ILLINOIS STATE WATER SURVEY
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Fact Sheet 2 from Contract Report 2015-02

Groundwater Availability in Northeastern Illinois from Deep Sandstone Aquifers

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Desaturation of sandstone

Many communities in the western suburbs of Chicago currently obtain water from deep Cambrian-Ordovician sandstone aquifers. These aquifers are generally covered by 100-800 ft of low permeable material (aquitards), which impedes the ability of rain water to infiltrate into the aquifers. As a result, it can take decades to replenish water withdrawn from these aquifers. In parts of the region, demands for deep groundwater have been high, causing water levels (also known as heads) to decrease substantially. This has created a risk of desaturation of the sandstone aquifers. See Contract Report 2015-02 for more detailed results and discussion (Abrams et al. 2015).

Partial desaturation of sandstone can threaten its viability as an aquifer, and hence its availability as a water supply (Roadcap et al. 2013). Partial desaturation occurs when the head falls below the top of the aquifer, and pore spaces become dewatered in response to withdrawals. There are at least four potential negative outcomes of desaturating aquifers (Figure 1).

1) Small-capacity wells penetrating the upper portion of the sandstone may go dry.
2) Wells will likely produce less water and additional wells may be needed to meet demand.
3) Desaturated sandstone will be exposed to oxygen, which alters the water chemistry, with potentially negative effects.
4) If heads decrease enough, the entire aquifer can become completely desaturated and unusable.

Historically, desaturation of the uppermost sandstone (the St. Peter) was observed in Cook and DuPage counties during the 1980s at the height of groundwater pumping. Heads have partially recovered in these counties as communities switched to Lake Michigan water, as seen in Figure 2a. Other areas have avoided further desaturation by supplementing groundwater withdrawals with alternate sources of water, such as the Fox and Des Plaines Rivers (Figure 2b). However, desaturation continues outside of these areas, such as in Will County, where communities predominantly rely on sandstone aquifers for their water supply (Figure 2c).

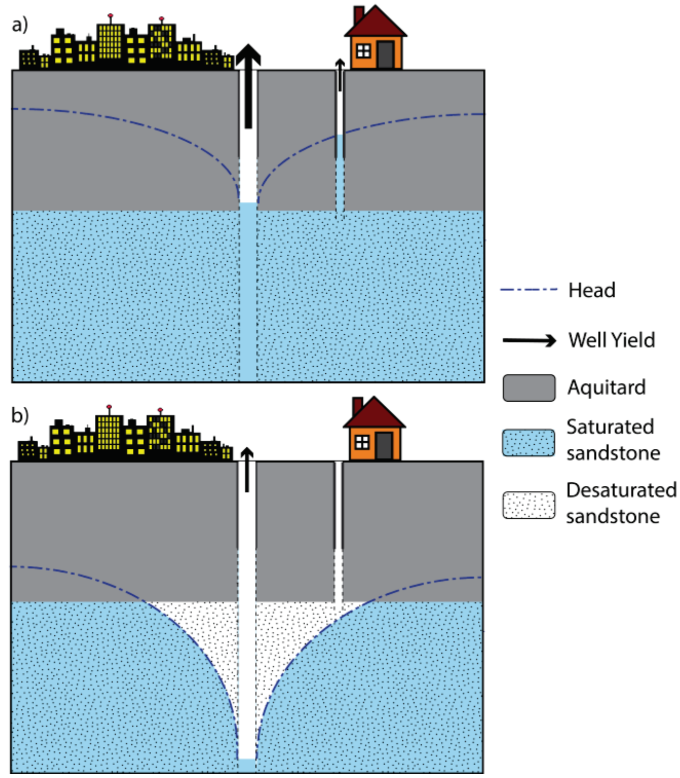

Figure 1: a) Completely saturated sandstone and b) partially desaturated sandstone.

Risk of desaturation

In 2014, the Illinois State Water Survey (ISWS) conducted their largest synoptic measurement of deep sandstone heads in 34 years. Heads were found to have decreased in many portions of Illinois, falling below the top of the sandstone aquifers in some areas. The results from this measurement were used to generate maps depicting risk of desaturation for 2014 and for several future simulations. The risk zones are categorized as:

- **Partial desaturation under pumping conditions**
- **Partial desaturation under non-pumping conditions**
- **Complete desaturation**

It should be noted that partial or complete desaturation may not be observed at every well within a risk zone. Observed desaturation will be contingent on well construction (i.e., casing and total depth) and pumping from nearby wells. Also note that under pumping, desaturation may be more severe than depicted.

