Including the Mahomet-Teays Aquifer System in a National Groundwater Monitoring Network

Statement of Interest

Introduction

The "Framework" document (SOGW, 2009) lays out an excellent argument for establishing a national groundwater monitoring network (NGWMN) and provides substantial insight on the components of such a network. We believe the host of groundwater level and quality data being collected by numerous state and federal agencies in Illinois and Indiana can strongly contribute to a national network. The Illinois State Water Survey (ISWS) proposes to take the lead on this Pilot Study in cooperation with several federal, state, and local entities. The ISWS and Illinois State Geological Survey (ISGS) have been collecting groundwater data on Illinois' aquifers for over 100 years. With the input and cooperation of numerous federal, state, and local entities, we are pleased to propose the Mahomet-Teays aquifer for consideration in the NGWMN initiative.

The Mahomet-Teays Aquifer

One region of water-supply concern has been a 15-county area of east-central Illinois extending eastward into Indiana. This area is largely underlain by the buried Teays bedrock valley, referenced by the USGS (Lloyd and Lyke, 1995) as containing several important surficial aquifers within the Central Lowland Province (figure 1).

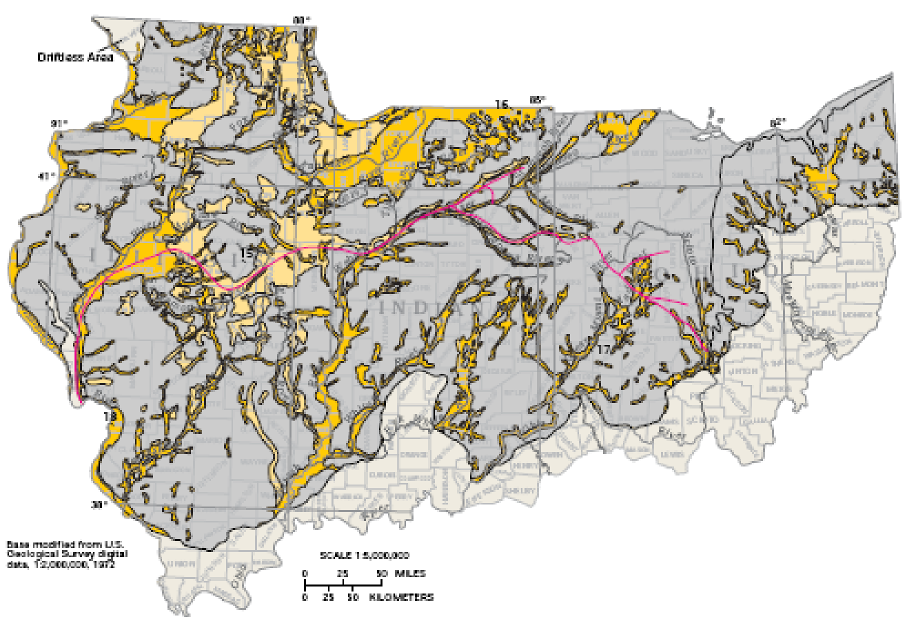

Figure 1. Aquifers in unconsolidated deposits of the Central Lowland Province (from Lloyd and Lyke, 1995). The red line traces the thalweg of Teays bedrock valley.

Known in Illinois as the Mahomet Aquifer, the aquifer occupies a portion of the Teays bedrock valley extending across east-central Illinois from the Indiana border near Hoopeston to the Illinois River near Havana (figure 2). The Mahomet Aquifer varies in thickness from a feather-edge along the valley walls to 150 feet or more along its central axis. In Illinois, the aquifer provided an estimated 220 mgd to communities, industry, agriculture, and rural wells (71 mgd of which was for municipal use). It has been the subject of numerous state and locally-funded studies in Illinois (e.g., Visocky and Schicht, 1969; Kempton et al., 1991; Holm, 1995; Wilson et al., 1998; Hollinger et al., 2000; Roadcap and Wilson, 2001; Burch, 2008) and Indiana (Bruns and Steen, 2003); a portion of the aquifer also falls within the federally-funded USGS Lower Illinois River Basin (LIRB) NAWQA study area (Warner and Schmidt, 1994). Initiation of this *Statement of Interest (SOI)* has received support from the Illinois Environmental Protection Agency (IEPA), the USGS-Illinois Water Science Center (USGS-IL), the ISGS, and the Indiana Department of Natural Resources (INDNR) and USGS-Indiana Water Science Center (USGS-IN).

