USGS National Ground-Water Monitoring Network Cooperative Agreement

Final Technical Report

Award #G21AC10224-00- Minnesota Department of Natural Resources

Figure 1: A site photograph showing the five new groundwater observation wells that were installed as part of this project.

Project Title: Groundwater Level Monitoring Network Expansion and Well Replacement

Project Term: 07/15/2021 through 07/14/2023

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Background

The Minnesota Department of Natural Resources (MN DNR) applied for a USGS National Ground-Water Monitoring Network (NGWMN) grant in 2021 to expand both the NGWMN and the MN DNR's groundwater level monitoring networks. The goal was to install five new dedicated groundwater observation wells into five different aquifers at one location in Minneapolis, Minnesota. The wells would fill a gap in the existing networks and be used for long-term groundwater level monitoring of principal aquifers. Two of the wells would also serve as replacements for nearby observation wells that are no longer accessible. MN DNR was awarded up to $149,755.27 of funding from the NGWMN later that year to help fund the well installations.

Summary of Accomplishments

The project commenced on July 15, 2021 and ended on July 14, 2023. All of the work fell under Objective 5 (well drilling) of the NGWMN program. Funding for the four bedrock wells was funded 50/50 (50% from the MN DNR and a matching 50% from the NGWMN grant). The MN DNR fully funded the installation of the Quaternary water table well. In summary, all five of the originally planned wells were successfully installed:

- A 699ft deep Wonewoc Sandstone bedrock well
- A 540ft deep Tunnel City Group bedrock well
- A 440ft deep Jordan Sandstone bedrock well
- A 300ft deep Prairie du Chien-Shakopee bedrock well
- A 64ft deep Quaternary water table well

The wells have been surveyed, added to MN DNR's databases, and added to the NGWMN well registry. Two of the wells have been instrumented with pressure transducers and data loggers, so they are providing hourly water level data to the network. The three wells that are not instrumented are measured by hand approximately 8 times per year until they can be instrumented later in 2024.

Description of Work

The first steps of the project involved coordinating and scoping final well site selection. Underground utilities were located to reveal any buried utility lines or other limitations at the drill site. A permit was obtained for the drill site to ensure long-term access and clarify well ownership.

The bedrock drilling portion of the project was then assembled and sent out for bid. Bids were returned in January 2022. The MN DNR hired the licensed well contractor Traut Companies, from St. Joseph, MN to drill the four bedrock wells. The roto-sonic drilling method was specified for the high-quality cuttings samples and to temporarily case off the thick layer of surficial sand and gravel materials while drilling.

The first well to be drilled was the Prairie du Chien-Shakopee well, which began on 11/15/2022. The unconsolidated Quaternary material drilled as expected. However, at 193 feet, the drill crew encountered St. Peter Sandstone, which was thought to be absent at this location. First estimated bedrock was expected to be the Prairie du Chien Group at 240 feet deep. See Figure 2 (below) for a photograph of the roto-sonic cores recovered from this borehole, including cores of the St. Peter Sandstone.

Figure 2: Continuous drill cores recovered using the roto-sonic drill method. Note the footages are labeled on the bags; the 200ft to 210ft interval is at the top of the photo, and 250ft to 260ft interval is near the bottom.

The St. Peter Sandstone ended up being present from 193-244 feet. This sandstone is a soft, clean, fine-grained sandstone notorious for locking up sonic drill casings when using the roto-sonic drill method. The drill crew was able to successfully complete this well with some minor adversity, but because of the problematic St. Peter Sandstone, the roto-sonic method was no longer appropriate to use for the remaining bedrock wells. MN DNR revised the project details and switched the drill method for the remaining bedrock wells to Dual Rotary/Reverse Circulation (DR/RC). The DR/RC drill rig arrived on site in February 2023 and spent the next 2 months installing the 3 remaining bedrock wells without issue.