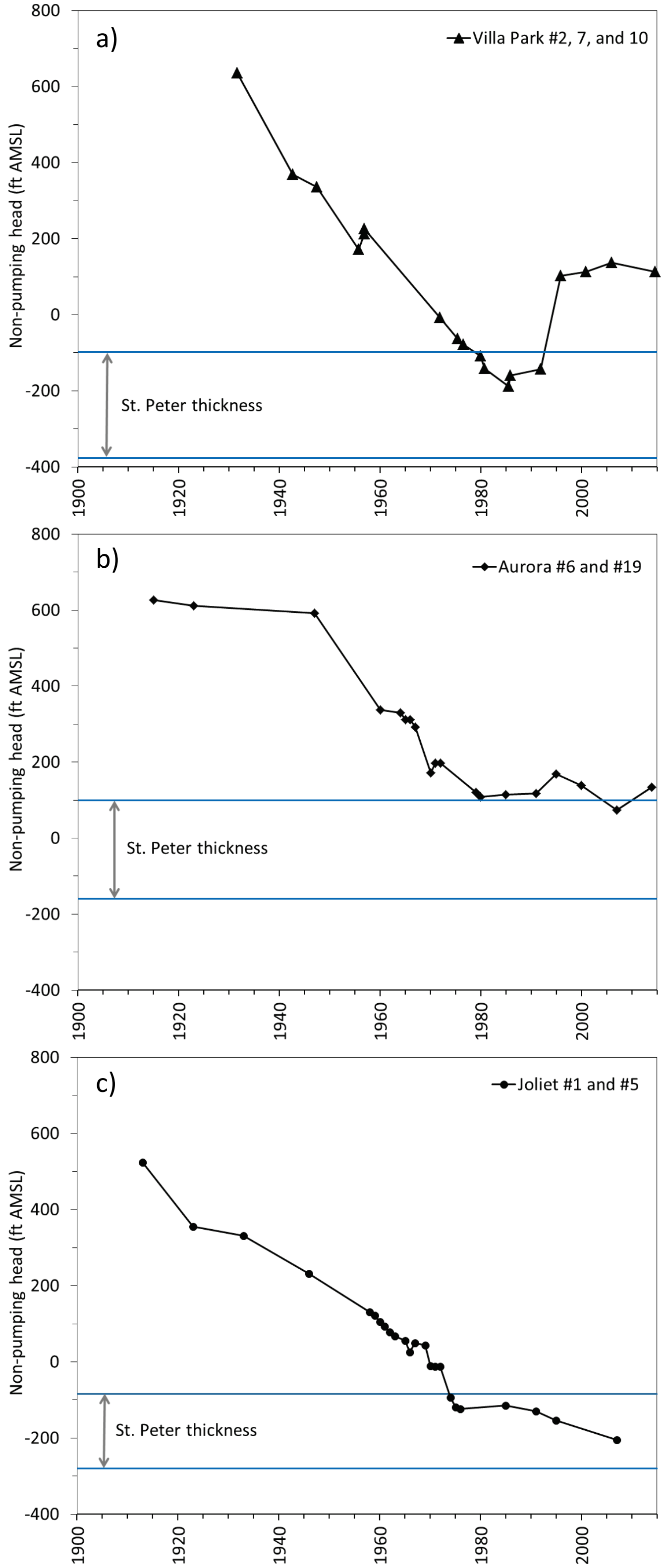

Figure 2: Hydrographs of public water facilities in Northeast Illinois where a) heads recovered when communities switched to Lake Michigan water, b) heads stabilized by supplementing sandstone withdrawals with Fox River water, and c) heads have declined with continued sandstone withdrawals. Also shown are the top and bottom elevations of the St. Peter Sandstone in these areas.

2014 risk of desaturation

The risk of desaturation in the 2014 map was developed using the data obtained from the synoptic measurements (Figure 3). Also shown are wells where desaturation was observed under pumping or non-pumping conditions. These wells are limited to those measured in the past 15 years, which excludes many residential wells in the region for which no recent data are available. While the risk zone for complete desaturation is relatively small in 2014, complete desaturation of the St. Peter Sandstone has been observed.

