Petition to Designate the Mahomet Aquifer as a Sole Source Aquifer

December 10, 2012

Submitted by: City of Champaign, the Town of Normal, City of Urbana, University of Illinois-Champaign/Urbana, Village of Savoy, City of Delavan, Village of Mahomet, Village of Mansfield, and City of Gilman

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Technical Preparation by: Layne Hydro, Bloomington, Indiana

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1. PETITIONER IDENTIFYING INFORMATION

Aquifer	Name: Mahomet Aquifer
	Location: Cass, Champaign, DeWitt, Ford, Iroquois, Logan, Macon, Mason, McLean, Menard, Piatt, Tazewell, Vermilion, and Woodford counties in Illinois
Petitioner	City of Champaign, the Town of Normal, City of Urbana, University of Illinois-Champaign/Urbana, Village of Savoy, City of Delavan, Village of Mahomet, Village of Mansfield, and City of Gilman
	102 North Neil Street
	Champaign, IL 61820-4042
	(217) 403-8710
Responsible Person	Joseph Hooker
Contact	Joseph Hooker
	(217) 403-8710

In addition to these petitioners, there are numerous other entities that we have reached out to and have expressed their support for this petition. All letters of support received and outreach activities completed as of December 10, 2012, are attached to this petition.

2. NARRATIVE

The Mahomet Aquifer is an economically important drinking water supply source for east-central Illinois. The Aquifer, principally composed of buried sand and gravel deposits that fill a wide bedrock valley, is the primary source of drinking water for over 100 communities and tens of thousands of rural homeowners located within 14 east-central Illinois counties: Cass, Champaign, DeWitt, Ford, Iroquois, Logan, Macon, Mason, McLean, Menard, Piatt, Tazewell, Vermilion, and Woodford counties (Figure 1).

In 2010, the Aquifer provided an estimated 53 million gallons of drinking water per day (Mgd) to approximately 120 public water supplies and thousands of rural wells, together serving over 500,000

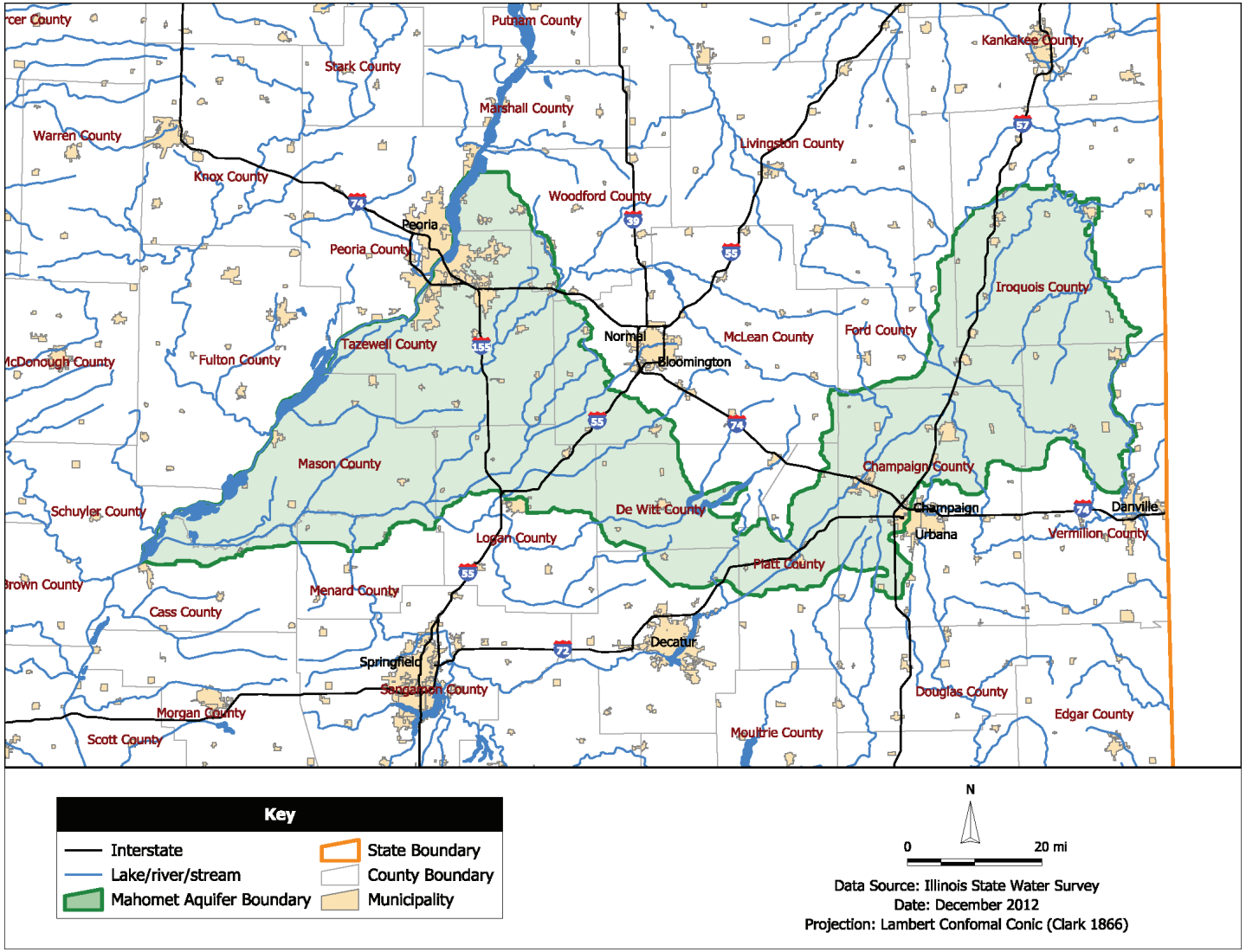

Figure 1. Location of the Mahomet Aquifer system in east-central Illinois (modified from Roadcap et al., 2011).

people. The Mahomet Aquifer System provides 94% of the water to the service area today, and demand is expected to increase over the next 50 years (Wittman Hydro Planning Associates, 2008). The aquifer is also a critical resource for the flagship campus of the University of Illinois and many self-supplied agricultural, industrial, institutional, and commercial users that rely upon it for cooling, process water, and row-crop irrigation, providing an estimated 170 Mgd to the region's self-supplied commercial, industrial, and agricultural users (Illinois State Water Survey Illinois Water Inventory Program, 2012).

For areas outside the Mahomet Aquifer boundary, significant groundwater resources are not available. While there are bedrock and sand and gravel aquifers adjacent to the Mahomet, they typically do not yield large, sustainable quantities of water to wells - not enough to provide adequate quantities to satisfy demand requirements of large communities like Champaign/Urbana (a combined ~22 Mgd) or Normal (>4 Mgd). For those aquifers that could serve smaller communities nearby, an economic feasibility analysis indicates that for most of these towns the aquifers are not an economically viable alternative.

There are many streams and rivers that overlie or are near the Mahomet Aquifer service area. These include the: Illinois River; Mackinaw River; Sangamon River and its tributaries Salt Creek and Sugar Creek; Iroquois River and its tributary Sugar Creek; Embarras River; Kaskaskia River; and Salt Fork that flows into the Vermilion River. While these streams and rivers provide significant amounts of water, they are not near or accessible to all users within the Mahomet Aquifer service area. For those streams and rivers that could serve nearby communities, an economic feasibility analysis indicates that for most towns and cities developing supplies from these rivers or streams would not be economically viable. There are also four drinking water reservoirs within or near the Mahomet Aquifer service area but none of these have sufficient capacity to serve additional users. Therefore, there are neither alternative

groundwater nor surface water supply sources available for the vast majority of communities that currently rely upon the Mahomet Aquifer.

The coalition of governmental and institutional entities listed as petitioners is pursuing Sole Source Aquifer designation for the Mahomet Aquifer for the following reasons:

1. **Its importance as a drinking water source and as a critical economic resource** – As described above, almost every town and every private water user relies upon the Mahomet as a high-quality, inexpensive source of water. Additionally, agricultural users, particularly irrigators, and other industries rely heavily upon the Mahomet for source water. As this Petition will document, economic, sustainable alternative sources of water are not available.
2. **Its vulnerability to contamination** – In addition to its drinking water and economic importance, the aquifer is vulnerable to contamination. The western portion of the aquifer, in Mason and Tazewell counties, has no protective, confining layers over the aquifer and potentially contaminating activities on the land surface have the ability to rapidly affect the aquifer. The eastern two-thirds of the aquifer, from Vermilion County through McLean County, is generally considered to be protected from contamination by relatively thick overlying confining geologic materials. However, numerous connections to the surface via complex pathways composed of relatively coarse-grained materials have been documented, such that a variety of activities have the potential to impact the aquifer in the future.
3. **Its high water quality** – Overall, the quality can be described as very good to excellent. While the water is hard (200+ mg/L as $CaCO_3$), can contain arsenic above the drinking standard (10 µg/L), and is relatively high in iron (≥1 mg/L), total dissolved minerals are less than 500 mg/L, and treatment costs to meet drinking water standards remain low.

3. Sole or Principal Source Data

This portion of the petition documents the data showing that the Mahomet Aquifer meets the requirements of sole or principal source.

3.1. Aquifer Service Area

The Mahomet Aquifer service area is largely confined to the physical aquifer boundary (Figure 2). However, Illinois American Water - Champaign Operations provides water to several communities outside the boundary of the aquifer. These communities are located predominantly in eastern and southern Champaign County and farther south in Douglas, Coles, and Cumberland counties. The communities of Champaign, Urbana, the University of Illinois, Savoy, St. Joseph, Bondville, and Pesotum are retail service locations. Wholesale customers of Illinois American Water - Champaign Operations include: Tolono, Sidney, Philo, Seymour Water District, Tuscola, Arcola, and the Embarras Area Water District. Cerro Gordo (Piatt County), Petersburg (Menard County), Virginia (Cass County), and Normal (McLean County) also withdraw water from the Mahomet but lie outside the recharge area. The Mahomet Aquifer does not provide all of Normal's water; in 2010, the Mahomet Aquifer provided 36% of Normal's 4.3 Mgd water demand, the rest coming from 11 wells outside the Mahomet Aquifer boundary.

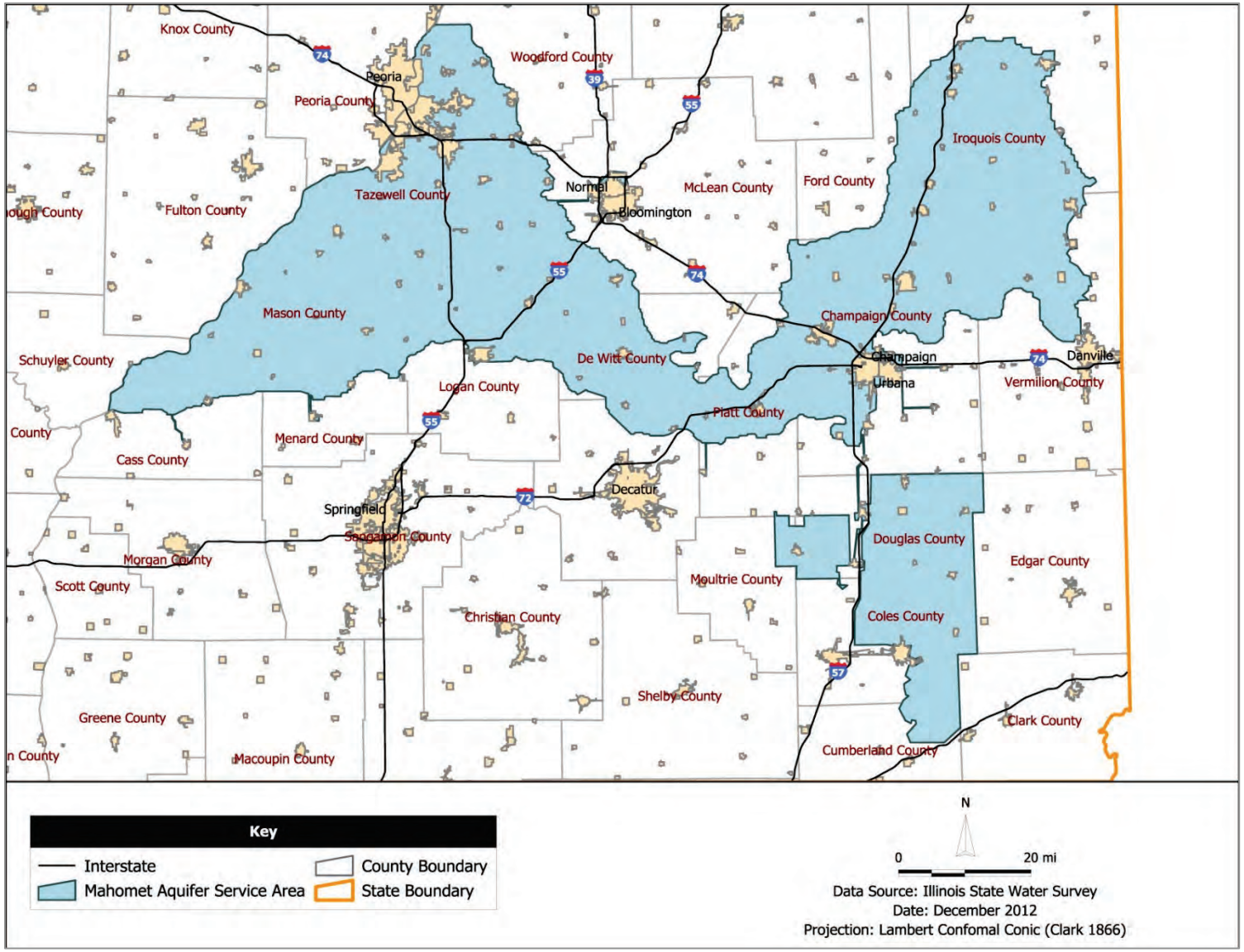

Figure 2. Mahomet aquifer service area.

3.2. POPULATION

An estimated 513,700 people live within the Mahomet Aquifer service area and 509,000 people (or 99%) are served by the Mahomet Aquifer. The public drinking water systems supply water to approximately 456,000 people (Illinois Environmental Protection Agency, 2012a). An additional 52,800 people are estimated to use the Mahomet Aquifer from private, domestic wells. The self-supplied, domestic population was estimated based upon the number of domestic wells on record with the ISWS within the Mahomet Aquifer boundary, the total amount of water withdrawn from this same area in 2005 (U.S. Geological Survey, 2009), and divided by an estimated per capita water use of 82 gallons per day (gpd) (Wittman Hydro Planning Associates, 2008). This estimate of self-supplied domestic users is conservative because the number of well on record is likely less than the actual numbers of wells.

3.3. CURRENT SOURCES OF DRINKING WATER

Within the Mahomet Aquifer service area, the vast majority of the community drinking water sources and all of the private domestic water sources use the Mahomet Aquifer system (Table 1). Shallower aquifers directly overlying the Mahomet are considered part of the Mahomet Aquifer system (i.e., part of the petitioned aquifer system) because there are numerous interconnections between these shallow aquifers and the underlying Mahomet; this is more fully described in the Recharge Area Section. Within the Mahomet Aquifer service area, no intakes from surface waters are used for public supply. The other aquifers shown in Table 1 include the shallow, local aquifers that lie outside the Mahomet Aquifer boundary that are used by cities and towns within the service area boundary. These include local, low yield aquifers used by Normal, Arthur, Ashmore, Newman, and Villa Grove (which sells to Camargo).

Table 1. Current drinking water sources for the Mahomet Aquifer service area. gpd = gallons per day.

Source/Use	Public Water Supply (Community & Non-community)		Private and Other		Total	
	gpd	Percent	gpd	Percent	gpd	Percent
Petitioned Aquifer	53,150,000	87.3%	4,310,000	7.1%	57,460,000	94.4%
Other Aquifers	3,440,000	5.6%	0	--		5.6%
Surface Water	0	--	0	--		--
Transported from outside	0	--	0	--		--
Total	56,590,000	92.9%	4,310,000	7.1%	60,900,000	100%

The public water supply percentages are based upon data from the ISWS Illinois Water Inventory Program that collects self-reported annual water withdrawal and source data from Illinois' public supplies and major water users (except row-crop irrigators). The source of water was also confirmed through the Illinois EPA, which maintains data on every public water supply system's source, population, and service connections. All domestic, private users use groundwater, which is withdrawn from the Mahomet and overlying shallow aquifers (U.S. Geological Survey, 2009).

3.4. Seasonal Variations

While there are seasonal increases during the summer months due to lawn irrigation and other outside uses such as pool filling and car washing, the estimates of use shown in Table 1 do not reflect this seasonal variation because data is collected only on annual withdrawals in Illinois. Since no monthly data is available, seasonal variations were not assessed. However, summer demand increases are considered in the following section.

3.5. Actual Use versus Potential Capacity

Roadcap et al., (2011) estimated that the Mahomet Aquifer system can theoretically supply approximately 600,000,000 gpd, which exceeds the current drinking water use estimate of 57,460,000 gpd. Much greater amounts of water are pumped from western regions of the Mahomet Aquifer to irrigate crops during the growing season. According to estimates by the Imperial Valley Water Authority, over 50 billion gallons of water were pumped in Mason and southern Tazewell counties for irrigation purposes in 2011 (this averages to over 340 Mgd for the 5 months in which irrigation occurred in 2011, June-October). For the 6 year period from 2006 to 2011, irrigation season withdrawals from this area averaged nearly 41 billion gallons of water, or approximately 316 Mgd during the irrigation season, or slightly over 112 Mgd if averaged across the whole year. Without the Mahomet Aquifer, row- and specialty-crop production in this area would not be possible.

Additionally, peak summer daily demand is typically 50 to 100 percent greater than annual average daily demand (Mayes, 2000). This suggests that drinking water demand could be conservatively estimated as 86,190,000 gpd during the summer (using a 50 percent increase over 57,460,000 gpd). Added to the average 316 Mgd summer irrigation demand, brings summer seasonal aquifer demand to 402 Mgd, or 67% of the aquifer's estimated potential yield. So, while the aquifer is still not currently used to its full capacity, these estimates do show that the aquifer is extremely important for drinking water, for the agricultural community, and is crucial to the public and economic health of the region.

3.6. Potential Sources

Potential Alternative Drinking Water Sources are defined as those that are currently used within the service area but their capacity is not fully used (the petitioned aquifer is excluded from this category) or

a water source that is “near”, as defined in the Sole Source Aquifer Petition Guidance. For purposes of this Petition, “near” was defined on the basis of what other communities have determined to be economically viable transmission distances from to their source of supply. This average distance was calculated to be 10 miles and includes the average distance from the water source to the supply area for all water suppliers whose source lies beyond the city limits and especially those communities that currently use the aquifer and lie beyond the boundary of the Mahomet Aquifer (e.g., Petersburg, Cerro Gordo, Virginia, Normal, and those areas served by Illinois American Water at Champaign). There are four sources of potential alternative water sources for the area “near” the Mahomet Aquifer System Service Area: 1) sand and gravel aquifers; 2) bedrock aquifers; 3) reservoirs; and 4) free-flowing streams and rivers.

3.6.1. SAND AND GRAVEL AQUIFERS

For areas outside the Mahomet Aquifer boundary, there are shallow, local groundwater sources that typically produce less than 100 gallons per minute (gpm) yields to wells. A map of Illinois sand and gravel well yields shows how quickly well yields decline beyond the boundary of the bedrock valley that defines the Mahomet Aquifer (Figure 3). The Mahomet Aquifer, stretching across the middle of Illinois from Indiana to the Illinois River, can be clearly seen. In Figure 3, aquifer areas with wells that can yield greater than 500 gallons per minute (gpm) are generally seen along Illinois’ major modern stream systems (e.g., Mississippi, Rock, Fox, Illinois, Wabash rivers) and two ancient, buried valley systems: the Troy Valley in Boone and DeKalb counties in north-central Illinois and the Mahomet-Teays Valley in east-central Illinois. With regard to the Mahomet Aquifer, the greatest well yields (>500 gpm) are found along the central axis of the Mahomet-Teays Valley where the aquifer is thickest and an area nearer the Illinois River where the aquifer is more extensive and is unconfined. Well yields in these areas commonly

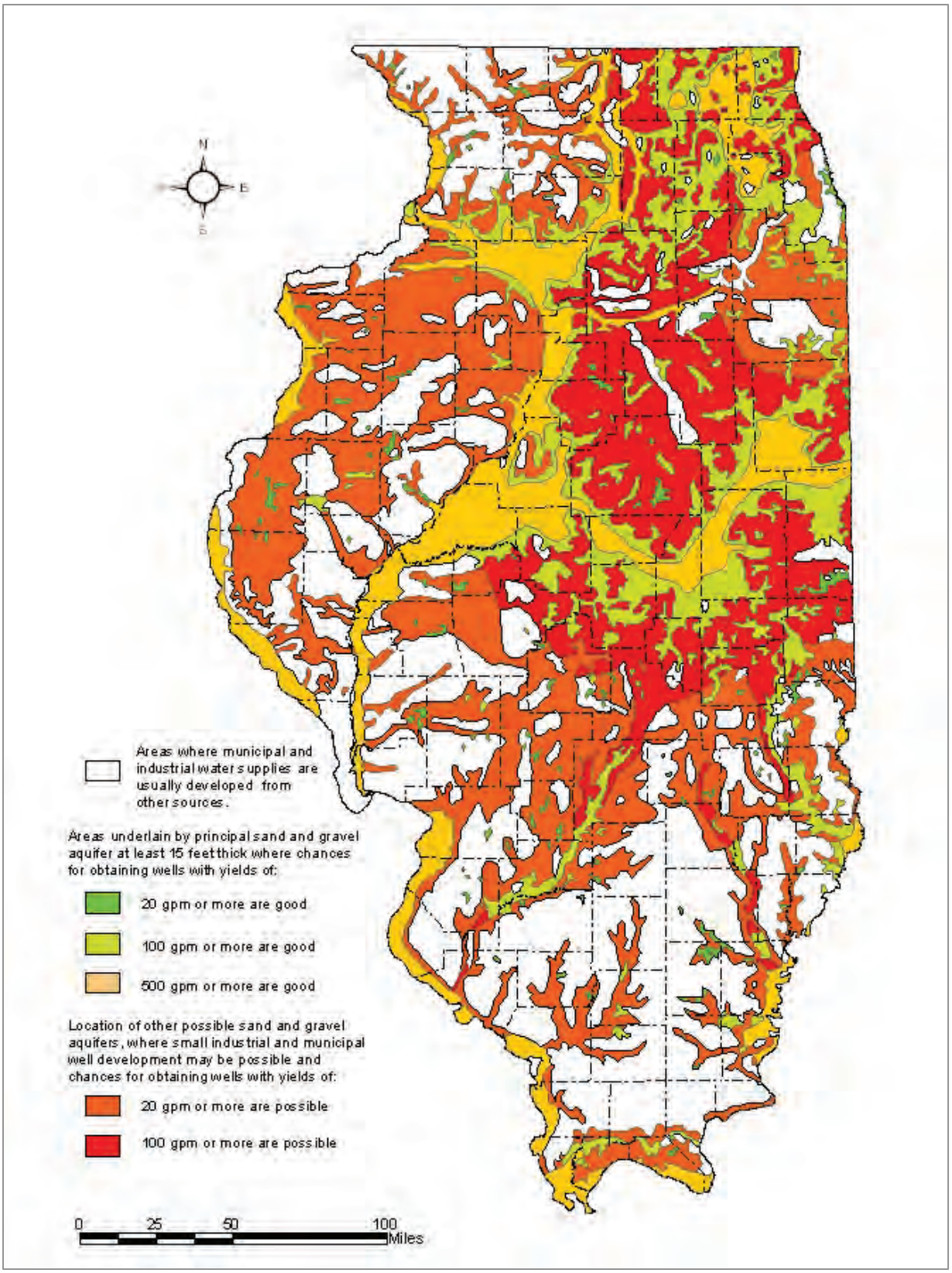

Figure 3. Yields of sand and gravel wells in Illinois (Illinois State Water Survey, unpublished data).

exceed 1,000 to 2,000 gpm. Near the edge of this bedrock valley, well yields are diminished, but still often exceed 100 gpm and provide significant water to many communities.

