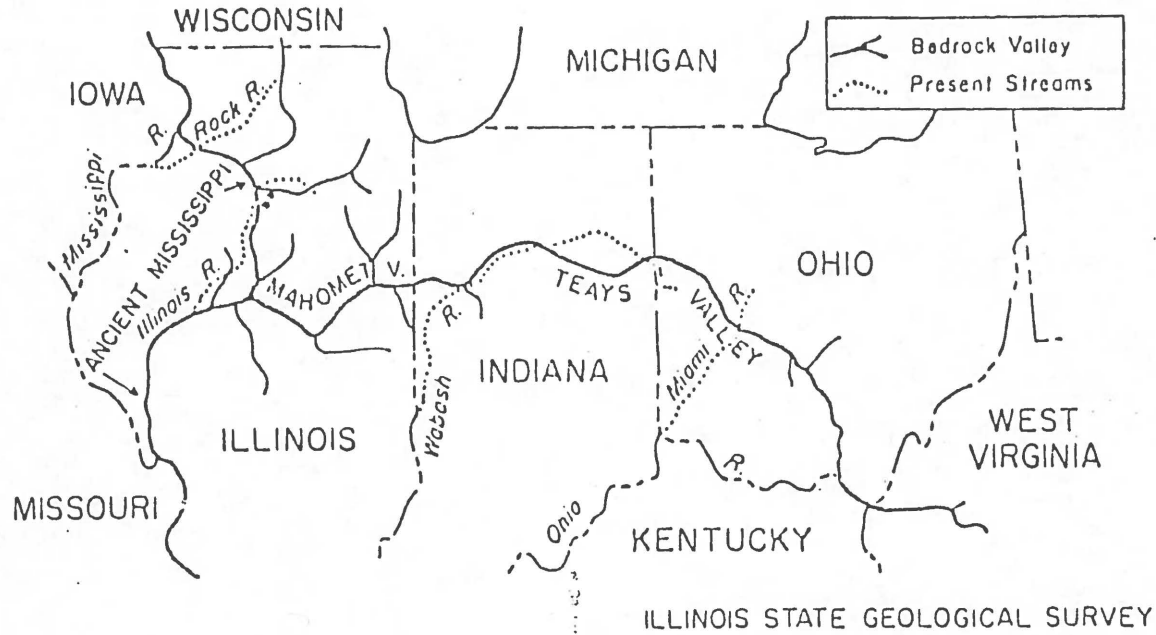
### How Water Enters the Aquifers

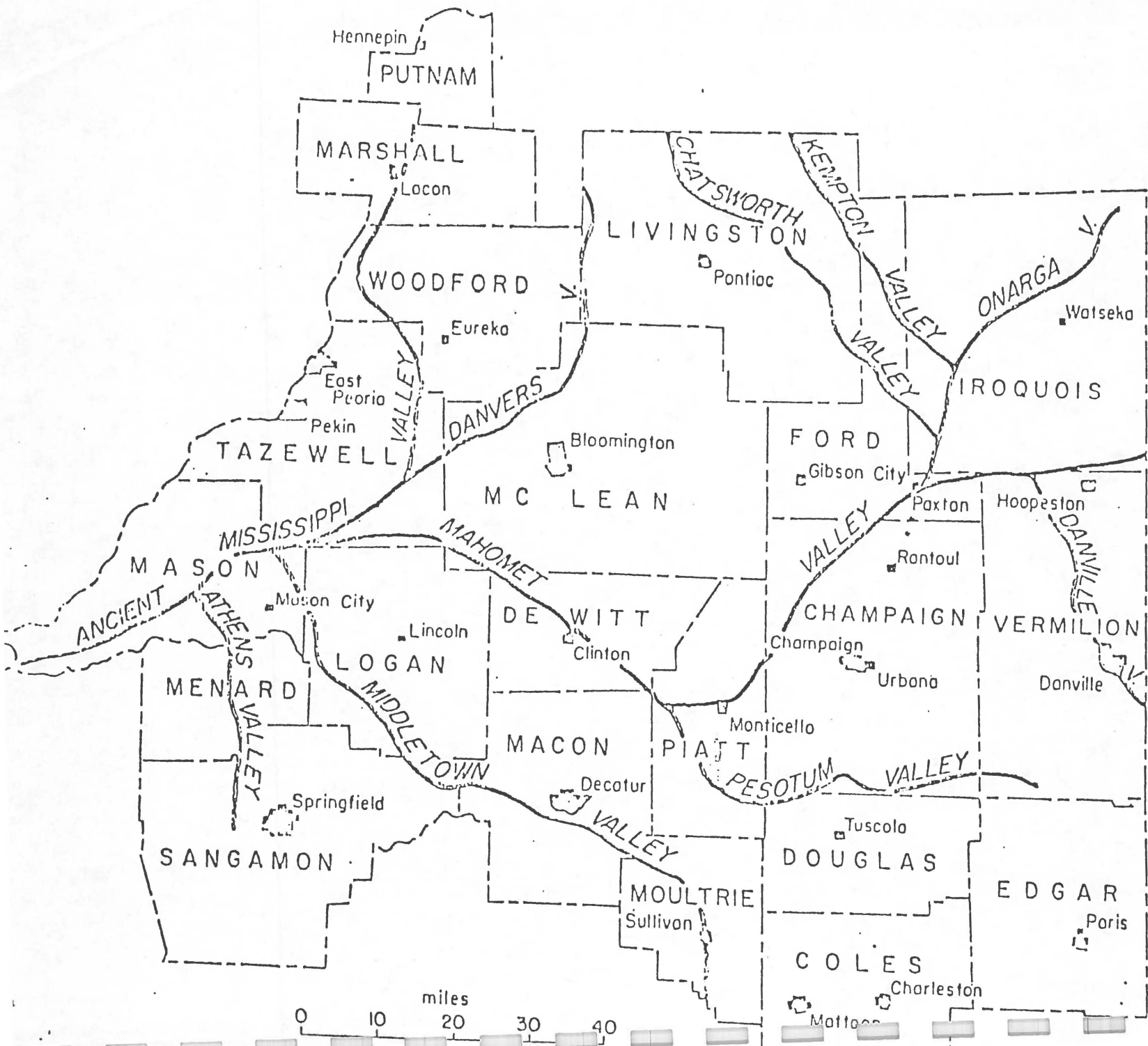
The water in the buried Mahomet Valley does not come from the Appalachian Mountains, or from any great distance. Rather, the water which fills the openings between the sand and gravel particles is the rainfall and snow melt that soaks into the land surface over and adjacent to the valley. The water moves slowly downward through the thick overlying glacial clays to the sand and gravel and replaces water that is pumped from wells and that seeps into the main rivers that cross the Mahomet Valley. The aquifers of the Mahomet Valley are such a large reservoir of water that pumpage of wells is little affected even by periods of drought.

### The Future

The cities of Champaign and Urbana are indeed fortunate, as are the other communities along or near the Mahomet Valley. For the most part, our water supplies are assured, provided they are developed and managed on the basis of the most up-to-date knowledge. As new data from well drilling become available, geologists at the Illinois State Geological Survey can determine more precisely the position of the valley and the distribution and character of the deposits in it. Similarly, the Illinois State Water Survey will continue to update information on the quantity and quality of the water currently being produced, allowing for better predictions of future trends in use and supply. Such information should help to insure wise development and use of the ground water in the sand and gravel aquifers of one of our truly great natural resources, the Mahomet-Teays Valley.

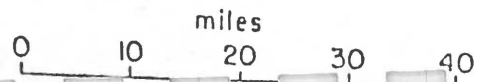
Location of the Mahomet-Teays Bedrock Valley in Illinois, Indiana, Ohio and West Virginia.





CAPTION

Location of the deepest channels of the buried Mahomet and Ancient Mississippi Valleys and their larger tributaries in east-central Illinois.



CAPTION

Simplified cross sectional view of the Mahomet Valley and its deposits from northwest of Mahomet to southeast of Champaign-Urbana..

