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# Establishment of a Groundwater Monitoring Network in Sugar Grove Township, Kane County, IL

Letter Report to Sugar Grove Water Authority

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**Introduction and Background**

Groundwater is the sole source of water for communities and homeowners in Sugar Grove Township. Several different aquifers, which vary by geologic material, extent, and depth, provide groundwater to both domestic and municipal wells. Understanding the local geology and hydrogeology (how groundwater moves though geologic material) is thus essential for long-term planning of sustainable water use in Sugar Grove Township.

There are two major bedrock valleys in Sugar Grove Township: the St. Charles Bedrock Valley in the northwest portion of the township, and the Aurora Bedrock valley in the central portion of the township (Figure 1). These bedrock valleys formed by downcutting and erosion of local streams prior to glacial advances. Once glaciers advanced over the landscape, these bedrock valleys filled in with a mix of unconsolidated material consisting of clays, silts, sands, and gravels. Portions of these filled-in bedrock valleys serve as important aquifers where they are highly transmissive (capable of transmitting water readily under a hydraulic gradient), which usually occurs where sand and gravel is thick and laterally extensive. Wells that are screened into the glacial sand and gravel deposits are referred to as “sand and gravel” wells.

The upper bedrock units that underlie the glacial material throughout the township consists of the Silurian Dolomite and the Maquoketa Shale (Figure 2). The Silurian Dolomite is the uppermost bedrock unit and is not laterally continuous due to pre-glacial erosion. The underlying Maquoketa Shale is exposed at the bedrock surface where the Silurian Dolomite is completely eroded away. The Silurian Dolomite unit was subjected to considerable erosion and dissolution prior to glaciations, creating fractures and secondary porosity in which water can readily flow through. Erosion occurred to a lesser degree for the Maquoketa Shale because it is the deeper of the two units and is less susceptible to dissolution because it is primarily composed of shale. Thus, wells open to the Silurian Dolomite are typically more productive than wells open to the Maquoketa Shale. Regionally, the Maquoketa Shale is an important aquitard that separates shallow aquifers from deeper aquifers. Wells open to either of these bedrock units are referred to as “shallow bedrock” wells. Due to variability of fracturing and secondary porosity in the shallow bedrock units, well yields can be highly variable.

Underlying the shallow bedrock units is the St. Peter and Ironton-Galesville Sandstones, which together make up the Cambrian-Ordovician Sandstone aquifer. The sandstone aquifer is an important regional aquifer that is utilized by many high-capacity municipal and industrial wells in the region. Wells open to either or both sandstones are referred to as "Cambrian-Ordovician sandstone" wells. Domestic wells and municipal wells throughout the township (including wells operated by the town of Sugar Grove) utilize all three of these aquifers (Figure 3).

**Motivation and Scope of Study**

Water supply issues are currently a concern for the Cambrian-Ordovician sandstone aquifer throughout Kane, Kendall, and Will Counties. In the southeastern portion of Kane County, the St. Peter Sandstone is at-risk of desaturation under pumping level conditions (Abrams et al. 2015). Current trends indicate that water levels in the St. Peter Sandstone will continue to decline and should be monitored in the long term. In Sugar Grove Township there has been 300-600 feet of water level decline in the sandstone aquifer due to regional and local withdrawals (Figure 4), however there have been no disruptions to wells open to the sandstone aquifer to date in the township.

There has been minimal to no regional drawdown in the sand and gravel aquifer or the shallow bedrock aquifer throughout the township, but this could occur if withdrawals increase to meet the demand of a growing population, or if withdrawals have to be allocated to shallower aquifers as the Cambrian-Ordovician sandstone aquifer is depleted. The most recent water demand forecast developed by the Chicago Metropolitan Agency for Planning (CMAP) indicates that the Village of Sugar Grove is expected to increase its water demand by 1 to 3 million gallons per day (MGD) (CMAP 2019a) which is an increase of over 25% out to 2050 (CMAP 2019b). This increase will likely add additional stress to the aquifers in the township. Water levels in the sand and gravel and shallow bedrock aquifers can also be affected if nearby wells are drilled into the St. Peter and are left uncased to the shallow aquifers. This provides a pathway for shallow groundwater to potentially drain into the sandstone aquifer, which may change water levels in both aquifers. While this has not been documented in Sugar Grove Township, it has occurred in nearby Campton Township (Hadley et al. 2020).

To assist with the long-term water supply planning and the evaluation of sustainability of current groundwater withdrawals in Sugar Grove Township, the Sugar Grove Water Authority (SGWA) and Illinois State Water Survey (ISWS) partnered to establish a shallow groundwater monitoring program that collects water level data in real-time at dedicated monitoring wells and at domestic wells. This shallow monitoring network was established starting in 2017 and is focused only on the shallow aquifers (sand and gravel and shallow bedrock) due to the availability of monitoring wells and the prohibitive cost of drilling a dedicated St. Peter monitoring well. The goals of establishing the groundwater monitoring network are to evaluate: 1) seasonal changes in the shallow aquifers, 2) longer-term (several year) water level trends, and 3) changes in water levels due to local withdrawals. Establishing the shallow groundwater monitoring program will also allow baseline conditions of the sand and gravel and shallow bedrock aquifers to be determined before there are future stresses on the system. Future stresses could include increased groundwater use due to development, land cover changes, or climate change. Projected climate change in the region is expected to cause wetter spring months followed by hotter and drier summers and an increase in droughts (Metropolitan Planning Council 2018), which will affect the timing and magnitude of aquifer recharge.

In addition to establishing a shallow groundwater monitoring network, the ISWS intended to locally recalibrate the Kane County groundwater flow model established by Meyer et al. (2009) using the data collected by this program. Specific goals were to modify aquifer and geologic properties in the flow model so that model outputs matched observed water level data gathered by this project. However, due to unforeseen budget restrictions, this portion of the project had to be left out of the scope of work and is not discussed further. Another goal of the project was to review the occurrence of existing wells being deepened into the St. Peter, which may indicate local supply issues, and add those wells into the Kane County groundwater flow model. However, the ISWS and the Illinois State Geological Survey had no records of this occurring in Sugar Grove Township.

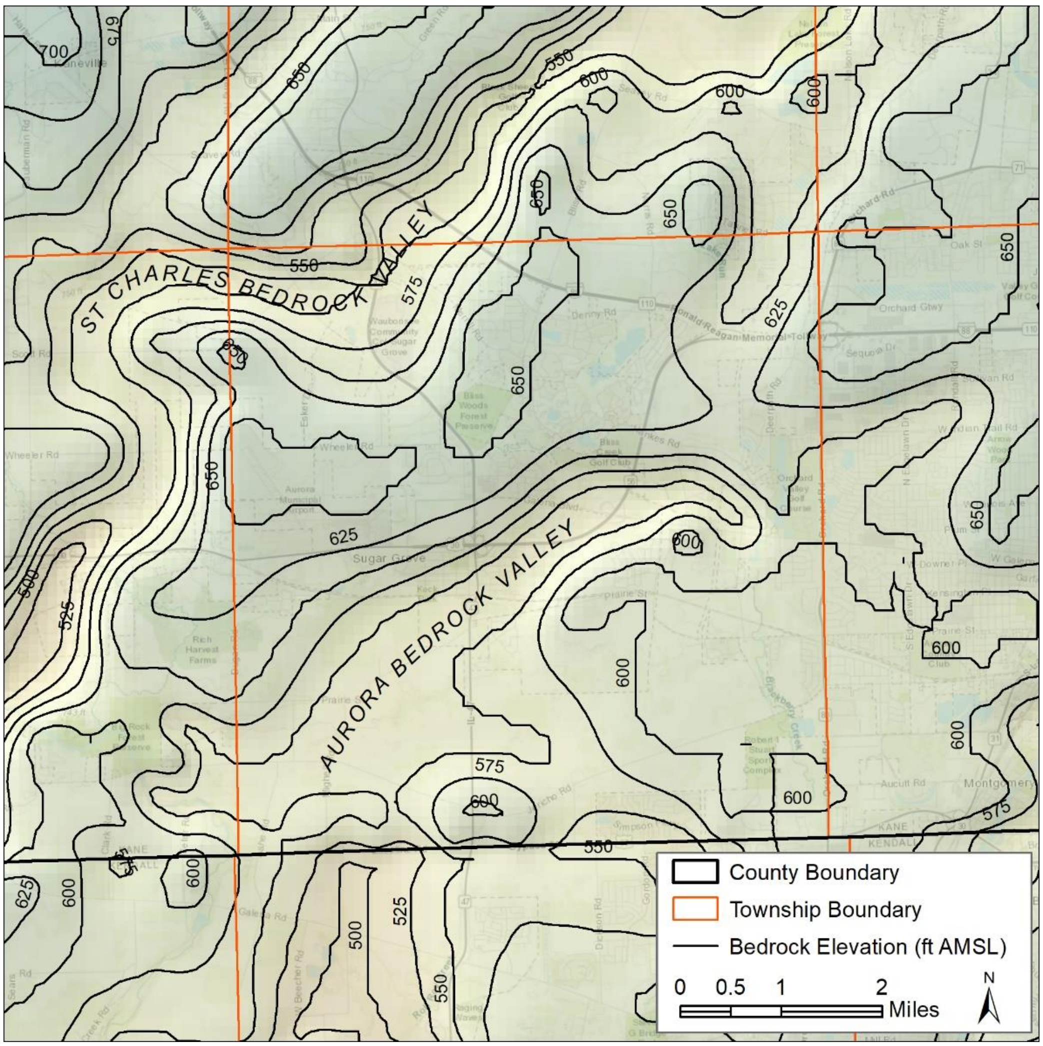


**Figure 1**. Map of bedrock topography in Sugar Grove Township (central township boundary) showing the major bedrock valleys.