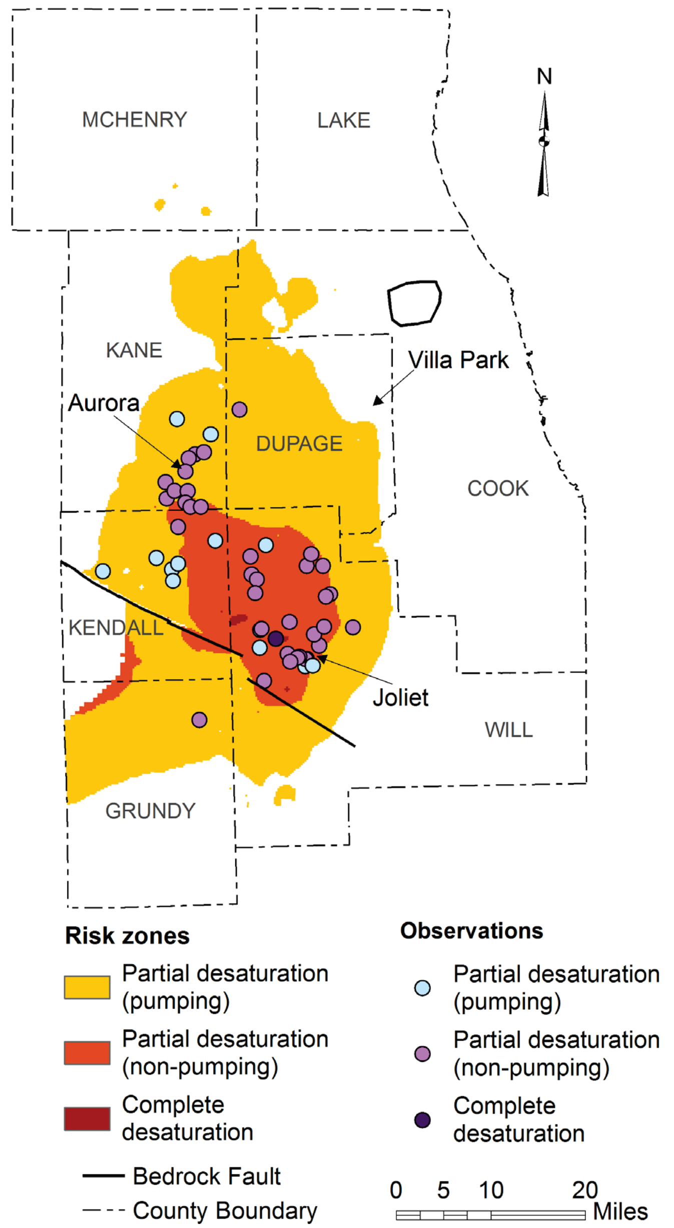

Figure 3: Risk of desaturation for the St. Peter Sandstone in 2014. Also shown are wells where desaturation has been observed since 2000. As little recovery has occurred in the risk area, historical observations are shown alongside 2014 synoptic measurements.

2050 risk of desaturation

The projected risk of desaturation for 2050 was developed using a groundwater flow model discussed in Roadcap et al. (2013); three scenarios are depicted in Figure 4. Scenario A holds 2011 pumping rates constant (the most complete data available at the time of model development). Scenarios B and C simulate increased water demand based on projections developed for northeastern Illinois using socioeconomic and climate data (Dziegielewski and Chowdhury 2009). All simulations indicate that the risk of desaturation will increase between 2014 and 2050 for most areas.

The risk of desaturation for 2014 and 2050 is also shown in a cross-sectional view in Figure 5. While desaturation has always been a concern for the St. Peter Sandstone, the 2050 simulations also indicate a potential risk to the deeper Ironton-Galesville Sandstone due to increased withdrawals from this unit in recent years.

Implications for future water supply

As the three scenarios depict in Figure 4, the future extent of desaturation will depend on the rate of withdrawals from sandstone aquifers. Unconstrained pumping from these sandstones will result in further desaturation. Switching to alternate sources of water will increase the viability of the aquifers for those who have few alternatives, such as residential well owners and industries, though local geologic complexity leaves the long-term viability of the aquifers in question for some areas with heavy withdrawals. As this problem has developed from the combined influence of sandstone withdrawals across the region, it is our recommendation that communities collaborate in planning for future land use and water supply decisions.