Drill cuttings were examined in the field and later bagged and submitted to the Minnesota Geological Survey (MGS) for detailed interpretation. The wells were also gamma-logged by the MGS to help identify the different stratigraphic units present at the site. This information was used to help inform where to place the bottom of the well casing and open hole intervals.

The MN DNR drill crew installed the unconsolidated Quaternary well in May 2023. This well was installed using the hollow auger drill method. Drill cuttings and sediment saturation levels were examined in the field as the drilling progressed, which helped to identify where to place the screened interval of the well.

All five wells were constructed according to Minnesota Department of Health (MDH) rules for well and boring construction. See Figure 3 (below) for a cross-sectional diagram of how the bedrock wells were constructed.

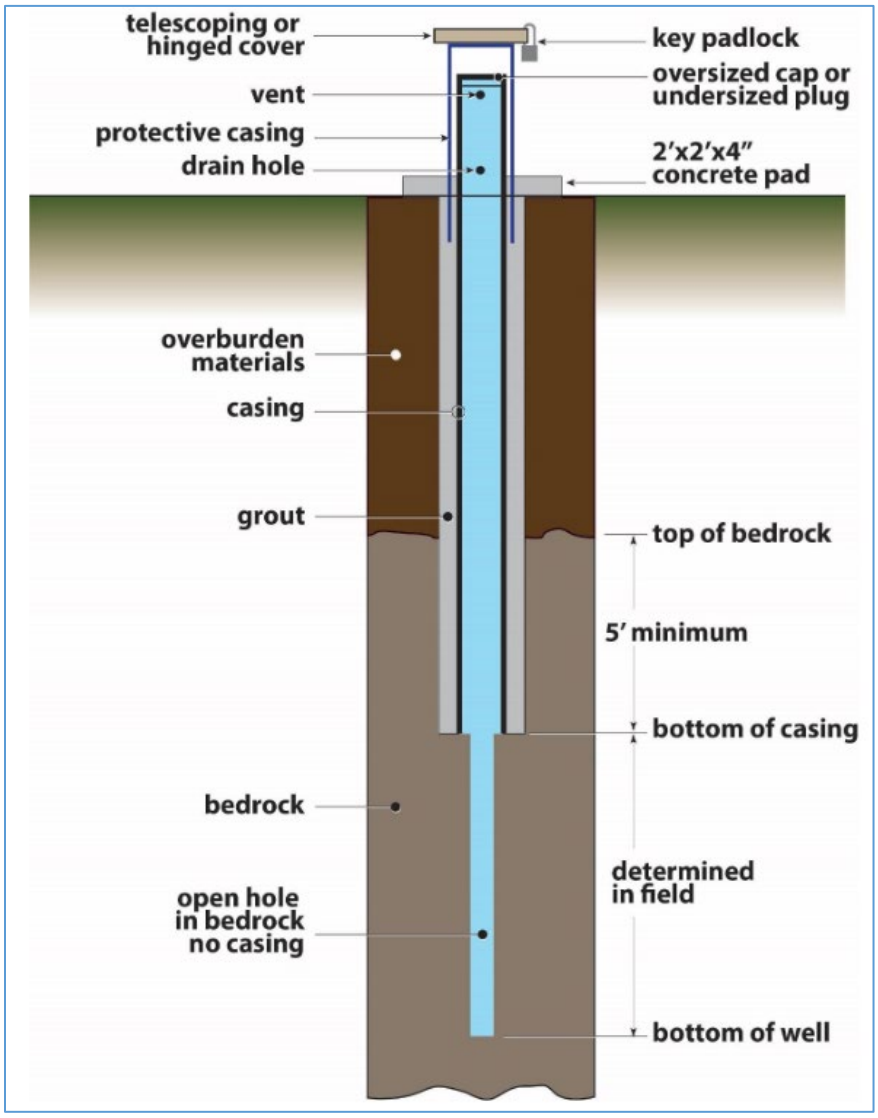

Figure 3: Diagram of typical observation well construction into bedrock. Source: Pennsylvania DEP

Drilling and installation of the five wells and final site clean-up was completed by June 2023. See Table 1 (below) for specific details of the wells.