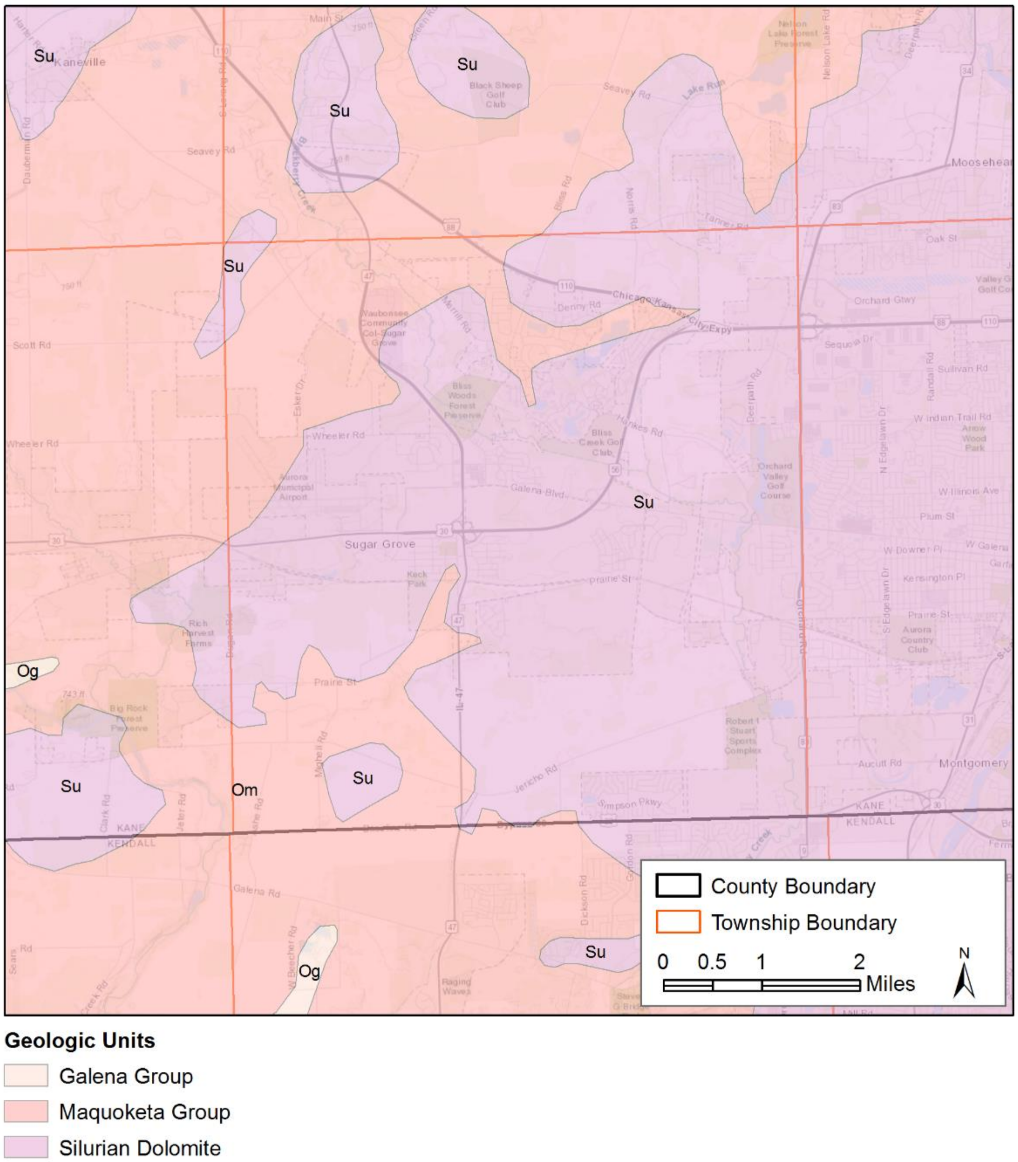


**Figure 2.** Map depicting the geologic units at the bedrock surface in Sugar Grove Township (central township boundary).

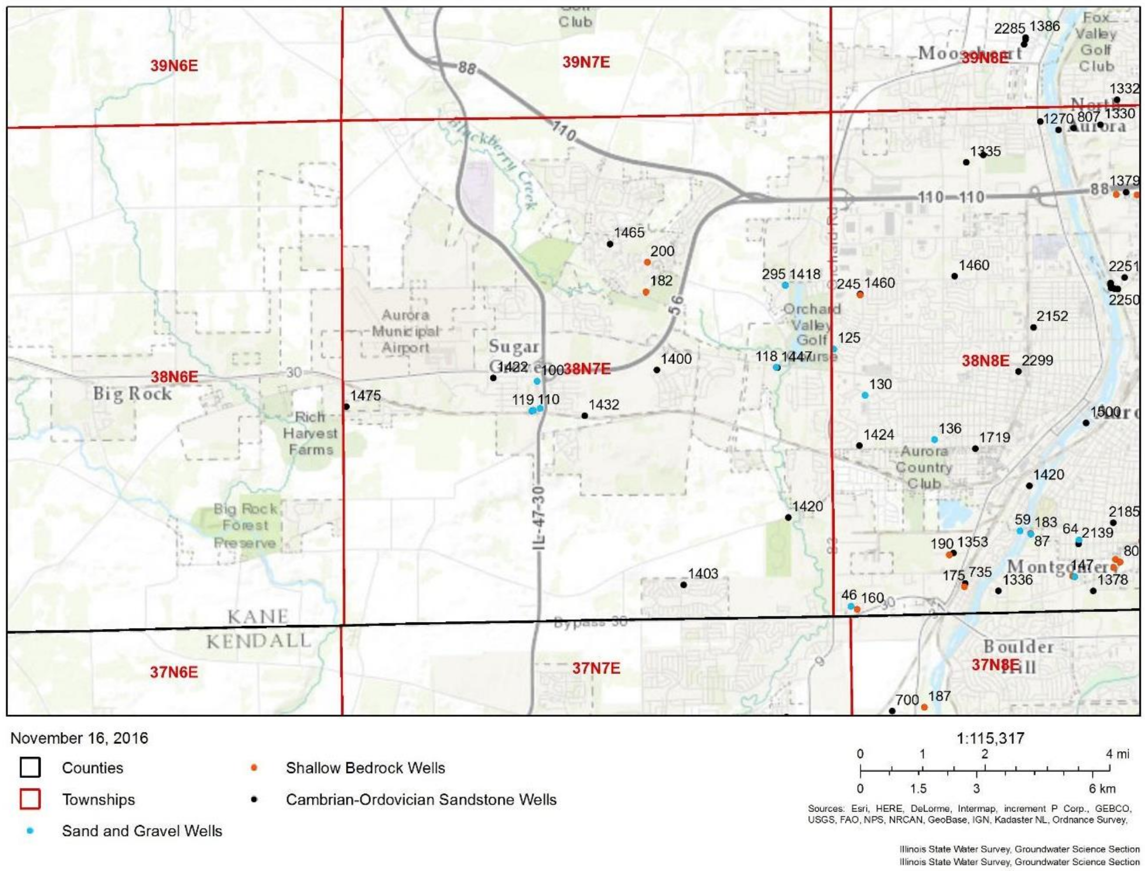


**Figure 3.** Community Supply Wells throughout Sugar Grove Township (central township boundary) and in neighboring townships. Numbers next to wells indicate well depth.

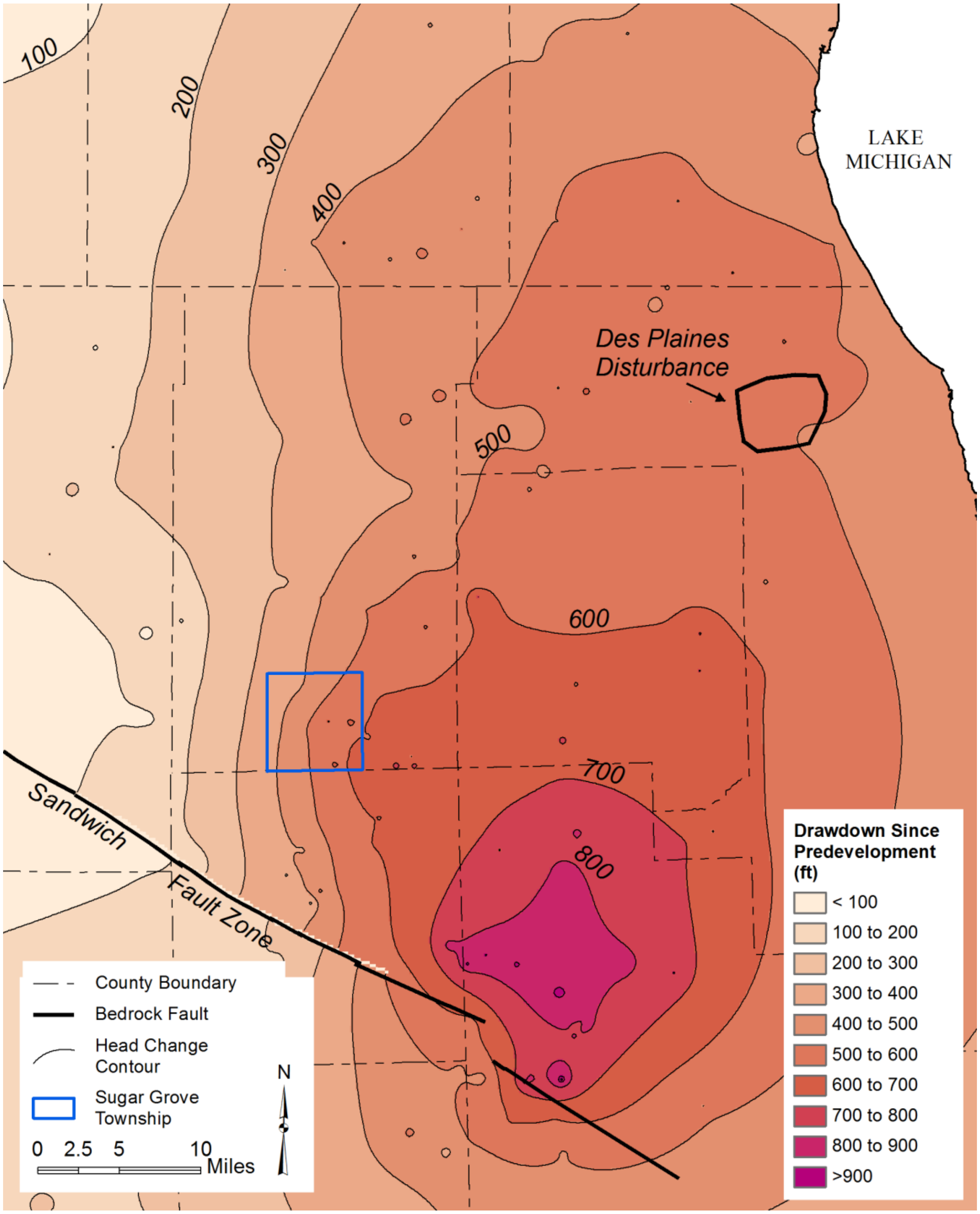


**Figure 4.** Drawdown in the St. Peter Sandstone aquifer since predevelopment conditions. Drawdown in Sugar Grove Township typically ranges from 300-600 feet.