Beyond the edge of this bedrock valley, where the Mahomet Aquifer is not present, well yields diminish rapidly and the statewide map suggests well yields only of "100 gpm or more are possible". It is in this area that shallower, thinner sand and gravel deposits lay more like a blanket across the region (as opposed to following the bedrock valley boundaries). The Glasford sand and gravel deposits are discontinuous so aquifer yields are often low. While some of these deposits may be locally sufficient for smaller communities, their limited size, low production and increased sensitivity to drought make them inappropriate for larger communities that require 1 Mgd or more, certainly not enough to provide adequate quantities to satisfy demand requirements of communities like Champaign/Urbana (a combined ~22 Mgd) or Normal (>4 Mgd).

The limits of the aquifer are also illustrated by a map of estimated aquifer yields (Figure 4). On this map, potential aquifer yields were based upon estimations of aquifer recharge, assuming that long-term potential yields should not exceed recharge. As a result, the map expresses aquifer yields in terms of recharge rates; for reference, a recharge rate of 100,000 gpd/mi^2 is equal to 2.1 inches/year. Here again, higher-yielding areas exceeding 150,000 gpd/mi^2 along the main axis of the Mahomet Aquifer and 100,000-150,000 gpd/mi^2 along the valley flanks can be seen. Outside the valley boundaries, potential yields quickly fall to less than 50,000 gpd/mi^2 (or recharge is less than 1 inch/year). Outside the Mahomet Aquifer system, this map suggests that a 1 Mgd well field would require 20 mi^2 of recharge area.

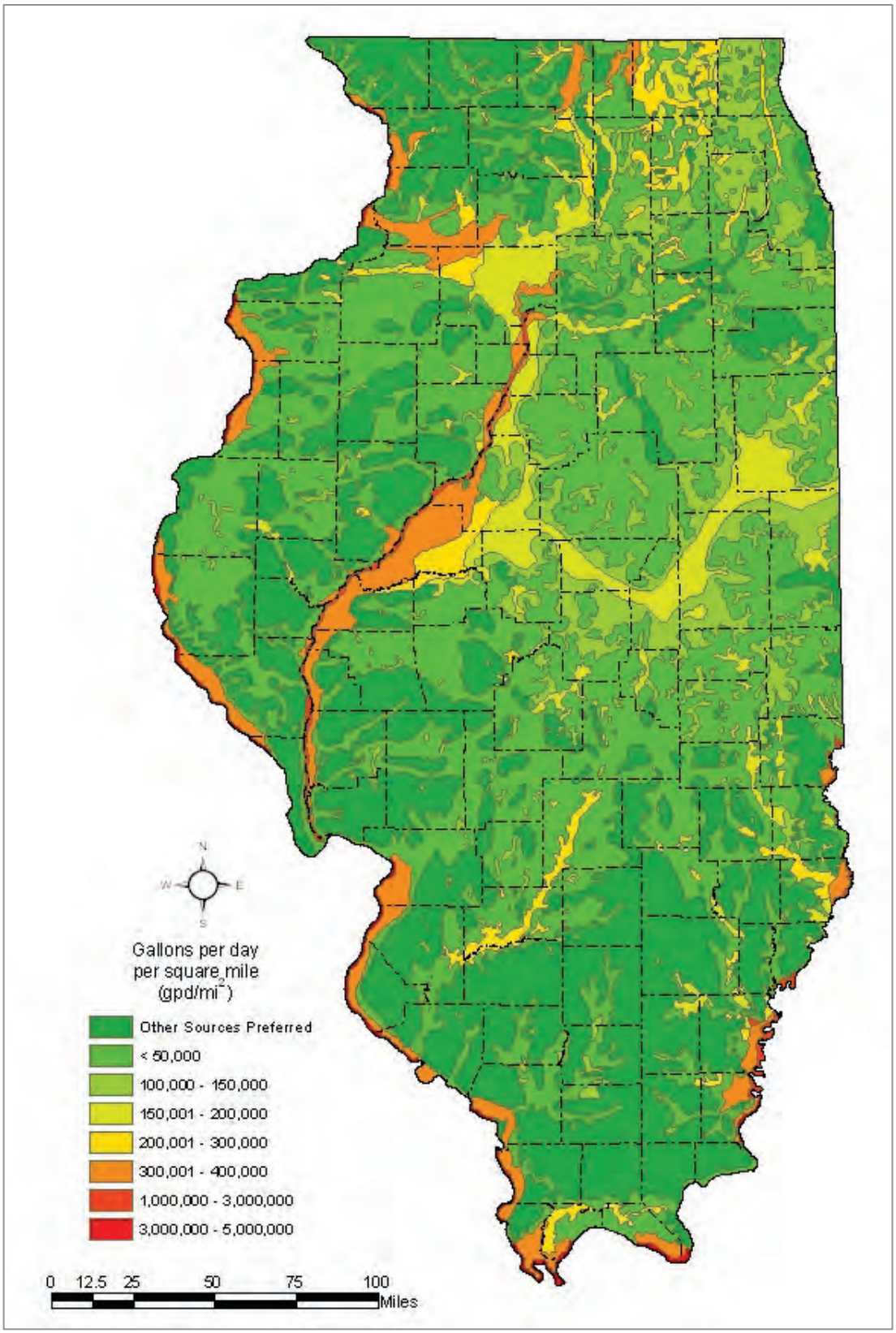

Figure 4. Estimated potential yields of sand and gravel aquifers in Illinois (from Wehrmann et al., 2003).

Therefore, if the Mahomet Aquifer in the Champaign area was to become unusable and an alternative groundwater supply outside of the boundary of the Mahomet was needed, a minimum supply on the order of 20 to 25 Mgd will be needed. For a 20 to 25 Mgd demand and a recharge rate of 50,000 gpd/mi^2, an aquifer (and well field) covering an area of 400 to 500 mi^2 will be needed, an area nearly half the size of Champaign County (1,000 mi^2). Public supply withdrawals across the entire Mahomet Aquifer are on the order of 50 Mgd, or about twice the amount pumped in the Champaign/Urbana area. Thus, if it was necessary to replace the entire public supply by alternative groundwater supplies near the Mahomet Aquifer, it will require aquifer areas (and well fields) covering at least 900 to 1,000 mi^2.

For the largest Mahomet Aquifer community supply (Illinois American Water – Champaign Operations), the development of a new 20+ Mgd supply from groundwater resources beyond the boundaries of the Mahomet Aquifer is simply not possible. The Town of Normal has 10 Glasford aquifer wells, located outside the Mahomet Aquifer; and while these wells provide a significant portion of Normal's demand, long-term declines in water levels created the need for drilling wells in the Mahomet Aquifer. Other communities near, but not over, the Mahomet Aquifer, such as Cerro Gordo, Petersburg, and Virginia have abandoned wells in town, constructed pipelines, and developed dependable groundwater supplies in the Mahomet. To further illustrate the reliability of the Mahomet Aquifer and the undependability of other local aquifers, the City of Bloomington has investigated development of Mahomet Aquifer wells to supplement their reservoirs (Herzog et al., 1995a and 1995b and Wilson et al., 1998). Danville has made similar inquiries (Larson et al., 1997), as well as Springfield (Anliker and Woller, 1998).

Alternative small- to moderate-size groundwater supplies may exist in very localized areas and a few even may be sufficient for supplies exceeding 1 Mgd outside the boundary of the Mahomet Aquifer, but locating such supplies will require a field exploration and aquifer-testing program before well fields are developed and pipelines are laid. For small communities, such expenses will quickly become

economically infeasible. Therefore, without definitively knowing if any area outside the Mahomet Aquifer boundary offers a viable alternative source of groundwater, an economic analysis was conducted to determine if communities could economically develop an alternate groundwater supply (see the following section on Potential Alternative Drinking Sources).

3.6.2. BEDROCK AQUIFERS

As stated by Roadcap et al. (2011), when speaking of their 15-county east-central Illinois study area, the bedrock in this region of Illinois generally is incapable of providing large supplies of water.

> *Except for domestic supplies, bedrock aquifers are not significant sources of groundwater in the 15-county water supply planning region. Groundwater that is suitable for domestic use may be obtained from the fine-grained sandstones or small, widely spaced fractures in the limestone or coal layers of the shallow Pennsylvanian rocks found near the bedrock surface. On the bedrock uplands where glacial deposits are typically thin and do not contain extensive sand and gravel aquifers, bedrock aquifers are important sources of supply for domestic wells. Water supplies in parts of Iroquois County are obtained from the Silurian carbonate rocks. In general, the quality of groundwater in the bedrock decreases with depth. Groundwater in deep bedrock formations is too mineralized for most uses.*

The bedrock lying immediately beneath the Mahomet aquifer regions is largely composed of Pennsylvanian- and Mississippian-aged rocks (Figure 5). A ridge of Silurian-Devonian rocks cut upward through the Pennsylvanian and Mississippian rocks beneath portions of Champaign, Ford, and Iroquois

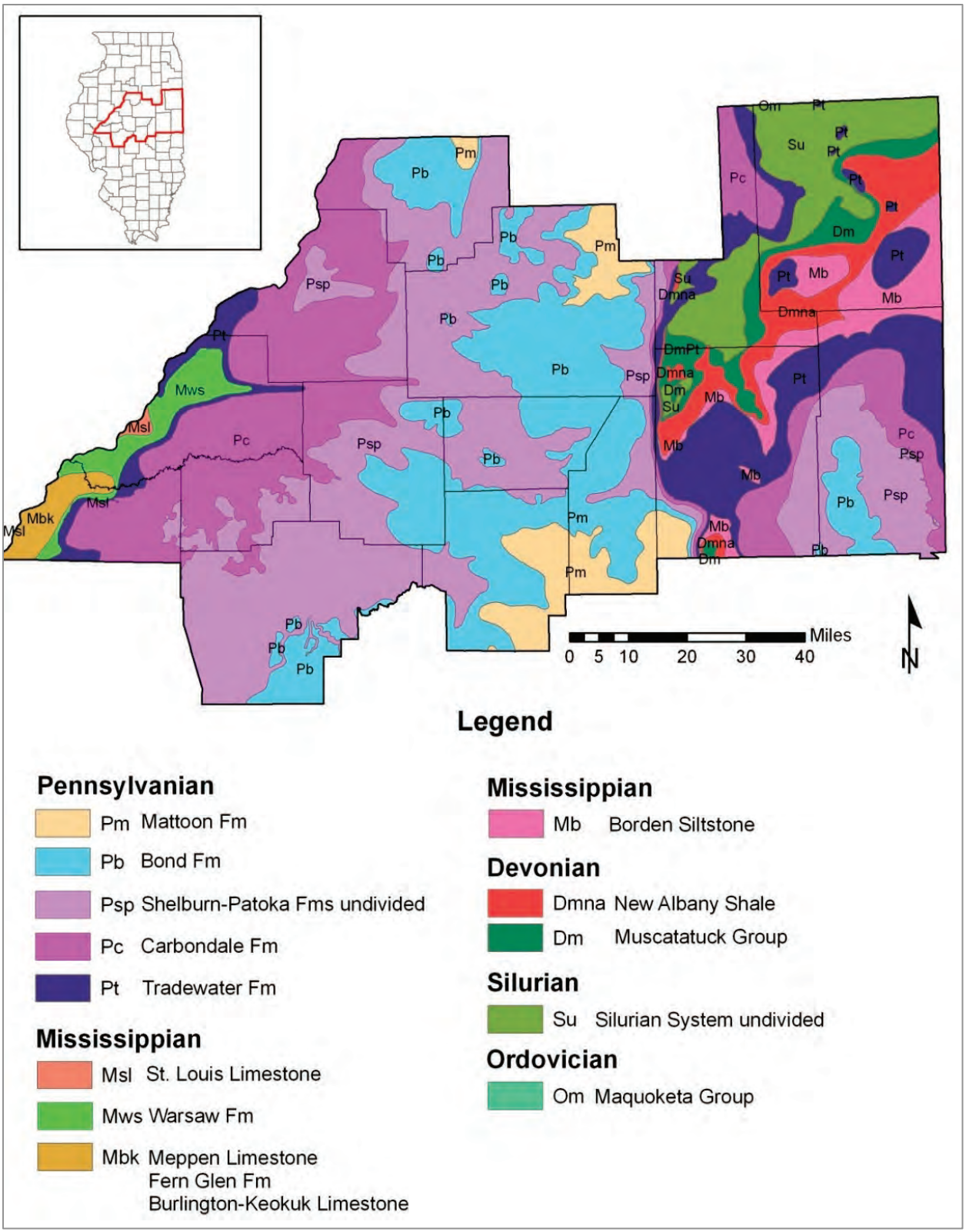

Figure 5. Bedrock geology of east-central Illinois (from Roadcap et al., 2011).

counties. This anticline extends south of Champaign County into Douglas County as well. As mentioned above, Silurian carbonate rocks can provide moderate supplies. However, well yields are not large and water quality is poor.

As an example of the bedrock aquifer limitations, for many years, bedrock wells drilled to depths of 450 to 700 feet deep into these rocks were used to supply water to the town of Tuscola (in Douglas County). However, to meet the moderate needs of Tuscola, seven to eight wells were required, each pumping only 20 to 50 gpm. The total dissolved mineral content of the water was typically in the 600 to 800 mg/L range. Numerous investigations sought to find adequate supplemental supplies to meet the needs of a growing Tuscola. Finally, in 1994, Tuscola contracted with Northern Illinois Water Corporation (now Illinois American Water) to purchase Mahomet aquifer water, ending their use of Silurian-Devonian bedrock and decades of local water supply concerns.

3.6.3. Reservoirs

There are four water supply reservoirs that lie over or near the Mahomet Aquifer: Lake Vermilion serving Danville, Evergreen Lake and Lake Bloomington serving Bloomington, and Lake Decatur serving Decatur. Clinton Lake is a privately owned reservoir used for cooling water for nuclear power generation. Lake Springfield and Lake Shelbyville lie too far away to be considered as alternative sources. For private well owners, small reservoirs (i.e., farm ponds) were not economically evaluated. Costs will greatly depend on precipitation, runoff, watershed area, property size, homeowner/farm water demand, and treatment needed.

Lake Vermilion lies just outside the aquifer service boundary in central Vermilion County, just northwest of the city of Danville. The reservoir is operated by Aqua Illinois, Inc. to supply to Danville, Catlin, Westville, and unincorporated Vermilion County. Lake Vermilion's estimated yield was recently updated

and published by Roadcap et al. (2011). The 90 percent confidence yield estimates for Lake Vermilion for a 50-year and 100-year drought recurrence, based on projected losses in reservoir capacity are shown in Table 2. The average water demand for the last four years (2007-2010) for Danville is 8.1 Mgd and has been projected to increase to 9.0 Mgd by 2050 (WHPA, 2008). So, although Lake Vermilion currently has adequate capacity to serve Danville, its yield will diminish in coming years while Danville's demand is expected to increase. Therefore, it would not be appropriate to suggest there is additional capacity to serve as an alternate supply in the future.

Evergreen Lake, Lake Bloomington, and the Mackinaw River Pumping Pool currently serve the needs of Bloomington. This water system lies within McLean County approximately 5 to 6 miles north of Bloomington, Illinois. In 2011, Roadcap et al. assessed the entire Bloomington water system to be *at risk* (Table 3) and within the upcoming decade to be *inadequate* if demand continues to increase and no additional supplies are developed. The City of Bloomington's 2005 demand was approximately 11 Mgd and is projected to grow to approximately 13 Mgd by 2050 (WHPA, 2008). Therefore, it would not be appropriate to suggest there is additional capacity to serve as an alternative supply in the future for nearby towns affected if the Mahomet Aquifer were contaminated. The Mahomet Aquifer has, in fact, been studied as a supplemental supply for Bloomington (Wilson et al., 1998).

Table 2. Changes in future yield estimates for the Danville Water Supply System based on projected losses in reservoir capacity (from Roadcap et al., 2011)

Year	**90% yield (Mgd) at selected recurrence intervals**	
	50-year	**100-year**
1998	11.3	10.1
2010	10.5	9.5
2020	9.9	9.0
2030	9.4	8.6
2040	8.9	8.2
2050	8.5	7.8

Table 3. Bloomington's system (Lake Bloomington, Evergreen Lake, and Mackinaw pumping station) computed 2010 yield during drought (from Roadcap et. al, 2011).

Historic Drought	50% yield	90% yield
1939-1941	12.7	10.6
1988-1990	14.6	11.8
1955-1957	15.9	14.2

Lake Decatur lies within the City of Decatur and is situated centrally within Macon County. The lake could serve the town of Cerro Gordo, strictly based upon this Petition's 10-mile definition of "near". Roadcap et al. (2011) also assessed the system, which serves both the City of Decatur and Archer Daniels Midland Company, and found it to be *at risk* even when including the 6.2 to 8.0 Mgd of water withdrawn from the Mahomet Aquifer during emergencies (including drought). Therefore, if the 6.2 to 8.0 Mgd were removed from the water budget due to contamination, the system's capacity to serve other needs would be further diminished. In recent years (2007-2008) approximately 36 Mgd was with withdrawn from Lake Decatur (Roadcap et al., 2011). Here again the drought analysis completed by Roadcap et al. shows that there is limited to zero water available for other users (Table 4). Thus, no existing water supply reservoirs near or over the Mahomet Aquifer can serve as an alternative water source.

Table 4. Computed 2010 yield of the Decatur water supply system (from Roadcap et. al, 2011).

Historic Drought	Minimum water level = 10% of lake volume remaining	
	50% yield	90% yield
1930-1931	38.1	32.8
1914-1915	39.0	33.4
1953-1954	43.5	36.4
Worse-case (10-month) drought	32.9	27.1
	Minimum water level = 30-day supply of water remaining	
	50% yield	**90% yield**
1930-1931	36.4	31.6
1914-1915	37.0	31.8
1953-1954	40.8	34.4
Worse-case (10-month) drought	31.8	26.5

3.6.4. FREE-FLOWING STREAMS AND RIVERS

Within and near the aquifer service area there are multiple surface water sources and many of these sources have the capacity to serve the local community needs. The major river systems include the Embarras River, Illinois River, Iroquois River, Kaskaskia River, Mackinaw River, Sangamon River, and Vermilion River, and their tributaries. Of the 120 community water supply systems that rely upon the Mahomet Aquifer, 5 of them have insufficient free-flowing streams and rivers to meet their 2010 pumping rates. These include Buckley, Illinois American Water – Champaign Operations, Loda, Rankin, and Thawville. For all private well owners, free-flowing streams and rivers were not evaluated. Each of the other potential surface water sources will be considered in the economic analysis.

In Illinois, streams classified as Public Waters are provided low flow protection by the Illinois Department of Natural Resources (IDNR). Only a small number of streams are identified as public waters of Illinois; these consist primarily of the larger navigable rivers in the state. Within the Mahomet Aquifer area, only two rivers are considered public waters: the lower Sangamon River below Springfield and the Illinois River. Absent detailed analyses for a given stream regarding instream flow needs, the IDNR commonly uses the 7-day 10-year low flow value ($Q_{7,10}$) as the protected minimum flow for Illinois public waters. This means that no new withdrawal from these rivers is permitted if it causes flow to be reduced below the $Q_{7,10}$ (Meyer et al., 2012). During periods of low flow, the river intake must be shut down and an alternative source of water used until stream flow is great enough to allow stream withdrawals to resume. For the Mahomet Aquifer region, the duration of an extended drought, for which low flow protection might be expected, is 120 days or longer; therefore, requiring construction of sufficient off-channel storage to meet a town's daily water demand requirements for 120 days (personal communication, Vernon Knapp, 11/30/12).

Embarras River System

The Embarras River and its tributaries run through Champaign, Douglas, and Cumberland counties and would be a source of water for Arcola, Embarras Water District, Hindsboro, Oakland, and Tuscola. The Embarras River near Greenup has a $Q_{7,10}$ flow of 5.2 cfs or approximately 3,360,000 gallons/day (ISWS, 1988). It is believed that the Embarras River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal restrictions on water withdrawals from the Embarras River system.

Illinois River System

Because the Illinois River System is so large and many of its tributaries also could act as sources of water, this description only discusses the main stem of the river. The Illinois River forms the western boundary of the aquifer service area and the western hydraulic boundary of the aquifer recharge area. The Illinois River also forms the western boundary of Cass, Mason, Tazewell, and Woodford counties. At the far most southwestern edge of the aquifer service area the $Q_{7,10}$ flow in the Illinois River near Beardstown is 2,360,000,000 gallons per day; please note that this flow includes flow from the Iroquois, Mackinaw, and Sangamon rivers. The towns that are near enough to utilize the Illinois River include: Creve Coeur, East Peoria, Germantown Hills, Havana, Marquette Heights, Metamora, Morton, North Pekin, Pekin, and Washington. It is believed that the Illinois River is not used for drinking water due to the less expensive and easily available Mahomet Aquifer.

The Illinois River is designated as a public water of Illinois and the $Q_{7,10}$ is a protected minimum flow, which means that no new withdrawal will be permitted if the withdrawal is calculated to reduce the river flow below its $Q_{7,10}$ discharge. We did not assume this constraint would eliminate the water source.

Iroquois River System

The Iroquois River system lies in eastern portion of the aquifer service area and flows through Iroquois County. Cissna Park, Crescent City, Danforth, Gilman, Milford, Onarga, Watseka, Wellington, and Woodland are all near the Iroquois River and its tributaries. The Iroquois River's main stem has a $Q_{7,10}$ flow of 30.0 cfs or 19,400,00 gallons/day just across the northern Iroquois County line. It is believed that the Iroquois River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal constraints on water withdrawals from the Iroquois River.

Kaskaskia River System

The Kaskaskia River System headwaters are in Champaign County and from there it and its tributaries lie in Piatt, Douglas, Moultrie, and Coles counties. Sadorus, Tolono, and Tuscola lie close enough to the Kaskaskia River or its tributaries to switch to this source. Near these three towns, the Kaskaskia River has a $Q_{7,10}$ flow of 5.1 cfs or 3,300,000 gallons/day. It is believed that the Kaskaskia River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. While there are no known legal constraints to withdrawing water from the upper Kaskaskia River system, withdrawal of water above Tuscola could result in a "first in right" claim by Equistar Chemicals that operates Mahomet Aquifer wells to supplement flows on the upper Kaskaskia for their industrial use at Tuscola.