New Wells Added to the NGWMN Network				
NGWMN Site Number	Geologic Formation	Principal Aquifer	Depth (ft)	Replaces Well #
877500	Wonewoc Sandstone	Cambrian-Ordovician	699	216060
870126	Tunnel City Group-Mazomanie Sandstone	Cambrian-Ordovician	540	
870127	Jordan Sandstone	Cambrian-Ordovician	440	203542
870128	Prairie du Chien-Shakopee Dolomite	Cambrian-Ordovician	300	
867063	Quaternary (Glacial drift)	Sand and Gravel	64	

Table 1: New wells added to the NGWMN network through this project.

Well logs and construction records were completed for all the new wells (see Figure 4 (below) for an example). In addition, a survey-grade GPS was used to record the location of the wells and determine the ground elevation and the measure-point elevation at the top of the well casing.

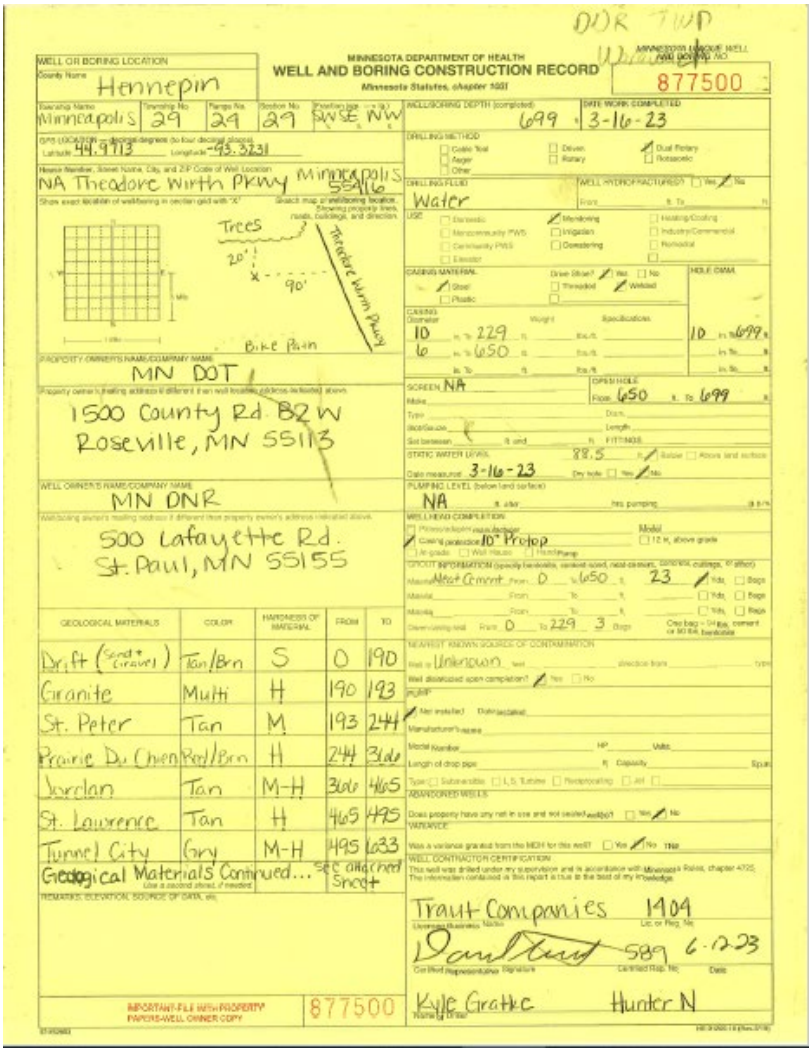

Figure 4: A completed well construction record for NGWMN Site #877500.