**Establishment of Monitoring Well Network**

The shallow groundwater monitoring network was established starting in 2017 using mostly a mix of domestic wells (individual homeowners), wells owned by businesses or municipal entities, and dedicated observation wells. The ISWS worked closely with the SGWA to identify and assess these wells for long-term monitoring sites. Throughout the three-year study period, a total of six long-term monitoring sites were established (Table 1, Figure 5,) and outfitted with either Campbell Scientific pressure transducers and telemetry equipment or with Wellntel acoustic sensors. Pressure transducers are hung below the water level in the well and read pressure of water above the sensor on an hourly basis. The pressure is then converted to a depth to water, readings are stored on a datalogger, and data is sent to the ISWS office via a cellular modem. Near-real time water levels (within the hour) are displayed as interactive hydrographs on the ISWS webpage developed for this project at: https://www.isws.illinois.edu/groundwater-science/groundwater-monitoring-well-networks/sugar-grove-township.

Acoustic sensors operate by sending an acoustic sound pulse down the well, which hits the water surface in the well casing and bounces back up and is detected by a small microphone. The travel time of the sound wave is converted to a depth to water. The readings are sent from the sensor to the homeowner's modem via a radio signal and readings are uploaded to the Wellntel website. The sensors also detect when the well is turned on/off via a current reader which prompts the sensor to take a reading at the start and end of a pumping cycle. When the pump is not running, timed readings are taken every 4 hours by default.

Although the acoustic sensors are a non-invasive method for water level detection, it is a relatively new technology that has several limitations:

1. Acoustic signals can be noisy resulting in anomalous readings. For example, the acoustic waves may not be read by the microphone upon first return, resulting in water levels that are much deeper than the true water levels. Conversely, acoustic waves can bounce off pump cables, ledges, or other protrusions and send a signal back too early, resulting in water level readings that are too shallow. These anomalous readings resulted in a noisy hydrograph at Site 1 (Elliott well). We also observed instances of "pump off" readings that were higher than static water levels, even though these reading should be recording the lowest water levels during the pumping cycle. This indicated that the timing of pump on/off readings may be off at certain times.
2. Short battery life or interruptions to internet service can cause disruptions to data collection, as was the case with using these in Campton Township (Hadley et al. 2020), however this did not occur often at the Elliott well.
3. Data is only accessible via the Wellntel proprietary website or is sent as spreadsheets upon request. The Elliott well is therefore not displayed as a live hydrograph on the ISWS website.

**Table 1**. List of monitoring wells and well attributes in Sugar Grove Township. Dashes indicate no data available.

| Site | Well Name | Well Type | Well Depth (ft) | Aquifer | Year Drilled | Depth to water (ft) when drilled | Sensor Type |
|---|---|---|---|---|---|---|---|
| 1 | ELLIOTT, JERRY | Private-domestic | 100 | Shallow bedrock | < 1991 | 10 | acoustic |
| 2 | AURORA MUNICIPAL AIRPORT | Municipal | 204 | Shallow bedrock | 1960 | 18 | transducer |
| 3 | HEARTLAND DRIVE | Private-industrial | 165 | Shallow bedrock | - | - | transducer |
| 4 | ISGS-HANNAFORD TRAIL | Observation well | 116 | Sand and gravel | 2003 | - | transducer |
| 5 | SUGR-18-03 | Observation well | 122 | Sand and gravel | 2018 | 27 | transducer |
| 6 | RATOS, JIM & MARY | Private-domestic | 300 | Shallow bedrock | 2019 | 52 | transducer |

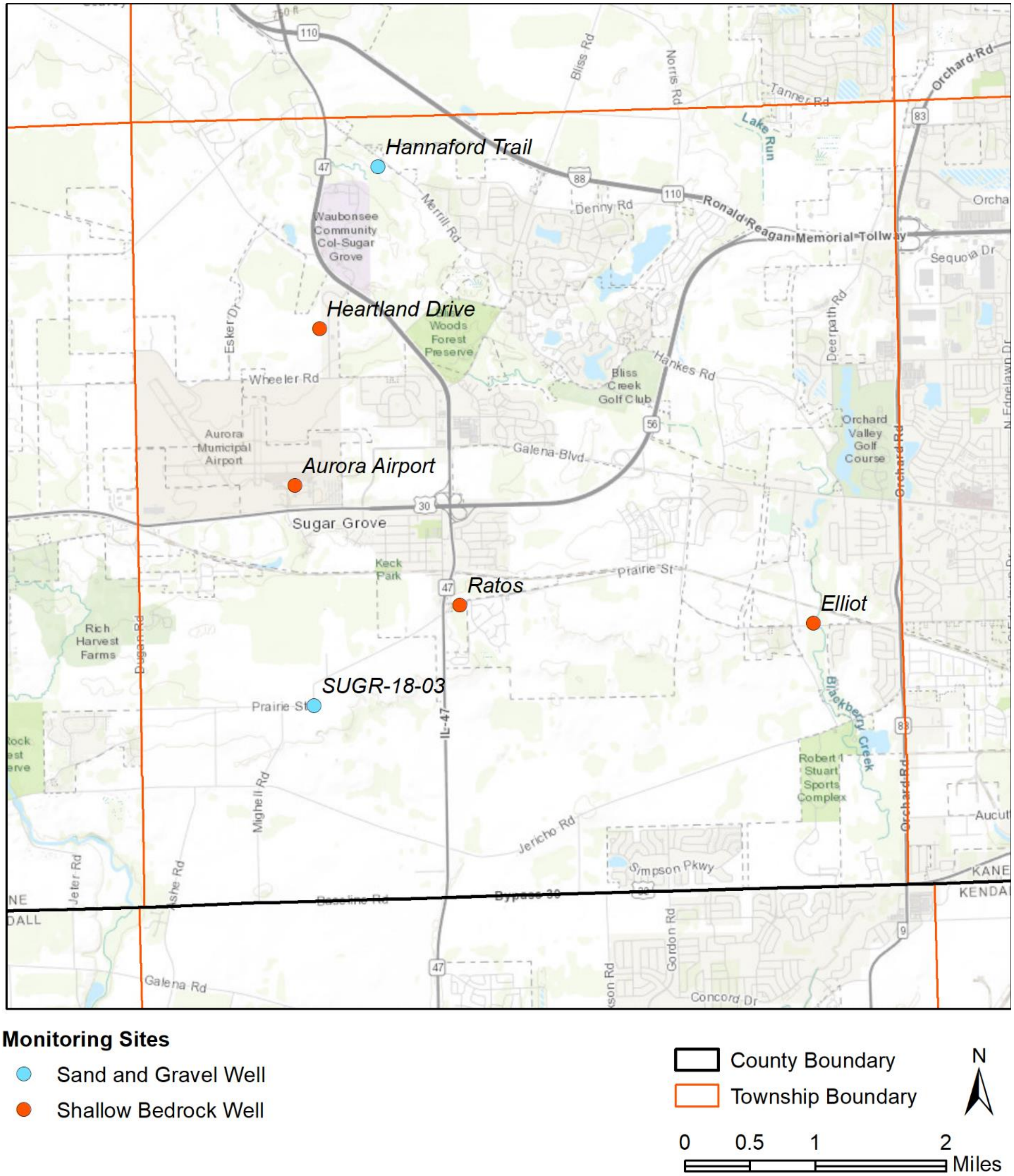


**Figure 5**. Map of monitoring wells in Sugar Grove Township.

**Monitoring Wells and Hydrographs**

The following section presents well construction information and hydrographs for each monitoring well established for this project. Water levels were plotted with daily rainfall amounts as recorded at the USGS Blackberry Creek gaging station near Montgomery (USGS gaging station 05551675), which is the nearest reliable precipitation data in the area that we are aware of. Rainfall was included in these hydrographs to see the relative relationship between rainfall levels and response of the aquifers, if any, at the monitoring wells. This comparison gives indication of how fast the aquifers may be recharging by precipitation and the degree of confinement of the aquifer. However, for the Elliott well, steam stage was plotted instead of rainfall because this site is very close to Blackberry Creek (< 150 feet away) and it was assumed that there is a strong hydraulic connection between the creek and the shallow bedrock aquifer.

*Elliott Well*

The Elliott well is a privately owned well drilled prior to 1991. The ISWS does not have a well log on file, but there is a record of well servicing (see Appendix for service record) that indicates that this well is 100 feet deep and open to the Silurian Dolomite (shallow bedrock aquifer). The Elliott well is the only monitoring site where a WellIntel acoustic sensor was used exclusively to monitor groundwater levels because the presence of a pitless adapter in the well prevented a transducer from being used. It was also prudent to use an acoustic sensor as to not interfere with the pump within the well. Using the acoustic sensor also allowed water levels to be taken based on the timing of pumping cycles. The Elliott hydrograph is shown in Figures 6-9. The acoustic sensor was installed February 2017.

Several different trends and aquifer responses are observed at this monitoring well. There is: 1) the long-term trend over a weekly/monthly basis that is closely associated with trends in Blackberry Creek stage, 2) the sharp increases in groundwater elevation as a result of storm events and periods of higher stage in Blackberry Creek, 3) the sharp but temporary drawdowns (less than an hour in duration) associated with pumping cycles at the well itself, and 4) the drawdowns of several feet due sustained over several weeks due to withdrawals at the nearby Aurora 101 municipal sand and gravel well (Figures 8, 9).

In general, the shallow bedrock aquifer at this site responds rapidly to storm events on Blackberry Creek and mimics the conditions of Blackberry Creek. The elevation of Blackberry Creek near the Elliot well is around 633 feet above mean sea level (AMSL) which is very similar to the groundwater elevations measured in this well (Figures 6, 7). The similar elevations and response of the aquifer to stream conditions indicates that Blackberry Creek and the shallow bedrock aquifer have a strong hydraulic connection in this area of the township. This is not too surprising, considering that the unconsolidated glacial material is thin at this location (less than 30 feet thick according to the neighboring well log at 39W664 Prairie Street) and consists of mostly sand and gravel. This thin deposit of sand a gravel provides a ready pathway for groundwater to move between the streambed of Blackberry Creek and the shallow bedrock unit. The unconsidered glacial material thickens to the north of the Elliott well since that is where the upper end of the Aurora Bedrock Valley extends to (Figure 1). This upper end of the bedrock valley is where the Aurora 101 well is located (Figure 3) (southwest of the Orchard Downs golf course). We were surprised to see that withdrawals from the Aurora 101 sand and gravel well, which typically pumps at 700 gallons per minute (gpm) for several weeks at a time, caused immediate drawdowns of several feet at the Elliott well (Figures 8, 9). Recovery of groundwater elevation also occurred rapidly at the Elliott well once Aurora 101 was shut off. This rapid repose at the Elliott well indicates that the shallow sand and gravel aquifer has a strong hydraulic connection with the shallow bedrock aquifer and that the two aquifers behave very similarly. Depth to water at the Elliot well is typically around 10-11 feet, which is a similar depth to water reported when the well was serviced. Over the period or record since 2017, there is no clear upward or downward trend in groundwater levels, but simply seasonal changes through time.

