

REGIONAL DRAWDOWNS

The effects of groundwater withdrawals on a regional scale are seen in the Lower Fox River Valley, southeastern Wisconsin, Dane County and the Central Sands. 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.

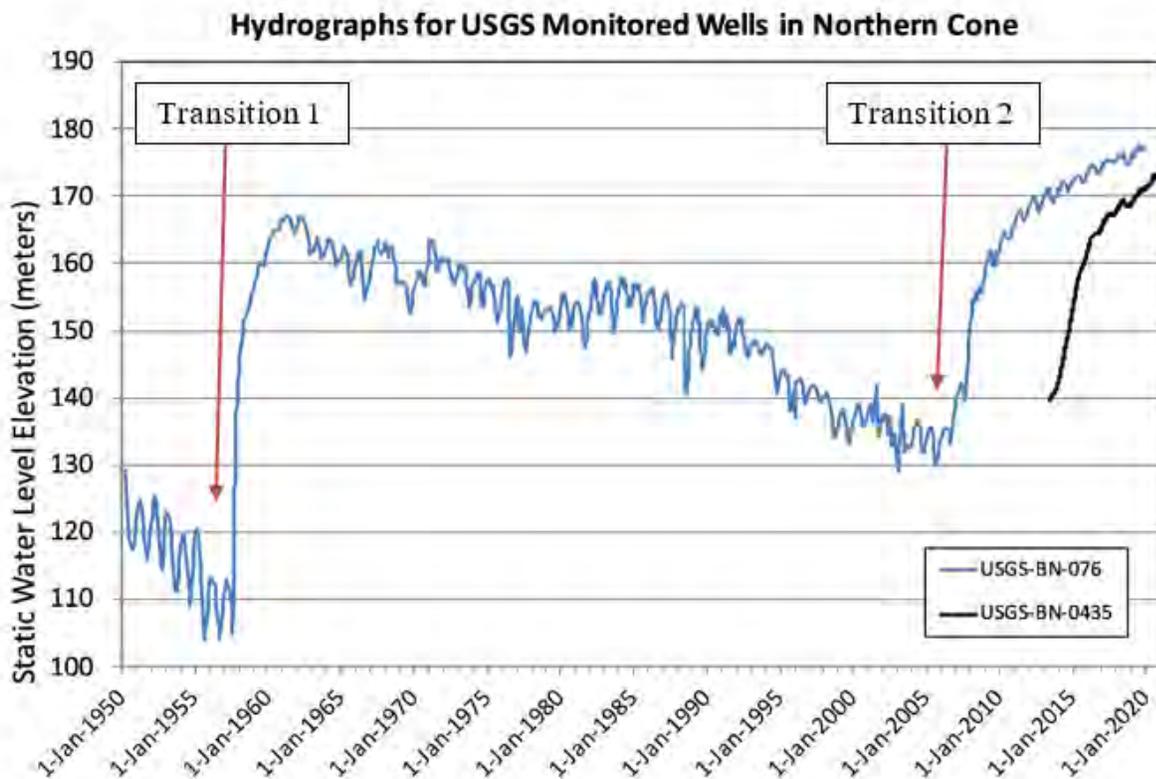


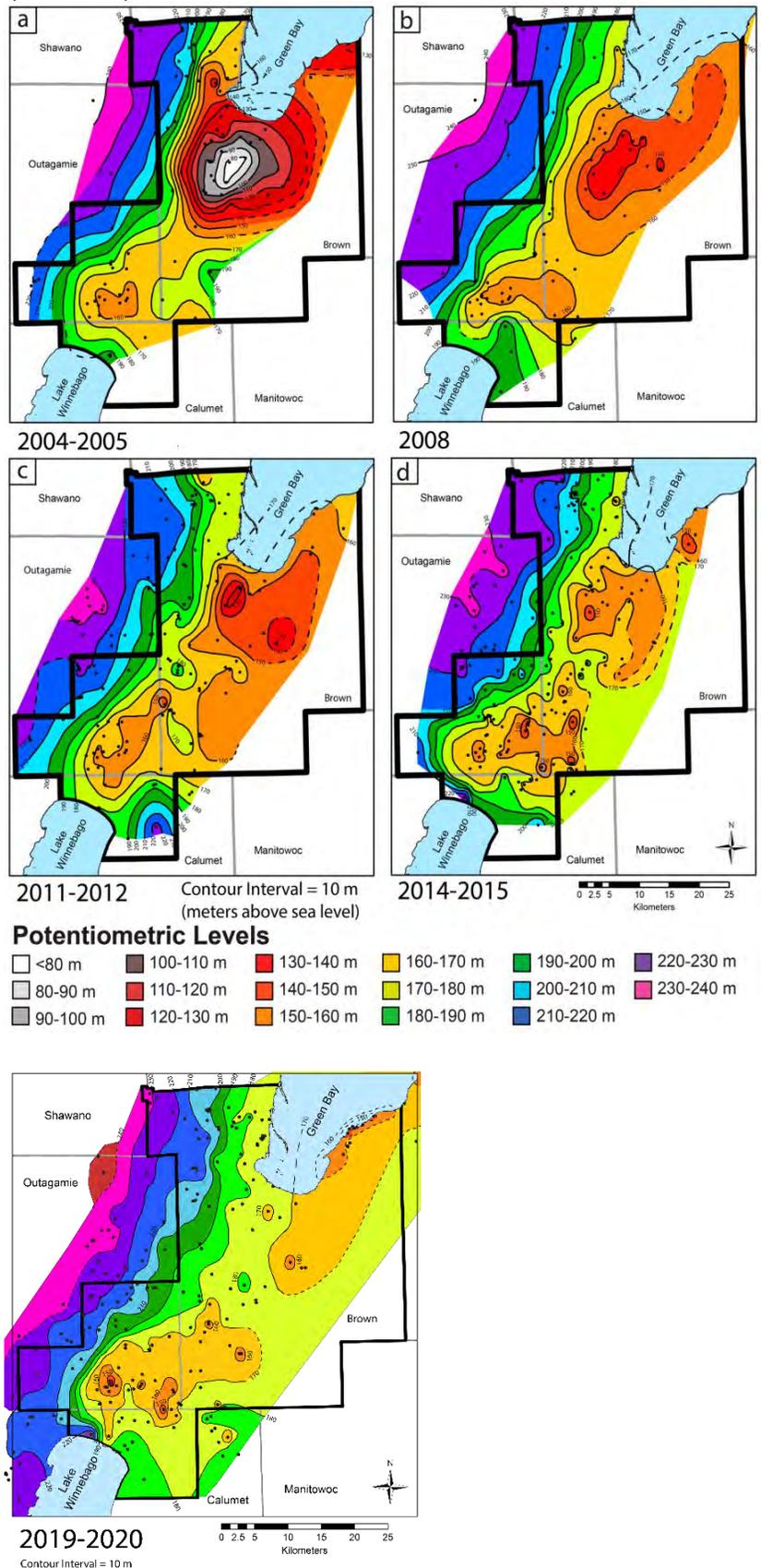
Figure 1: Changes in groundwater levels in a groundwater level monitoring well in Green Bay, Wisconsin. Transition 1 is City of Green Bay Switch to surface water. Transition 2 is Green Bay suburbs switch to surface water.

By 2005, increased pumping from the communities surrounding Green Bay caused water levels to decrease 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.

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.

We know from previous drawdown and pumping records that when the pumping rate reaches around six 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.

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



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 1990's and early 2000's demonstrated an average of 7 feet per year decline in deep wells¹. However, an added well in Waukesha County to the groundwater observation network shows 2020 water levels to be approximately 150 feet higher than the levels observed in a nearby observation well in 1998². The reduced drawdown is likely due to reduced pumping by communities from groundwater conservation efforts, reduced industrial water use 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. 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