Mackinaw River System

The Mackinaw River and its tributaries would primarily serve areas in McLean, Woodford, and Tazewell counties including Danvers, Deer Creek, Eureka, Goodfield, Green Valley, Hopedale, Mackinaw, South Pekin, and Tremont. The Mackinaw River has a $Q_{7,10}$ flow of 46.7 cfs or 30,200,000 gallons/day just

before it empties into the Illinois River. It is believed that the Mackinaw River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal constraints on withdrawing water from the Mackinaw River system.

Sangamon River System

The Sangamon River system covers the largest portion of the Mahomet Aquifer service area and flows through Champaign, DeWitt, McLean, Macon, Piatt, Macon, Logan, Menard, Mason, and Cass counties. The towns that could be served by the Sangamon River and its tributaries include: Easton, Atlanta, Heyworth, Wapella, Waynesville, Emden, San Jose, Clinton, De Witt, Kenney, Lincoln, Middletown, Weldon, Maroa, Chandlerville, Fisher, Greenview, Mahomet, Mansfield, Mason City, Monticello, Oakford, Sangamon Valley PWD, Seymour Water District, Virginia, Argenta, Cerro Gordo, Cisco, Hartsburg, Mc Lean, New Holland, Stanford, Armington, Minier, and Petersburg. The Sangamon River has a $Q_{7,10}$ flow of 248 cfs or 160,300,000 gallons/day just before it empties into the Illinois River near Beardstown. It is believed that the Sangamon River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal constraints on withdrawing water from the Sangamon River system above Springfield. The lower portion of the Sangamon River system is a “public water” and is subject to $Q_{7,10}$ low flow protection. We did not assume this constraint would eliminate the water source.

Vermilion River System

The Vermilion River system lies in the very eastern portion of the Mahomet Aquifer service area and flows from Illinois into Indiana near Georgetown, Illinois. The Vermilion River and its tributaries lie within Ford, Champaign, and Vermilion counties. The towns that lie near the Vermilion River and its tributaries include: Potomac, Paxton, Hoopeston, Rossville, Philo, Sidney, Ludlow, Gifford, Rantoul,

Thomasboro, Henning, Alvin, and Bismarck. The Vermilion River exits Illinois with a $Q_{7,10}$ flow of 48.1 cfs or 31,000,000 gallons/day. It is believed that the Vermilion River and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal constraints on withdrawing water from the Vermilion River system.

MINOR STREAMS AND RIVERS

Three towns, Delavan, Manito, and Forest City, all could withdraw water from Quiver Creek and its tributaries. This creek lies at the western edge of the Mahomet Aquifer service area in Tazewell and Mason counties, and flows directly into the Illinois River. It has a $Q_{7,10}$ flow of 14.0 cfs or 9,000,000 gallons/day. It is believed that Quiver Creek and its tributaries are not used for drinking water due to the less expensive, easily available, and drought resistant Mahomet Aquifer. There are no known legal constraints on withdrawing water from the Quiver Creek system; however, its use as an alternative source of water may be limited because its flow is almost entirely, if not entirely, groundwater discharge from the Mahomet Aquifer. If the Mahomet were to become unusable, Quiver Creek likely would be unusable as well.

3.6.5. ALTERNATIVE DRINKING WATER SOURCES

As described above, sand and gravel aquifers and free-flowing streams are the only two alternative drinking water sources. These two sources may theoretically have sufficient capacity to generally replace the Mahomet Aquifer (Table 5); see section 3.6.6 for a discussion of how each of these supplies was calculated. The major exception to this is that neither a nearby surface water source nor a nearby groundwater source have sufficient capacity to supply enough water to Illinois American Water-Champaign Operations. In addition, Bayles Lake Lot Owners Association, Buckley, Loda, Rankin, and

Table 5. Alternative drinking water sources matrix.

Alternative Source	Estimated Daily Supply	Percent	Data Source
Petitioned aquifer supply	600,000,000		Roadcap et al., 2011
Sand-and-gravel aquifers (10 mile buffer around service area)	458,300,000	16.1	Approximated using GIS analysis of state-wide aquifer yield estimates
Illinois River near Beardstown	2,355,825,073	82.9	$Q_{7,10}$ value = 3645 cfs includes the flow from Mackinaw River, Sangamon River, and Iroquois River; from Map 11 Border Rivers, ISWS, 1988
Salt Fork near Danville (this is the flow that is in the Vermilion River below Danville)	20,294,350	0.7	$Q_{7,10}$=31.4 cfs; from Map 8 Embarras Region, ISWS, 1988
Embarras River near Greenup	3,360,848	0.1	$Q_{7,10}$=5.2 cfs; from Map 8 Embarras Region, ISWS, 1988
Kaskaskia River near Atwood	3,296,216	0.1	$Q_{7,10}$= 5.1 cfs; from Map7 Kaskaskia Region, ISWS, 2002
Total potential alternative supply	**2,841,076,487**		

Thawville do not have nearby surface water sources (i.e., it is more than 10 miles to a surface water source). Further, Armington, Cissna Park, Delavan, Easton, Hopedale, and Rankin do not have another groundwater source nearby (it is more than 10 miles to an aquifer outside the Mahomet Aquifer system). For all other alternative groundwater supply sources, their specific locations are not easily determined, and because the total potential yield of all such sources was estimated from a statewide map, it was conservatively assumed that for most community water supplies not only is a groundwater source available within 10 miles but it was also assumed to have sufficient capacity to meet community demands. As will be shown, even if such a source were to be available, it would not be economically feasible for most communities to use.

3.6.6. Estimated daily supply

The critical drought flow for each of the surface water sources was estimated by reviewing each of the associated 7-day, 10-year low flow discharge maps developed by the ISWS (maps are available for

viewing and downloading at this ISWS web-site: http:/www.isws.illinois.edu/docs/maps/lowflow/). Each town was located on the map and the nearest point that had sufficient flows to supply the amount withdrawn in 2010 for that particular town was used as the estimate (Table 6). For Bayles Lake Lot Owners Association, Buckley, Illinois American Water – Champaign Operations, Loda, Rankin, and Thawville no surface water sources with sufficient supply were found within the 10 mile "near" radius.

Surface water resources have not been developed in this part of Illinois because the Mahomet Aquifer system provides a reliable, inexpensive, drought resistant source and there is a large economic difference between developing and treating groundwater and surface water resources. Water quality differences, increased treatment costs, additional water supply system infrastructure, available watershed drainage area, viable reservoir sites, and distances to viable surface water sources are significant factors in the lack of surface water intakes across the Mahomet Aquifer service area.

For aquifers that lie around the Mahomet Aquifer perimeter and which may be near enough to be potential alternative drinking water supplies (i.e., within the 10-mile distance previously defined as "near"), no yield estimates have been previously made. On the other hand, Roadcap et al. (2011) estimated the total yield of the Mahomet Aquifer as approximately 600 Mgd. Using the Mahomet Aquifer's surface area of 4,100 square miles, this translates to an effective recharge rate of 146,000 gpd/mi^2 and is reasonably comparable to the range of potential yields mapped over the Mahomet Aquifer in Figure 4, suggesting that an estimate of the total potential yield of those aquifers surrounding the Mahomet can be reasonably made using Figure 4.

To make such an estimate, an analysis was made using GIS technology to define a 10-mile buffer zone around the perimeter of the Mahomet Aquifer. Then, using the varying potential yields mapped on Figure 4 within that 10-mile buffer and the varying areas of those yields values, a total composited

Table 6. Alternate surface water supply for community water supplier.

Community Water Supplier	2010 pumping rate (gpd)	Low-flow estimate (gpd)	Low-flow estimate (cfs)	Water Source	Map
Arcola	444,500	969,475	1.5	Embarras River	Map 8 Embarras Region
Argenta	53,151	3,037,689	4.7	Sangamon River	Map 5 Sangamon Region
Armington	27,165	129,263	0.2	West Fork Sugar Creek	Map 5 Sangamon Region
Atlanta	158,326	1,551,161	2.4	Kickapoo Creek	Map 5 Sangamon Region
Belmont Water Inc.	15,499	2,520,636	3.9	Sugar Creek	Map 3 Kankakee Region
Cerro Gordo	56,575	3,296,216	5.1	Sangamon River	Map 5 Sangamon Region
Chandlerville	42,220	153,823,420	238	Sangamon River	Map 5 Sangamon Region
Cisco	24,658	2,326,741	3.6	Sangamon River	Map 5 Sangamon Region
Cissna Park	75,197	193,895	0.3	Mud Creek	Map 3 Kankakee Region
Clinton	854,607	3,231,584	5	Salt Creek	Map 5 Sangamon Region
Country Lane MHP	2,844	174,506	0.27	Kickapoo Creek	Map 5 Sangamon Region
Crescent City	56,458	180,969	0.28	Spring Creek	Map 3 Kankakee Region
Creve Coeur	690,623	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Danforth	64,392	15,123,815	23.4	Iroquois River	Map 3 Kankakee Region
Danvers	143,726	1,292,634	2	Mackinaw River	Map 3 Kankakee Region
De Witt	19,261	420,106	0.65	Salt Creek	Map 5 Sangamon Region
Deer Creek	43,795	969,475	1.5	Mackinaw River	Map 3 Kankakee Region
Delavan	219,544	2,132,846	3.3	Main Ditch	Map 5 Sangamon Region
Dewey PWD	9,080	174,506	0.27	Sangamon River	Map 5 Sangamon Region
East Lynn Community Water Supply	7,349	904,844	1.4	Mud Creek	Map 3 Kankakee Region
East Peoria	2,756,762	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Easton	25,463	775,580	1.2	Crane Creek	Map 5 Sangamon Region
Embarras Water District	479,500	2,197,477	3.4	Embarras River	Map 8 Embarras Region
Emden	68,848	1,034,107	1.6	Prairie Creek	Map 5 Sangamon Region

Community Water Supplier	2010 pumping rate (gpd)	Low-flow estimate (gpd)	Low-flow estimate (cfs)	Water Source	Map
Eureka	654,795	775,580	1.2	Mackinaw River	Map 3 Kankakee Region
Fisher	159,485	174,506	0.27	Sangamon River	Map 5 Sangamon Region
Forest City	14,564	5,493,694	8.5	Quiver Creek Drainage Ditch	Map 5 Sangamon Region
Fountain Valley MHP	17,181	2,068,214	3.2	Upper Salt Fork Drainage Ditch	Map 8 Embarras Region
Germantown Hills	413,945	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Gifford	72,132	3,037,689	4.7	Upper Salt Fork Drainage Ditch (3.2 cfs) or Middle Fork Vermilion River (1.5 cfs)	Map 8 Embarras River Region
Gilman	237,534	15,123,815	23.4	Iroquois River	Map 3 Kankakee Region
Goodfield	85,271	1,292,634	2	Mackinaw River	Map 3 Kankakee Region
Grandview MHP	27,173	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Green Valley	47,104	16,287,186	25.2	Mackinaw River	Map 3 Kankakee Region
Greenview	77,148	49,120,084	76	Sangamon River	Map 5 Sangamon Region
Groveland Township Water District	134,742	1,927,963,290	2983	Illinois River	Map 11 Border Rivers
Hartsburg	40,500	9,177,700	14.2	Sugar Creek	Map 5 Sangamon Region
Harvard Hills Water Corp	13,861	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Havana	267,422	2,026,203,458	3135	Illinois River	Map 11 Border Rivers
Henning	32,200				
Heyworth	265,032	407,180	0.63	Kickapoo Creek	Map 5 Sangamon Region
Hindsboro	61,250	1,292,634	2	Embarras River	Map 8 Embarras Region
Hoopeston	601,449	904,844	1.4	North Fork Vermilion River	Map 8 Embarras Region
Hopedale	83,348	323,158	0.5	Little Mackinaw River	Map 3 Kankakee Region
Kenney	21,942	4,330,323	6.7	Salt Creek	Map 5 Sangamon Region
Lake Iroquois Association	50,666	323,158	0.5	Middle Fork Vermilion River	Map 8 Embarras Region
Lake Wildwind MHP	18,000	1,938,950,677	3000	Illinois River	Map 11 Border Rivers

Community Water Supplier	2010 pumping rate (gpd)	Low-flow estimate (gpd)	Low-flow estimate (cfs)	Water Source	Map
Lake Windermere Estates Subdivision	23,529	4,524,218	7	Mackinaw River	Map 3 Kankakee Region
Illinois American – Lincoln	775,716	17,385,924	26.9	Salt Creek	Map 5 Sangamon Region
Ludlow	27,279	2,714,531	4.2	Upper Salt Fork Drainage Ditch (3.2 cfs) or Middle Fork Vermilion River (1.0 cfs)	Map 8 Embarras Region
Mackinaw	225,188	2,520,636	3.9	Mackinaw River	Map 3 Kankakee Region
Mahomet	523,425	904,844	1.4	Sangamon River	Map 5 Sangamon Region
Manito	164,150	646,317	1	North Quiver Ditch	Map 5 Sangamon Region
Mansfield	80,651	904,844	1.4	Sangamon River	Map 5 Sangamon Region
Maroa	145,361	3,813,270	5.9	Salt Creek	Map 5 Sangamon Region
Marquette Heights	181,894	1,927,963,290	2983	Illinois River	Map 11 Border Rivers
Mason City	189,178	48,538,399	75.1	Sangamon River	Map 5 Sangamon Region
Mc Lean	82,380	8,402,120	13	Sugar Creek	Map 5 Sangamon Region
Metamora	315,178	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Middletown	19,496	24,560,042	38	Salt Creek	Map 5 Sangamon Region
Milford	164,348	2,326,741	3.6	Sugar Creek	Map 3 Kankakee Region
Mill Point MHP	900	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Minier	101,170	8,078,961	12.5	Sugar Creek	Map 5 Sangamon Region
Monticello	665,600	1,486,529	2.3	Sangamon River	Map 5 Sangamon Region
Morton	2,201,904	1,929,902,241	2986	Illinois River	Map 11 Border Rivers
New Holland	21,572	10,534,965	16.3	Sugar Creek	Map 5 Sangamon Region
Normal	1,551,040	9,306,963	14.4	Sugar Creek	Map 5 Sangamon Region
North Pekin	111,677	1,927,963,290	2983	Illinois River	Map 11 Border Rivers
North Tazewell PWD	572,655	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Oak Lane Acres Subdivision	7,739	1,929,902,241	2986	Illinois River	Map 11 Border Rivers

Community Water Supplier	2010 pumping rate (gpd)	Low-flow estimate (gpd)	Low-flow estimate (cfs)	Water Source	Map
Oak Ridge Sanitary District	20,739	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Oakford	70,000	142,836,033	221	Sangamon River	Map 5 Sangamon Region
Oakland	196,000	1,292,634	2	Embarras River	Map 8 Embarras Region
Onarga	159,593	180,969	0.28	Spring Creek	Map 3 Kankakee Region
Paxton	510,184	807,896	1.25	Middle Fork Vermilion River	Map 8 Embarras Region
Illinois American - Pekin	5,736,268	1,927,963,290	2983	Illinois River	Map 11 Border Rivers
Penfield PWD	14,795	969,475	1.5	Middle Fork Vermilion River	Map 8 Embarras Region
Petersburg	334,247	57,974,625	89.7	Sangamon River	Map 5 Sangamon Region
Philo	175,000	14,283,603	22.1	Salt Fork	Map 8 Embarras Region
Pleasant Plains MHP	3,230	3,296,216	5.1	Kaskaskia River	Map 7 Kaskaskia Region
Potomac	50,739	1,680,424	2.6	Middle Fork Vermilion River	Map 8 Embarras Region
Prairie View Water Association	2,233	1,929,902,241	2986	Illinois River	Map 11 Border Rivers
Rantoul	1,365,921	2,068,214	3.2	Upper Salt Fork Drainage Ditch	Map 8 Embarras Region
Rossville	129,842	452,422	0.7	North Fork Vermilion River	Map 8 Embarras Region
Saddlebrook Estates Subdivision	9,578	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Sadorus	24,849	3,296,216	5.1	Kaskaskia River	Map 7 Kaskaskia Region
San Jose	64,942	2,003,582	3.1	Prairie Creek	Map 5 Sangamon Region
Sangamon Valley PWD	341,627	361,937	0.56	Sangamon River	Map 5 Sangamon Region
Seymour Water District	52,850	710,949	1.1	Sangamon River	Map 5 Sangamon Region
Sidney	198,450	14,283,603	22.1	Salt Fork	Map 8 Embarras Region
South Pekin	65,753	16,287,186	25.2	Mackinaw River	Map 3 Kankakee Region
Stanford	51,489	8,854,541	13.7	Sugar Creek	Map 5 Sangamon Region
Thomasboro	100,192	2,197,477	3.4	Upper Salt Fork Drainage Ditch	Map 8 Embarras Region
Timberlan Subdivision	7,007	1,938,950,677	3000	Illinois River	Map 11 Border Rivers

Community Water Supplier	2010 pumping rate (gpd)	Low-flow estimate (gpd)	Low-flow estimate (cfs)	Water Source	Map
Tolono	420,000	3,296,216	5.1	Kaskaskia River	Map 7 Kaskaskia Region
Tremont	215,005	840,212	1.3	Prairie Creek	Map 3 Kankakee Region
Tuscola	837,200	3,296,216	5.1	Kaskaskia River	Map 7 Kaskaskia Region
Valley View 4 and 6 Knolls Subdivision	20,459	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Valley View Subdivision	7,195	1,938,950,677	3000	Illinois River	Map 11 Border Rivers
Virginia	197,316	157,701,322	244	Sangamon River	Map 5 Sangamon Region
Wapella	56,458	413,643	0.64	Kickapoo Creek	Map 5 Sangamon Region
Washington	1,152,559	1,929,902,241	2986	Illinois River	Map 11 Border Rivers
Washington Estates Inc.	122,482	1,929,902,241	2986	Illinois River	Map 11 Border Rivers
Watseka	649,589	11,633,704	18	Iroquois River	Map 3 Kankakee Region
Waynesville	45,613	646,317	1	Kickapoo Creek	Map 5 Sangamon Region
Weldon	36,912	3,231,584	5	Salt Creek	Map 5 Sangamon Region
Wellington	18,583	2,326,741	3.6	Sugar Creek	Map 3 Kankakee Region
West Side MHP	7,014	3,231,584	5	Salt Creek	Map 5 Sangamon Region
White Heath Waterworks	65,753	904,844	1.4	Sangamon River	Map 5 Sangamon Region
Woodland	20,356	2,326,741	3.6	Sugar Creek	Map 3 Kankakee Region
Youngs Hillcrest MHP	1,973	969,475	1.5	Middle Fork Vermillion River	Map 8 Embarras River

potential yield for that buffer zone was calculated. This total potential alternative groundwater yield was determined to be 458 Mgd; the composite recharge rate for the 10-mile buffer zone area (6,575 mi^2) can be calculated as 70,000 gpd/mi^2, a value greater than the <50,000 gpd/mi^2 mapped in dark green but less than the 100,000-150,000 gpd/mi^2 mapped in lighter green on Figure 4.

This total buffer zone yield of 458 Mgd (Table 5) is less than the modeled yield of the Mahomet Aquifer, but is still much greater than the current drinking water demand across the aquifer. However, while this composite yield incorporates the spatial variability of the potential yields of those boundary aquifers, it does not mean those aquifers can actually meet the specific demands of Mahomet Aquifer communities that may come to need that water if the Mahomet were deemed unusable. Further, for Armington, Cissna Park, Delavan, Easton, Hopedale, and Rankin, communities in the interior of the Mahomet, these groundwater sources are not accessible. Additionally, for all private (domestic) users, these sources are too far away to be used, likely requiring connection to a public supply via rural water distribution system. Further analysis to examine economic feasibility is presented in a later section of this Petition.

3.6.7. ECONOMIC ANALYSIS

Currently, all of the community water suppliers use groundwater as a source of drinking water. In order for these towns to convert to a nearby surface water source, the following items would be needed to produce water of similar quality for each supply:

- Surface water intake(s)
- Surface water treatment plant
- Off-channel storage
- Raw water transmission pipeline(s)
- Additional operation and maintenance costs

- Land, engineering, and other soft costs

In addition to the items above, the following assumptions were made for the economic analysis:

1. The financing would occur through a municipal bond at 4% for 30 years
2. The surface water plant would need to be double the average 2010 pumping rate to account for maximum day pumping, the minimum design would be 0.1 Mgd, and that the design capacity would be rounded up to the nearest tenth of an Mgd
3. The costs for a surface water intake, conventional filter plant, and raw water pumps were all estimated using EPA's 2007 Cost Models (U.S. EPA, 2010)
4. Pipeline length was estimated using a straight line distance from the nearest water source to the nearest municipal boundary line. Or if the public supplier was not a municipality, the pipeline length was estimated as a straight line distance from the existing wells to the nearest water source. These assumptions are conservative since the pipeline would need to follow road right-of-ways. Pipeline costs were estimated at $250,000/mile based upon communication with a local engineering firm experienced with public water supply projects. .
5. Off-channel storage capacity was estimated by multiplying the average daily 2010 pumping rate by 120 days (Vern Knapp, personal communication). The cost estimates for this storage was based upon data from Texas as EPA does not publish costs models for off-channel storage (South Central Texas Regional Water Planning Group, 2010).
6. Operation and maintenance costs were estimated from using AWWA's "Benchmarking Performance Indicators for Water & Wastewater Utilities; Survey Data & Analyses Report". Figure 5-35 was used as the source and the median value for Midwest Utilities was chosen. The 2010 yearly pumping rate was used for the amount treated each year.
7. Land, engineering, and other soft costs were estimated to be 25% of the total capital costs.

8. The median household income was taken from U.S. Census data for the municipality or if not a municipality, then county level data was used (U. S. Census Bureau, 2010).

Using these assumptions and costs, the annual cost per household was compared to the 0.4% and 0.6% median household income. If the annual cost per household was greater than the 0.6% median household income for a particular town or city, it was determined to be economically infeasible. If the annual cost per household was greater than 0.4% but less than 0.6%, the alternative source was classified as economically possible. If the annual cost per household was less than 0.4% than the alternative source was classified as economically feasible. Out of the 111 community water suppliers that had an alternative source available, 102 were economically infeasible, 7 were possible, and 2 were economically feasible. This means that for 92% of the public water suppliers, an alternative surface water source is not economically feasible, and for 98% of the public water suppliers it would possibly be an undue economic burden on the customers. The costs for developing a new surface water source, the 0.4% and 0.6% of the median household income, and the economic feasibility for each town is included in Table 7 and the full data used is included in Appendix A.

