

Regional Drawdowns

The effects of groundwater withdrawals on a regional scale are seen in the Lower Fox River Valley, southeastern Wisconsin, and Dane County. The Lower Fox River Valley and southeastern Wisconsin were designated Groundwater Management Areas based on water level drawdowns of more than 150 feet observed in those two regions. Drawdowns in parts of Dane County have been around 50 feet. Large groundwater drawdowns indicate changes in the flow systems. Around 1900, flowing wells were present in both the Lower Fox River Valley and southeastern Wisconsin. Pumping has caused drawdowns in those aquifers so that today the water levels are often hundreds of feet below the ground surface. Excessive drawdowns can cause reduced yields to wells, lower water quality, and divert water from surface waters.

Lower Fox River Valley

Water levels in the Lower Fox River Valley have varied widely over time. Water levels in the deep aquifer of the Lower Fox River Valley were above the land surface before significant pumping from that aquifer in 1900. By 1957, increased pumping in the deep sandstone aquifer lowered water levels by hundreds of feet. In response the City of Green Bay switched from groundwater supply to surface water supply and the water levels increased more than 200 feet in the aquifer. By 2005, increased pumping from the communities surrounding Green Bay caused water levels to have decreased to the low levels seen in 1957. In response to that drawdown, six suburban communities in the Lower Fox Valley reduced consumption of groundwater by about 8.2 million gallons per day by switching to surface water supplied by pipeline from Lake Michigan in 2007. As a result, water levels in the deep sandstone aquifer in and around Green Bay have risen. These changes at one well can be seen in Figure 1.

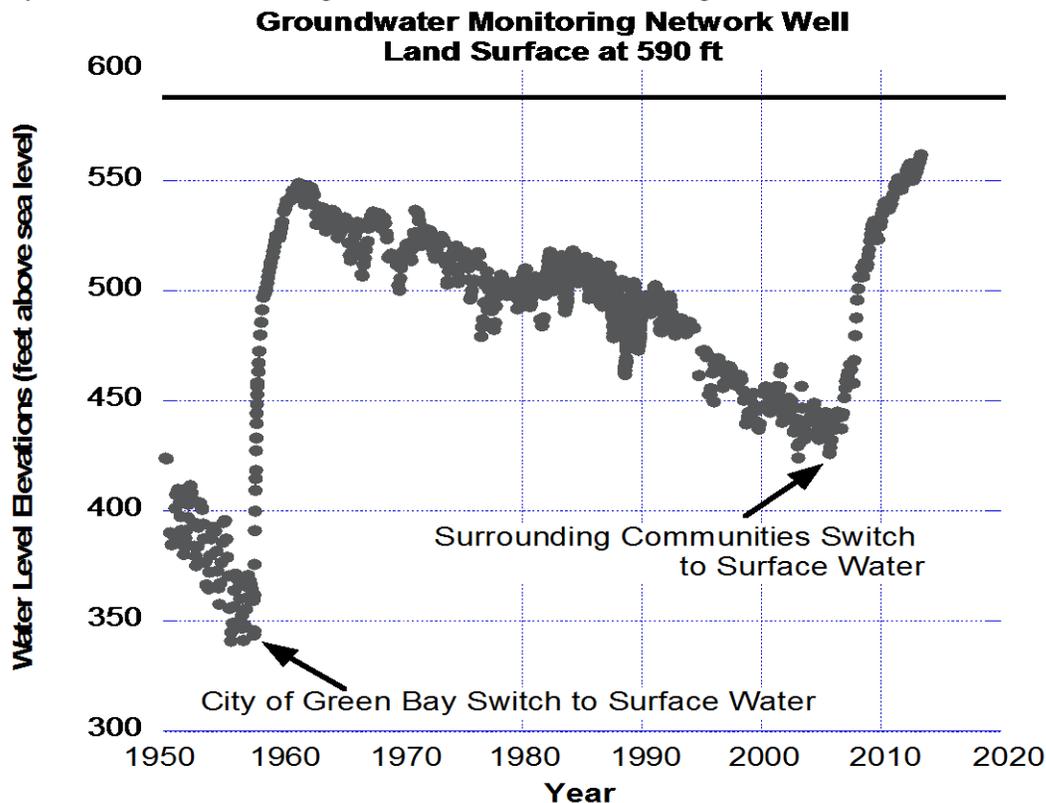
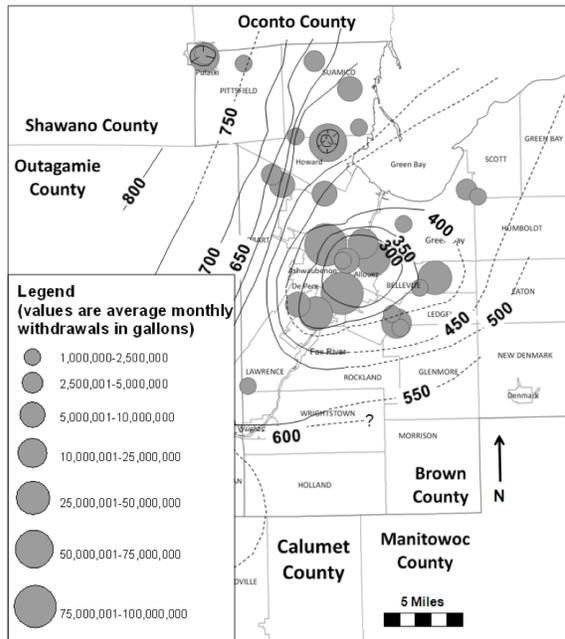
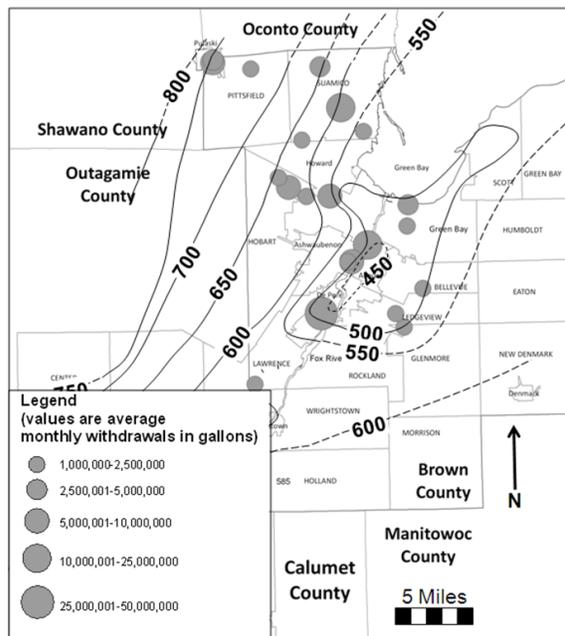