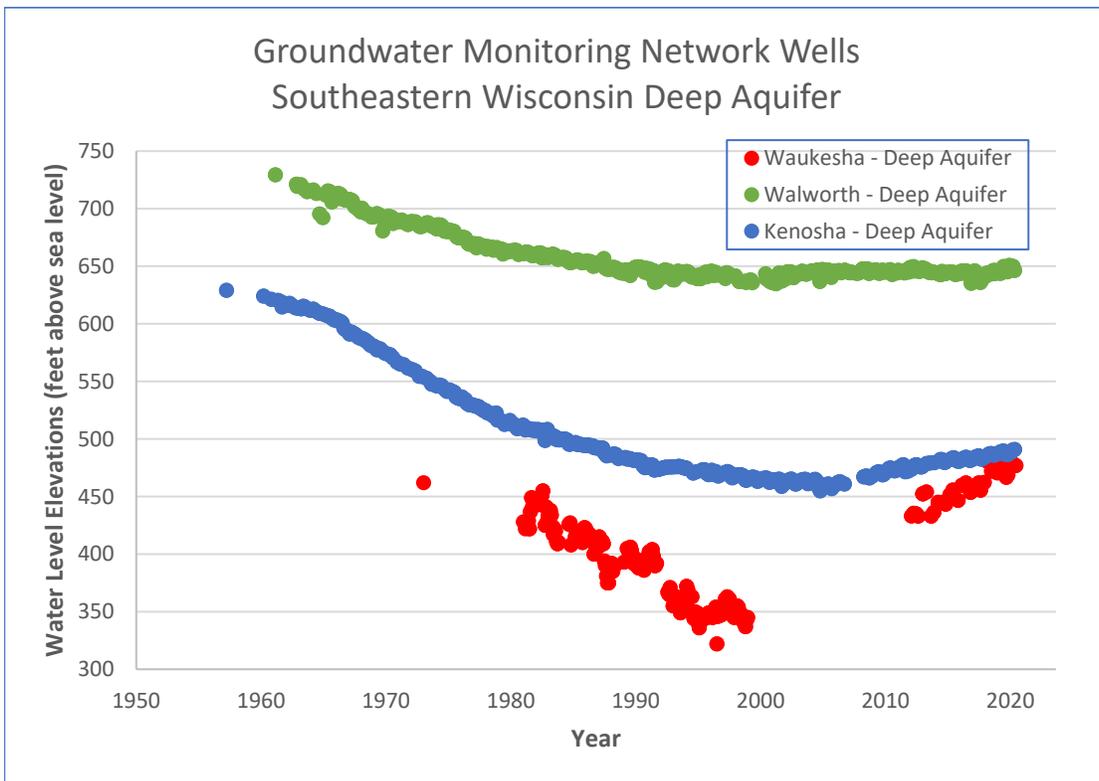


Figure 3: Water levels in a groundwater level monitoring wells in Waukesha, Kenosha and Walworth counties (DNR).

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 1990's and early 2000's demonstrated an average of 7 feet per year decline** in deep wells³. However, an added well in Waukesha County to the groundwater observation network shows 2020 water levels to be approximately 150 feet higher than the levels observed in a nearby observation well in 1998⁴. The reduced drawdown is likely due to reduced pumping by communities from groundwater conservation efforts, reduced industrial water use 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. The City of Waukesha, the largest municipal water withdrawer in Waukesha County, switched its water source from groundwater wells to Lake Michigan in 2023. As a result the USGS deep sandstone aquifer groundwater level monitoring well located in the City of Waukesha already shows additional increase in water levels from the City of Waukesha no longer pumping from their deep aquifer wells (Figure 4).