The hydrograph is quite noisy due to anomalous readings of the acoustic sensor. In April of 2019, there was a significant downward shift in water levels of around 10 feet, however the Aurora 101 well was not running during this time (Figure 9). This anomalous downward shift is most likely due to inaccuracies of the acoustic sensor and not because of withdrawals at the well itself or at nearby wells. Some manual hand measurements also do not match the output from the acoustic sensor indicating that these sensors are less accurate than pressure transducers and are prone to more drift.

*Aurora Municipal Airport Well*

The Aurora Municipal Airport well is an unused bedrock well drilled in 1960 to a depth of 204 feet and is open to the Silurian Dolomite (see Appendix). A pump is installed within the well, but it is disconnected and never turned on. A temporary pressure transducer and Wellntel unit were installed in the fall months of 2017, but then a dedicated transducer and telemetry station was installed in February 2018. Only the continuous telemetry data is shown in Figure 10.

The hydrograph indicates that shallow bedrock water levels respond rapidly to most rainfall events, although the magnitude of response is variable. In other words, sometimes it rains heavily and there is a sharp increase in groundwater levels and sometimes large rainfall events produce only small increases in groundwater levels. This may be due to antecedent soil conditions prior to the rainfall events. Nevertheless, groundwater levels fluctuate by several feet throughout each year. Water levels are typically highest in spring months due to high precipitation amounts, and thus higher recharge rates, and are lowest in the late summer and early fall months due to drier conditions. The highest groundwater elevation was recorded on 5/31/2019 following a period of significant rainfall. There is no signature of any nearby pumping affecting this well and thus is generally influenced only by seasonal precipitation patterns. Over the 2.5 year period of record with continuous data, there is no clear upward or downward trend in groundwater elevations. Depth to water at this well is typically less than 15 feet deep from the point of measurement (top of well casing) which is shallower than the depth to water when drilled (18 feet).

*Heartland Drive Well*

The Heartland Drive well is a privately owned well previously used for a business but is no longer used. There is still a pump installed, but the pump does not run. The ISWS does not have a well log for this well, but the total depth of this well was measured at 165 feet deep using an electric dropline. Given the measured overall well depth, we assume this well is open to the Silurian Dolomite. The Heartland Drive hydrograph is shown in Figure 11. A pressure transducer and telemetry station were installed in May 2018.

The hydrograph at Heartland Drive is very similar to the Aurora Municipal Airport hydrograph. This is unsurprising, considering that the two monitoring wells are close spatially (within 1.5 miles) and they are open to the same aquifer. Groundwater elevations are around 15 feet higher at this site in comparison to the Aurora Airport well, but this can be attributed to the difference in land surface elevation. Land surface elevation is higher at this site (718 feet AMSL) in comparison to the Aurora Airport well (703 feet AMSL), which is a difference of 15 feet. Similar to water levels at the Aurora Airport well, groundwater elevations at the Heartland Drive well are highest in the spring months are lowest in the late summer and early fall months. There is no signature of nearby groundwater withdrawals affecting water levels at this monitoring well.

*Hannaford Trail Well*

The Hannaford Trail well is a dedicated monitoring well that was drilled in 2003 by the Illinois State Geological Survey (ISGS) as part of a geologic mapping program. The well is located on Kane County forest preserve property (Hannaford Trail Forest Preserve) and is open to the glacial sand and gravel aquifer within the St. Charles bedrock valley (Figure 1). The well is 116 feet deep (see Appendix). Water levels have not been measured since the time of drilling. A pressure transducer and telemetry station were installed in May 2019 and the hydrograph is shown in Figure 12. A research agreement was made between the ISWS and the Kane County Forest Preserve District to install this equipment on their property.

Overall, the hydrograph at this site is remarkably similar to the hydrograph at the Heartland Drive site (which is open to the shallow bedrock aquifer). Both sites are at land surfaces elevations of around 718 feet AMSL and both sites have very similar groundwater elevations. The sand and gravel aquifer at this site responds rapidly to rainfall events and shows a pattern of high groundwater levels in the spring months and low groundwater levels in the late summer and early fall months. The fact that both the Hannaford Trail and Heartland Drive sites have very similar groundwater levels and responses to rainfall events indicates that the two different aquifers are behaving very similarly and that there is a strong hydraulic connection between these two aquifers in the northern portion of Sugar Grove Township. In terms of geology this makes sense, since the sand and gravel deposits that this well is open to is probably in direct hydraulic communication with the Silurian Dolomite formation via fractures and secondary porosity.

The Hannaford Trail hydrograph also shows small daily drawdown events for several hours each morning. This drawdown is typically less than a foot but can be several feet at times. The uniform pattern of drawdown indicates that there is a nearby well that runs on a scheduled basis which produces this small drawdown response. This could very likely be due to a sand and gravel well at the nearby Waubonsee Community College that may be scheduled to run daily.

*SUGR-18-03 Well*

The SUGR-18-03 (S-curve) well is a dedicated monitoring well that was drilled in the fall of 2018 under the National Groundwater Monitoring network program, funded via the US Geological Survey. The goal of the drilling program was to increase the number of monitoring wells within the bedrock valleys in Kane County, which includes this site and others outside of Sugar Grove Township. The ISGS conducted the well drilling. The well is 122 feet deep and is open to a very thin (approximately 3 feet thick) sand and gravel lens at the base of the Aurora bedrock valley (Figure 1). The well log indicates that this thin sand and gravel lens in overlain by dense clays and silts that are around 70 feet thick (see Appendix). A transducer and telemetry station were installed in April 2019 and the hydrograph is shown in Figure 13.

The hydrograph differs from the previous monitoring well hydrographs in that there is a much more muted response to rainfall events. The sand and gravel aquifer at this site has similar trends to the other monitoring sites in that groundwater levels are highest in spring months and lower in fall and winter months but differs in how rapid the aquifer responds to precipitation. The muted response at this site indicates that either the sand and gravel lens is not laterally continuous and is somewhat isolated, or that there is very little permeability in the overlying glacial clays which prevents recharge from readily entering the thin sand and gravel aquifer at this location. There is no clear upwards or downwards trend overall, but the period of record is fairly short (only 1.5 years).

*Ratos Well*

The most recent monitoring well established for this project is the Ratos well. The Ratos well was drilled in 2019 and is a privately owned domestic well. The well is 300 feet deep and is open to the Silurian Dolomite and Maquoketa Shale bedrock units (see Appendix). The well is fairly large in dimeter and lacks a pitless adapter, which allowed installation of a pressure transducer. The transducer and telemetry station were installed in November 2019 and the hydrograph is shown in Figure 14.

The hydrograph shows seasonal trends similar to the previous hydrographs, but also shows drawdown events occurring as a result of the pump cycling on throughout each day. Groundwater elevations are steady in the winter and early spring months and increase in May due to more rainfall. Groundwater levels have since declined in summer months in response to drier conditions. The more muted response to rainfall also indicates that the shallow bedrock aquifer is not recharged here as rapidly in comparison to the Aurora Airport or Heartland Drive sites. Groundwater elevations are lowest at this site in comparison to the other 5 monitoring wells, perhaps because this is the deepest of the monitoring wells and is open to a deeper section of the shallow bedrock aquifer. Up to 6 feet of drawdown occurs when the pump is running, but there is rapid recovery in the well once the pump is cycled off. There is no clear upwards or downwards trend overall, but the period of record is fairly short (only 9 months).

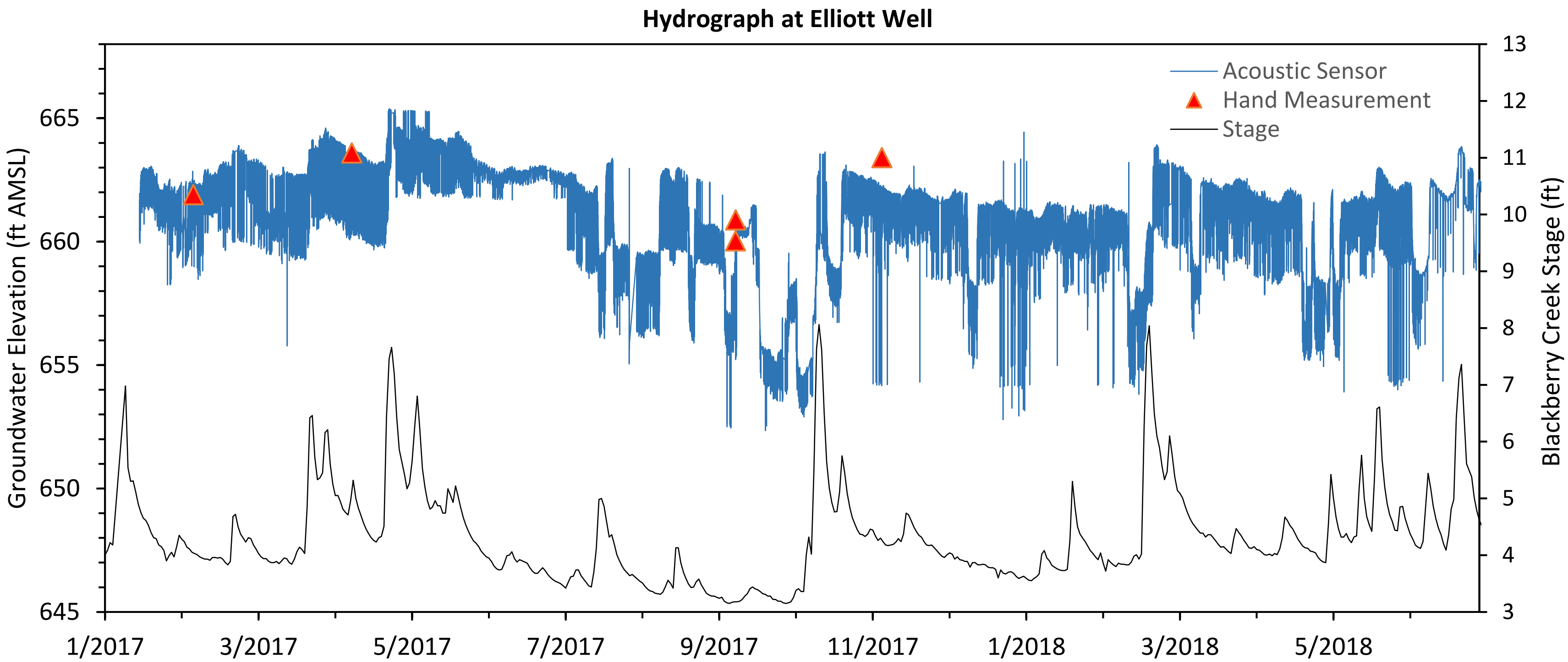


Figure 6. Hydrograph for the shallow bedrock aquifer at the Elliott monitoring well from February 2017 to July 2018.