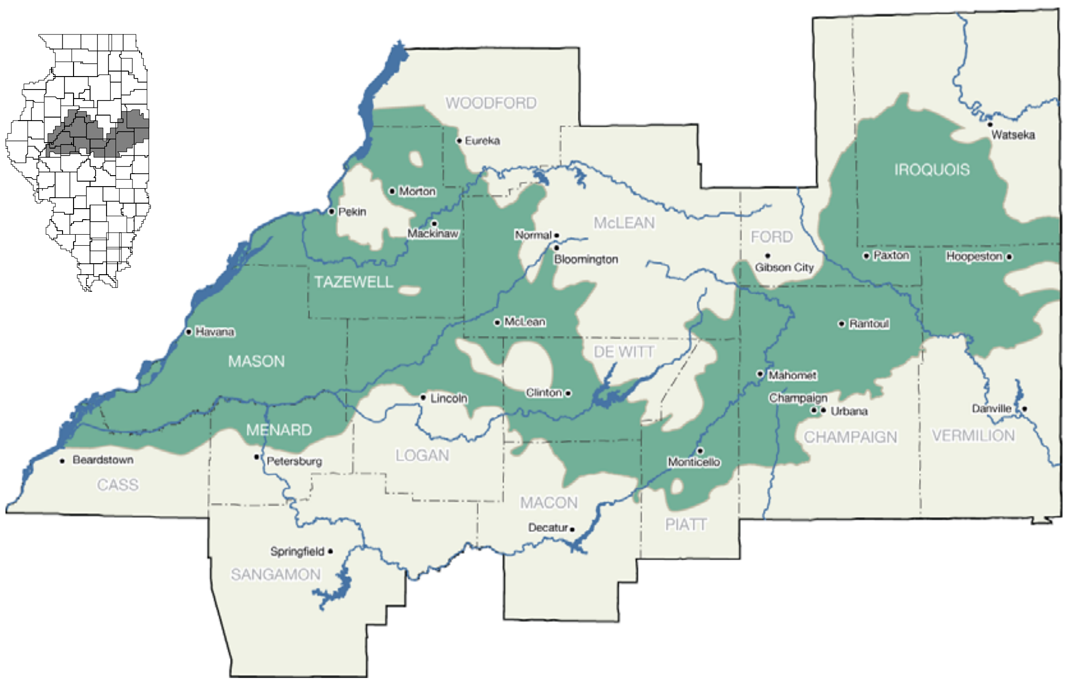

Figure 2. Mahomet Aquifer region within Illinois.

Ongoing and Historical Groundwater Data Collection

The ISWS operates an observation well "network" composed of over 180 wells at over 140 sites (figure 3), largely comprised of wells especially built for monitoring aquifer conditions (i.e., water levels and quality). Numerous sites contain "nested" observation wells to monitor the Mahomet Aquifer, overlying confined units, and the water table. Geologic records and construction details of these wells are available. Water level observations generally are collected on a monthly or quarterly basis with selected wells containing digital dataloggers polling