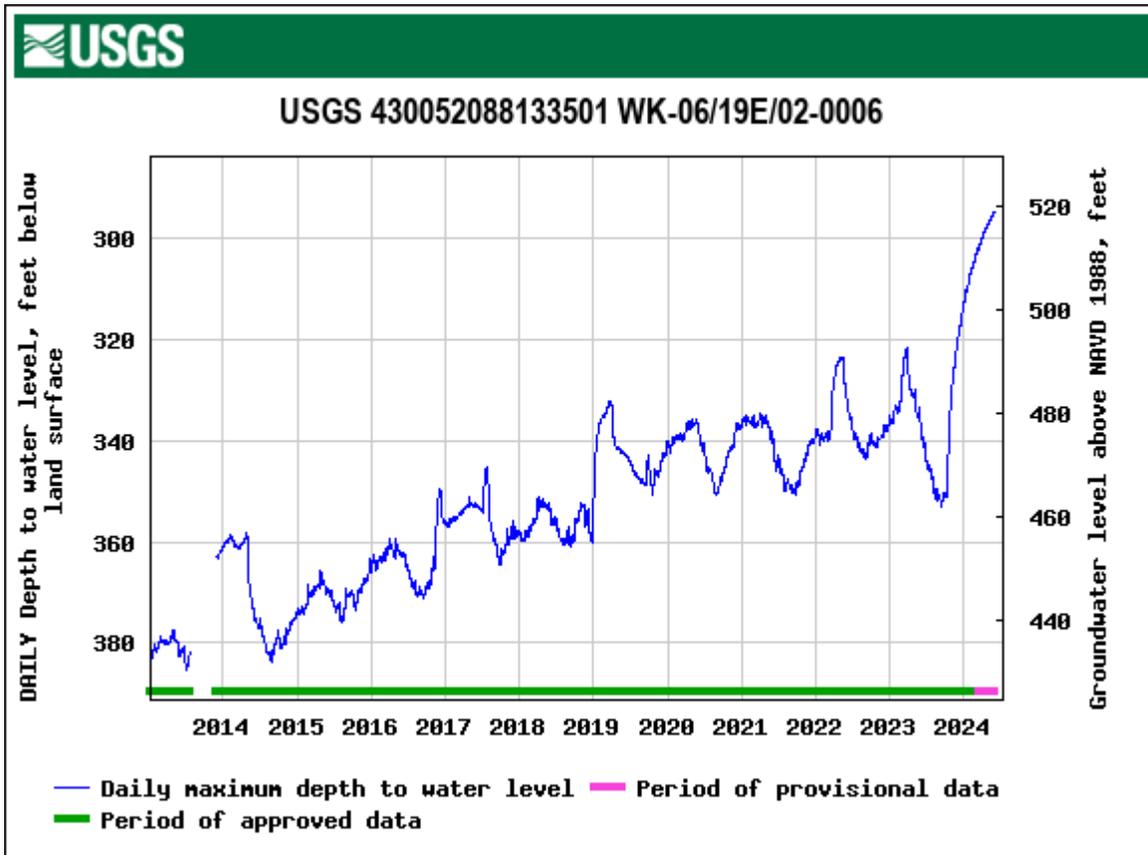


Figure 4. USGS Groundwater level monitoring network well located in the City of Waukesha monitoring water levels in the deep sandstone aquifer. The water level in this well has risen 55 feet between October 2023 and May 2024.

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 Dane County model 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 2010 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. For the model period of 2006-2010, municipal water use was 88% (46 million gallons per day) of the total groundwater withdrawals (52 million gallons per day). Water use in Dane Co. has decreased by about 7% since the model period 2006 – 2010.

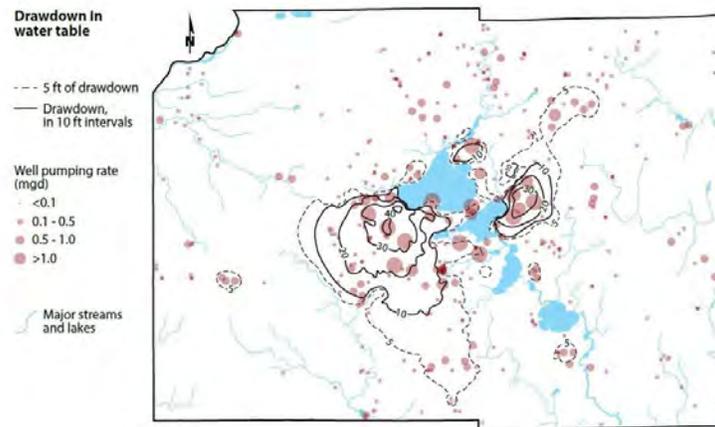


Figure 4: Simulated drawdown (feet) in the Mount Simon Sandstone; predevelopment to 2010. The Mount Simon Sandstone, located several hundred feet below land surface and up to 800 feet thick, is the lowermost aquifer unit within Dane County. This porous sandstone is a highly productive aquifer which provides the bulk of groundwater supplies to high-capacity municipal and industrial wells across Dane County (WGNHS).

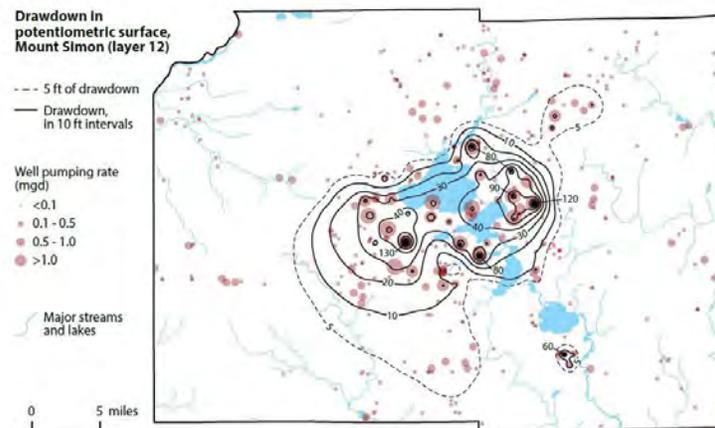


Figure 5: Simulated drawdown (feet) at the water table; predevelopment to 2010. Drawdowns from the lower Mount Simon aquifer system propagate upwards to the shallow sand and gravel and upper bedrock aquifer systems to create drawdowns at the water table (WGNHS).

For the period 2018 – 2022 total water withdrawals averaged 48 million gallons per day.

References:

1. 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.
2. Pfeiffer, S.M. personal communication, 2013.
3. Parsen, M.J., Bradbury, K.R., Hunt, R.J., and Feinstein, D.T., 2016, The 2016 groundwater flow model for Dane County, Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 110, 56 p.
4. Bradbury, K.R., M.N. Fienen, M.L. Kniffin, J.J. Krause, S.M. Westenbroek, A.T. Leaf, and P.M. Barlow. 2017. A groundwater flow model for the Little Plover River in **Wisconsin's Central Sands. Bulletin 111. Wisconsin Geological and Natural History Survey**, 82 p. Available at <http://wgnhs.uwex.edu/pubs/B111>