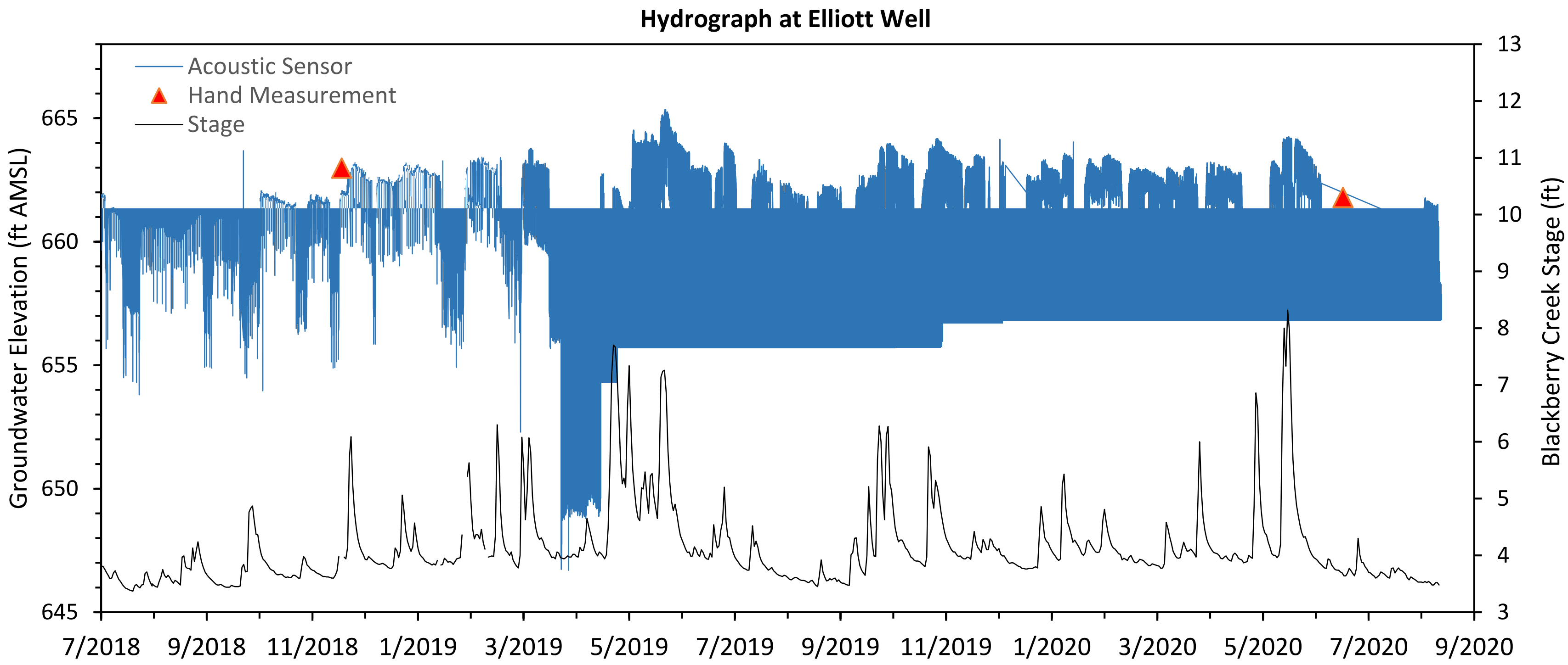


Figure 7. Hydrograph for the shallow bedrock aquifer at the Elliott monitoring well from July 2018 to present

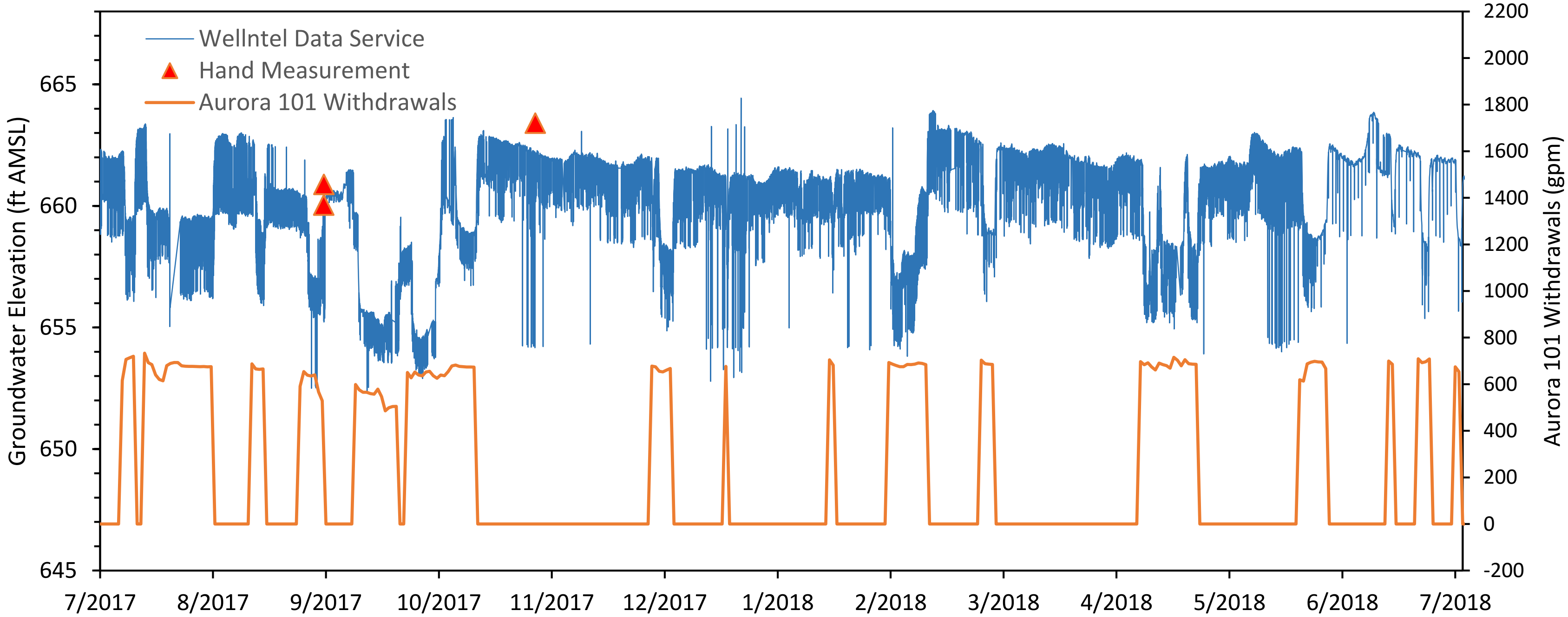


Figure 8. Hydrograph for the shallow bedrock aquifer at the Elliott monitoring well from July 2017 to July 2018 showing the influence of withdrawals occurring at the nearby Aurora 101 sand and gravel well. Note the corresponding drawdown during each pumping cycle of the Aurora 101 well.

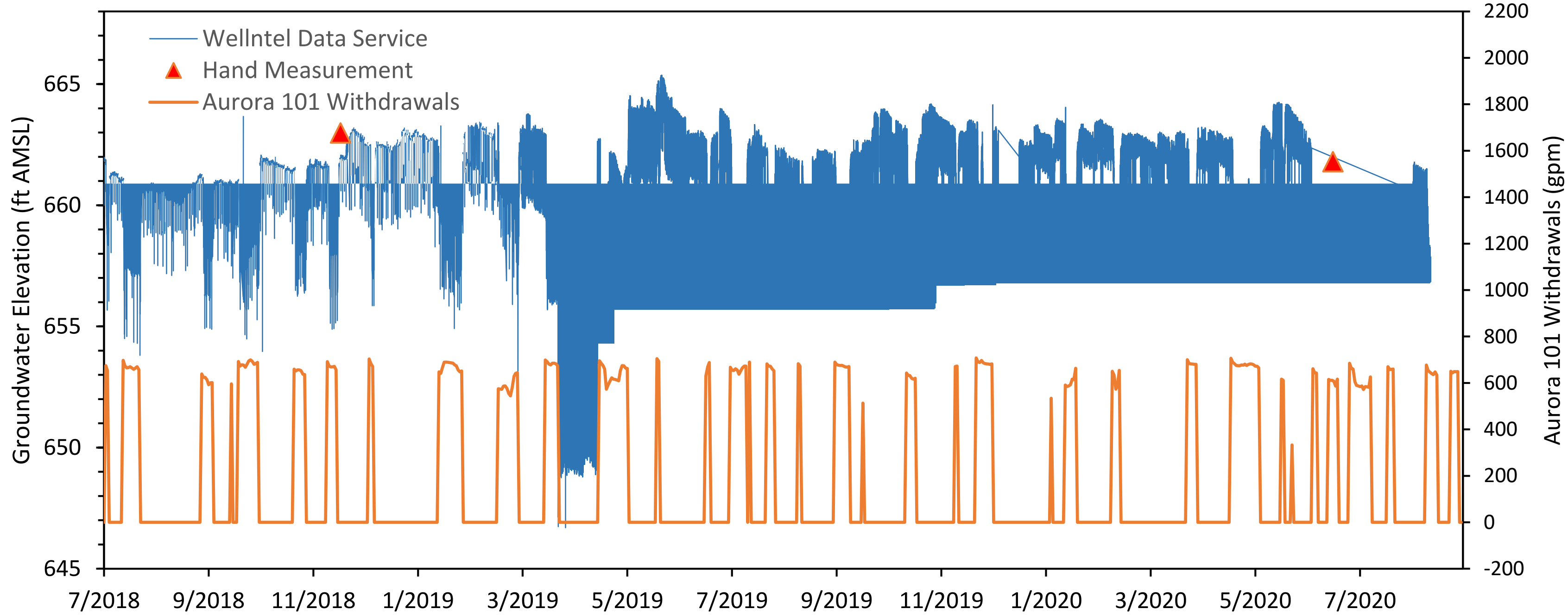


Figure 9. Hydrograph for the shallow bedrock aquifer at the Elliott monitoring well from July 2018 to August 2020 showing the influence of withdrawals occurring at the nearby Aurora 101 sand and gravel well. Note the corresponding drawdown during each pumping cycle of the Aurora 101 well. The large downshift in water levels in April 2019 was likely due to anomalous senor readings since Aurora 101 was not running at the time.