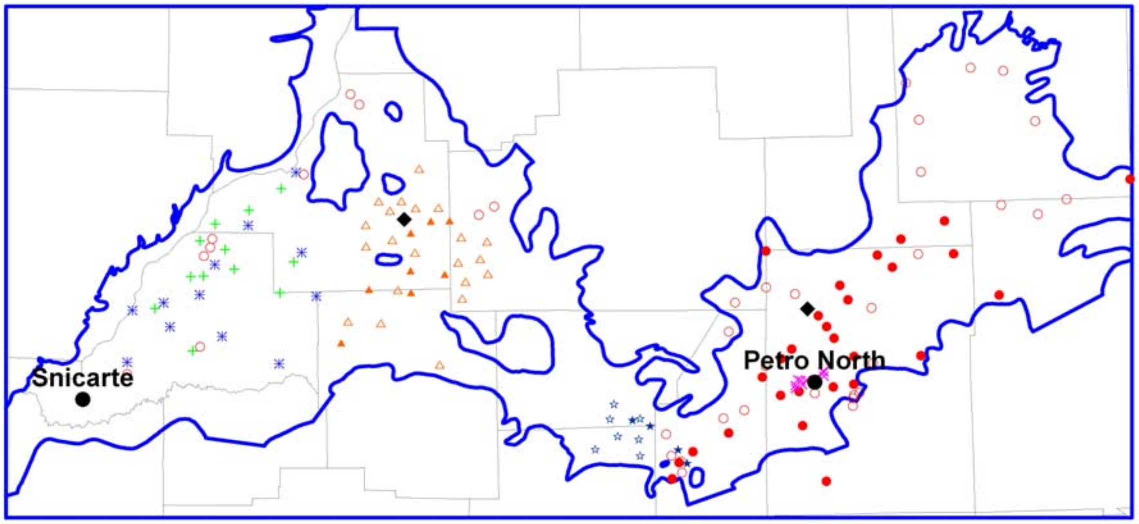

Figure 3. Mahomet Aquifer ob-wells in Illinois (see text for details, closed symbols note nested sites).

water levels as often as hourly. Numerous local and state entities fund a cooperative ISWS/ISGS drilling and monitoring effort. On the west, the Imperial Valley Water Authority has outfitted 11 wells (blue asterisks) with dataloggers 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 (brown circles) for local resource development monitoring. Just east of this area are ob-well sites (orange triangles) maintained via funding from the Long Range Water Plan Steering Committee, a coalition of local water authorities, counties, and communities. The City of Decatur maintains a set of ob-wells (blue stars) around a well field intermittently operated in times of drought to supplement their surface reservoir supply. The eastern half of the aquifer contains a host of ob-wells (red circles and magenta x's) drilled and maintained through state and private (e.g., Illinois American Water Co.) funds. Two ISWS ob-wells have a 50+ year historical record (Snicarte and Petro North), having been started in the 1950s during or after the major drought of that era.

The State of Indiana maintains three observation wells in the Teays valley and the INDNR and USGS-IN have pledged their cooperation on this *SOI*. In addition, the USGS-IL in cooperation with the ISWS will be initiating real-time groundwater level monitoring at two selected ob-well sites within the Mahomet Aquifer system (marked by black diamonds in figure 3). Data will be presented/accessed through USGS' National Water Information System Web Interface. This will complement two active sites in western Indiana maintained by the USGS-IN.

Further, most of Illinois' observation wells have been sampled for a variety of water quality parameters for purposes of documenting general groundwater chemistry (Wilson et al., 1998), and in some cases, geochemistry (Panno et al., 1994). Naturally-occurring arsenic also has been a subject of characterization (Holm, 1995; Kelly, 2005; Holm and Wilson, 2009) as has a microbiological examination of selected wells (Kirk et al., 2004). Public water supply wells have been periodically sampled by the IEPA, ISWS, and USGS-IL for a variety of regulatory, public service, and research purposes. Historical IEPA records of raw water quality have been incorporated into the ISWS' groundwater quality database. Additionally, the USGS-IL has collected samples from dozens of private supply, and observation wells for analyses of a wide range of naturally-occurring and anthropogenic constituents, including trace metals, herbicides, and wastewater compounds.

As a result of all these investigations, and given the complexity of the glacial setting, water movement into and within the aquifer is relatively well understood. Conceptual models of groundwater flow have been developed (figure 4). The eastern portion of the aquifer is confined by as much as 200 feet of glacial till; average recharge is quite low (~½ inch/year) but is greater through random sparse interconnections to shallower coarse-grained materials and streams. To the west, confining layers are absent and recharge is rapid (>12 inches/year). A three-dimensional digital groundwater flow model of the aquifer system has been created and calibrated and is undergoing constant updating as new hydrogeologic data are collected and analyzed. The model provides a very solid framework for putting observations into context of the flow system, identifying target areas for monitoring stressed and unstressed regions of the aquifer, and locating data gaps.