Figure 1: Changes in groundwater levels in a groundwater level monitoring well in Green Bay, Wisconsin (WGNHS)

The water levels continue to rise and some homeowners and the town of Howard have reported flowing wells. If water use continues to decrease, the number of flowing wells will increase over time as the water levels rise above the land surface. Contours of water levels before and after the reduction of pumping in 2007 are shown in Figure 2.



Contour Interval 50 feet - values in feet above mean sea level
Dashed lines indicate estimated values



Contour Interval 50 feet - values in feet above mean sea level
Dashed lines indicate estimated values

Figure 2: Water table elevations in Brown County (WGNHS).

We know from previous drawdown and pumping records that when the pumping rate reaches around 6 million gallons per day that the deep aquifer has the potential to become dewatered, raising concerns about changes in the aquifer chemistry that might increase arsenic or radium concentrations. This provides good rationale for monitoring high-capacity pumping in this aquifer.

Southeastern Wisconsin

Water levels in southeastern Wisconsin have shown the largest decreases in Wisconsin. These decreases have raised concerns about increases of radium to wells above drinking water standards and increased pumping costs. As was the case for the Lower Fox River Valley, water levels in the deep sandstone aquifer were above the land surface before significant pumping in 1900. Pumping increased steadily from 1900 to 2000 and water levels in some wells steadily decreased by more than 500 feet. Figure 3 shows the water table decline until around 2000 to 2005. Research and monitoring from the late 90's and early 2000's demonstrated an average of 7 feet per year decline in deep wells (Feinstein et al., 2004). However, a recently added well in Waukesha County, to the groundwater observation network shows 2013 water levels to be approximately 50 feet higher than the levels observed in a nearby observation well in 1998 (Pfeiffer, 2013). The reduced drawdown is likely due to reduced pumping by communities from groundwater conservation efforts and from seeking alternative sources of water to the deep sandstone. The deep sandstone aquifer sometimes has radium concentrations over the drinking water standard of 5 pCi/l. Treatment of that water can be costly, leading some communities to look at other water sources.

