ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois State Water Survey

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SWS

April 3, 2007

Mr. Barry Suits, P.E.
Network Operations Manager
Illinois American Water Company
201 Devonshire Drive
Champaign, IL 61820

RE: Review of WHPA report, *Modeling a New Well Field for Champaign-Urbana*

Dear Mr. Suits:

This letter comprises our review of the report "*Modeling a New Well Field for Champaign-Urbana*", dated November 27, 2006, and prepared by Wittman Hydro Planning Associates, Inc. As such, this fulfills Task 3c in Grant C7702 between Illinois-American Water Company (IAWC) and the University of Illinois at Champaign/Urbana.

GENERAL COMMENTS

This report describes an analysis "to evaluate the sustainable yield of the Mahomet Aquifer and consider the long-term impacts of a new wellfield located several miles west of the municipality [of Champaign-Urbana]." Although an objective of the report is to describe sustainable yield, the term is not defined.

The report concludes that "the sustainability of Champaign/Urbana public water supply [out to 2040] will be determined by the combined water use in the region." We concur with this statement and are pleased to see that the first part of the report provides a regional water demand analysis. This projects increases in water withdrawals in many parts of the aquifer, even though recent increases in water demand for ethanol plants are not included specifically. However, we are disappointed that the water demand projections apparently were not used in any modeling scenarios to determine the sustainable yield and the impacts of a new IAWC wellfield. In fact, projected growth by "Other Wells", i.e., non-IAWC wells, within the model domain was kept a constant 18.6 million gallons per day (MGD) throughout the steady-state simulations. We believe that 18.6 MGD withdrawals by other wells is far too high, and that no increased withdrawals from other wells is not reasonable. So it begs the questions as to why the regional water demand analysis is included in the report and whether the Champaign/Urbana public water supply would be determined to be sustainable if, as seems highly likely, there are additional industrial (e.g., ethanol plant related), agricultural, and public and domestic water withdrawals in the area.

Recharge rates are important in any study of sustainable yield, but we believe, in general, that the recharge rates used in the model are too high, too spatially variable, and change too much with increasing pumpage. The effects of the high recharge rate are offset for the 2004 scenario by applying an unrealistically high scale factor of 1.65 to the pumpage. This problem may make the predictions for the worst-case scenario more likely than the predictions from the calibrated model scenario.

We have gained many insights on the Mahomet Aquifer from the WHPA model. For example, there can be multiple hypotheses for how recharge enters the aquifer (constant flux vs. head-dependent flux in the model). However, these hypotheses may result in different predictions for the same past or future pumping scenarios. As the state of our knowledge stands now, we simply do not have enough information about the overlying Glasford sands to determine how the interaction between the Glasford and the Mahomet aquifers influences recharge. Based on what we see in the modeling portion of the report and in the some of the statements in the conclusions, we believe this information is vital to making predictions on the impacts of a new wellfield with any certainty. The WHPA model also shows some significant dewatering in the Glasford sands, indicating that future modeling should be done as transient simulations and not as a series of steady-state simulations.

Specific Comments:

Task 1 – Regional Groundwater Demand Analysis

1. The report is inconsistent on what planning is being used. The demand projections for the Champaign Operation were carried out only to the year 2016, however, the planning scenarios used to assess the viability and impact of the new wellfield went out as far as 2040. The estimated future use given in 2040 impact scenario shows a net increase of 16 MGD but with a total use of 51.1 MGD (p.86), a value that is 27.8 MGD greater than the estimated 2006 pumpage (p. 9). The report also uses the estimates of future regional water use based on the SIU report (Dzielgielewski *et al*., 2005), which only go out to 2025. All of the timelines should be consistent for evaluation purposes.

2. Commercial and industrial pumpage is projected in the report to slowly decrease in Champaign County. Given that The Andersons is likely to operate a ~2 MGD ethanol plant just north of Well 59, that the City of Decatur operates a drought-emergency 15 MGD well field near Argenta, and there are various proposals to pump Mahomet Aquifer water to Tuscola from industrial wells along Route 10 near Bondville, it would seem necessary to anticipate these new demands for modeling purposes. Further, it is unclear how the SIUC data were manipulated to create the numbers shown in Table 11 (page 29).