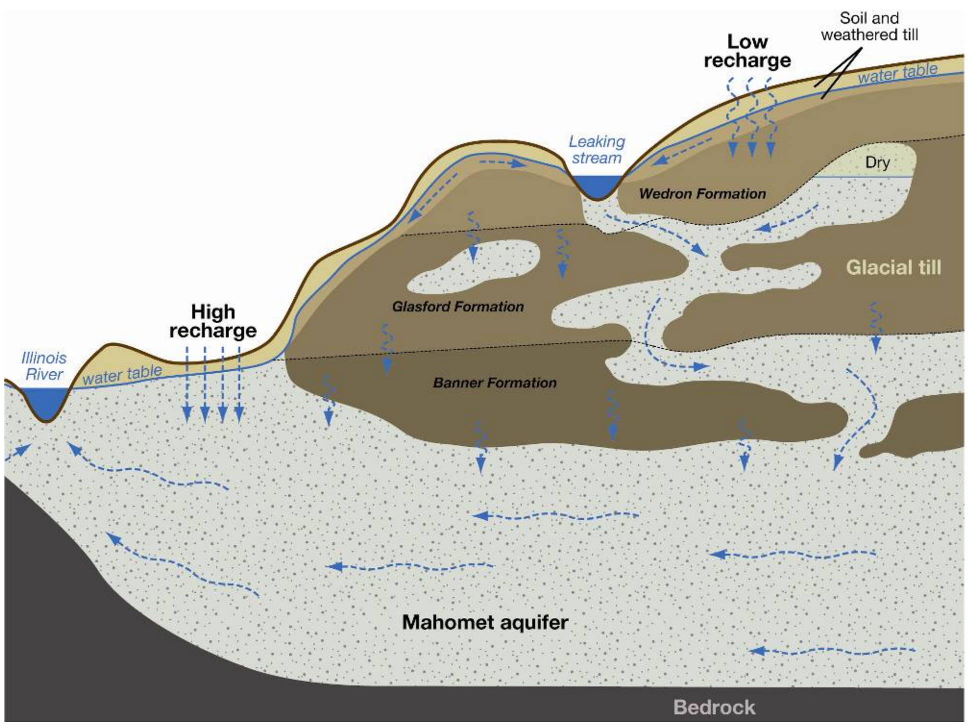

Figure 4. Conceptual framework for groundwater movement into and within the Mahomet Aquifer.

Maps of the aquifer potentiometric surface within Illinois have been completed (e.g., figure 5). Within Illinois, groundwater flow is generally down-valley from east to west discharging to the Illinois River. Discharge to other surface outlets on the eastern perimeter (Iroquois River to the northeast, Wabash River to the east, and Middle Fork Vermilion River to the southeast) also is apparent. A large cone of

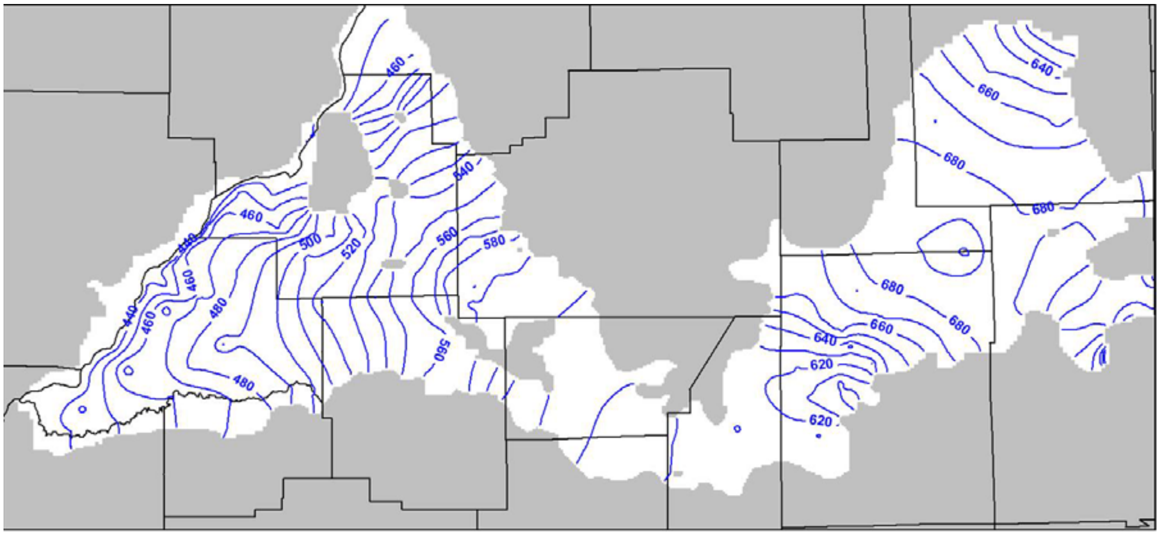

Figure 5. Potentiometric surface of the Mahomet Aquifer, July 2009 (unpublished).

