Understanding Our Shared Water Supply

The State of Illinois and Boone County are funding a project to study the geology of Boone County to better understand how the different layers and structures below the land surface allow water to move within it. This gives the County new tools and technology to safeguard our precious water supply. In my first article, the reader learned something about Boone County's water supply (https://www.naturalland.org/geologic-study-boosts-groundwater-understanding/).

When you cut out a wedge from a layer cake you can easily see the different layers in a 3D view for that part of the cake. Depending on how the cake was made, other slices may show different layers or features that were hidden from the first view. Boone County has a very complex geology. The subsurface contains hidden features like the buried Troy Bedrock Valley! An important geologic feature that cuts diagonally across the county from the northeast toward the southwest. The new geologic mapping will reveal a very detailed, three-dimensional (3D) view of what lays below the ground surface to a depth of nearly 1,000 feet. Including a significantly detailed understanding of that Troy Bedrock Valley and the sedimentary layers that fill it!

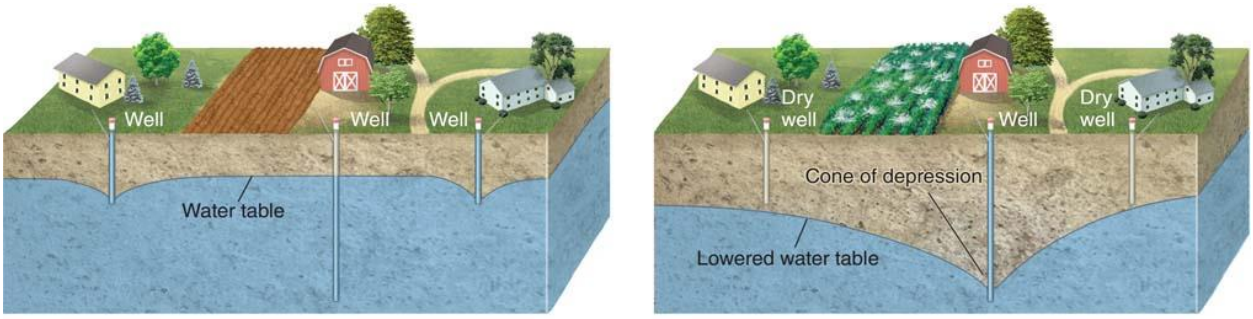
Sediment is normally laid down in horizontal layers. Different types of sediment like gravel, sand, silt, and clay form these layers. Sand and gravel are sediments that are often deposited by moving water like a fast-flowing stream or river. In the not too distant past, Boone County has experienced tremendous rivers of water melting off glaciers. These meltwater streams and rivers carried volumes of sediment and left behind thick layers of sand and gravel. A layer of sand and gravel can form an aquifer, which is a layer that allows water to easily move into and through the spaces between the grains of sand and gravel. These aquifers are usually close to the land surface and are often considered shallow groundwater sources.

Glaciers left other deposits with mixtures of all types of sediment – such as glacial tills that also have been compacted by the weight and force of the moving ice. Visualize a mile thick mass of ice! As glaciers move, they gouge the land beneath and pick up a lot of debris. That debris can get ground up and/or smeared onto the land below it. When the ice melts away one of the common glacial deposits left behind is the material that was being dragged and smeared into the new land surface called till. Tills create denser horizons of material. These denser layers can form barriers which restrict the downward flow of water and thus affect groundwater recharge. Different types of glacial deposits are found in Boone County and the surrounding area. Glacial deposits are exceptionally complex as glaciers did not simply advance and melt away. Instead, each glacial episode has numerous periods where the ice sheet advanced and then partially melted away. Each time it could scrape away previous deposits and place new deposits over the top. Leaving behind a very complicated landscape and subsurface geology!

In addition, our local system of groundwater sources goes deeper - into the bedrock. Many Boone County residents live in one of the local towns or the City of Belvidere. These communities often draw their water supply from deeper wells drilled into sandstones in the bedrock. The deeper sandstones and bedrock water sources are regional in scale and extend across most of northern Illinois and into other midwestern states including Wisconsin, Iowa, and Minnesota. These same groundwater sources are used by many communities and despite the vast extent and size of these water sources; some places have, over time, pumped enough water out, that they have emptied their groundwater tank so to speak.

Those communities have had to face serious challenges to their water supply. Part of the reason that these communities emptied their deep sandstone water source is the fact that the geology there has layers of rock above the sandstones that restrict downward movement of water and effectively prevent local groundwater recharge from happening.

Figure 1 Depiction of how a well or wells form a "cone of depression."



(a) Before heavy pumping **(b)** After heavy pumping

Figure 26.5a-b

Friedland, *Environmental Science for AP®, 2e*, © 2015 W.H. Freeman and Company

Figure 1 shows how a well creates a "cone of depression" around it when pumping water out. This effect can be amplified if there are many wells pulling water out of a groundwater source (aquifer). As wells continue to pump water out and there is one or more restricting layers that do not allow water to be replaced or recharged, the cone of depression will deepen and encompass a larger and larger area around them. Instead of local rainfall replenishing the groundwater source, water is pulled from an ever-greater distance within the same layer as the water seeks to refill the emptied spaces.

In the northern half of Illinois, a number of communities have been pumping water out of the deeper sandstones for many years. The amount of water being pumped out has been exceeding the amount of water that can recharge those sandstone groundwater sources. This has created a very large cone of depression.