Acknowledgments

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References

Abrams, D.B., D.R. Hadley, D.H. Mannix, G.S. Roadcap, S.C. Meyer, K.J. Hlinka, K.L. Rennels, K.R. Bradbury, P.M. Chase, and J.J. Krause. 2015. *Changing Groundwater Levels in the Sandstone Aquifers of Northern Illinois and Southern Wisconsin: Impacts on Available Water Supply.* Illinois State Water Survey Contract Report 2015-02, Champaign, IL.

Dziegielewski, B., and F.J. Chowdhury. 2008. Regional Water Demand Scenarios for Northeastern Illinois: 2005-2050. Project Completion Report Prepared for the Chicago Metropolitan Agency for Planning. Department of Geography and Environmental Resources, Southern Illinois University.

Roadcap, G.S., S.C. Meyer, W.R. Kelly, H.A. Wehrmann, and Y.F. Lin. 2013. *Groundwater Studies for Water Supply Planning in Kendall County, Illinois*. Illinois State Water Survey Contract Report 2013-05, Champaign, IL.

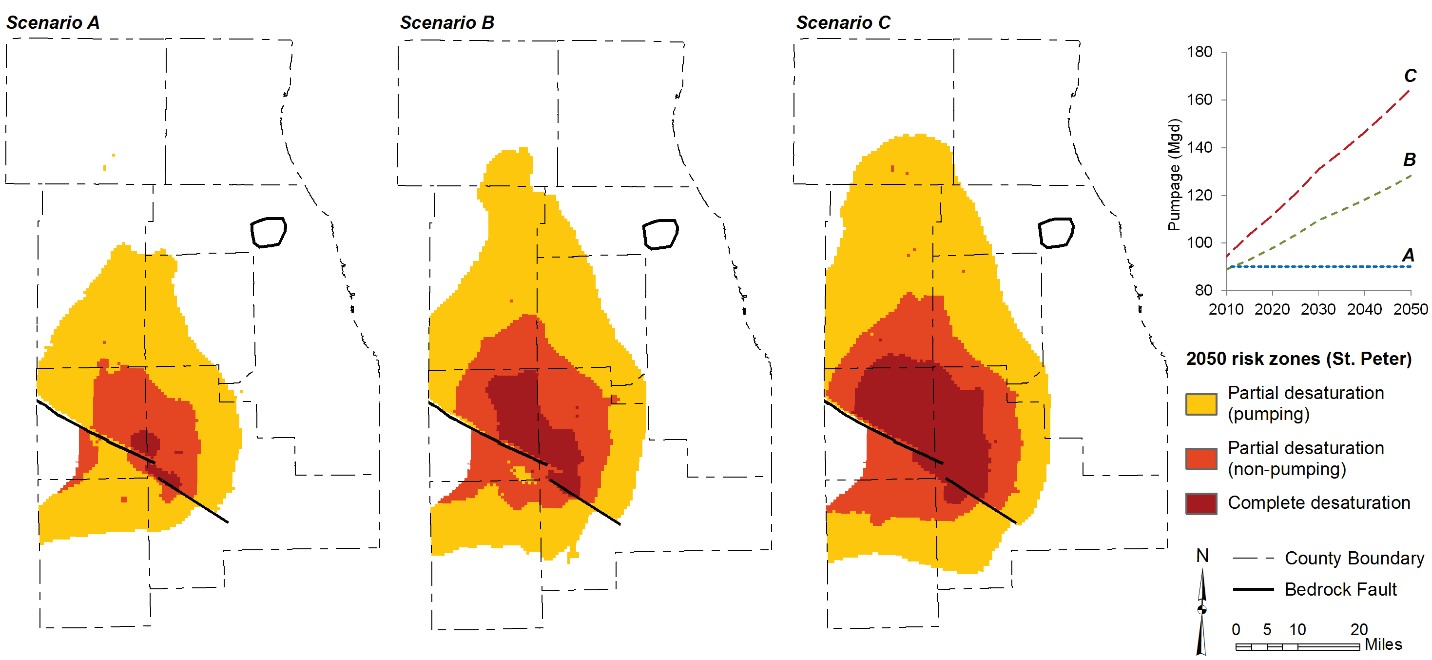

Figure 4: Risk of desaturation of the St. Peter Sandstone projected for 2050 using A) no increase in pumpage, B) a less resource intensive growth scenario, and C) the current trends scenario (Roadcap et al. 2013). The graph highlights total projected sandstone pumpage to 2050 in each scenario for the area shown.