depression in the Champaign area has substantially altered the natural movement of groundwater down-valley, such that a groundwater divide now exists beneath Piatt County. The preparation of this *SOI* has made it apparent that additional available data in Indiana can complement the Illinois data.

The degree of confinement, expressed via feet of available potentiometric head above the top of the Mahomet Aquifer (figure 6), along with a firm understanding of the geology and hydrogeology of the aquifer system (the aquifer and overlying units), gives credence to the conceptual model portrayed in figure 4.

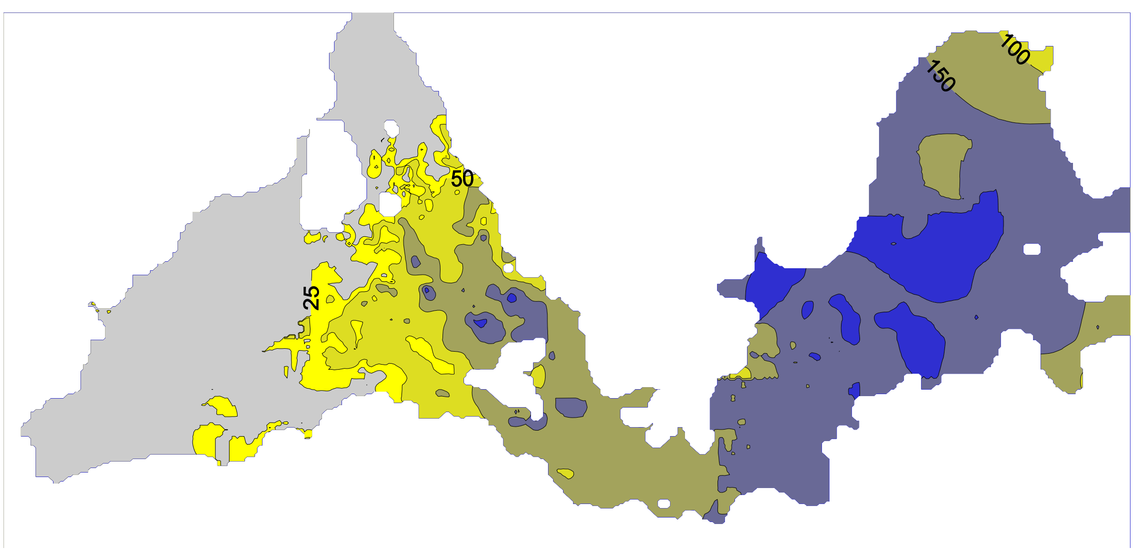

Figure 6. Available feet of potentiometric head above the top of the Mahomet Aquifer. Greatest head exceeds 200 feet (dark blue) on the eastern portion of the aquifer. The aquifer is unconfined (gray area) on the west.

Long-term hydrographs at Snicarte (figure 7) and Petro North (figure 8) identify ambient (unstressed) and targeted (stressed) aquifer regions. Although not provided in this *SOI*, additional hydrographs portray, for example, the effects of seasonal irrigation withdrawals and groundwater/stream interaction. Maintaining wells and the capacity for long-term data collection (and archival) is important for determining aquifer yield, documenting groundwater/stream interaction, identifying new areas of stress, and assessing aquifer system responses to climate change. Data gaps clearly exist where ob-wells are lacking (figure 3); the digital flow modeling process also indicates where data gaps exist especially regarding overlying inter-aquifer connections and potential groundwater/stream interactions.