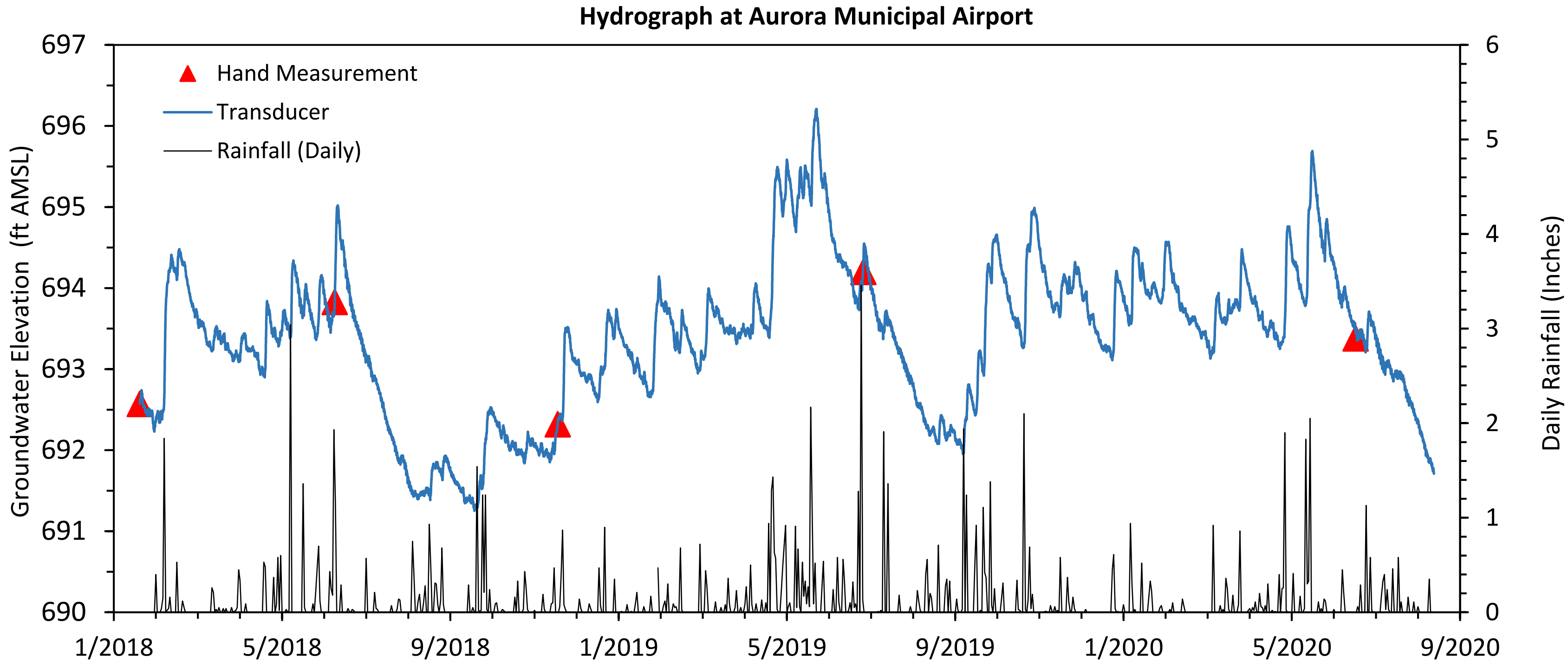


Figure 10. Hydrograph for the shallow bedrock aquifer at the Aurora Municipal Airport monitoring well.

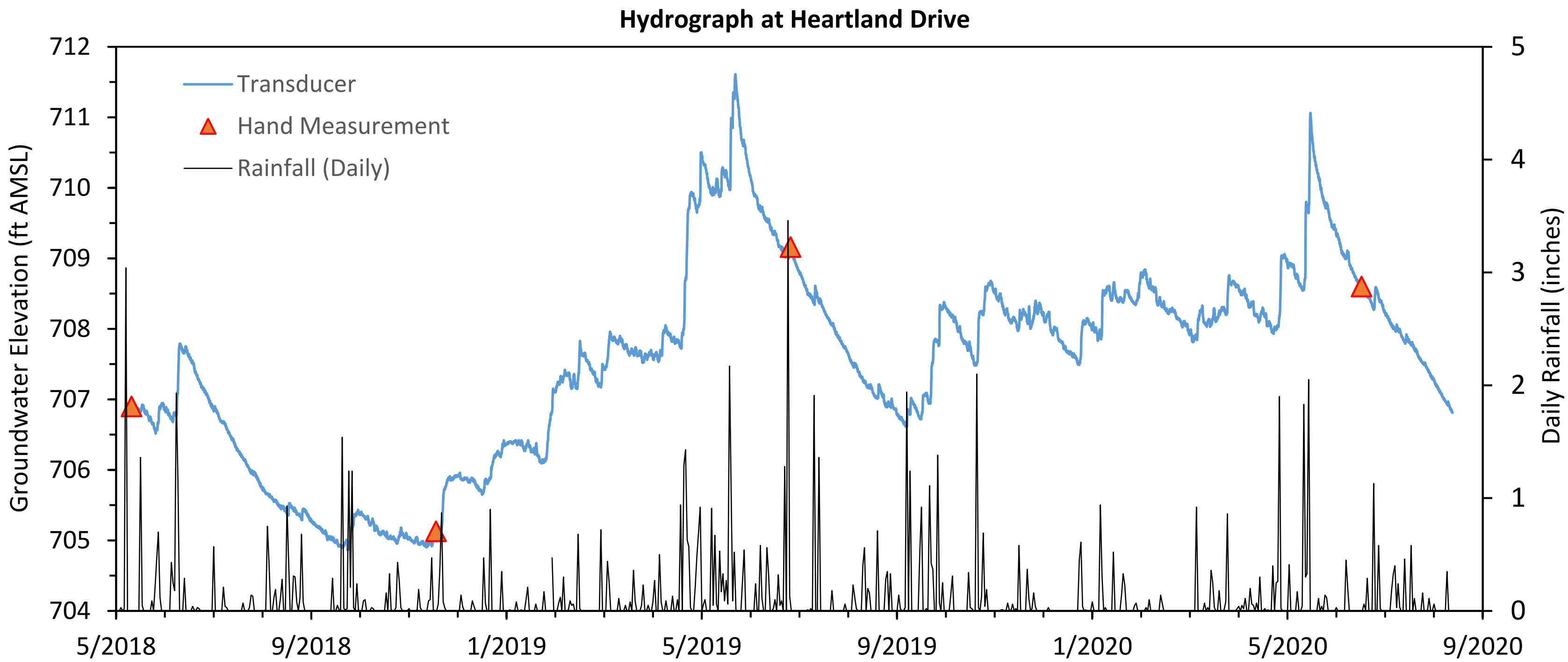


Figure 11. Hydrograph for the shallow bedrock aquifer at the Heartland Drive monitoring well.

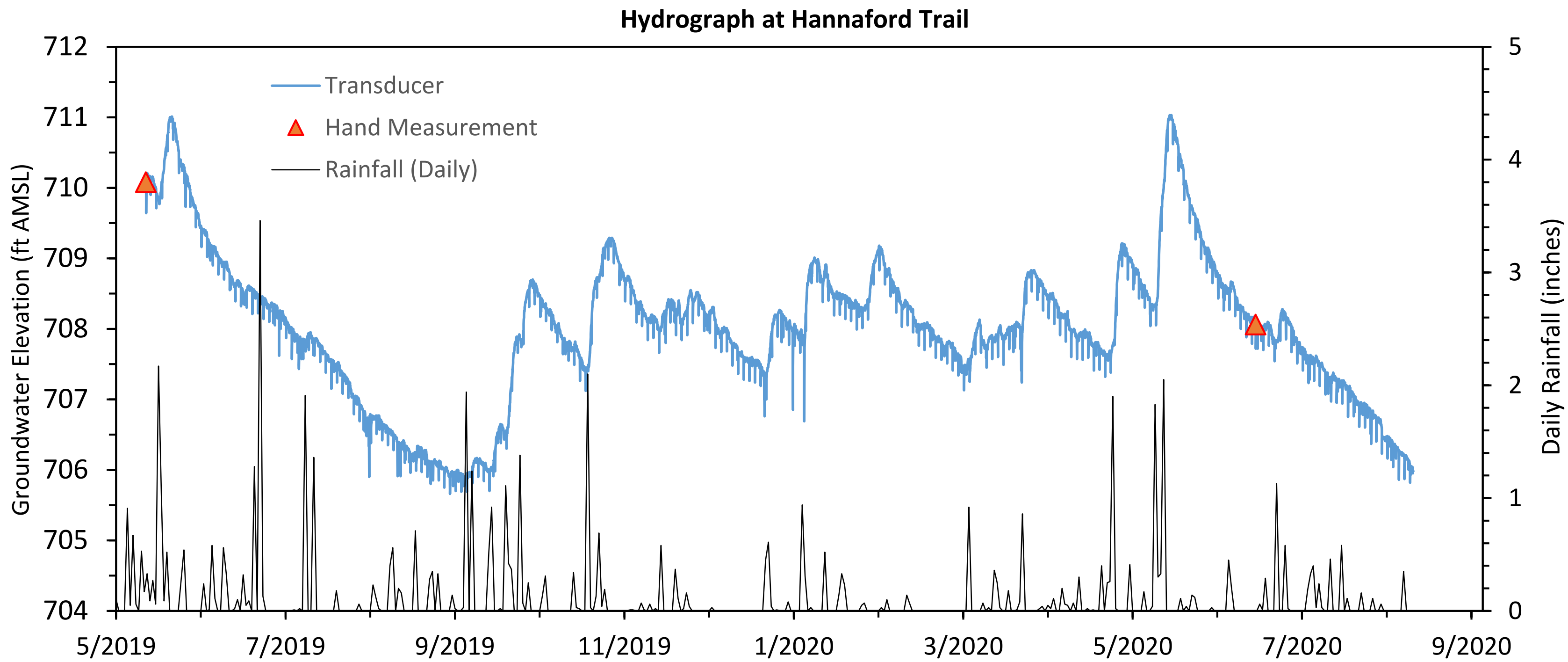


Figure 12. Hydrograph for the sand and gravel aquifer at the Hannaford Trail monitoring well.