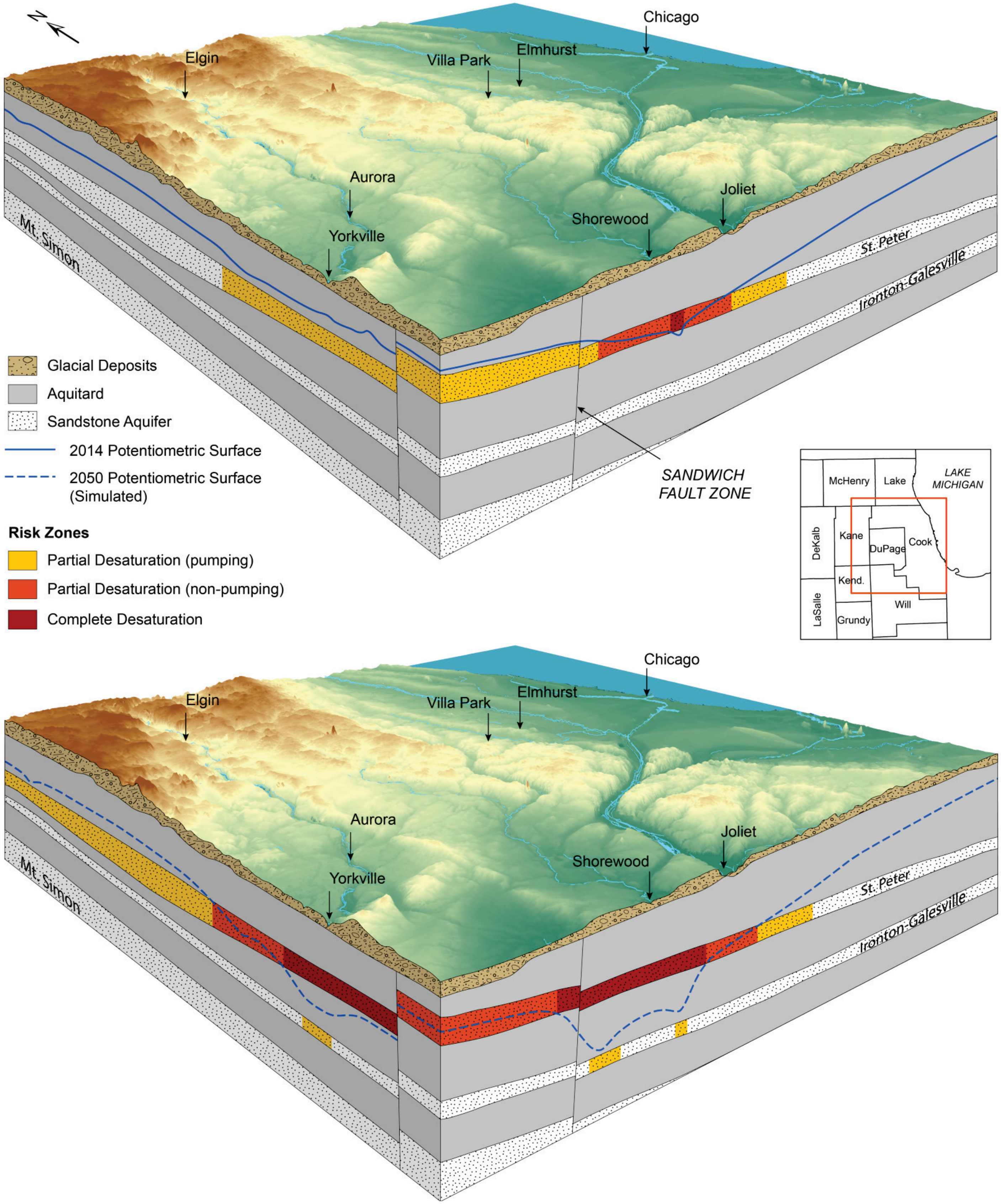

Figure 5: Risk of desaturation of the St. Peter Sandstone and the Ironton-Galesville Sandstone in 2014, based on observations, and 2050, simulated using the current trends scenario (Roadcap et al. 2013). The potentiometric surface lines represent the lowest non-pumping head in the system.