For all private water users, it was assumed that the costs of developing a surface water source would be economically infeasible for the following reasons:

1. The cost of developing a shared utility would be greater than the costs of just developing a new water source
2. The additional costs of laying pipeline to each individual customer, which would be more disparate than within an urban area, would be cost prohibitive
3. The time it would take to implement these changes if contamination were to occur would be on the order of years during which time individual owners would have to buy bottled water to

minimally meet their drinking water needs and, depending on the contamination, may require bottled water for all uses

For the alternative groundwater source, 120 public water suppliers were analyzed. Illinois American Water-Champaign Operations was not analyzed because they would need approximately three hundred, 100 gpm wells to provide sufficient water, which would require approximately 400 to 500 square miles for wells to be placed. We assumed this would be prohibitive both in costs and ability to obtain leases and/or land for this many wells. Additionally, Armington, Cissna Park, Delavan, Easton, Hopedale, and Rankin did not have a groundwater source near enough to warrant economic feasibility analysis.

For the economic analysis of groundwater sources, the following assumptions were made:

1. The groundwater design capacity would be twice the 2010 pumping rate. This allows for increasing future demands, provides some system redundancy, and addresses system peak demands
2. Each new well would produce 100 gpm
3. Each well would cost approximately $200,000 and would include construction, well house, electrical, and mechanical parts (based upon local engineering firms estimates)
4. The average distance of 10 miles of pipeline would be laid and that for each well over one, an additional 0.5 mile of pipe would be needed to tie the system together
5. Land, engineering, and other soft costs would be 25% of the total capital costs. We believe this assumption conservative for towns needing more than 10 wells because the cost of land Additionally, no right-of-way or legal fees for these right-of-ways are included
6. Financing would occur through a municipal bond at 4% for 30 years

Using these assumptions and costs, the annual cost per household was compared to the 0.4% and 0.6% median household income from the 2010 U.S. Census. If the annual cost per household was greater than the 0.6% median household income for a particular town or city, it was determined to be economically infeasible. If the annual cost per household was greater than 0.4% but less than 0.6%, the alternative source was classified as economically possible. If the annual cost per household was less than 0.4% than the alternative source was classified as economically feasible. Out of the 120 public water supplies analyzed, 92 were economically infeasible, 14 were possible, and 14 were economically feasible. This means that for 77% of the public water suppliers, an alternative groundwater source is not economically feasible, and for 88% of the public water suppliers it would possibly be an undue economic burden on customers.

The costs for developing a new groundwater source, the 0.4% and 0.6% of the median household income, and the economic feasibility for each town is included in Table 7 and the full data used is included in Appendix B.

Table 7. Economic analysis of a new surface water and groundwater source for each community water supplier.

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
Arcola	$165	$247	$573	No	$279	No
Argenta	$176	$264	$750	No	569	No
Armington	$202	$303	$1,013	No	No near source	n/a
Atlanta	$204	$307	$524	No	$358	No
Bath	$87	$131	Private wells	n/a	$1,501	No
Bay View Gardens	$201	$302	Private wells	n/a	$1,319	No
Bayles Lake Lot Owners Association	$189	$284	No near source	n/a	$751	No
Belmont Water Inc.	$189	$284	$2,000	No	$2,602	No
Buckley	$190	$285	No near source	n/a	$849	No
Cerro Gordo	$217	$326	$363	No	$364	No
Chandlerville	$180	$269	$575	No	$636	No
Cisco	$209	$313	$1,435	No	$1,394	No
Cissna Park	$177	$265	$755	No	No near source	n/a
Clinton	$161	$241	$317	No	$159	Yes
Country Lane MHP	$231	$346	$4,010	No	$6,506	No
Crescent City	$184	$275	$964	No	$859	No
Creve Coeur	$170	$255	$352	No	$194	Possible
Danforth	$193	$289	$1,662	No	$1,059	No
Danvers	$209	$313	$873	No	$469	No
De Witt	$233	$349	$2,673	No	$2,913	No
Deer Creek	$214	$321	$691	No	$574	No
Delavan	$183	$275	$682	No	No near source	n/a
Dewey PWD	$181	$272	$3,523	No	$3,904	No

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
East Lynn Community Water Supply	$158	$237	$7,365	No	$4,879	No
East Peoria	$207	$311	$308	Possible	$152	Yes
Easton	$172	$258	$949	No	No near source	n/a
Embarras Water District	$167	$251	$749	No	$372	No
Emden	$202	$303	$1,109	No	$949	No
Eureka	$196	$293	$478	No	$243	Possible
Fisher	$249	$374	$477	No	$352	Possible
Foosland	$204	$306	Private wells	n/a	$4,760	No
Forest City	$129	$194	$1,363	No	$1,877	No
Fountain Valley MHP	$181	$272	$1,219	No	$1,183	No
Germantown Hills	$369	$553	$383	Possible	$215	Yes
Gifford	$226	$338	$860	No	$584	No
Gilman	$163	$245	$643	No	$305	No
Goodfield	$312	$468	$772	No	$701	No
Grandview MHP	$217	$325	$2,194	No	$4,879	No
Green Valley	$174	$261	$770	No	$685	No
Greenview	$212	$318	$768	No	$599	No
Groveland Township Water District	$217	$325	$418	No	$290	Possible
Hartsburg	$170	$255	$1,210	No	$1,162	No
Harvard Hills Water Corp	$217	$325	$2,623	No	$2,674	No
Havana	$127	$190	$291	No	$198	No
Henning	$231	$347	Private wells	No	$2,121	No
Heyworth	$279	$419	$466	No	$269	Yes

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
Hindsboro	$148	$222	$1,565	No	$1,301	No
Hoopeston	$153	$230	$462	No	$222	Possible
Hopedale	$179	$269	$664	No	No near source	n/a
Illinois American – Champaign Operations	$160	$241	No near source	n/a	No near source	n/a
Kenney	$143	$215	$804	No	$1,027	No
Lake Iroquois Association	$189	$284	$1,319	No	$831	No
Lake Wildwind MHP	$264	$395	$1,657	No	$1,467	No
Lake Windermere Estates Subdivision	$217	$325	$1,597	No	$1,895	No
Kilbourne	$174	$261	Private wells	n/a	$1,328	No
Illinois American – Lincoln	$158	$237	$162	Possible	$87	Yes
Loda	$165	$248	No near source	n/a	$1,205	No
Ludlow	$154	$232	$1,337	No	$1,301	No
Mackinaw	$244	$366	$342	Possible	$229	Yes
Mahomet	$305	$457	$360	Possible	$169	Yes
Manito	$169	$254	$526	No	$356	No
Mansfield	$192	$288	$774	No	$569	No
Maroa	$196	$294	$530	No	$310	No
Marquette Heights	$215	$323	$327	No	$232	Possible
Mason City	$129	$194	$404	No	$241	No
Mc Lean	$183	$274	$731	No	$601	No
Metamora	$251	$377	$495	No	$256	Possible
Middletown	$170	$255	$798	No	$981	No
Milford	$150	$225	$510	No	$350	No

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
Mill Point MHP	$264	$395	$1,331	No	$2,440	No
Minier	$202	$304	$739	No	$357	No
Monticello	$229	$343	$347	No	$194	Yes
Morton	$269	$404	$325	Possible	$148	Yes
New Holland	$182	$273	$1,105	No	$1,259	No
Normal	$201	$302	$89	Yes	$47	Yes
North Pekin	$187	$281	$429	No	$317	No
North Tazewell PWD	$217	$325	$236	Possible	$124	Yes
Oak Lane Acres Subdivision	$217	$325	$7,870	No	$1,774	No
Oak Ridge Sanitary District	$264	$395	$2,203	No	$5,136	No
Oakford	$216	$323	$1,288	No	$1,139	No
Oakland	$146	$219	$684	No	$465	No
Onarga	$187	$280	$858	No	$469	No
Paxton	$183	$275	$365	No	$161	Yes
Illinois American - Pekin	$168	$251	$284	No	$142	Yes
Penfield PWD	$181	$272	$1,643	No	$2,054	No
Petersburg	$157	$235	$286	No	$184	Possible
Philo	$269	$403	$881	No	$520	No
Pleasant Plains MHP	$181	$272	$6,755	No	$8,872	No
Potomac	$180	$270	$650	No	$653	No
Prairie View Water Association	$217	$325	$14,786	No	$12,199	No
Rankin	$102	$153	No near source	n/a	No near source	n/a

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
Rantoul	$143	$214	$415	No	$201	Possible
Rossville	$173	$260	$494	No	$351	No
Saddlebrook Estates Subdivision	$217	$325	$9,329	No	$8,132	No
Sadorus	$231	$346	$816	No	$1,017	No
San Jose	$169	$253	$1,075	No	$813	No
Sangamon Valley PWD	$159	$238	$368	No	$229	Possible
Seymour Water District	$181	$272	$1,895	No	$1,508	No
Sidney	$203	$304	$661	No	$459	No
South Pekin	$186	$280	$665	No	$536	No
Spring Bay	$226	$339	Private wells	n/a	$1,038	No
Stanford	$205	$308	$1,140	No	$843	No
Thawville	$214	$321	No near source	n/a	$2,054	No
Thomasboro	$215	$323	$713	No	$465	No
Timberlan Subdivision	$264	$395	$5,468	No	$5,576	No
Tolono	$199	$298	$549	No	$295	Possible
Topeka	$108	$161	Private wells	n/a	$5,740	No
Tremont	$248	$372	$404	No	$267	Possible
Tuscola	$185	$278	$438	No	$213	Possible
Valley View 4 and 6 Knolls Subdivision	$217	$325	$3,008	No	$2,855	No
Valley View Subdivision	$264	$395	$4,586	No	$5,275	No
Virginia	$157	$236	$572	No	$299	No
Wapella	$206	$309	$1,288	No	$837	No
Washington	$243	$365	$229	Yes	$103	Yes

Community Water Supplier	0.4% of median household income (2010)	0.6% of median household income (2010)	Annual cost per household for new surface water supply	Is an alternative surface water source economically feasible?	Annual cost per household for new groundwater supply	Is an alternative groundwater source economically feasible?
Washington Estates Inc.	$217	$325	$808	No	$3,629	No
Watseka	$132	$198	$318	No	$179	Possible
Waynesville	$194	$291	$885	No	$912	No
Weldon	$162	$243	$1,296	No	$860	No
Wellington	$162	$243	$1,840	No	$1,479	No
West Side MHP	$181	$272	$3,312	No	$3,614	No
White Heath Waterworks	$223	$335	$956	No	$856	No
Woodland	$151	$226	$1,159	No	$1,501	No
Youngs Hillcrest MHP	$181	$272	$12,161	No	$11,481	No

3.6.8. Final alternative water supply matrix

As shown above, for the vast majority of the public water supplies, the sand and gravel aquifers and free-flowing streams are economically infeasible. As such, the final alternative water supply matrix shows that there are no economically feasible sources of water to replace the Mahomet Aquifer as a drinking water source (Table 8). If the other users of water, especially irrigators, were factored into this economic analysis, an even greater number of people and businesses would be impacted by the lack of Mahomet Aquifer water.

Table 8. Alternative drinking water sources matrix.

Source Estimated	Estimated Daily Supply	Percent
Petitioned aquifer supply	600,000,000	--
Sand-and-gravel aquifers (10 mile buffer around service area)	Unavailable or Economically infeasible	0
Illinois River near Beardstown	Economically infeasible	0
Salt Fork near Danville (this is the flow that is in the Vermilion River below Danville)	Economically infeasible	0
Embarras River near Greenup	Economically infeasible	0
Kaskaskia River near Atwood	Economical infeasible	0
Total alternatives	**0**	0

4. Petitioned Aquifer Boundary and Other Features

The Mahomet aquifer is a regionally significant Quaternary sand and gravel aquifer that extends beneath portions of a 14-county area of east-central Illinois and portions of 12 counties in north-central Indiana (Figure 6). Known as the Mahomet-Teays Aquifer (or more simply as the Mahomet Aquifer) in Illinois, and as the Teays-Mahomet Aquifer in Indiana, the aquifer occupies portions of the buried Teays-

Mahomet bedrock valley detailed within the regional portion (HA-730K) of the U.S. Geological Survey (USGS) *Ground-Water Atlas of the United States* (Lloyd and Lyke, 1995)

In Illinois the Mahomet Aquifer is hydrogeologically and hydraulically distinct from the upstream extension of the same buried valley fill in Indiana. The Illinois side of the Mahomet valley is broader, contains more sand and gravel, and is, therefore, much more productive than the Indiana portion of the aquifer. Because there are a greater number of users and fewer alternative sources of supply in Illinois (Indiana has large rivers and other alternative aquifers), the Mahomet Aquifer is more critical to communities and rural residents in Illinois as a drinking water resource. **Because of Illinois' dependence upon this aquifer, and as will be demonstrated, a hydraulic separation and a lack of alternative sources of water, it is only the Illinois portion of this aquifer for which Sole Source designation is being sought (**Figure 1**).**

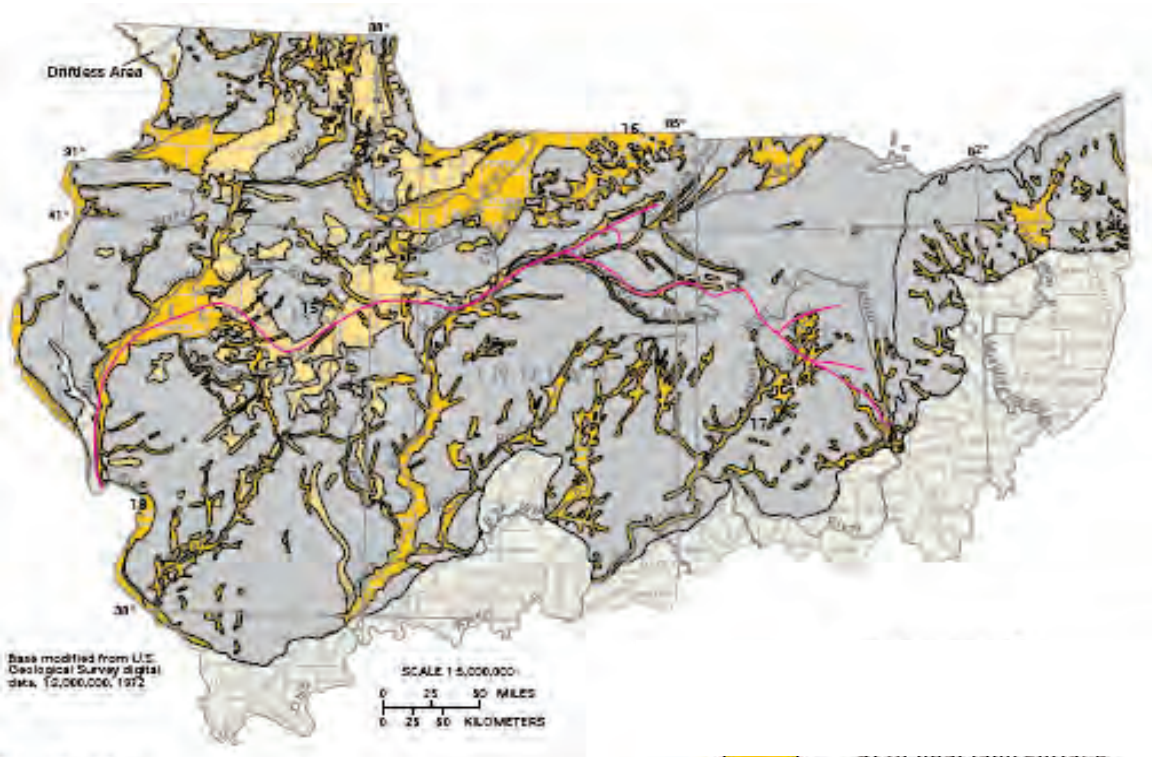

Figure 6. Aquifers in the unconsolidated deposits of the Central Lowland Province (from Lloyd and Lyke, 1995). The red line traces the thalweg of Teays bedrock valley.

Geologic investigations of the aquifer system portray a complex glacial setting of diamictons and intertill aquifers of varying potential overlying the basal Mahomet-Teays aquifer. Throughout this document, the term "Mahomet Aquifer," refers to the principal basal sand and gravel aquifer and "Mahomet Aquifer System," or "Aquifer System" refers to the principal aquifer, overlying aquifers, and confining units. **However, due to the movement of water through these various units into, and from, the Mahomet Aquifer, this Petition is intended to designate the Mahomet Aquifer System as a Sole Source Aquifer including overlying aquifers and geologic units as one hydrogeologic system.**

Numerous reports discuss the geology of the Mahomet Aquifer, or portions of the Aquifer, within Illinois. Appendix C presents a reference list of 64 reports, articles, and open-file reports that discuss Illinois geology, hydrology, or water quality pertinent to the Mahomet Aquifer region, of which no less than 40 publications refer specifically to all or portions of the Mahomet Aquifer. The appendix was organized to present these publications by aquifer region, either applying generally to Illinois or the entire aquifer, or to one of three segments of the aquifer (eastern, central, and western segments). The areas covered by some publication may overlap, but the publications can be generally applied to these aquifer regions: the eastern segment includes Iroquois, Ford, Vermilion, and Champaign counties; the central segment Piatt, Macon, DeWitt, McLean, Logan and Menard counties; and the western segment Cass, Mason, Tazewell, and Woodford counties.

The earliest publications, which touch upon the Mahomet Aquifer System, are *Groundwater Resources in Champaign County* (Smith, 1950) and *Groundwater Geology in East-Central Illinois* (Selkregg and Kempton, 1958). Two seminal reports present the geology and groundwater hydrology of the Aquifer and together describe the entire aquifer: for eastern and central segments of the Aquifer extending from the Indiana border to western McLean, Logan, and Menard counties (Visocky and Schicht, 1969) and for the western segment of the Aquifer, the Havana Lowlands region of Mason and Tazewell

counties (Walker et al., 1965). The most recent publication (Roadcap et al., 2011) regards all of the Mahomet Aquifer focusing on a predictive three-dimensional groundwater flow model constructed to assess the impacts of current and future water demands on the Aquifer. This Petition has relied heavily upon Roadcap et al. (2011) for presenting the most up-to-date information on the Mahomet Aquifer. A number of excerpts and figures from Roadcap et al. (2011) have been reproduced herein and a hard copy of this report is included in the Petition packet. Review of this document for a complete presentation of Mahomet Aquifer geology and hydrology is highly encouraged. Additional references to other documents are provided when addressing specific information requested on USEPA Completeness Determination Checklist.

4.1. GEOGRAPHY AND CLIMATE

Descriptions of the geography and climate of the region are provided in numerous documents. Geographic descriptions are found in Visocky and Schicht (1969) and Walker et al. (1965). Climate information contained in those two reports was updated with more recent information contained in the Climate Atlas of Illinois (2004).

The valley system covers an area of about 4,000 square miles, stretching from the Indiana state line near Hoopeston approximately 150 miles westward to the Illinois River near Havana. Principal portions of the buried Mahomet Bedrock Valley lie within 14 counties in east-central Illinois including southwestern Iroquois, southeastern Ford, northwestern Champaign, central Piatt, northeastern Macon, central De Witt, southeastern McLean, northern Logan, and southeastern Woodford Counties, extreme northern Menard and Cass Counties (along the Sangamon River) and all of Mason and Tazewell Counties (Figure 1).

The area lies within the Till Plains Section of the Central Lowland Physiographic Province (Leighton et al., 1948). The area is further subdivided: the main channel of the valley is in the Bloomington Ridged Plain; the extreme northeastern portion is in the Kankakee Plain; and the western portion ends in the ancient Illinois floodplain. Elevations range from 920 feet in southeast McLean County to 430 feet along the Illinois River. Large portions of the landscape have level or greatly rolling topography, interrupted by low, broad morainic ridges. Most of the ridges have gentle slopes so that local relief is normally low. Numerous terraces, dunes and sand ridges are found in western portions of the region in Mason and Tazewell counties. Local relief averages 50 feet, but along a few streams rises to 150 feet. Drainage in the area is primarily toward the many streams that traverse the region including the Iroquois River near Watseka; the North, Middle and Salt Forks of the Vermilion River above Danville; the upper Kaskaskia River near Champaign; the upper Sangamon River from Fisher to Monticello and extreme lower Sangamon River forming the northern border of Menard and Cass Counties; Salt Creek near Clinton; Sugar Creek below Bloomington; the Mackinaw River from Mackinaw to the Illinois River below Pekin; and the Illinois River itself.

The climate of the region is a humid continental type, characterized by cold, relatively dry winters and warm to hot, wet summers. Like the rest of Illinois, precipitation and temperatures exhibit a north-south trend across the aquifer. According to the Climate Atlas of Illinois (2004), the mean annual precipitation increases from 34 inches in the northern part of the region to 37 inches in the south-central part of the area. The average annual temperature is 52°F, ranging from an average low of 41°F to an average high of 62°F. Average summer temperatures range from 62° to 85°F and winter lows range from 19° to 36°F. The warmest month, July, has a mean temperature of 65°F and the coldest month, January, has a mean temperature of 43°F. Average annual precipitation ranges from 34 inches across the northernmost portions of the aquifer to 37 inches across the southernmost portions. Table 9 presents a range of precipitation likelihoods across the aquifer region for given recurrence intervals.

Table 9. Lowest and highest expected precipitation across the Mahomet Aquifer region for given recurrence intervals (from Climate Atlas of Illinois, 2004).

	Expected precipitation (inches)	
	Once in 5 years	**Once in 50 years**
Lowest precipitation	30-32	24-26
Highest precipitation	38-42	48-52

4.2. GEOLOGY

The origin of the Teays bedrock valley continues to be the subject of considerable debate and research. Well log data have been used to map the bedrock valleys, and for the past 50 years hydrogeologists have interpreted these data to develop a better understanding of the preglacial landscape below the thick glacial deposits of the Midwest. Research on this particular aquifer over the past several decades suggests that the pre-glacial Teays River drainage probably had its headwaters east of the Appalachian Mountains (Bleuer, 1989). From the headwaters it flowed westward through Ohio, Indiana, and finally into Illinois where the Teays River once flowed into the ancestral Mississippi River (Figure 6).

In Illinois, the Mahomet-Teays Aquifer extends from the Indiana border near Hoopeston to the Illinois River near Havana (Figure 1). In some places, the valley broadens to several miles across; at the downstream end at the confluence with the ancient Mississippi (the modern Illinois River), the aquifer is 20 to 30 miles wide. In Illinois, the generally accepted limit of the aquifer system places the edge of the Mahomet Aquifer at the 500-foot contour of the bedrock surface (Figure 7). Outwash deposits filled the bedrock valley during glacial retreat. The most productive sand and gravel that fills the bedrock valley commonly occupies the deeper portions of the now-buried valley; aquifer saturated thickness varies from less than 50 to just under 200 feet (Figure 8). These boundaries reflect the most recent work of the ISWS and Illinois State Geological Survey (ISGS) to define and characterize the Aquifer System.