Field Practices

Standard operating procedures (SOP) have been developed for hand-measurement of groundwater levels using electric dropline, steel tape, and Stevens chart-recorders. SOPs are being developed for the use of digital dataloggers, which are routinely checked with hand-measurements when data are downloaded. New procedures will be needed as more wells are outfitted with telemetry and actual field visits to wells are subsequently reduced. These guidelines will be developed with the USGS-IL, as part of their effort to expand real-time monitoring of groundwater levels in the aquifer.

SOPs also have been developed for water quality sampling and follow widely-accepted procedures for well purging and monitoring of selected purging parameters (e.g., temperature, conductivity, dissolved oxygen, pH) prior to sample collection, sample preservation, field and laboratory blanks, etc.

All field procedures can be documented.

Data Management

The ISWS maintains a groundwater database (gwdb). GWINFO is an exclusive ISWS user-interface to our Center's data, allowing quick access to groundwater data (e.g., well records, water withdrawals, water levels, and water quality). Data is available for querying, exporting, updating, and analysis. Essentially all data are related to a "point", typically a well, but possibly also a surface water intake or other x,y location. All related information is linked through a unique point identification number (called a P-number). The ISWS has considerable experience with data management issues and can provide some staff programming resources and consultation as needed (for example, in serving data or translating gwdb fields).

Only water levels from a very limited number of shallow water-table wells (http://www.isws.illinois.edu/warm/sgwdata/wells.aspx) are on the ISWS web-site. Two wells are located in the western, unconfined portion of the Mahomet Aquifer – at Snicarte and Kilbourne. Monthly data are available for Snicarte starting in 1958 (figure 7) and hourly data are available for Kilbourne starting in 2002. A host of USGS data can be found through http://wdr.water.usgs.gov/nwisgmap/ for both Illinois and Indiana. NAWQA site data for the Lower Illinois are available at http://groundwaterwatch.usgs.gov/StateMaps/IL.html. (These wells are not shown in figure 3 and contain a variety of monitoring wells, private wells, and public wells.)

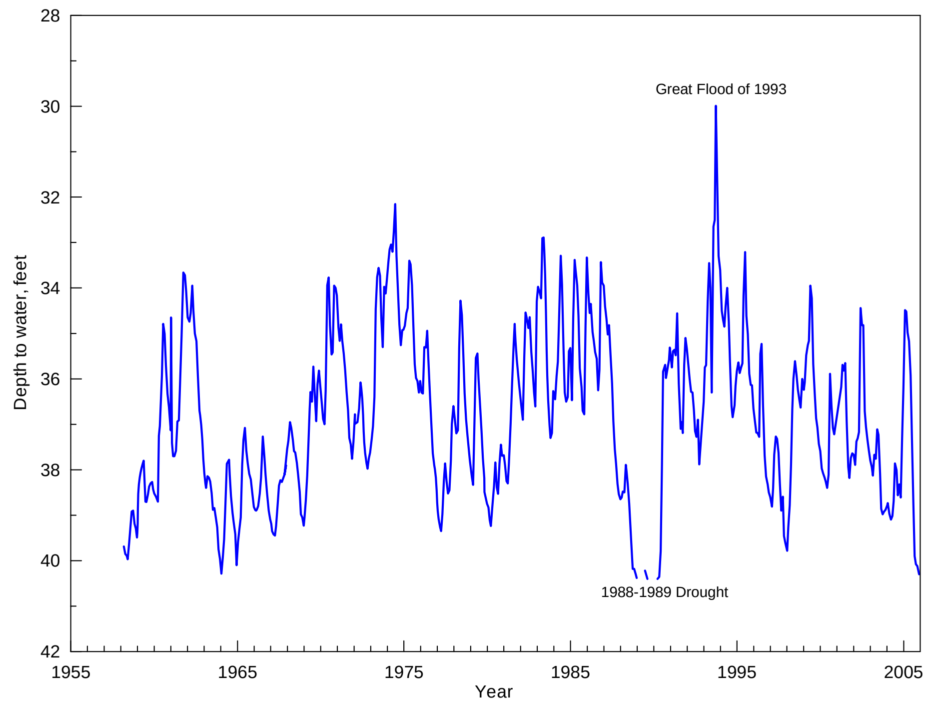

Figure 7. Long-term hydrograph near Snicarte, IL in the unconfined portion of the Mahomet Aquifer, showing a predominant response to climatic conditions even though >2000 irrigation wells have been drilled in the region over this period.