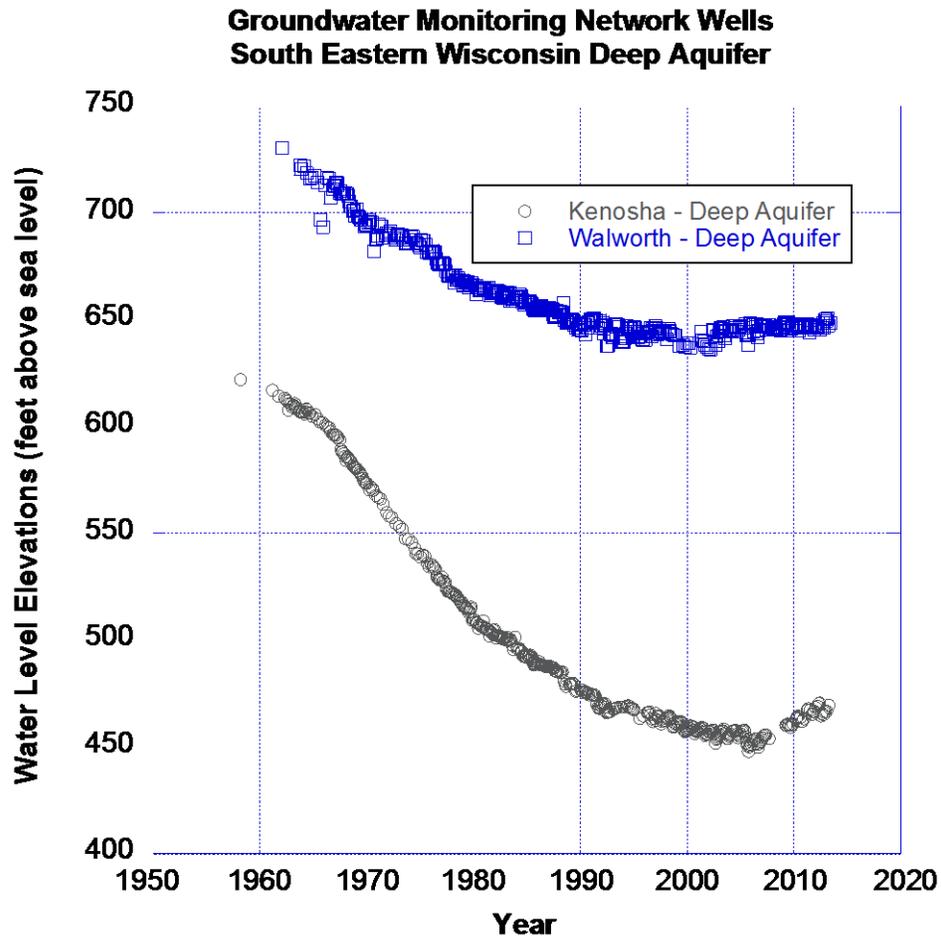


Figure 3: Water levels in a groundwater level monitoring wells in Kenosha and Walworth counties (WGNHS).

Dane County

Dane County presents another example of regional drawdowns which have been well documented through water level measurements and the development of multiple groundwater flow models, at a county-wide scale, over the past several decades. The latest version of the Dane County model, begun in 2010 and slated for publication later this year (2013), has focused on increasing the spatial resolution of the model grid, better simulating surface water groundwater interactions, and introducing transient flow capabilities, all while upgrading the computer codes and calibration methods. Each of these model improvements will provide new insights into the groundwater system within Dane County and a greater understanding of regional scale drawdowns.

The existing Dane County model, developed in the mid-1990s (Krohelski, 2000), was used to simulate drawdowns in both the Mount Simon Sandstone and at the water table. Figures 4 and 5 were generated by comparing predevelopment water levels to those measured in 2000 and document the presence of significant drawdowns in central Dane County, below the Yahara River corridor. In Dane County, municipal water supply is by far the primary groundwater user, representing roughly 80% of the total withdrawal rate of 60 million gallons per day. The next largest withdrawals are made by irrigation (under 10%) and aquaculture (under 5%).