Water levels in the wells were measured using a calibrated electronic tape. The measured water levels from all five wells (through October 2023) are shown in Figure 5 (below). The water levels in all five wells show a generally downward vertical gradient; however, the Jordan Sandstone water level and the Tunnel City Group water level show a reverse gradient for several months during the summer season. Installing comprehensive well nests like this shows the hydraulic gradient of various aquifers across confining layers and how they interact with each other through time.

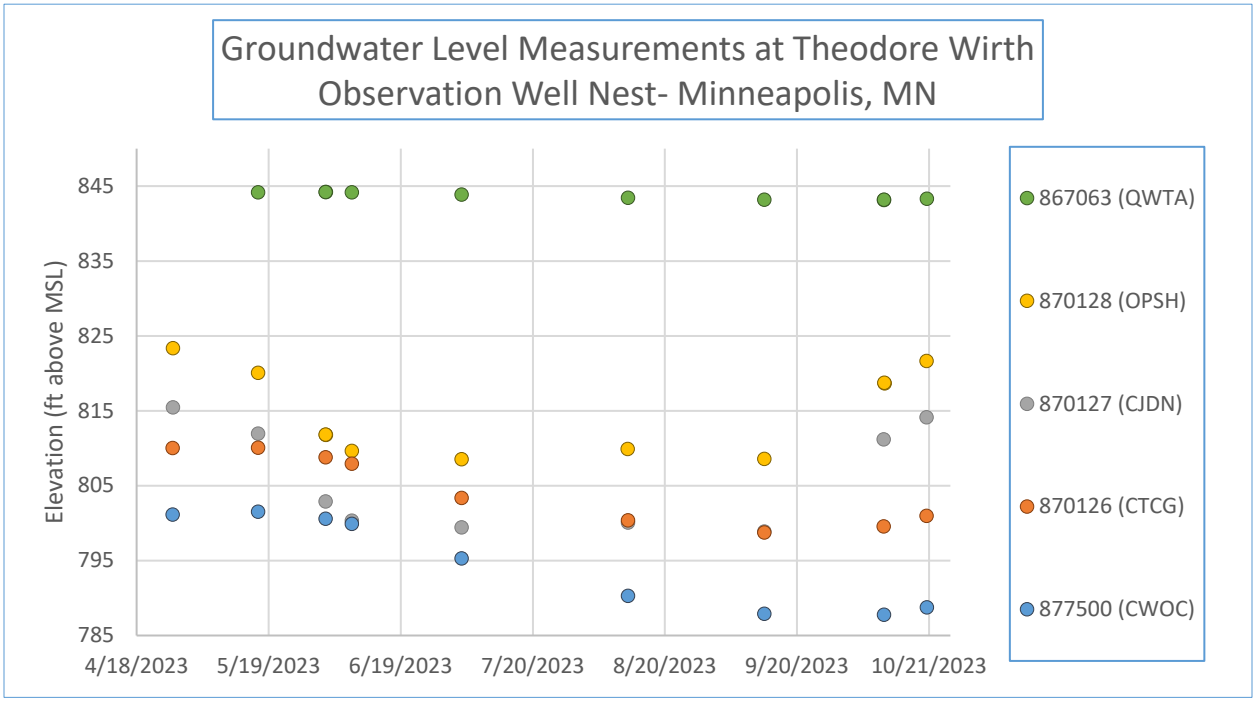

Figure 5: A graph displaying the water level measurements collected up until October 2023 at the project site.

Some of the wells received a pressure transducer/data logger for recording hourly water levels. The loggers will be visited quarterly by the MN DNR (or their partners) to manually measure the water levels and download the data. Data are then uploaded into the MN DNR's database, where they are reviewed and approved by staff before going to the MN DNR's Cooperative Groundwater Monitoring website (https://www.dnr.state.mn.us/waters/cgm/index.html) and to the NGWMN Data Portal website.