3. We believe water use from the Glasford Aquifer needs to be included explicitly or lumped with Mahomet Aquifer in the water demand forecasts. The two correction factors (% of county overlying the Mahomet and % withdrawal from the Mahomet Aquifer vs. the Glasford Aquifer) applied to some of the future water use may cause an unrealistic lowering of the SIUC projections. In Mason County, for example, the

Mahomet/Glasford use factor lowered the projected irrigation withdrawal by 25% (10 MGD), even though the Mahomet Aquifer is the sole aquifer in the county. In the other counties any large-capacity wells are going to be preferentially located over the Mahomet Aquifer to get sufficient water to operate.

Task 2 – Aquifer Characterization and Available Data

1. The report mentions the Sangamon River but does not include it specifically in the model. Our studies show a segment of this stream to be a very important, but potentially limited, recharge boundary for the Mahomet Aquifer which will have significant implications on modeling results.

2. Regarding discussions on page 43, a significant amount of research on recharge rates has taken place since the work by Walton (1965). As the complexity of the aquifer systems are better defined, estimated recharge rates have decreased. Please see the discussion of recharge rates in ISWS/ISGS Cooperative Groundwater Report 19.

Task 3 – Groundwater Flow Modeling

1. Evaluation of the model was made difficult by the lack of any statistical analysis of the errors between the field-measured water level data and the model predictions. The standard statistics used to assess the error in the model calibration, such as those suggested by Anderson and Woessner (2002), need to be provided in the report. What is the root mean error and what level of error would be deemed acceptable? The error at some critical points is too high, such as at the Seymour observation well where the calculated water level is 12 feet higher than the observed water level. For figure 28, there is no legend explaining the different symbols used.

2. We disagree that the placement of river cells (head-dependent flux boundaries) at the surface of the model to represent the water table in the Glasford Aquifer may be the "conceptually more honest" (p. 52) approach to representing recharge. The cells act to keep the head in the aquifer within 10 feet of the land surface and allows for additional recharge to occur as the head in an aquifer drops with additional pumpage. However, the depths to water in Glasford wells near Champaign are over 100 feet, suggesting by this conceptualization that recharge rates already are at a maximum. The actual water table near Champaign occurs in the surficial tills overlying the Glasford sands, thus the recharge rate should be controlled by the permeability of the till and the vertical gradient across it.

3. In a model, the head-dependent flow boundaries often produce unpredictable and unintended results. To adequately review how the recharge boundary behaves, we reran the model to examine the flow budgets. The MODFLOW model files were imported into the pre/post-processing software package Groundwater Vistas. The distribution of recharge produced by the model in a non-pumping scenario was very uneven. The heads in many of the cells were above land surface (negative recharge) while in other cells the head was below the assigned river bottom (10' below land surface). In the

latter case the recharge provided by the river cell reached a maximum of 1.35 in/yr. With increased pumpage some model cells may change from having a negative recharge rate of -1.35 in/yr to a positive recharge rate of 1.35 in/yr, a net gain of 2.7 in/yr. Without proper justification, we believe widely varying and changing recharge rates may be unwarranted given that water levels in Glasford sands are 40 to 140 feet below land surface (not 10 feet as modeled).

4. As expected, the modeled net recharge rate to layer 1 increases linearly with increasing pumpage, from 0.12 in/yr at 0 MGD to 0.50 in/yr at 53 MGD and to 0.63 in/yr at 69 MGD. As the pumpage increases, the number of river cells providing the maximum recharge rate also increases. Because the drawdown in Layer 1 is almost identical to the drawdown in Layer 3, the distribution of river cells reaching the maximum recharge rate is coincident with the growth of the cone of depression. This phenomenon acts to limit the growth of the cone of depression and is the likely reason the pumpage had to be scaled up by a factor of 1.65 to match the observed cone. By the time the pumpage reaches 69 MGD, most of the river cells overlaying the active portion of Layer 3 (Mahomet Aquifer) have reached the maximum recharge rate. The water for any additional pumpage beyond 69 MGD will have to come largely from horizontal flow in the Glasford Aquifer sands that extend beyond the lateral limit of the Mahomet Aquifer.

