Mapping Shallow Groundwater Levels in Kane County, Illinois

Randall A. Locke II, P.G., Illinois State Water Survey, Center for Groundwater Science

INTRODUCTION

Prompted by concerns for their county's water resources, Kane County officials selected the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) to conduct a 5-year study. The multifaceted investigations were initiated in 2002 and will provide baseline water-resources data, analyses, and tools for future analyses of water resources available to the county. This poster presents selected information from the shallow groundwater mapping investigation, which is fully described in ISWS Contract Report 2007-06, *Kane County Water Resources Investigations: Final Report on Shallow Aquifer Potentiometric Surface Mapping* [1].

STUDY AREA AND WELL NETWORK

The study area (Figure 1) included Kane County and adjacent townships in surrounding counties covering a total of 1260 square miles. A network of 1010 private, public, industrial, and commercial wells (Figure 2) was developed between May 2002 and August 2003 by contacting about 6000 well owners and operators. During September and October 2003, all wells in the network were revisited as quickly as possible and groundwater-level measurements were collected. Groundwater levels, also generally referred to as *heads*, rise and fall in response to groundwater withdrawals, recharge, evaporation and transpiration. Heads often follow seasonal cycles that are most noticeable in shallow aquifers and where pumping effects do not overwhelm natural cycles. Natural declines in heads usually begin in late spring and continue throughout summer and early fall. Heads begin to rise again in late fall and peak during the spring, when groundwater recharge from rainfall and snowmelt has its greatest effect [2]. Collecting head measurements during such a brief time helped minimize data variability from seasonal water level fluctuations.

SHALLOW HYDROGEOLOGIC FRAMEWORK

Dey et al. described the geology of the uppermost bedrock and unconsolidated materials in the study area [3,4,5,6,7] (Figure 3). For ISWS Contract Report 2007-06, analyses of sand-and-gravel head data were based strictly on individual geologic units determined by textural descriptions of the deposits (i.e., lithostratigraphic units). The St. Charles, Bloomington, Valparaiso, and Kaneville Aquifers [6,7] were not used as a conceptual basis for head mapping, because they often represent total thicknesses of coarse-grained deposits across multiple lithostratigraphic units that are not necessarily hydraulically connected or fully saturated. A benefit of using a lithostratigraphic approach was that information from the mapping investigations could be more readily used for groundwater modeling purposes.

SHALLOW HYDROGEOLOGIC FRAMEWORK (continued)

In Kane County, water levels were measured in the following shallow aquifers:

- *Surficial Henry Unit*
- *Beverly Unit*
- *Yorkville Sand Unit*
- *Batestown Sand Unit*
- *Ashmore Unit*
- *Glasford Unit*
- *Shallow Bedrock Aquifer*

The shallow bedrock aquifer includes 50-100 feet of the uppermost bedrock where secondary porosity has developed [8,9,10,11] and is conceptualized as weathered rock at or near the bedrock surface rather than rocks assigned to a single lithostratigraphic unit.

WELLS AND WATER USE

ISWS records indicate there may be 15,000 or more wells in Kane County and a majority appear to be drawing water from the shallow bedrock aquifer. In addition, the ISWS Illinois Water Inventory Program has information pertaining to 52 high-capacity wells (Figure 4), which accounted for 6.6 billion gallons (bg) or 96 percent of the total 6.9 bg of reported groundwater withdrawals from the shallow aquifers in Kane County in 2003. About 5.9 bg or 89 percent of the withdrawals from high-capacity wells were from sand and gravel aquifers [1]. So, while the shallow bedrock aquifer appears to supply water to the greatest number of wells, the shallow sands and gravels may provide the greatest volume. Deeper bedrock aquifers, including the productive Ancell Group and Ironton-Galesville sandstones, were not within the scope of the groundwater mapping investigation, but have been discussed previously [12].

HEAD MAPS

A *head map* represents the pressure surface of a particular geologic unit and illustrates the elevation to which water will rise, in wells open to that geologic unit. Head maps may use *contour lines* to connect points of equal head. Groundwater follows two main rules. First, groundwater flows from high head to low head. Second, the direction of groundwater flow is perpendicular to contour lines. Using those rules, head maps are useful to illustrate groundwater flow directions. Head data were collected from seven aquifers (noted above) and were used to construct head surface maps for the Ashmore Unit, Glasford Unit, and shallow bedrock aquifers.