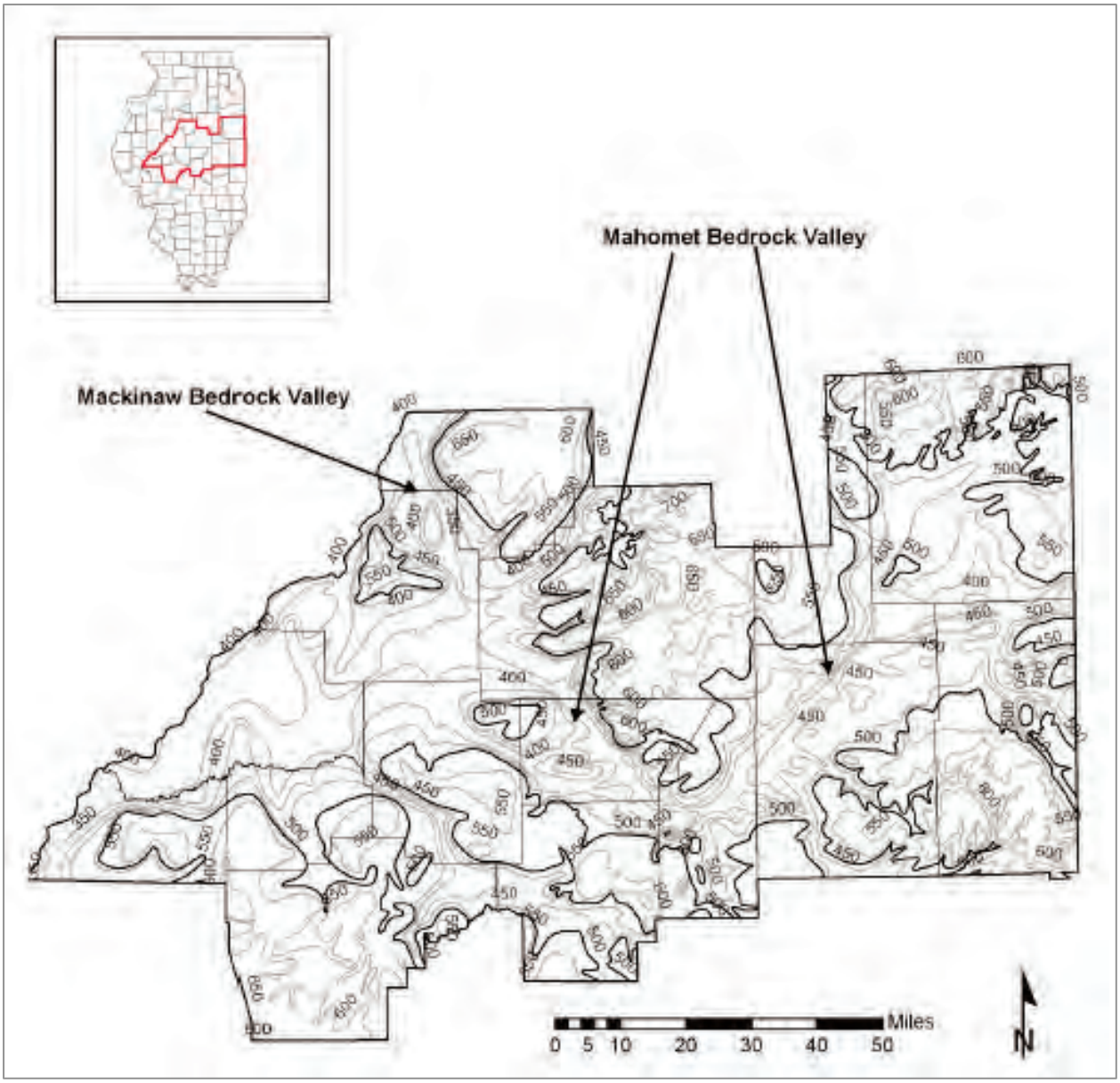

Figure 7. Topography of the bedrock surface beneath east-central Illinois. The 500-foot contour line approximates the edge of the bedrock valleys (modified from Herzog et al., 1994).

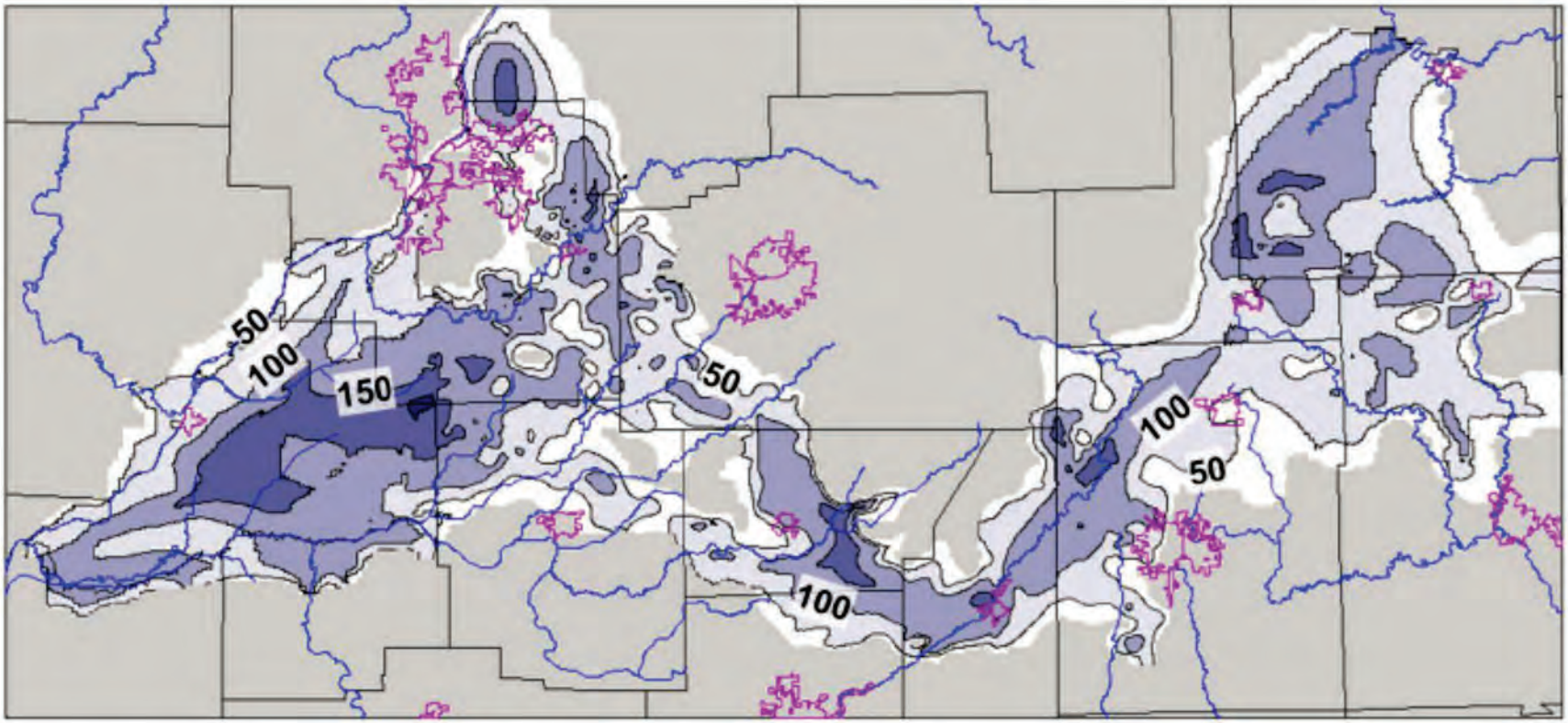

Figure 8. Saturated thickness of the Mahomet aquifer (from Roadcap et al., 2011).

The following descriptions are excerpted from Roadcap et al., 2011 (pages 17-26):

4.2.1. BEDROCK GEOLOGY

The bedrock underlying the east-central region (Figure 5) consists of several thousand feet of sandstone, limestone, dolomite, shale, and coal. Overall these sedimentary rocks dip to the south into the Illinois Basin. This regional dip is interrupted locally by the LaSalle Anticlinorium, a structural belt that trends north-south across the eastern part of the planning region.

The bedrock surface over much of the region is composed of Pennsylvanian shales and relatively thin layers of sandstone, limestone, and coal (Wilman et al., 1975). Because of the LaSalle Anticlinorium, older rocks (Silurian, Mississippian limestone, dolomite, and sandstone) form the bedrock surface in northern Champaign, southern Ford, and much of Iroquois Counties. Rocks at the bedrock surface along the southwest margin of the region are predominantly Mississippian limestones.

Two broad, deeply incised bedrock valleys, the Mahomet and Mackinaw, are the prominent features of the bedrock surface in the region (Figure 7). The bedrock surface in the region is generally concealed by the Quaternary deposits overlying it. However, bedrock is exposed at the land surface at some localities in the region, mostly in the southern half of Vermilion County, southern Menard County, and at isolated localities in Sangamon, Cass, and Logan counties (Piskin and Bergstrom, 1975).

The Mahomet Bedrock Valley in Illinois extends from the state line in Iroquois and Vermilion Counties to its confluence with the Mackinaw Valley in Tazewell County…The

bedrock surface was modified by the earliest continental glaciers that entered the state during the Ice Age (Killey, 2007), and by the large volumes of glacial meltwater that flowed from these very large ice sheets. The deepest parts of the Mahomet Bedrock Valley lie more than 500 feet below the present- day land surface (Kempton et al., 1991). The Mackinaw Bedrock Valley enters the region from the north in Tazewell County and trends to the southwest in Mason and Cass Counties where it exits the region. The Mackinaw is the course of the preglacial, ancestral Mississippi River. Similar to the Mahomet Bedrock Valley, the Mackinaw is filled with sediments left from continental glaciation and associated meltwater streams.

4.2.2. QUATERNARY GEOLOGY

Continental glaciers flowed southward from Canada beginning about two million years ago, advancing into Illinois as great sheets of ice that were many hundreds of feet thick. Careful study of the vast deposits of sediment left by the continental glaciers has led to the understanding that there were at least three major episodes of continental glaciation, and that each episode included several advances and retreats of the ice sheets.

The Banner Formation is the deepest of the major stratigraphic units (Figure 9). It is thought to have been deposited more than 500,000 years ago during the pre-Illinois Episode (Soller et al., 1999). This formation rests directly on the bedrock surface in the bedrock valleys, is draped on the valley walls, and extends onto the bedrock uplands. The top of the Banner is marked by a discontinuous, buried weather zone.

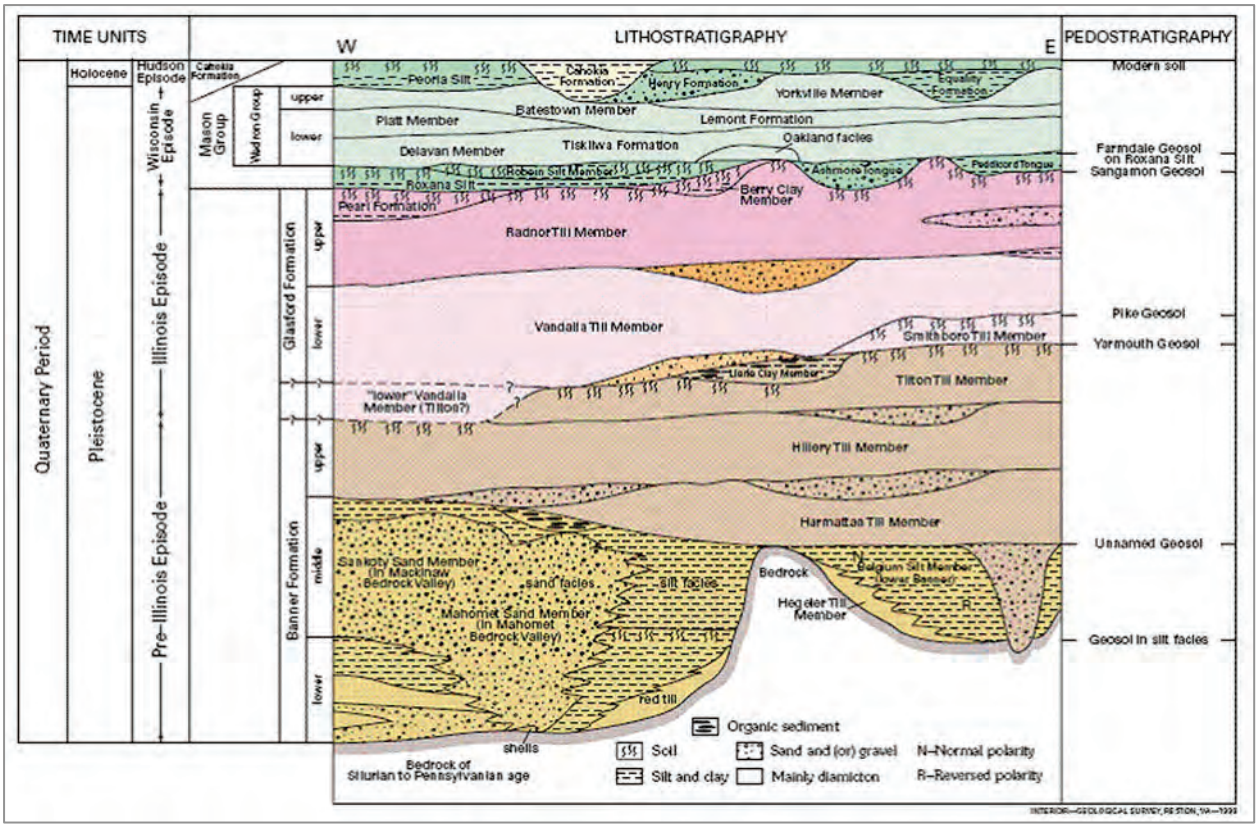

Figure 9. Diagrammatic stratigraphic column of glaciogenic sediments in east-central Illinois (from Soller et al., 1999).

The Banner Formation is divided into a lower, middle, and upper unit. Because the sediments of the lower Banner are locally present and in general not easily distinguished from the sediments of the middle Banner Formation, the lower and middle are typically considered as one unit. Sand and gravel deposits in the Mahomet Bedrock Valley (the Mahomet Sand Member) and those in the Mackinaw Bedrock Valley (Sankoty Sand Member) are the predominant sediments in the two bedrock valleys…Three till members (Tilton, Hillery, and Harmattan) compose the upper Banner Formation. Deposits of sand and gravel occur at the base of the Harmattan and between the three till members. Although the sand and gravel deposits in the upper Banner Formation are quite variable in thickness and areal extent, they form locally significant sources of

groundwater that supply rural domestic wells in the region, especially at locations on the bedrock uplands.

The Glasford Formation was deposited during the Illinois Episode between about 180,000 and 125,000 years ago (Soller et al., 1999) (Figure 9). The top of the Glasford is marked by distinctive, organic-rich zones (paleosols) that formed during the Sangamon Episode, the interglacial period following the Illinois Episode (Kempton et al., 1991). The Glasford Formation is composed primarily of till of the Radnor and the Vandalia Till Members. Deposits of sand and gravel that are found in the Glasford Formation typically occur between the Radnor and the Vandalia, and at the base of the Vandalia, although some deposits may be found within the till units. The sand and gravel deposits in the Glasford Formation typically are thin and limited in areal extent. These characteristics make it difficult to interpret the continuity and distribution of individual deposits. Where saturated, these deposits form locally important sources of groundwater in the region for rural domestic supplies. If the deposits are sufficiently thick, they may provide supplies to small communities. The Glasford Formation extends across the Mahomet and Mackinaw Valleys and onto the bedrock uplands adjacent to these valleys.

The Wedron and Mason Groups are the shallowest major stratigraphic units in the region (Figure 9). The sediments in these units were deposited during the Wisconsin Episode between 75,000 and 12,000 years ago (Soller et al., 1999). Although till predominates the sediments of the Wedron Group, the Wedron also includes very thin deposits of sand and gravel that are typically discontinuous and very limited in areal extent. The Mason Group consists predominantly of sand and gravel deposits, but also includes deposits of wind-blown silt (loess) and lake-bottom or slack-water sediments

(Hansel and Johnson, 1996). The deposits of the Mason Group are found along the main drainage ways in the region, or as very shallow deposits. The Mason Group is thickest in the western part of the region, particularly in Mason County where sand and gravel of the Mason Group directly overlies older sand and gravel (Walker et al., 1965).

The Mahomet Aquifer comprises the region's major groundwater resource. The aquifer occupies the lower part of the Mahomet Bedrock Valley. In some reaches of the Mahomet Bedrock Valley, the Mahomet Aquifer directly overlies the bedrock surface. In other parts of the bedrock valley, the aquifer directly overlies till or other fine-grained sediments. Deposits of till, silt, and clay also occur locally within the aquifer. Where these fine-grained sediments are not present, the aquifer consists of a continuous interval of sand to sand and gravel.

The Sankoty aquifer occupies the Mackinaw Bedrock Valley and coalesces with the Mahomet Aquifer in the confluence area of the Mackinaw and Mahomet Bedrock Valleys. Together these two aquifers form a single hydraulic unit, referred to herein as simply the Mahomet Aquifer.

Geologic cross sections typical of the confined, eastern two-thirds of the aquifer system within Illinois are shown in Figure 10 and Figure 11 (Herzog et al., 1995a). The basal Mahomet (Banner Formation) and its relationship to, and interconnections with, overlying deposits, especially Glasford sands can be seen. Well logs used to create these cross sections and other cross sections that appear in Herzog et al. (1995a) are from observation wells specifically drilled for the project, and are presented in Herzog et al. (1995b). Well logs for project monitoring wells drilled in the far eastern portion of the aquifer system in Iroquois, Vermilion, Ford, Champaign, and Piatt counties are presented in Burch (2008). Additional well records and less-detailed geologic cross sections appear in Visocky and Schicht (1969) and Walker et al.

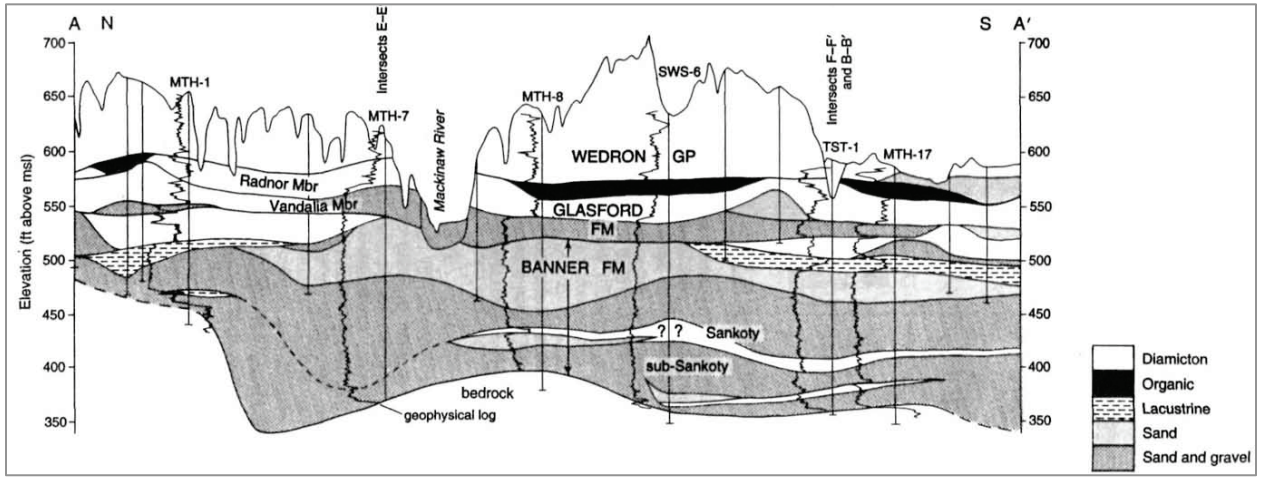

Figure 10. North-south cross section A-A' from Tremont in Tazewell County to Emden in Logan County (from Herzog et al., 1995a).

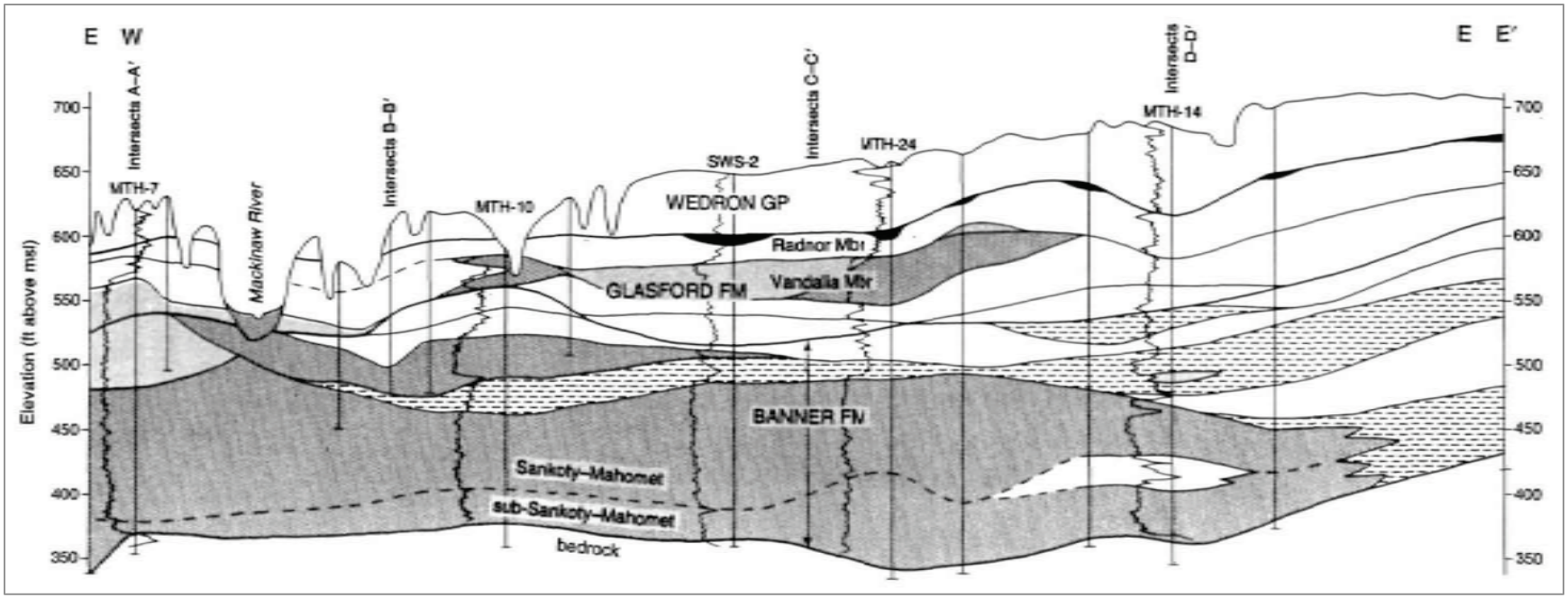

Figure 11. East-west cross section E-E', northeast of Stanford (McLean County) to northwest of Hopedale (Tazewell County).

(1965). West of Easton (Mason County), the confining units of diamicton are absent and the Mahomet Aquifer is unconfined.