Dane County

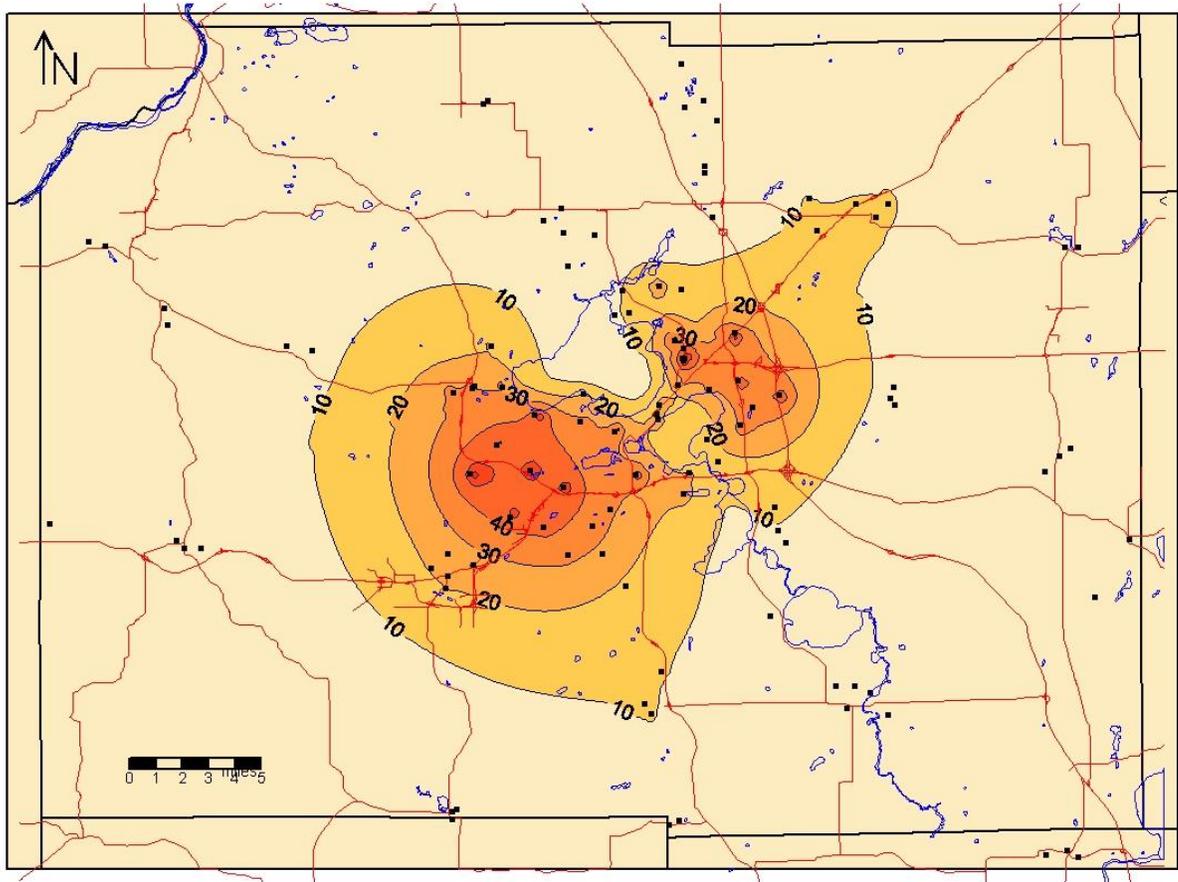
Simulated drawdown (feet) in the Mount Simon Sandstone;
predevelopment to 2000

Figure 4 - Simulated drawdown (feet) in the Mount Simon Sandstone; predevelopment to 2000. The Mount Simon Sandstone, located several hundred feet below land surface and up to 800 feet thick, is the lowermost aquifer unit within Dane County. This porous sandstone is a highly productive aquifer which provides the bulk of groundwater supplies to high-capacity municipal and industrial wells across Dane County.