Figure 2 shows the extent of that cone of depression. The center of the cone is located near Joliet, Illinois where the water levels in the sandstone aquifers have been lowered more than 800 feet since the original pre-settlement level. Each line forming a ring around that central location represents the level of drawdown in 100-feet of depth increments. Boone County, located on the northwest edge of this cone of depression, has experienced a drawdown of approximately 100 feet in the sandstones below it. Water moves at the ever-constant pull of gravity. The nature of this human made cone of depression, created by many wells across this region all drawing their water from the same source, will continue expanding as time moves forward. We need to be mindful that Boone County residents are using water from these sandstone aquifers too, and are likely contributing to the formation of this cone of depression.

This brings us back to conducting the 3D geologic mapping project. Boone County is not short of water now. Completing this study will significantly improve our understanding of the geology that holds our supply of water. Providing details about how the shallow groundwater sources connect with the deeper bedrock groundwater sources. Your Boone County officials and staff will be utilizing this information and its new technology to help ensure our water supply remains robust! Kisa Mwakanyamale-Gilke, Geophysicist with the Illinois State Geological Survey and team member working on the Boone County 3D geologic mapping project states "*Hydrologically, the geophysical data we are collecting will have crucial information on how the ground beneath our feat is organized to hold the water we rely on and how much water there is, with implications for irrigation, domestic water use, and economic growth for Boone County.*"

As previously noted, there is a public information and media day event being planned to answer questions about this study and how the work will be completed. That event will take place in late February or early March. More articles about this important work will be submitted between now and the public event.

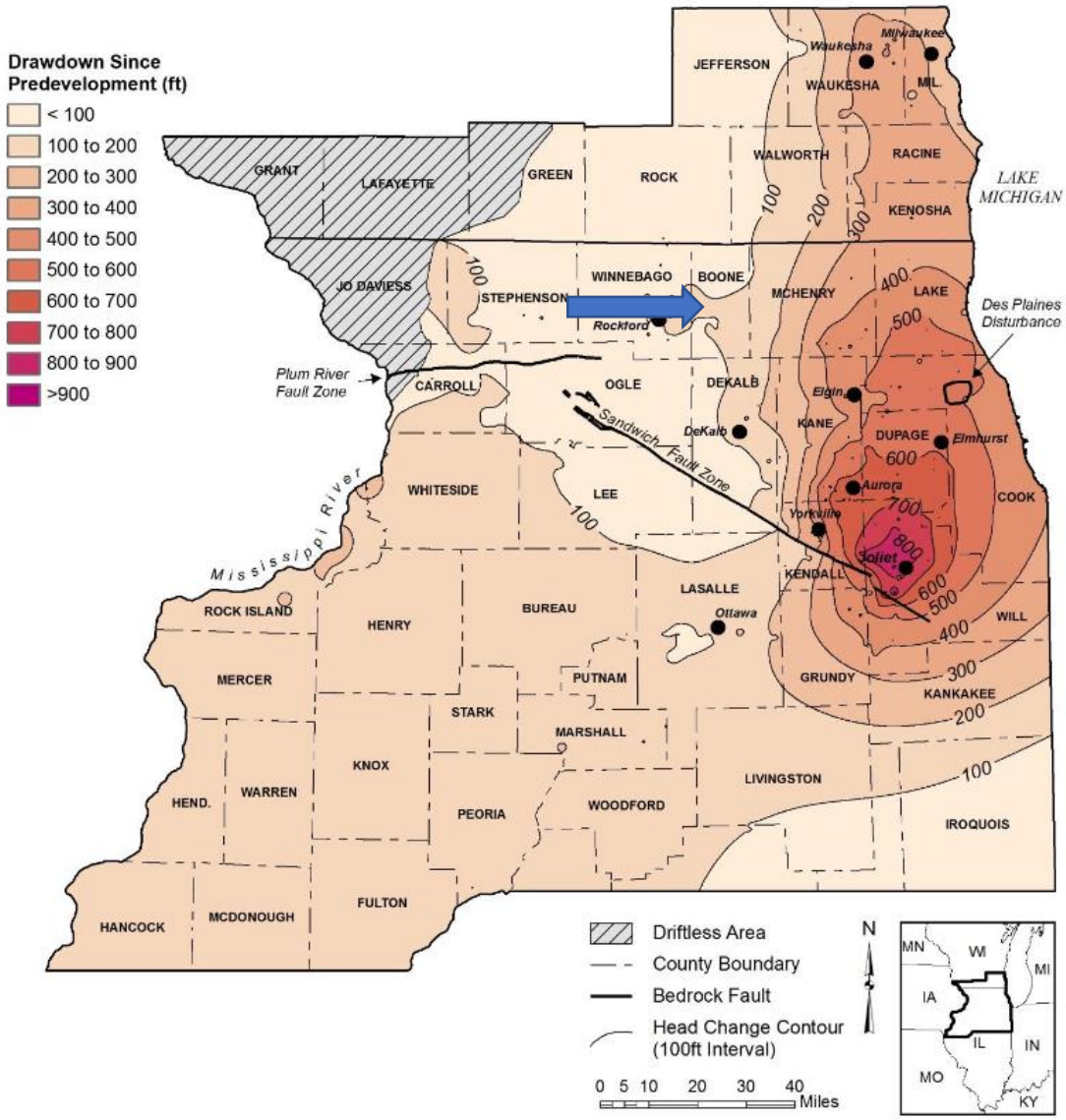


Figure 16: Drawdown of heads in the Cambrian-Ordovician sandstone aquifers from predevelopment to 2014.

Figure 2. ***(*****Source: Abrams et al., 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*****.)*** *The* ***Blue Arrow*** *shows where Boone County is located on this map. Changes in water levels prior to settlement to the 2014 water levels in the deep sandstone aquifers show a growing cone of depression. Darker shading within each line encircling the dark center shows the depth that water levels have dropped because of the removal by pumping. Most of this change has occurred in the last 40 or so years. Note that Boone County is on the edge of this cone of depression.*

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