4.3. HYDROLOGY

From Roadcap et al. (2011) (page 26):

> The hydrology of the Mahomet Aquifer has been studied on both a regional and on a more detailed basis of individual segments. The ISWS files also contain a vast amount of information from individual wells and community water supplies. Visocky and Schicht (1969) discuss the geologic setting, aquifer properties, water use, water level fluctuations, and the results of an electric analog model. Wilson et al. (1998) presented the first potentiometric surface map for the entire aquifer by combining data from regional studies with new data in McLean and Tazewell Counties. Burch (2008) constructed observation wells and measured water levels in the eastern half of the aquifer, including Piatt, Champaign, Ford, Vermilion, and Iroquois Counties.
>
> The aquifer in the Havana lowland region of Mason and Tazewell Counties has been studied by Walker et al. (1965), Clark (1994), Sanderson and Buck (1995), and Westcott et al. (2009). Burch and Kelly (1993) studied the Peoria, Pekin, and Morton area of northern Tazewell, western Woodford, and eastern Peoria Counties. The aquifer in eastern Tazewell County and western McLean Counties was examined through a series of studies by Kempton and Visocky (1992), Wilson et al. (1994), Herzog et al. (1995a, b), and Wilson et al. (1998). Anliker and Sanderson (1995) conducted a mass measurement of water levels in Piatt and DeWitt Counties while Layne Geoscience (1999) and Roadcap and Wilson (2001) studied the impacts of the Decatur emergency wellfield.

Groundwater in the Champaign area has been studied by Smith (1950), Foster and Buhle (1951), Sanderson and Zewde (1976), and Burch et al. (1999). Groundwater flow models were constructed for studies by Visocky and Schicht (1969), Clark (1994), Wilson et al. (1998), and Layne Geoscience (1999). Additional models were constructed by Marsh (1995) for Vermilion County and WHPA (2006) in the Champaign area.

As further corroboration of the importance of the Mahomet Aquifer to the region and to Illinois, the ISWS currently operates an observation well "network" composed of over 180 wells at over 140 sites (Figure 12), largely comprised of wells built especially for monitoring aquifer water levels and quality. Numerous sites contain "nested" observation wells to monitor the Mahomet Aquifer, overlying confined units, and the water table. Water level observations generally are collected on a monthly or quarterly basis with selected wells containing digital data loggers polling water levels as often as hourly. Numerous local and state entities have funded a cooperative ISWS/ISGS drilling and monitoring effort. On the west, the Imperial Valley Water Authority has outfitted and funded the ISWS to maintain 11 wells (blue asterisks) with data loggers for long-term water level monitoring. Also in this region are wells constructed for the Illinois Department of Agriculture (green crosses) for agrichemical sampling and ISWS wells (red circles) for local resource development monitoring. Just east of this area are observation well sites (orange triangles) maintained by the ISWS and funded by the Long Range Water Plan Steering Committee, a coalition of local water authorities, counties, and communities, to assess the viability of the aquifer for a potential major 15 Mgd development to serve the City of Bloomington and surrounding communities. The City of Decatur maintains a set of observation wells (blue stars) around its emergency well fields. The eastern half of the aquifer contains a host of observation wells (red circles and magenta x's) drilled and maintained by ISWS/ISGS through state and private funds (e.g., Illinois American Water).

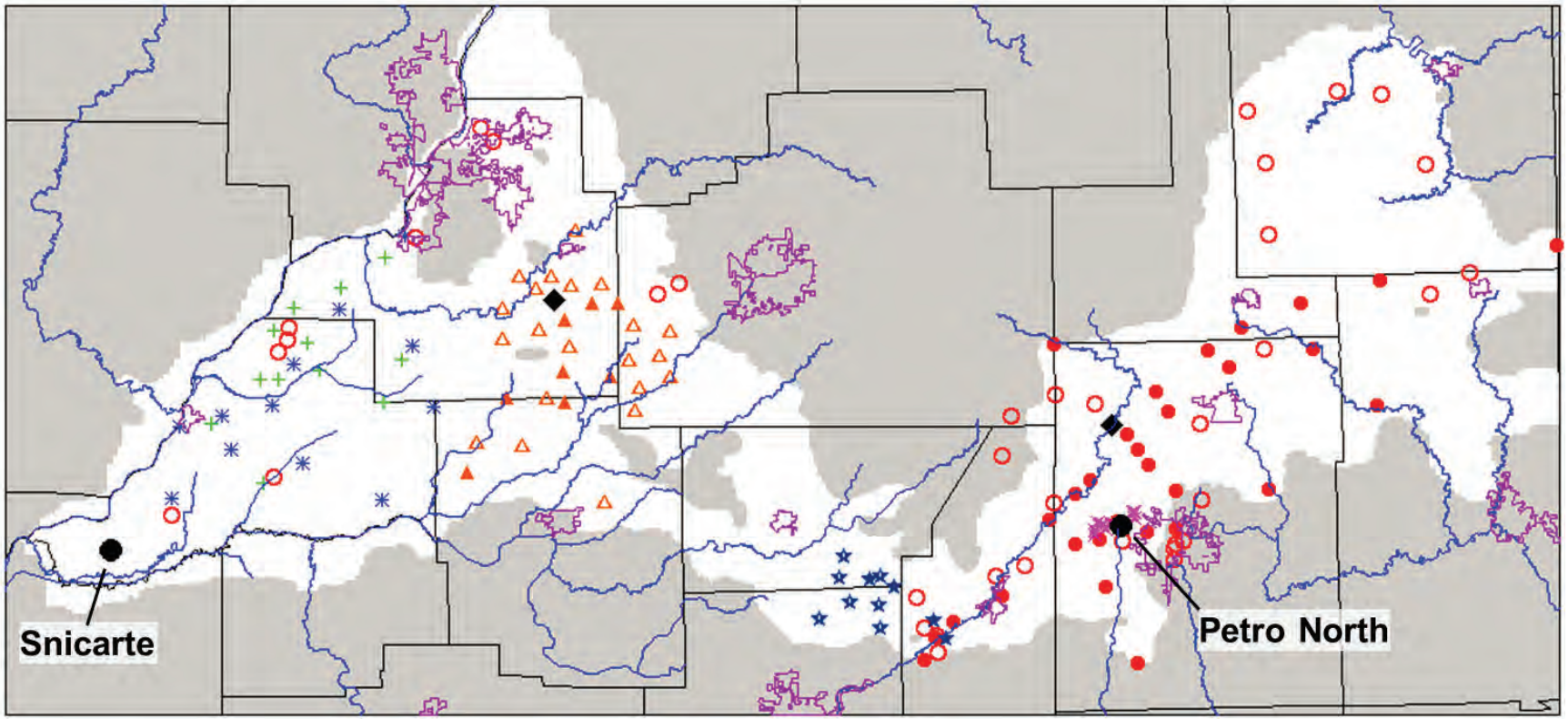

Figure 12. Location of observation wells in the Mahomet Aquifer; symbols are explained in the text (from Roadcap et al., 2011).

Two ISWS observation wells have 50+ year historical records (Snicarte and Petro North), having been started in the 1950s during or after the major drought of that era (Figure 13 and Figure 14). These two hydrographs clearly illustrate the difference between the prevailing conditions of the eastern (confined) and western (unconfined) portions of the aquifer. The Snicarte hydrograph (Figure 13) shows no long-term trend in water levels even though over 2,000 irrigation wells have been drilled in the region during the period shown on the hydrograph. Recharge during the non-growing season is great enough to overcome irrigation demand in this unconfined portion of the aquifer. The hydrograph does show a response to prevailing climate conditions, the droughts of 1988-89 and 2005 and the Great Flood of 1993. Conversely, the Petro North hydrograph (Figure 14) shows a long-term decline in water levels as regional pumpage increases to meet the growing drinking water demands of Champaign-Urbana and other Champaign County communities.

4.3.1. AQUIFER RECHARGE

Geologic cross-sections of the Mahomet System are presented in numerous documents (Walker et al., 1965; Visocky and Schicht, 1969; Wilson et al., 1994; Herzog et al., 1995a; Stumpf and Dey, in press). As previously discussed, these sections portray a complex glacial setting of diamictons and intertill aquifers of varying potential overlying the basal Mahomet Aquifer. Given the complexity of the glacial setting, a conceptual model of water movement into and within the aquifer was developed and which continues to evolve as new data are collected and analyzed (Figure 15).

Recharge of the Mahomet Aquifer is derived from two principal sources within the physical boundaries of the aquifer itself, those being a) leakage of precipitation through overlying geologic materials and b) leakage of streamflow along selected reaches of streams overlying the aquifer. Conceptually portrayed

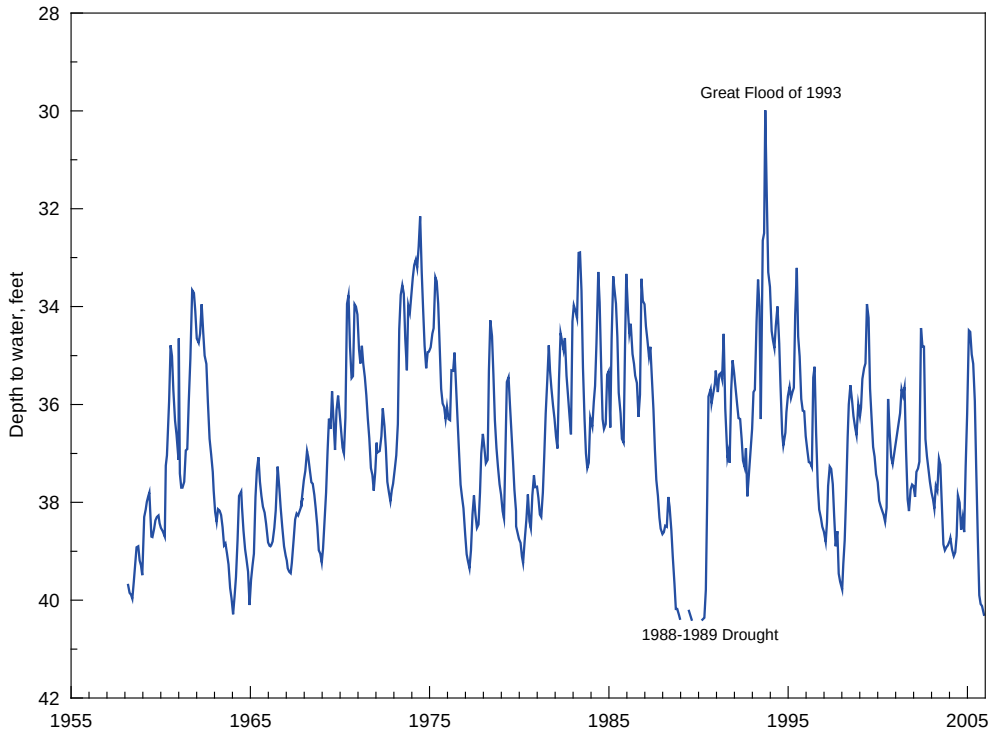

Figure 13. Long-term hydrograph near Snicarte in the western unconfined portion of the Mahomet aquifer (from Wehrmann et al., 2011).

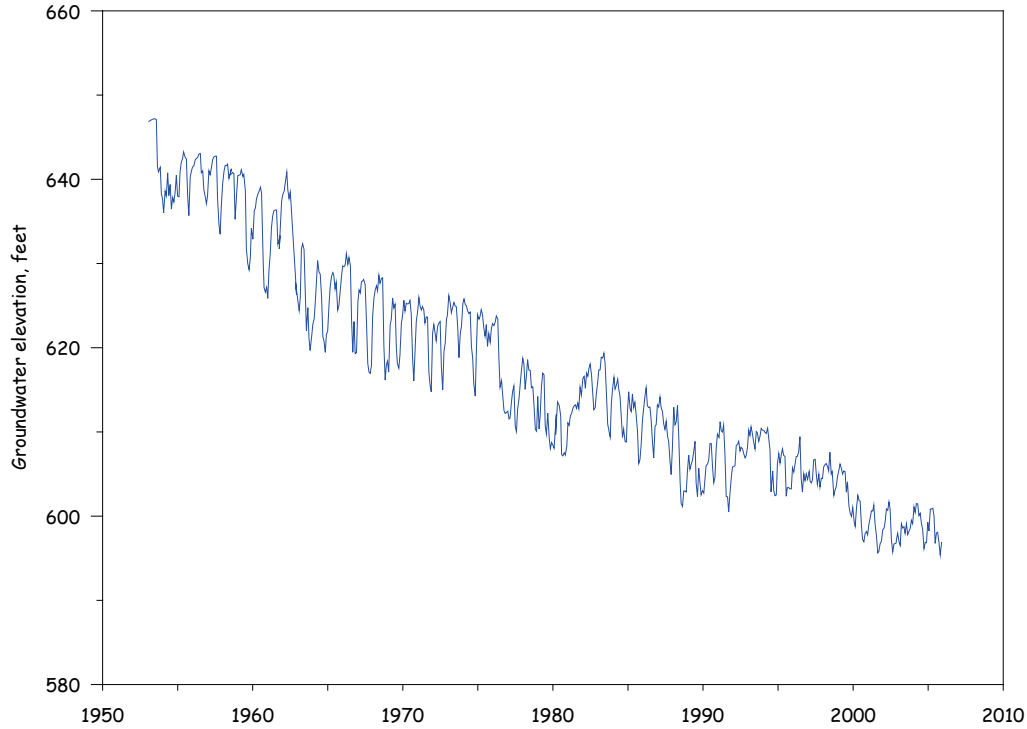

Figure 14. Long-term hydrograph at Petro North near Champaign in the eastern confined portion of Mahomet aquifer (from Wehrmann et al., 2011).

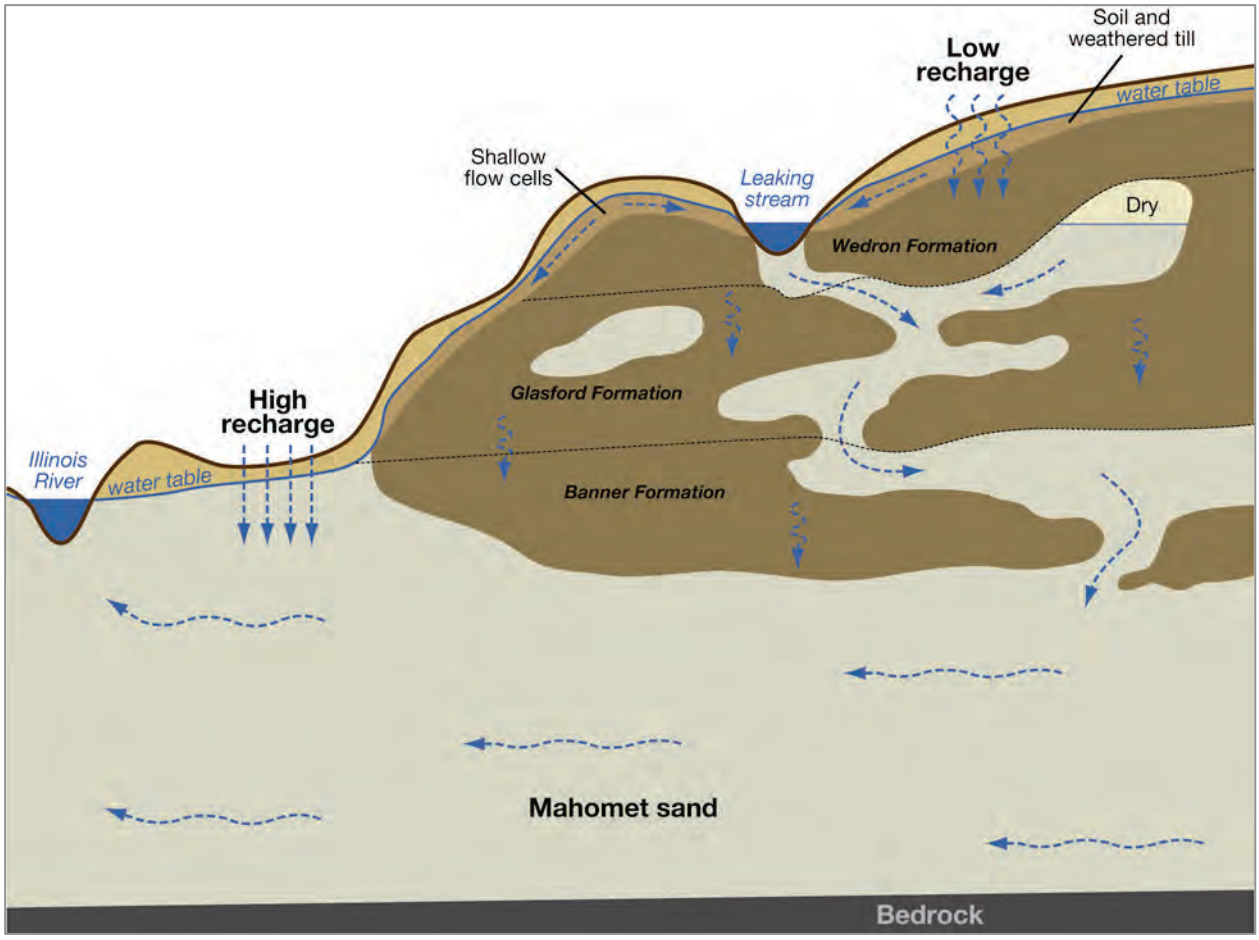

Figure 15. Conceptual framework for groundwater movement into and within the Mahomet-Teays aquifer (from Roadcap et al., 2011).

in Figure 15, the eastern portion of the aquifer is confined by as much as 200 feet of diamicton (glacial till). Average recharge to the aquifer is moderate to low (from 6 inches/year to less than 0.5 inch/year) with the higher rates occurring through sparse interconnections to shallower coarse-grained materials and streams. On the western end of the aquifer, nearer to the Illinois River in Mason and Tazewell Counties, the land surface elevation falls substantially as the Illinois River is approached. Here the confining layers are absent and permeable aquifer sands occur at land surface. The aquifer becomes unconfined and recharge is high (exceeding 12 inches/year). A three-dimensional groundwater flow model of the aquifer (Roadcap et al., 2011) best represents the current understanding of aquifer

recharge and especially the spatial variability in recharge rates and vertical fluxes (Figure 16 and Figure 17). Aquifer recharge areas from beyond the boundaries of the aquifer have not been mapped and are undocumented.

Portions of watersheds over the Mahomet Aquifer extend beyond the aquifer boundaries, most notably the upper Mackinaw and Sangamon River watersheds (Figure 18). USEPA guidance suggests that in situations where contaminated streamflows could lead to downstream aquifer contamination, via streamflow contribution to aquifer recharge, that the designated sole source area be extended to include those watershed areas. In this Petition, it is not recommended extending SSA area designation to upstream watersheds for the following reasons. The aquifer downstream of the watershed portions is confined and surface water/groundwater connections are limited to fairly small stream reaches, providing limited opportunity for cross-contamination (Roadcap and Wilson, 2001; Wilson et al., 1998). Further, the natural condition along these stream/aquifer interconnections is one of groundwater discharge. That is, the natural and most typical condition is for movement of groundwater upward to contribute to streamflow. Reversal of this condition is transient, such as during high river stage or, in the case of the Sangamon River below Monticello, during periods of drought when Decatur is operating its emergency well fields. Potentially contaminated surface water may move toward the aquifer during these periods, but is unlikely to actually reach the aquifer before the natural flow condition reverses the movement of pollutants back to the surface.

Therefore, extension of the Sole Source designation beyond the boundary of the aquifer due to recharge locations outside the area of the physical boundary of the aquifer currently is not justified.

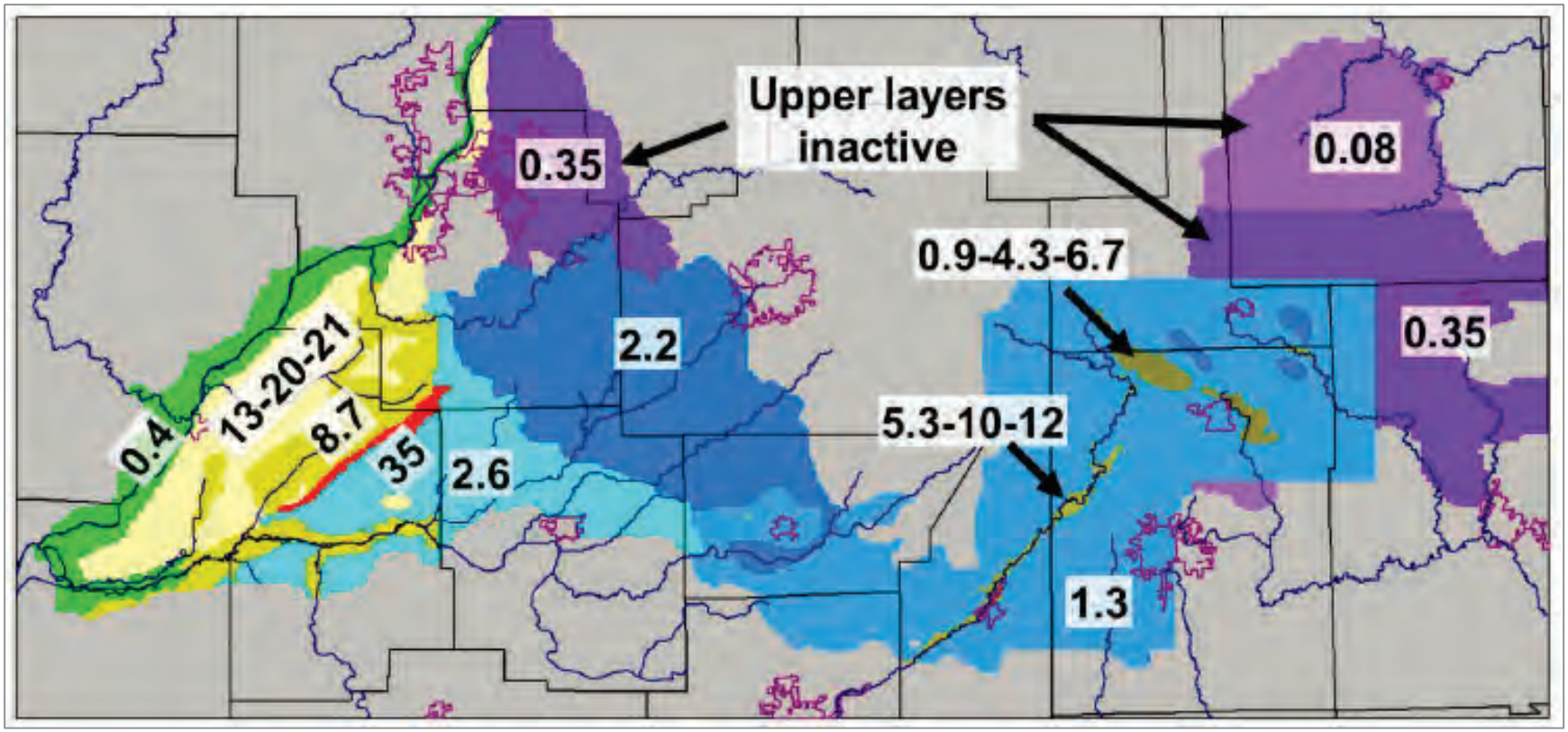

Figure 16. Recharge rates assigned to the Mahomet Aquifer flow model (from Roadcap et al., 2011). Zones with three values indicate linearly varying values from 1930-2005, 2005-2020, and 2020-2050 (inches/year).