Dane County

**Simulated drawdown (feet) at the water table;
predevelopment to 2000**

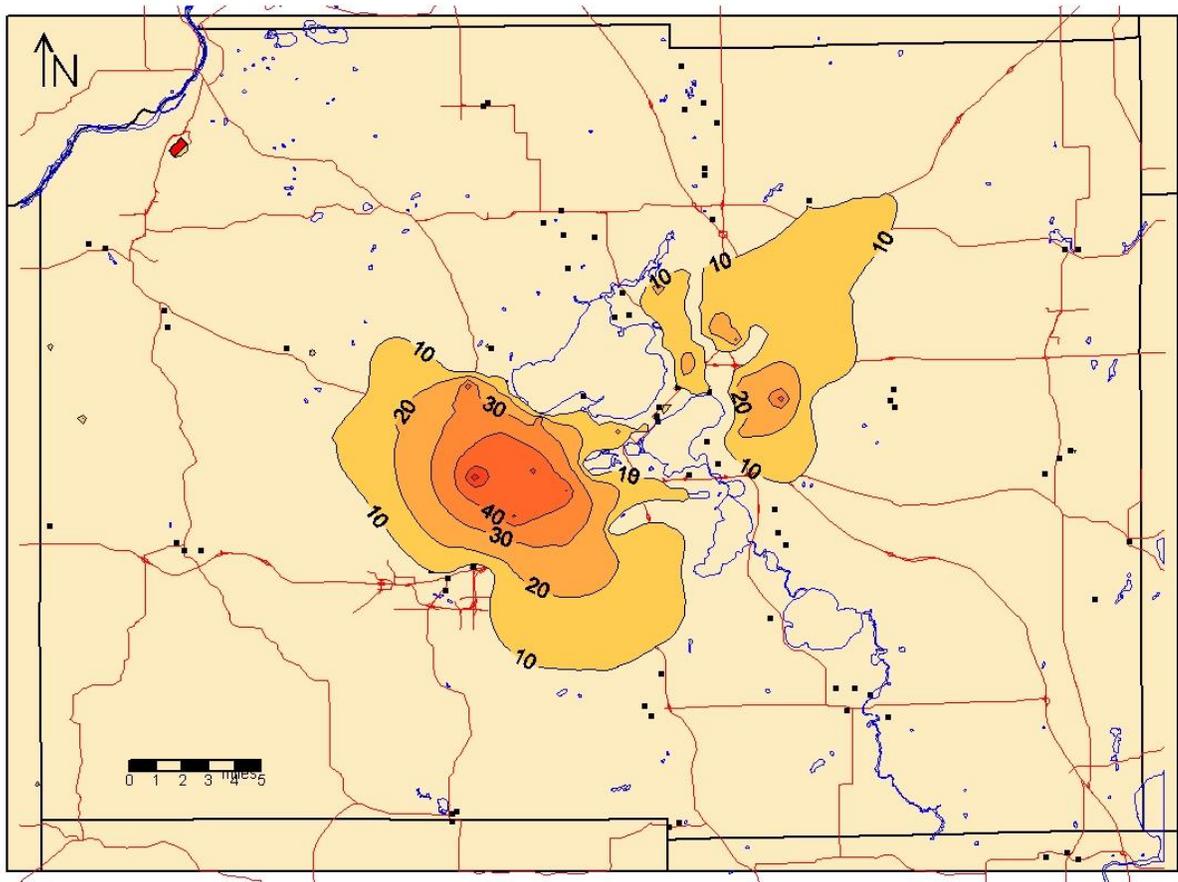


Figure 5 - Simulated drawdown (feet) at the water table; predevelopment to 2000. Drawdowns from the lower Mount Simon aquifer system propagate upwards to the shallow sand and gravel and upper bedrock aquifer systems to create drawdowns at the water table.

Water use data collected for the updated 2013 model, indicate that groundwater withdrawals have declined by up to 15% over the past 10-15 years across Dane County. These reductions are believed to be primarily attributable to recent wet years, during which water demand drops, and local groundwater conservation efforts. Once the updated 2013 model is complete, it will improve our understanding of regional drawdowns across Dane County and provide insights into groundwater systems across South Central Wisconsin.

See also <http://dnr.wi.gov/topic/groundwater/documents/GCC/Benefits/Drawdowns.pdf> for a discussion of how GCC-coordinated research and monitoring has addressed drawdowns.

References:

Feinstein, D.T., D.J. Hart, T.T. Eaton, J.T. Krohelski, and K.R. Bradbury. Simulation of regional groundwater flow in southeastern Wisconsin. 2004.

Krohelski, J.T., Bradbury, K.R., Hunt, R.J., and Swanson, S.K., 2000, Numerical model of Groundwater flow in Dane County, Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 98, 31 p.

Luczaj, J.A. and Hart, D.J., 2009, Drawdown in the Northeast Groundwater Management Area (Brown, Outagamie, and Calumet Counties, WI). Final Project Report submitted to the Wisconsin Department of Natural Resources on July 3, 2009; 59 pages.

Pfeiffer, S.M. personal communication, 2013.