5. We believe that the 65% increase in pumpage resulting from the PEST model calibration procedure is unreasonable. While we concede that our groundwater withdrawal figures may not represent 100% of all users, we doubt our pumpage figures for the Champaign area are off by 65% - 13 MGD in unaccounted for industrial and irrigation pumpage seems like quite a bit. Unfortunately, this seems to be a way to make up for a recharge rate that is too high. In addition, an extra 65% (13 MGD) does not appear in the discharge flux to area streams. The water levels used for the model calibration were collected in September and October, long after the peak summer pumping period. We suggest calibrating the model with a fixed pumping rate.

6. Because the net recharge rate to the Mahomet Aquifer is much higher under the active portion of Layer 1 than the rest of the model area (0.25 in/yr), a greater amount of groundwater appears to be flowing from Piatt County to the west than is supported by our water level data. For example, the modeled head loss across DeWitt County is approximately 60 feet while the measured value actually is less than 20 feet.

7. Stretches of the Sangamon and Vermilion Rivers are known sources of recharge and need to be in the model explicitly. Leakage from these rivers will lower the amount of recharge calculated in the model for Champaign County. Without the interaction with the Sangamon River, we believe the model cannot accurately represent water levels and the spread of the cone of depression to the west of the potential new wellfield.

Task 4 - New Wellfield Evaluation and Estimates of Impact

1. For the well interference assessment it states that logs of wells within 2-3 miles of the search area for the new wellfield were reviewed. The model suggests drawdowns extend 20 – 30 miles. It is not clear why the review was restricted to 2-3 miles of the search area. What is the justification for placing a cutoff for consideration of interference effects at drawdown exceeding twice the annual variation?

2. As acknowledged in the report, the study does not address the potential impacts of the Decatur wellfield on the aquifer, especially during a severe drought when it may be operated for many months and the Sangamon River has dried up. Decatur's DeWitt wellfield was constructed in 1990 in response to the drought of 1988 when the Sangamon River went dry. When a similar drought reoccurs, the impacts of the DeWitt wellfield may be large.

3. The development scenarios do not include increases in other public water systems such as Mahomet or Rantoul. Nor does there appear to be an analysis of future withdrawals from the Glasford Aquifer, or analysis of the effects on the Glasford or the rivers of additional withdrawals from the Mahomet Aquifer. These need to be evaluated for a comprehensive analysis of the future of the aquifers and streamflows in east central Illinois.

4. Concerns with the calibration of the model carry over to the development scenarios. Because the calibrated model used 2004 pumping rates that are 65% higher than the best estimates of the actual pumpage, the additional 16 MGD of pumpage from the new wellfield is disproportionately smaller (30% of 53.7 MGD vs. 49% of 32.5 MGD). Because drawdown is linearly related to pumpage, the increase in drawdown predicted by the model will be only 65% of the expected increase in drawdown. Therefore, the drawdown predicted for the worst-case parameter set shown on Table 22 and Figure 34 may be more likely than the predicted drawdown for the calibrated parameter set.

Please feel free to contact regarding any questions or comments,

Best regards,

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References

Wilson, S.D., G.S. Roadcap and others. 1998. **Hydrogeology and Groundwater Availability in Southwest McLean and Southeast Tazewell Counties. Part 2. Aquifer Modeling and Final Report.** ISWS and ISGS Cooperative Groundwater 19.

Anderson, M.P., and W.W. Woessner. 2002. **Applied Groundwater Modeling Simulation of Flow and Advective Transport.** Academic Press, San Diego.

Walton, W.C.1965. **Ground-water Recharge and Runoff in Illinois.** ISWS RI 48.