USE OF MAPS

Head maps can be used to characterize regional groundwater flow, identify areas of groundwater recharge and discharge, determine regional effects of groundwater withdrawals, and provide a baseline for comparison with future groundwater conditions.

Several observations can be made about the head map for the shallow bedrock aquifer (Figure 5). First, groundwater flow west of the Fox River is predominantly to the south and east. East of the Fox River, flow is to the south and west. Second, areas of relatively low head (particularly in east-central and southeastern Kane County) may reflect large withdrawals from the aquifer (Figure 4), hydraulically connected aquifers, and/or discharge to surface water bodies like the Fox River.

The maps produced for this investigation have been useful for developing a conceptual model of groundwater flow and corresponding mathematical groundwater flow models for a wide range of analyses, including aquifer development scenarios.

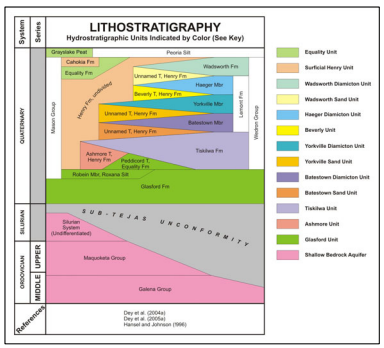

Figure 3. Shallow geologic materials in the study area.

CONCLUSIONS

An extensive effort was undertaken to assemble a network of 1010 wells to determine groundwater conditions in Kane County. These data also served as a basis to develop a conceptual model of groundwater flow and corresponding mathematical groundwater flow models. Based on the resulting maps and other data collected, the following conclusions can be made:

- At least seven shallow aquifers are used for water supply in Kane County. The most laterally continuous is the shallow bedrock, but the most productive units appear to be sand-and-gravel deposits.
- In 2003, 52 high-capacity wells accounted for 6.6 billion gallons or 96 percent of the total reported groundwater withdrawals of 6.9 billion gallons from the shallow aquifers in Kane County.
- Head data were of sufficient density to construct head maps for three aquifers: the Ashmore Unit, Glasford Unit, and shallow bedrock.
- The head maps have multiple uses. They can characterize regional groundwater flow, identify areas of groundwater recharge and discharge, determine regional effects of groundwater withdrawals, and act as a baseline for comparison with future groundwater conditions.
- Groundwater flow west of the Fox River is mostly south and east. East of the Fox River, flow is mostly south and west.
- Areas of relatively low head (particularly in east-central and southeastern Kane County) may reflect large withdrawals from the aquifer, hydraulically connected aquifers, and/or discharge to surface water bodies like the Fox River.
- Previous nomenclature for aquifers of Kane County (i.e., Valparaiso, Kaneville, Bloomington, and St. Charles) may need to be further assessed for its ability to accurately represent hydraulic connections between coarse-grained lithostratigraphic units.