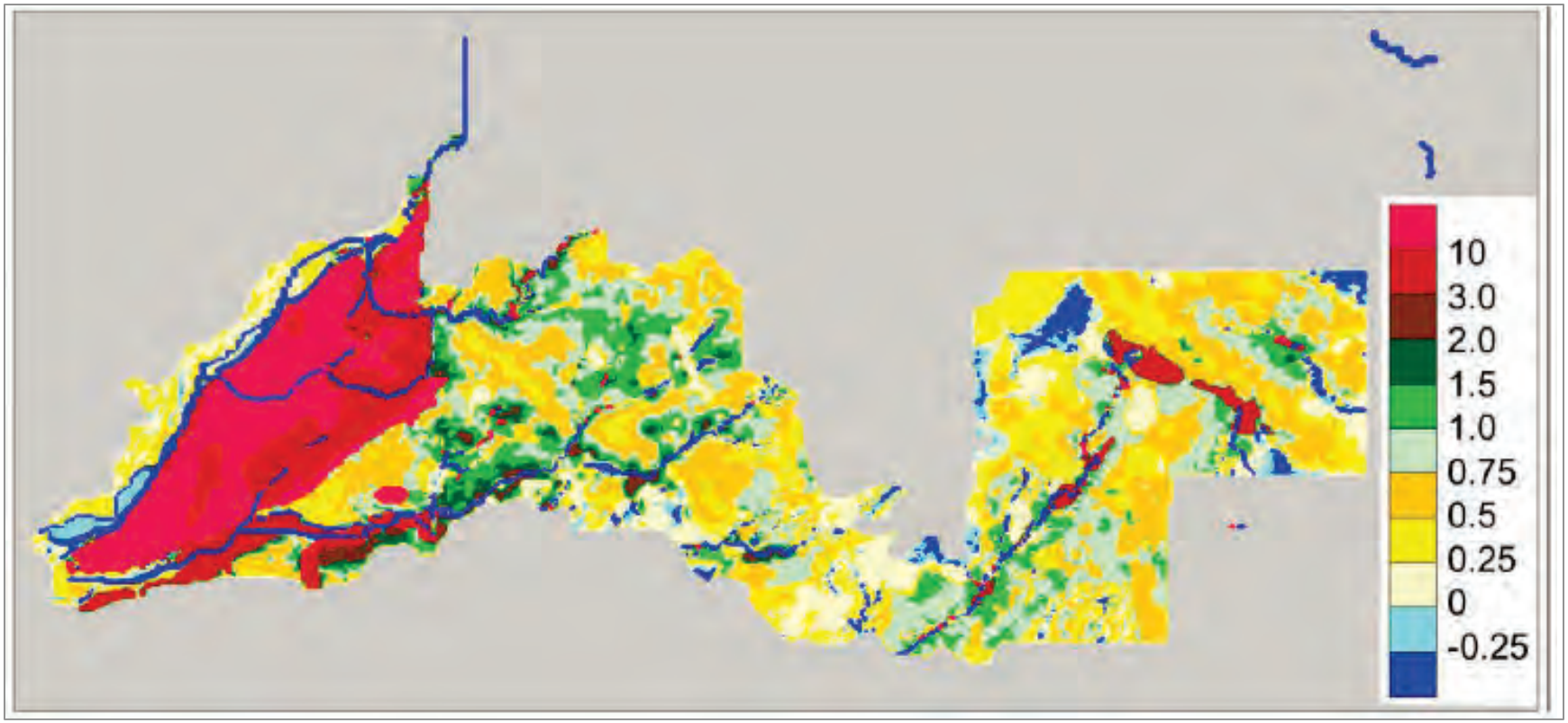

Figure 17. Calculated vertical fluxes from layer 1 to layer 2 for the Mahomet Aquifer flow model, in inches/year (from Roadcap et al., 2011).

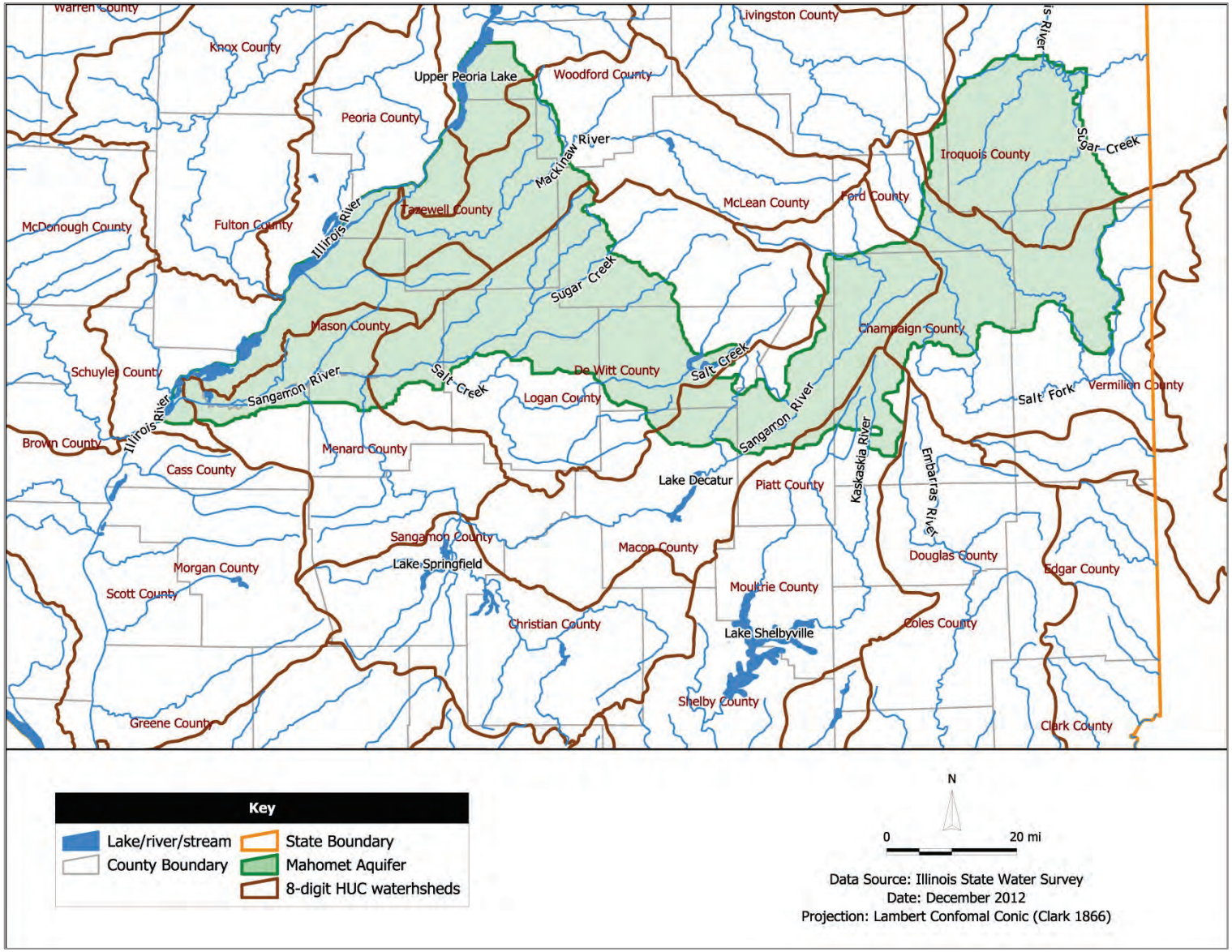

Figure 18. Watersheds overlapping the Mahomet Aquifer system.

4.3.2. GROUNDWATER FLOW – POTENTIOMETRIC SURFACE

A potentiometric surface map of the entire aquifer within Illinois (Figure 19) was created by compositing groundwater level measurements collected during five separate studies: Burch (2008) in Piatt, Champaign, Ford, Vermilion, and Iroquois counties; Anliker and Sanderson (1995) in DeWitt, Piatt, and Macon counties; Wilson et al. (1998) in McLean, eastern Tazewell, and Logan counties; Sanderson and Buck (1995) in Mason and western Tazewell counties; and Burch and Kelly (1993) in northern and Woodford counties. Based on this surface map, groundwater flow is predominantly down-valley from east to west discharging to the Illinois River and several interconnected streams such as the Sangamon and Mackinaw Rivers. This map was subsequently improved by Roadcap et al. (2011) to address a variety of contouring and boundary issues (Figure 20).

A large cone of depression in the Champaign area has substantially altered the natural down-valley movement of groundwater, such that a groundwater divide now exists west of Champaign beneath Piatt County (Figure 21). Groundwater withdrawals from the Mahomet at Champaign in 2010 were 22 Mgd (see also the Petro North hydrograph within this cone of depression, Figure 14). Groundwater in that area now moves eastward into the Champaign cone. Groundwater level monitoring in the shallower Glasford sands in this particular region shows that pumping from the Mahomet Aquifer at Champaign also is affecting groundwater levels in the shallower Glasford, confirming that interconnections do occur across stratigraphic units within the petitioned Aquifer System (Figure 22).

Another important aspect to the potentiometric surface is that groundwater is also discharging to surface outlets on the eastern perimeter including the Iroquois River to the northeast and the North Fork Vermilion River to the east and southeast (Figure 20). **Therefore, the petitioned boundary of**

Mahomet Aquifer does not extend to Indiana; rather being terminated at those natural hydraulic boundaries.

4.3.3. AQUIFER HYDRAULIC PROPERTIES

The ISWS conducts and analyzes aquifer tests at sites throughout Illinois and keeps the results of data analysis in an aquifer property database (Kohlhase, 1989). Roadcap et al. (2011) mapped the results of 24 high-quality aquifer tests that collected drawdown vs. time data using relatively high pumping rates and long test periods. The hydraulic conductivities (K) from these tests range from 210 feet/day at Petersburg to 440 feet/day at Champaign, Monticello, and northern Mason County (Figure 23). An exceptionally high value of 2,000 feet/day was derived in a boulder field at Mapleton along the Illinois River. Excluding this value, the mean K is 320 feet/day and a geometric mean of 304 feet/day. With aquifer thicknesses commonly exceeding100 feet, aquifer transmissivity often exceed 30,000 feet2/day (or ~240,000 gallons/day/foot) and accounts for the very high yields of wells that completely penetrate the aquifer.

4.3.4. WELL YIELDS AND GROUNDWATER USE

Figure 24 presents a map of the locations of high-capacity wells completed in the Mahomet Aquifer used in the groundwater flow model developed by Roadcap et al. (2011). Community drinking water wells are fairly evenly spread across the aquifer while irrigation wells predominate on the western unconfined portion of the aquifer. A summary of wells used by communities located over the aquifer is presented in Appendix D. A number of wells are capable of pumping in excess of 500 gallons per minute (gpm). Often, those wells that are rated less than 100 gpm are either a) completed in overlying shallower aquifers, or b) completed in the upper part of the basal Mahomet aquifer rather than completely penetrating the aquifer.

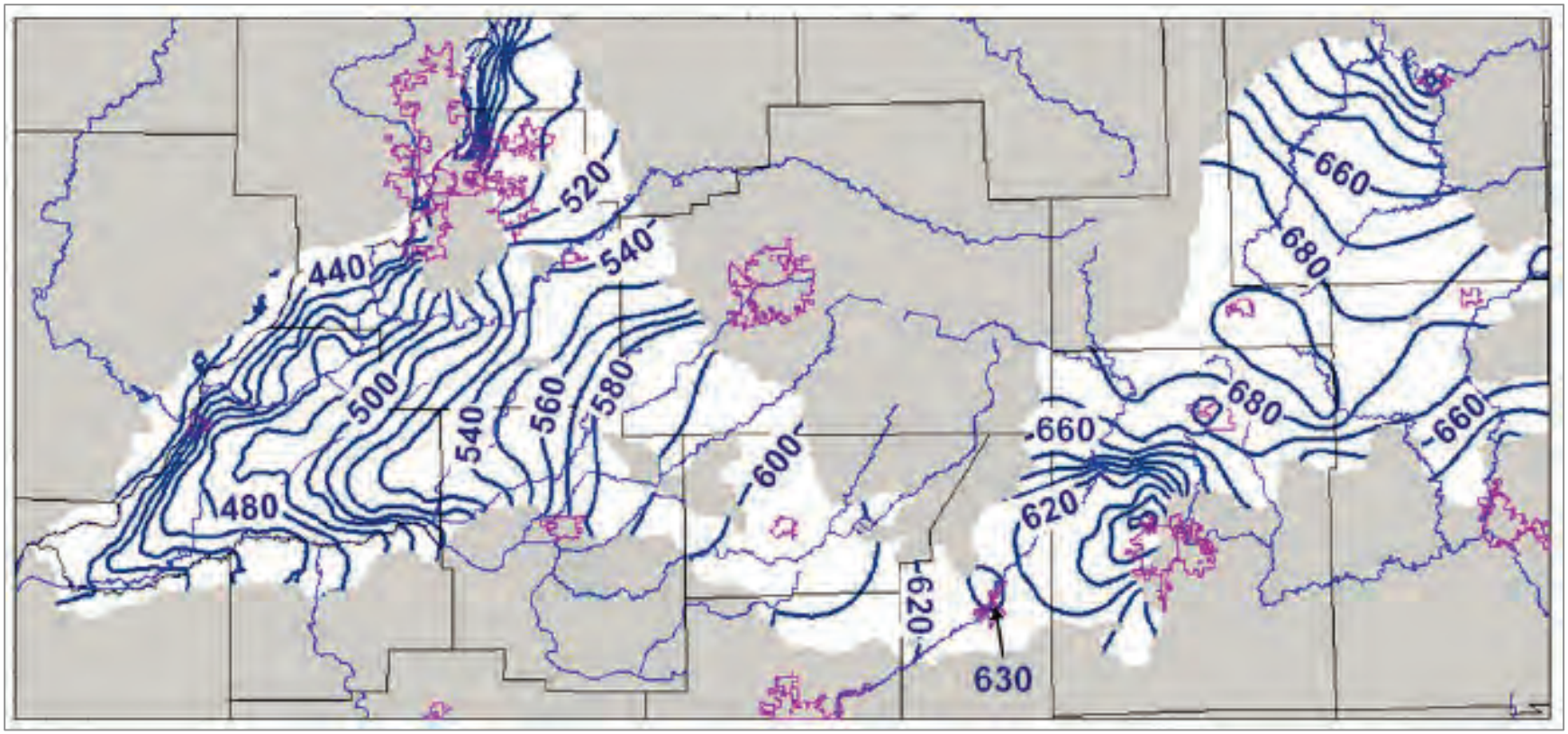

Figure 19. Composite potentiometric surface of the Mahomet Aquifer based on measurements from 1990 to 2009 (from Roadcap et al., 2011).

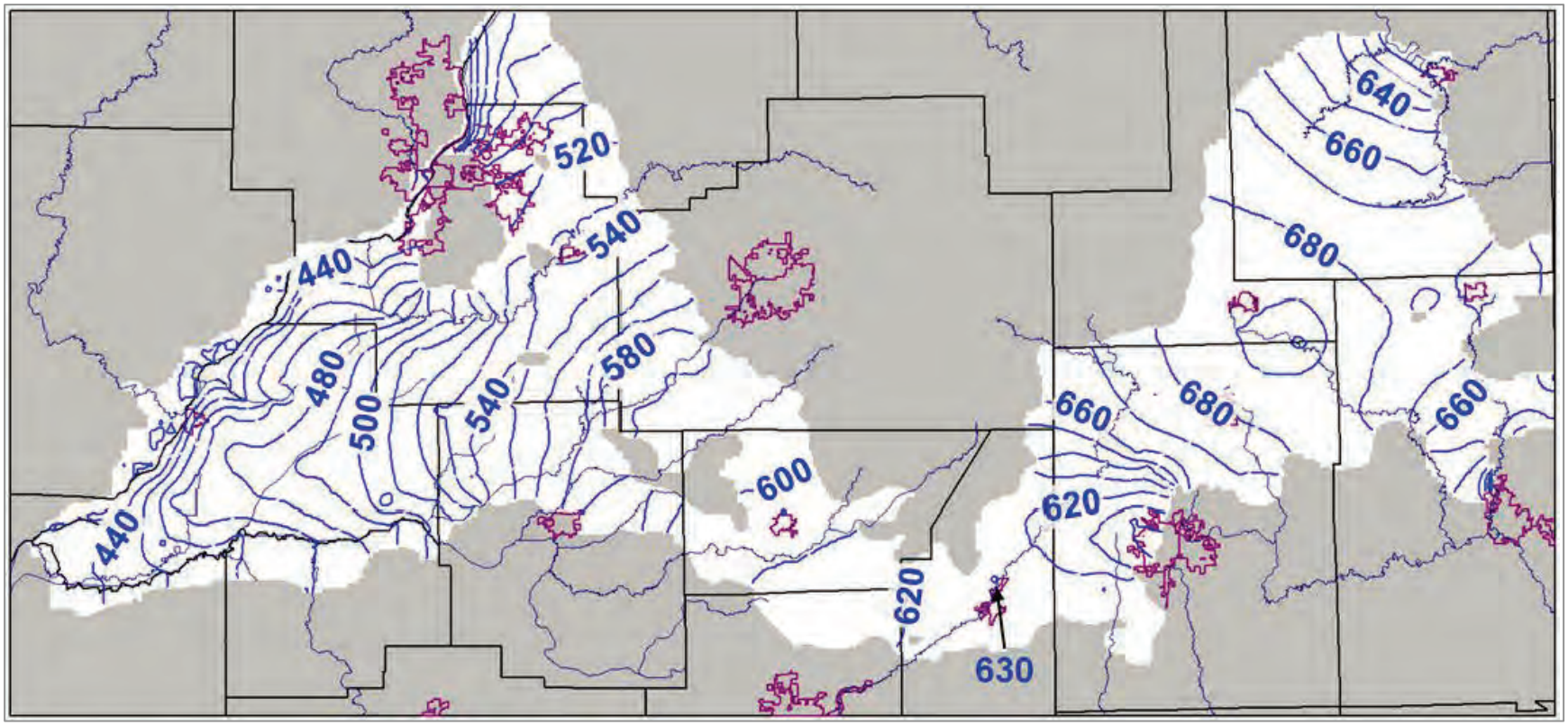

Figure 20. Potentiometric surface of the Mahomet Aquifer improved from Figure 19 using a finite difference contouring algorithm (from Roadcap et al., 2011).

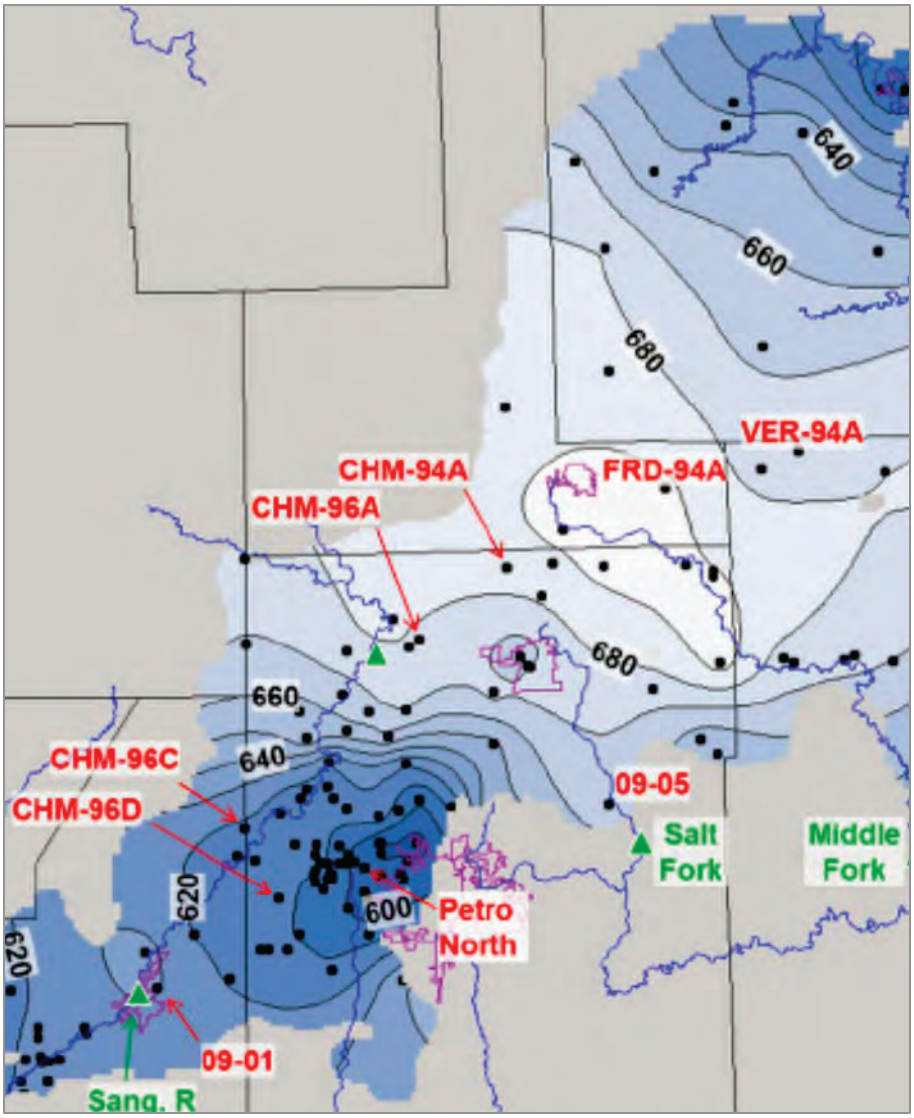

Figure 21. Potentiometric surface in the Mahomet Aquifer showing the groundwater divide due to pumping in the Champaign area (from Roadcap et al., 2011).