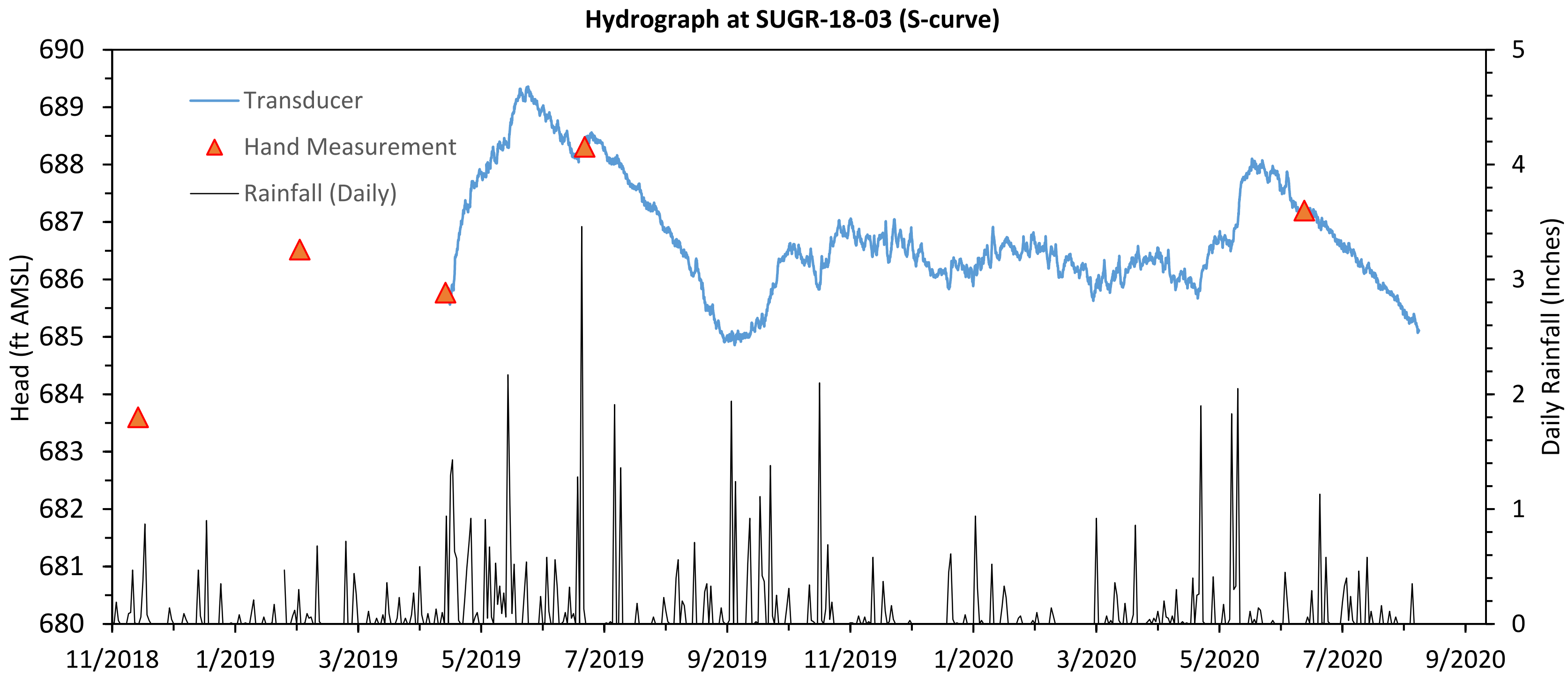


Figure 13. Hydrograph for the sand and gravel aquifer at the SUGR-18-03 (S-curve) monitoring well.

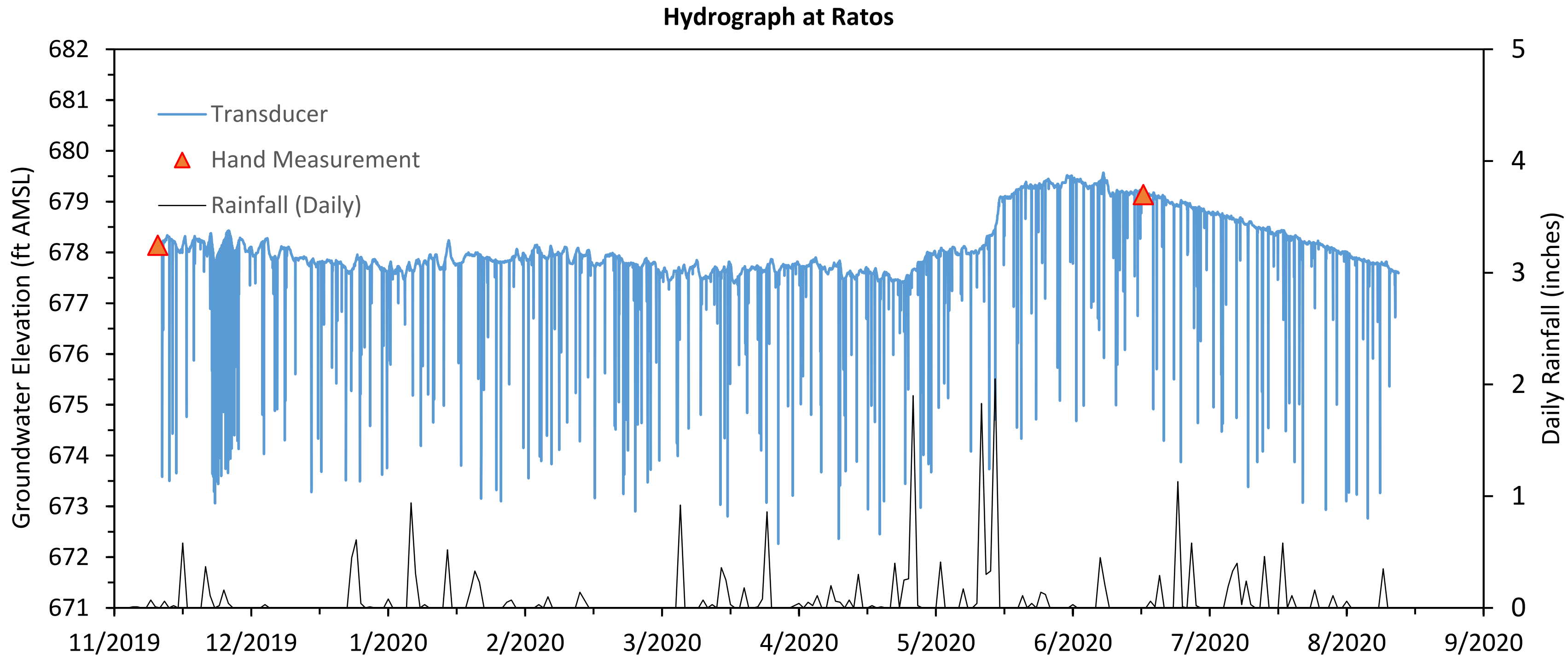


Figure 14. Hydrograph for the shallow bedrock aquifer at the Ratos monitoring well.

**Regional Water Use and Future Demands**

The ISWS collects water use data for every municipality in the state under the purview of the Illinois Water Inventory Program. Every year, municipalities are asked to report the annual amount of groundwater withdrawn from each of their wells and to report via paper or online methods. However, some facilities do not report or have missing data records upon submission. We present water use for Sugar Grove and the surrounding municipalities of Aurora, North Aurora, Montgomery, and Yorkville in order to provide an overall picture of how groundwater use has changed through time. In the following figures, we classify withdrawals based on the major aquifer types. Results shown are from 2005 to 2018. Records from 2019 and 2020 are still being collected by the IWIP program and are therefore not included here.

Figures 15-19 show reported water use by aquifer type for Sugar Grove and surrounding communities. Figure 20 shows the total use of Sugar Grove and the 4 surrounding municipalities. Between 2005 and 2018, the Village of Sugar Grove withdrew around 0.8 MGD, mostly from the deep sandstone aquifer. Water use at Sugar Grove generally stayed the same over this 13-year period. At Aurora, groundwater use has generally declined since 2005, mostly due to reductions in deep sandstone use and an increased reliance on the Fox River. Water use from the sand and gravel and shallow bedrock aquifers increased since 2005 from around 0.5 MGD out of each aquifer to around 1 MGD out of each aquifer. Aurora is by far the largest water user in the communities surrounding the Village of Sugar Grove. North Aurora only withdraws groundwater from the deep sandstone aquifer and water use has generally stayed the same at around 1.75 MGD since 2005. At Montgomery, withdrawals from the deep sandstone increased from 2005 to 2012 but then decreased from 2012 to 2018. Shallow bedrock withdrawals have fluctuated from less than 0.5 MGD to over 1 MGD, but does not have any significant trend. Withdrawals from the sand and gravel aquifers at Montgomery has generally stayed below 0.25 MGD. Yorkville only withdraws from the deep sandstone aquifer and water use has increased since 2005.

Overall water use, comprised of withdrawals from the Village of Sugar Grove and the four surrounding communities mentioned above, has declined overall since 2005, primarily because Aurora has reduced their withdrawals out of the deep sandstone aquifer. However, it should be noted that Yorkville did not report their sandstone use in 2018. Overall, there has been an increase in withdrawals from the sand and gravel and shallow bedrock aquifers since 2005 and is currently (as of 2018) around 1.5 MGD out of each.

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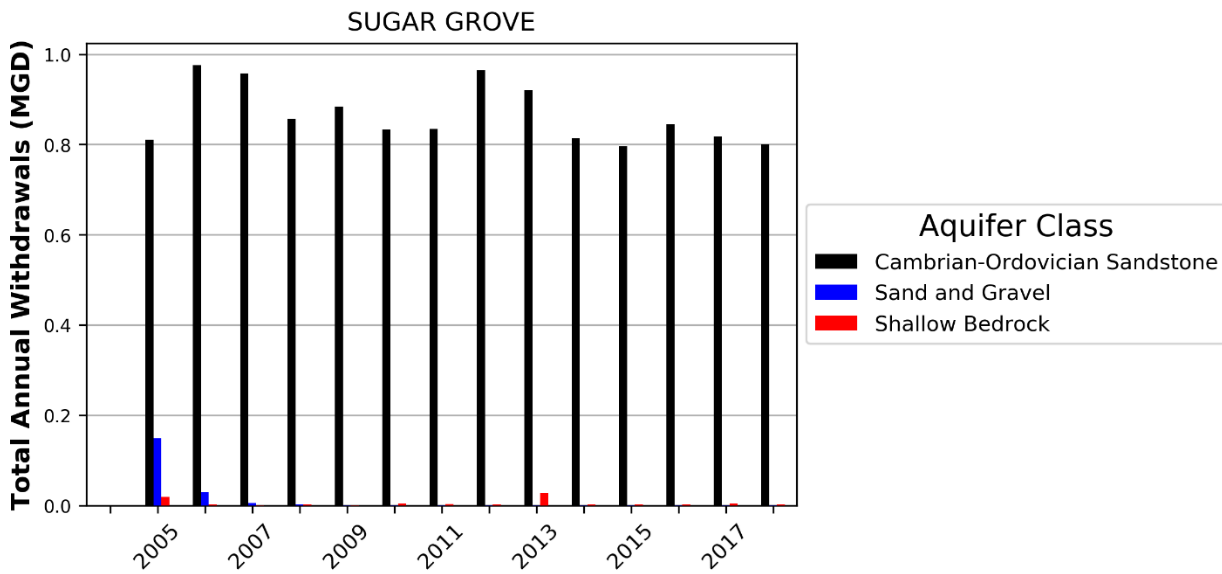


Figure 15. Groundwater withdrawals at the Village of Sugar Grove from 2005 to 2018, classified by aquifer type.