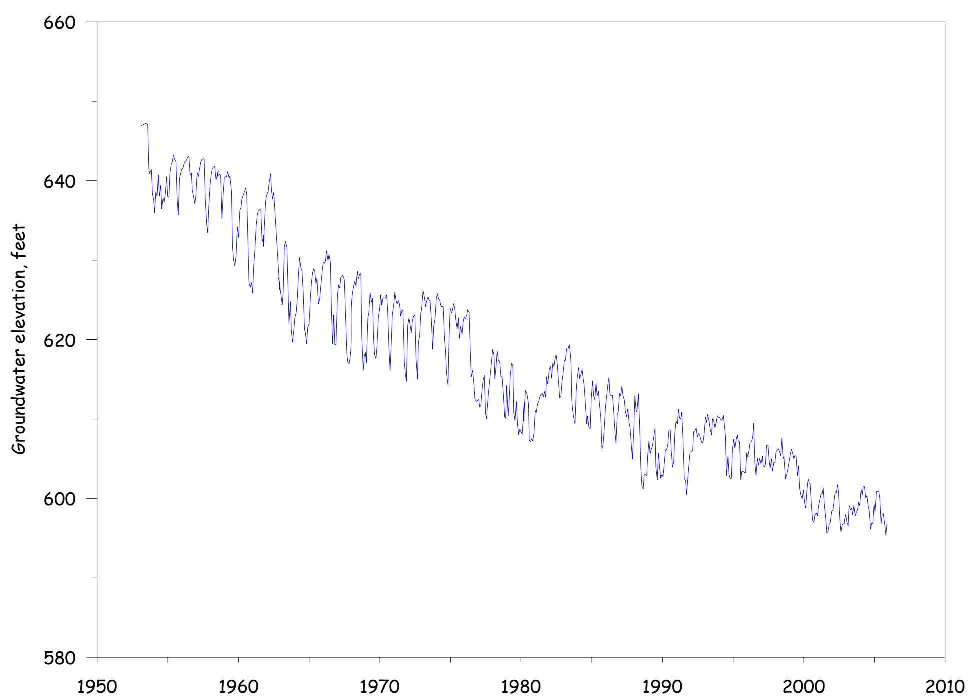

Figure 8. Long-term hydrograph at ob-well Petro North near Champaign, IL in the confined portion of Mahomet Aquifer, showing trend response to continuously increasing withdrawals.

Project Management

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Project Goals and Tasks

The principal goal of this project is to assist in the creation of recommendations for initiating a fully-realized NGWMN based on lessons-learned in our Pilot Study and in cooperation with the other Pilot coordinators and the SOGW. This means being able to assess data quality and availability in a variety of formats from a diverse set of federal/state/local entities to better understand the needs across the Nation for input to a NGWMN, and in particular, for glaciated aquifer systems such as represented by this Pilot *SOI*. In addition, the experience of the Project team will be especially useful in estimating budgets for collecting data, adding new monitoring sites, and finally archiving and accessing the data.

Coordination with Pilot team cooperators will be essential. A brief list of tasks includes:

- Identify all relevant data points and document each with regard to data type (e.g., water level, water quality and quality parameters), well type, frequency of measurement and period of record. *Timeframe: January-April*
- Determine data quality through documentation of data collection procedures and evaluating relative measuring point integrity. *Timeframe: January-April*
- Identify key monitoring points of high quality and sufficient measurement frequency for inclusion in a NGWMN, keeping in mind the site location with respect to aquifer conditions (confined, unconfined), aquifer development (stressed, unstressed, transitional), surface water interaction, and period of record (important for evaluating potential impacts of climate change). *Timeframe: May-June*
- Identify data gaps, for example, in terms of spatial resolution, aquifer characteristics (e.g., surface interaction), modeling uncertainty. *Timeframe: July*
- Estimate costs for collecting data at selected existing monitoring points, establishment of new monitoring points, data archival, and data access/ dissemination. *Timeframe: August-October*
- Provide feedback to SOGW in oral and written form. *Timeframe: November-December (for report completion). Oral and e-mail communication will occur throughout the study period).*

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