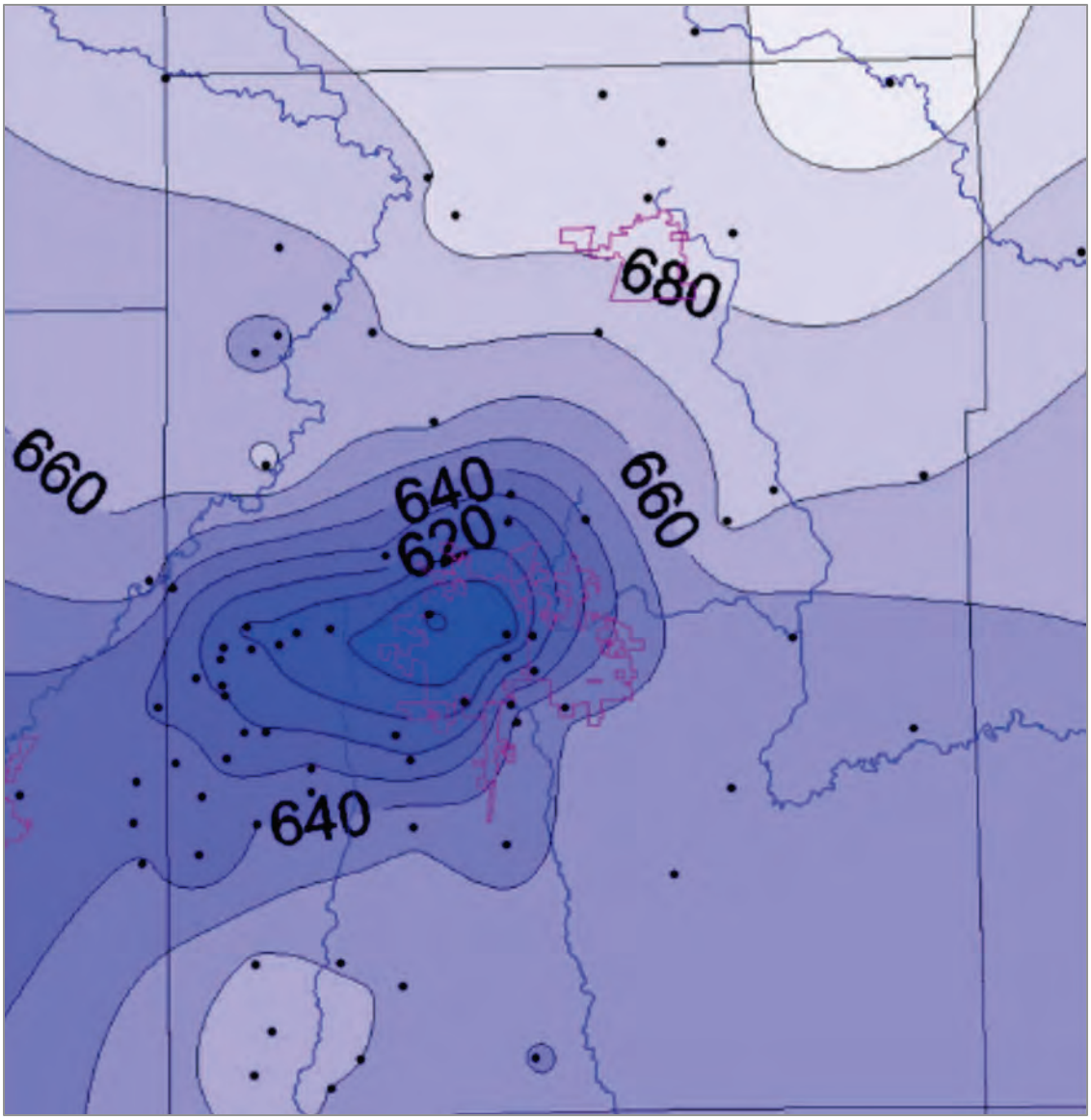

Figure 22. Potentiometric surface of the Glasford aquifer in Champaign and Piatt Counties (data points represented by black dots) (from Roadcap et al., 2011).

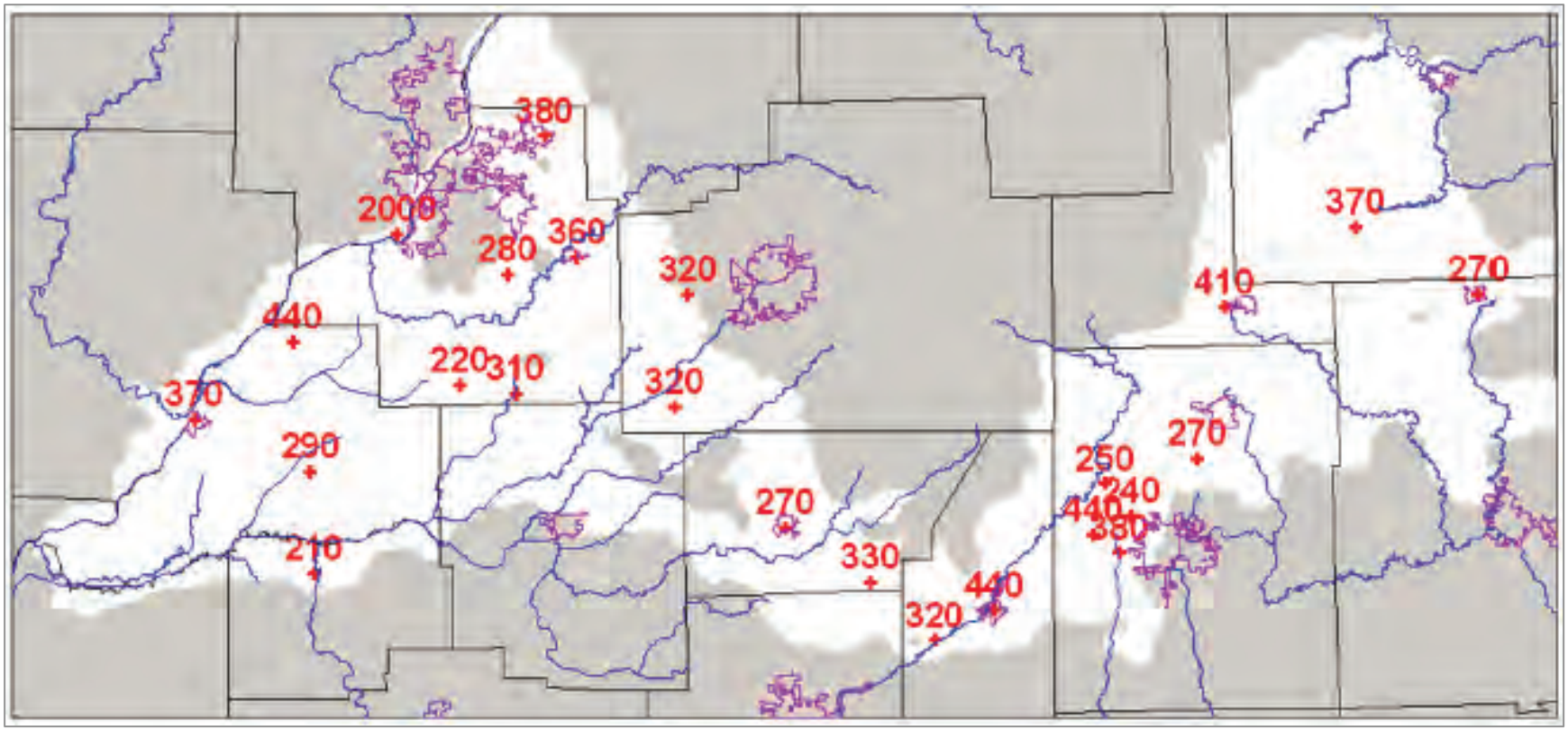

Figure 23. Mahomet Aquifer hydraulic conductivities estimated from select aquifer test data, in feet/day (from Roadcap et al. 2011).

As mentioned previously, approximately 54 million gallons of drinking water are pumped from the Mahomet Aquifer System every day. The distribution of community supply pumpage across the Mahomet Aquifer boundary is displayed in Figure 25. Far greater amounts of water are pumped to irrigate crops during the growing season. According to estimates by the Imperial Valley Water Authority, over 50 billion gallons of water were pumped in Mason and southern Tazewell counties for irrigation purposes in 2011 (over the five months in which irrigation occurred in 2011, June-October, this averages over 340 MGD). For the six-year period from 2006-2011, irrigation season withdrawals from this area averaged nearly 41 billion gallons of water, or approximately 316 Mgd during the irrigation season, or slightly over 112 Mgd if averaged across the whole year. Without the Mahomet Aquifer, row- and specialty-crop production in this area would not be possible.

A statewide map of sand and gravel well yields is presented in Figure 3. Aquifer areas with wells that can yield greater than 500 gallons per minute (gpm) are generally seen along Illinois' major modern stream systems (e.g., Mississippi, Rock, Fox, Illinois, Wabash rivers) and two ancient, buried valley systems: the Troy Valley in Boone and DeKalb counties in north-central Illinois and the Mahomet-Teays Valley in east-central Illinois. With regard to the Mahomet Aquifer, the greatest well yields (>500 gpm) are found along the central axis of the Mahomet Bedrock Valley where the aquifer is thickest and an area nearer the Illinois River where the aquifer broadens and is unconfined. Well yields in these areas actually commonly exceed 1,000 gpm. Along the flanks of this bedrock valley, where the aquifer is not as thick, well yields are diminished, but still often exceed 100 gpm and provide significant water to numerous communities.

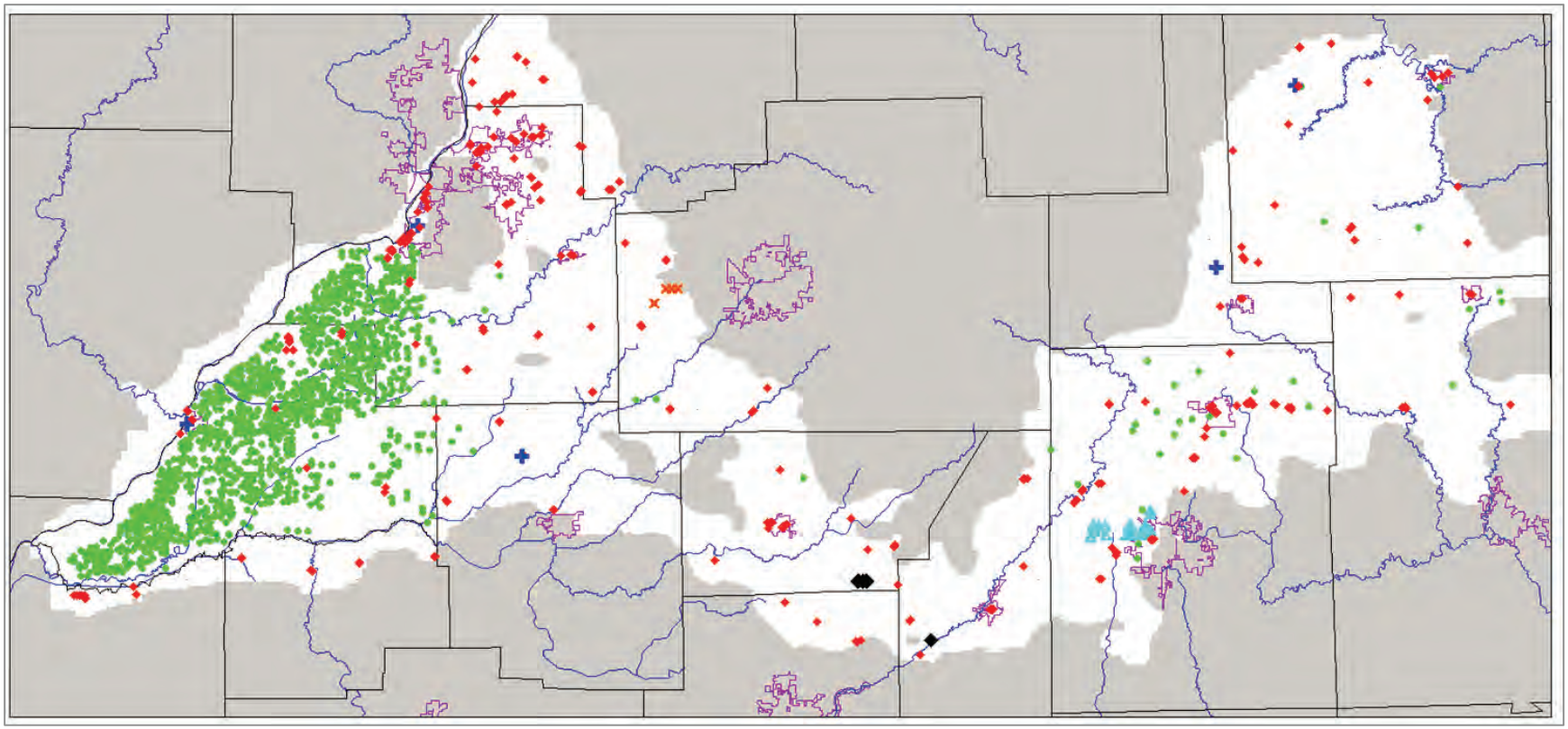

Figure 24. Distribution of high-capacity wells across the Mahomet aquifer: green dots – irrigation wells; red diamonds – public and commercial wells; orange x's – Town of Normal Mahomet wells; black diamonds – Decatur emergency wells; cyan triangles – Illinois American wells at Champaign; blue crosses – hypothetical industrial wells used for modeling potential future uses.

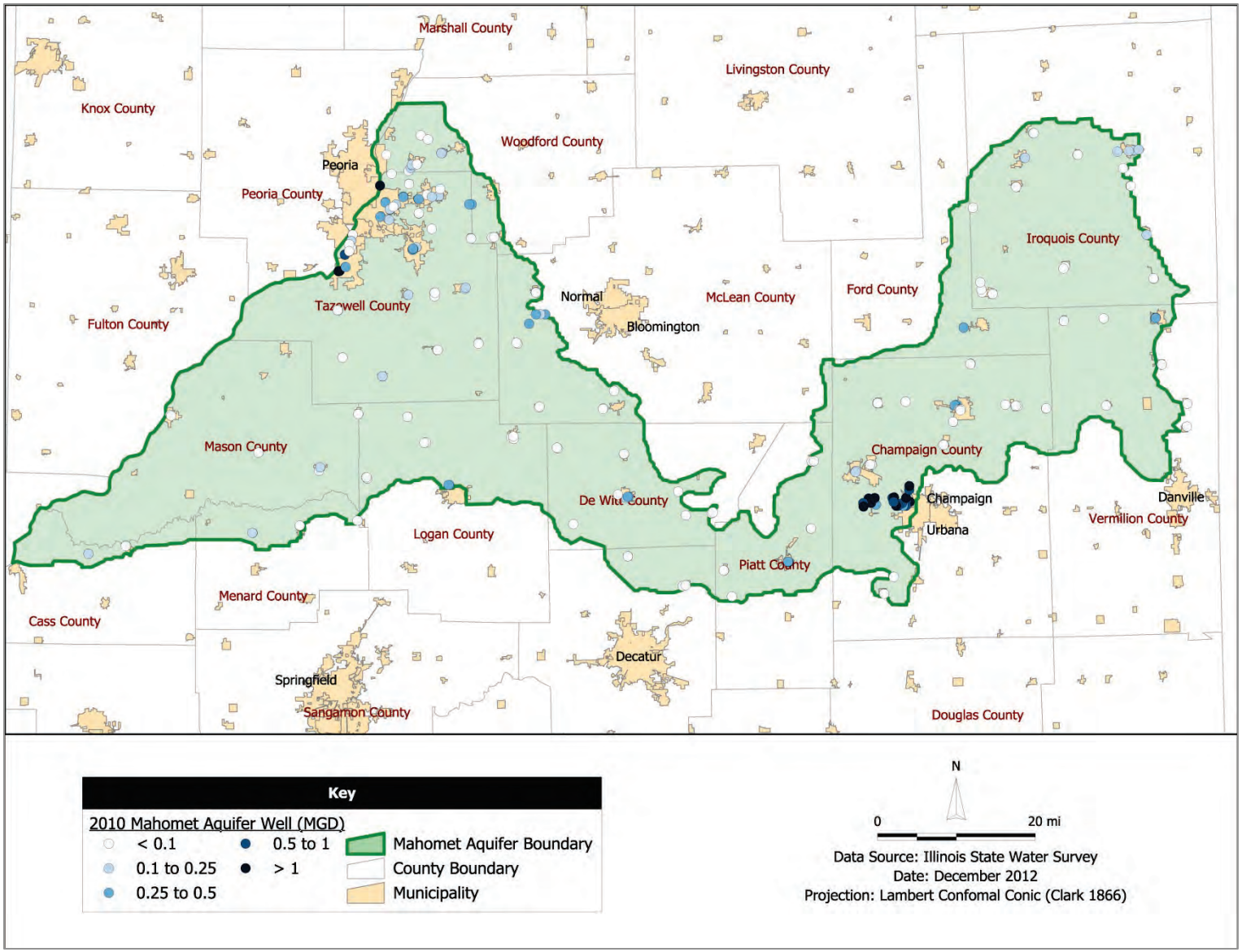

Figure 25. 2010 pumping rates for each community water supply well withdrawing from the Mahomet Aquifer system (ISWS, unpublished data).

5. Designated Area and Project Review Area

The designated area and project review area have been described previously and are one and the same for this petition. As required by the petition guidelines, a map showing the proposed boundaries of the designated area overlying a topographic map is included as Plate A. Plate B shows the petition boundary, county boundaries, major streams and lakes, cities and towns, latitude and longitude of a reference point, and an inset map.

6. Information Related to Significant Public Health Hazard

Fortunately, the Mahomet Aquifer has been spared from widespread contamination problems. Perhaps the most prevalent problem regards the presence of naturally-occurring arsenic in the Mahomet and overlying aquifers, in highly variable and unpredictable concentrations. Trace levels of herbicides and herbicide transformation products have been found infrequently in selected shallow monitoring wells and domestic wells, and in at least one community well in the highly susceptible far-western portion of the aquifer. Anthropogenic contamination, where it has occurred, has been in sensitive environments near threatening activities.

Like most glacial aquifers, the greatest risk is posed where the aquifer is shallow and protective layers of fine-grained materials are absent. This would occur over the unconfined portions of the aquifer in Mason and Tazewell Counties and, potentially, where connections to the surface occur in the confined, eastern portion of the aquifer. Unfortunately, as stated in Roadcap et al. (2011), "the interconnections between the Glasford and the Mahomet Aquifers appear to be highly variable and localized, making predictions of where they occur difficult." Limited data collection through specialized research projects has found trace levels of herbicides and herbicide transformation products in some shallow monitoring

and domestic drinking water wells. This suggests that while the aquifer is not subject to rapid contamination, avenues do exist through which transport of contaminants can potentially occur. Some of these avenues have been documented, while others remain unknown. Prevention of future contamination through due diligence and protection of the aquifer will be key for the aquifer's future.

Most of Illinois' observation wells (Figure 12) have been sampled for a variety of water quality parameters for purposes of documenting general groundwater chemistry (Wilson et al., 1998; Holm 1995; Burch, 2008), or geochemistry (Panno et al., 1994; Hackley et al., 2010). In some instances, water quality results have been used to infer recharge sources or rates (Panno et al., 1994; Roadcap et al., 2011). Results of historical IEPA analysis of community wells within the aquifer boundary area are provided as digital data only in Appendix E.

Overall, the quality can be described as very good to excellent. However, the water is hard (200+ mg/L as $CaCO_3$), relatively high in iron (≥1 mg/L), while total dissolved minerals are less than 500 mg/L. As might be expected, in the deeper, confined portions of the system, nitrate concentrations are low (<0.02 mg/L as N) while ammonia is prevalent (> 1mg/L).

Nitrate occurrence in the unconfined western portion of the aquifer is much different. Research of nitrate transport beneath an irrigated field (Kelly and Ray, 1999) found maximum nitrate-nitrogen (NO_3-N) concentrations slightly greater than 20 milligrams per liter (mg/L) in a zone 15-30 feet below the surface, well above the drinking water standard of 10 mg/L. Nitrate was generally absent below 30 feet in the aquifer, likely due to denitrification reactions. Tritium data suggest that vertical movement of solutes in the aquifer is rapid, and that there has been enough time to transport solutes from the surface or soil zone to depths in excess of 100 feet. Because drinking-water wells generally are screened well below the zone of elevated nitrate concentrations in this area, it appears that fertilizer applications do not have a negative effect on drinking-water quality for most homeowners.

Naturally-occurring arsenic also has been a particular subject of characterization (Holm, 1995; Kelly, 2005; Holm and Wilson, 2009). Concentrations exceeding the 10 µg/L drinking standard are common, and while often reduced to acceptable concentrations in public supplies that are treated, can remain high in untreated public and private wells. According to Kelly (2005), elevated arsenic concentrations (>50 µg/L) are as likely to be found in Glasford aquifers as in the underlying Mahomet. There is considerable spatial variability in arsenic, with wells relatively close together having dramatically different concentrations. Research suggests that geochemical conditions control arsenic concentrations; arsenic is low in wells with sulfate and only high in wells with no or low sulfate. Wells with high arsenic also often contain methane, high organic carbon, and ammonium.

Public water supply wells within the Mahomet Aquifer System have been sampled by the Illinois EPA (IEPA), ISWS, and USGS for a variety of regulatory, public service, and research purposes. Most historical IEPA records of raw water quality have been incorporated into the ISWS' groundwater quality database. The IEPA currently operates a statewide Community Water Supply (CWS) "Ambient Network", sampling selected community supply well raw water (i.e., not treated) for a variety of analytes, most recently focusing on volatile organic compounds. Additionally, the USGS-IL has collected samples from dozens of private, community, and dedicated observation wells for analyses of a wide range of naturally-occurring and anthropogenic constituents, including trace metals, herbicides, and wastewater compounds (e.g., Mills and McMillan, 2004; Warner, 2000). Major dissolved anions and cations form the basis for analysis; however, many additional recent sampling events (since about 2000) have included a host of organic parameters (e.g., volatile organic compounds, agricultural chemicals including degradates, and gasoline components and the additive MTBE). Of particular importance is that no organic compounds have been found in the Mahomet Aquifer IEPA CWS Ambient Network or by Mahomet Aquifer monitoring well sampling by ISWS (Holm, 1995; Wehrmann et al., 2011). However, the gasoline additive MTBE has been found in public wells serving Creve Coeur, North Pekin, and Marquette Heights located near petroleum

terminals on the Illinois River. Trace levels of atrazine, α-chlordane, and γ-chlordane were found in Creve Coeur No. 3 (Illinois Environmental Protection Agency, 2012b).

Trace levels of herbicide transformation products also have been found in the Mahomet Aquifer in private wells sampled by USGS. Possible causes for the occurrence of such compounds within the deep, confined aquifer have been speculated including a) previously unknown interconnections with shallower deposits (and hence, faster travel times to the confined aquifer) and b) well age and poor well construction methods providing interaquifer communication. These contaminants also have been found in shallow monitoring wells overlying the Mahomet, with greater frequency, possibly related to compound application rates, macropore transport, and shallow depth (Kelly Warner and William Morrow, USGS-Illinois, personal communication, 11/15/12).

The Illinois Department of Agriculture maintains a statewide pesticide monitoring network using shallow monitoring wells specifically completed in vulnerable hydrogeologic units (Mehnert et al., 2005). Several monitoring wells in the network were drilled in the unconfined western portion of the Mahomet Aquifer in Mason and Tazewell Counties (Figure 12). Similar to the findings of the USGS-IL, trace levels of herbicides and herbicide transformation products have been infrequently found in these monitoring wells (personal communication, Warren Goetsch and Dennis McKenna, IL Department of Agriculture, 11/16/2012).

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APPENDIX A – ECONOMIC ANALYSIS DATA FOR ALTERNATIVE SURFACE WATER SOURCES

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APPENDIX B – ECONOMIC ANALYSIS DATA FOR ALTERNATIVE GROUNDWATER SOURCES

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APPENDIX C – REFERENCES BY REGION

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APPENDIX D – PUBLIC WATER SUPPLY WELL INFORMATION

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APPENDIX E – DIGITAL DATA OF INFORMATION RELATED TO SIGNIFICANT PUBLIC HEALTH HAZARD

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