REFERENCES

1. Locke, R.A., II, and S.C. Meyer. 2007. *Kane County Water Resources Investigations: Final Report on Shallow Aquifer Potentiometric Surface Mapping*. Illinois State Water Survey Contract Report 2007-06, Champaign, IL.
2. Visocky, A.P., and R.J. Schicht. 1969. Groundwater Resources of the Buried Mahomet Bedrock Valley. Illinois State Water Survey Report of Investigation 62, Champaign, IL.
3. Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving. 2004a. Kane County Water Resources Investigations: Interim Report on Geologic Investigations. Illinois State Geological Survey Open File Series 2004-9, Champaign, IL.
4. Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving. 2004b. Preliminary Bedrock Geology Map, Kane County, Illinois. Illinois State Geological Survey Illinois Preliminary Geologic Map IPGM Kane-BG, Champaign, IL.
5. Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving. 2004c. Preliminary Geologic Cross-sections, Kane County, Illinois. Illinois State Geological Survey Illinois Preliminary Geologic Map IPGM Kane-CS, Champaign, IL.
6. Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving. 2004d. Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois. Illinois State Geological Survey Illinois Preliminary Geologic Map IPGM Kane-QA, Champaign, IL.
7. Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving. 2005. Kane County Water Resources Investigations: Interim Report on Three-Dimensional Geological Modeling. Illinois State Geological Survey Open File Series 2005-6, Champaign, IL.
8. Bergeron, M.P. 1981. Effect of Irrigation Pumping on the Ground-Water System in Newton and Jasper Counties, Indiana. U.S. Geological Survey Water-Resources Investigations Report 81-38, Urbana, IL.
9. Graese. A.M., R.A. Bauer, B.B. Curry, R.C. Vaiden, W.G. Dixon, Jr., and J.P. Kempton. 1988. Geological-Geotechnical Studies for Siting the Superconducting Super Collider in Illinois: Regional Summary. Illinois State Geological Survey Environmental Geology Notes 123, Champaign, IL.
10. Visocky, A.P., and M.K. Schulmeister. 1988. Ground-Water Investigations for Siting the Superconducting Super Collider in Northeastern Illinois. Illinois State Water Survey Circular 170, Champaign, IL.
11. Kay, R.T., and K.A. Kraske. 1996. Ground-Water Levels in Aquifers Used for Residential Supply, Campton Township, Kane County, Illinois. U.S. Geological Survey Water-Resources Investigations Report 96-4009, Urbana, IL.
12. Burch, S.L. 2002. A Comparison of Potentiometric Surfaces for the Cambrian-Ordovician Aquifers of Northeastern Illinois, 1995 and 2000. Illinois State Water Survey Data/Case Study 2002-02, Champaign, IL.

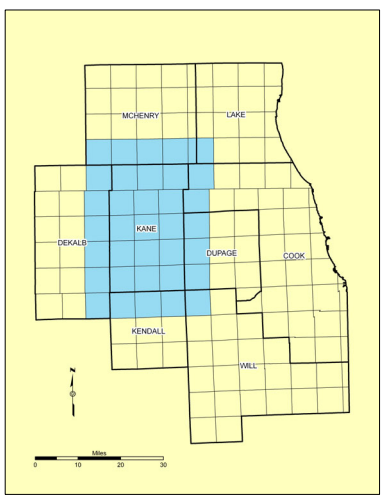

Figure 1. Study Area

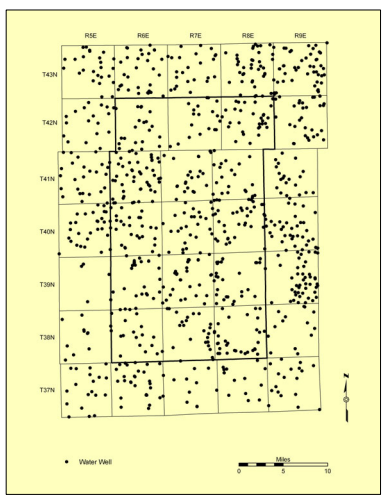

Figure 2. Well Network

Above: Scott Meyer measures a municipal well while the operator watches. **Below:** Mark Anliker and Noe Velazquez survey and collect information about a domestic well.

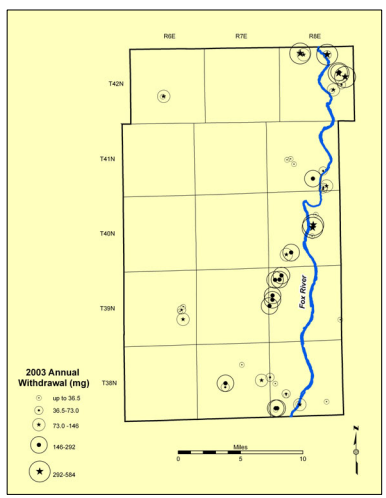

Figure 4. High-capacity wells in Kane County

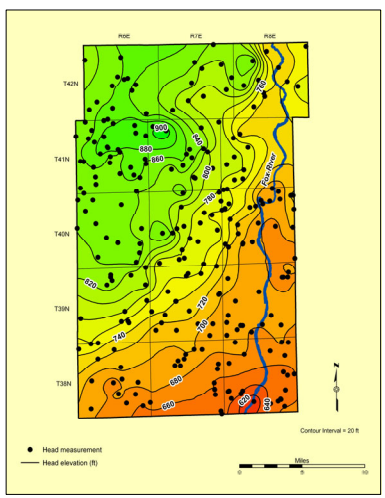

Figure 5. Shallow bedrock aquifer head surface