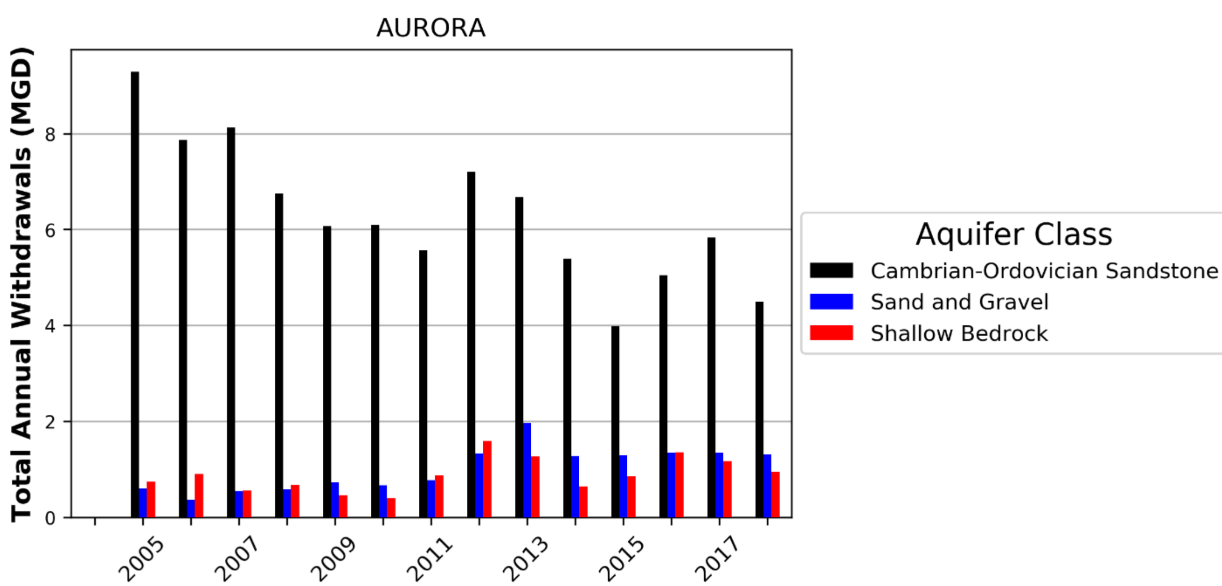


Figure 16. Groundwater withdrawals at Aurora from 2005 to 2018, classified by aquifer type.

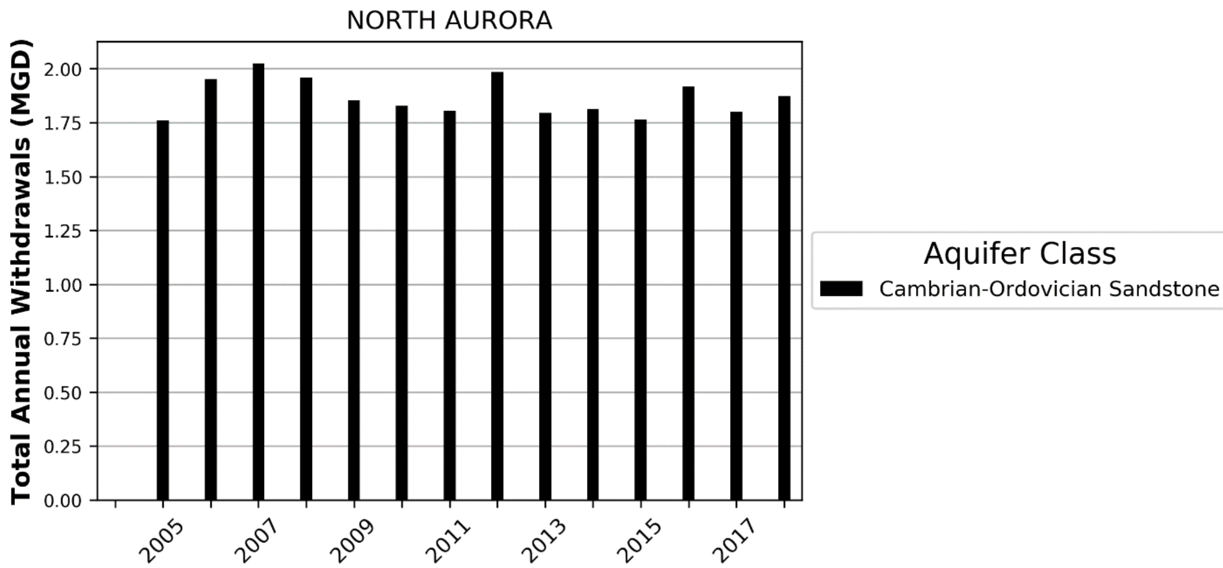


Figure 17. Groundwater withdrawals at North Aurora from 2005 to 2018, classified by aquifer type.

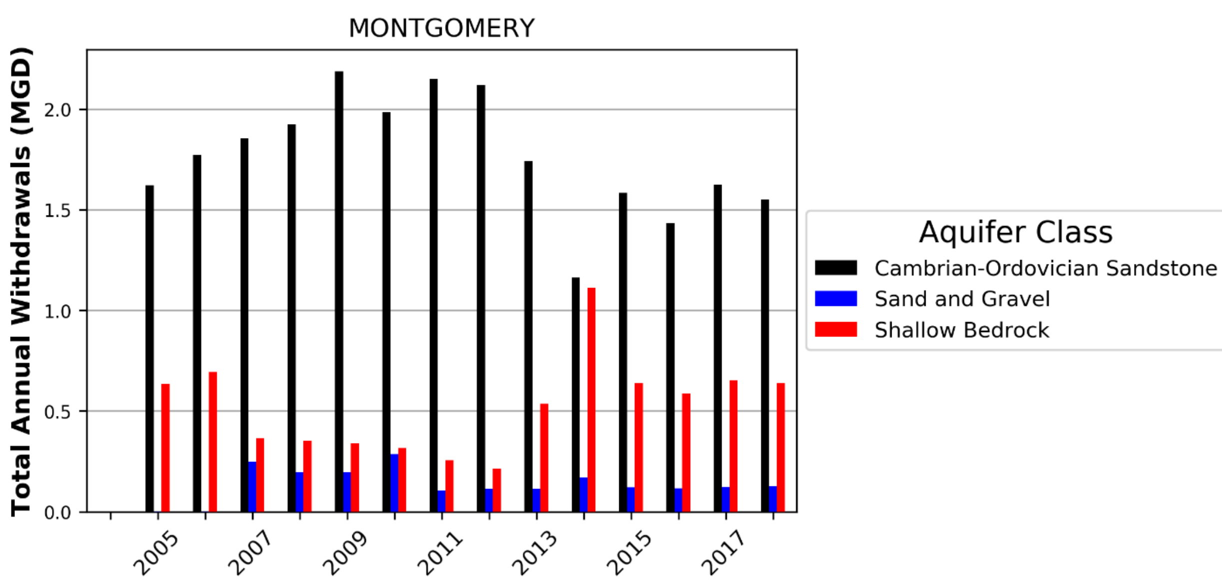


Figure 18. Groundwater withdrawals at Montgomery from 2005 to 2018, classified by aquifer type.

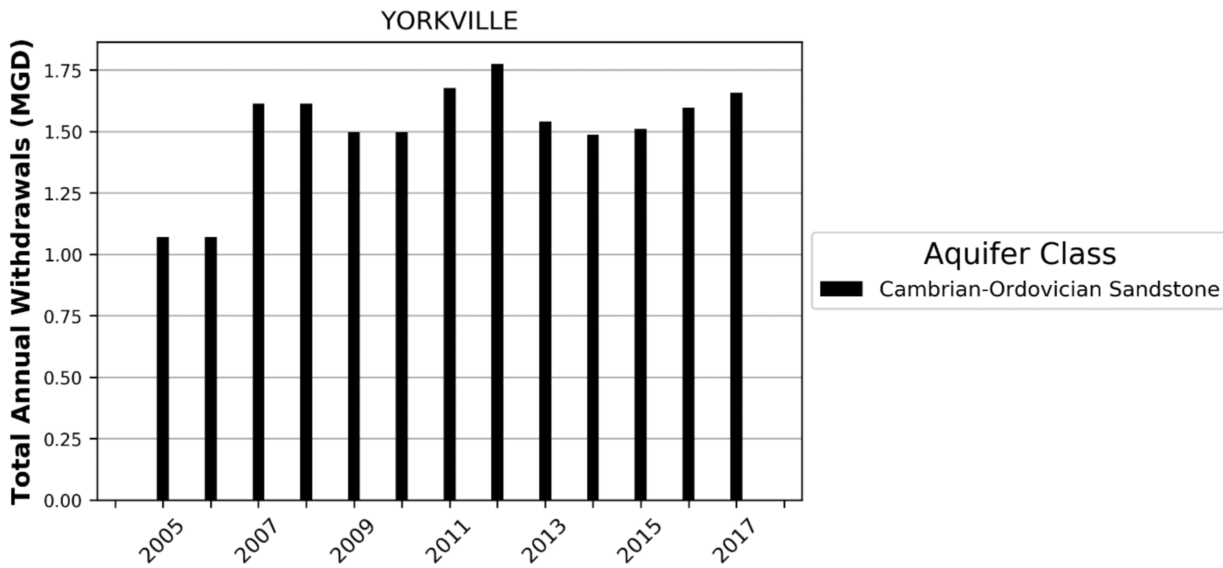


Figure 19. Groundwater withdrawals at Yorkville from 2005 to 2018, classified by aquifer type. Note that 2018 is not reported.

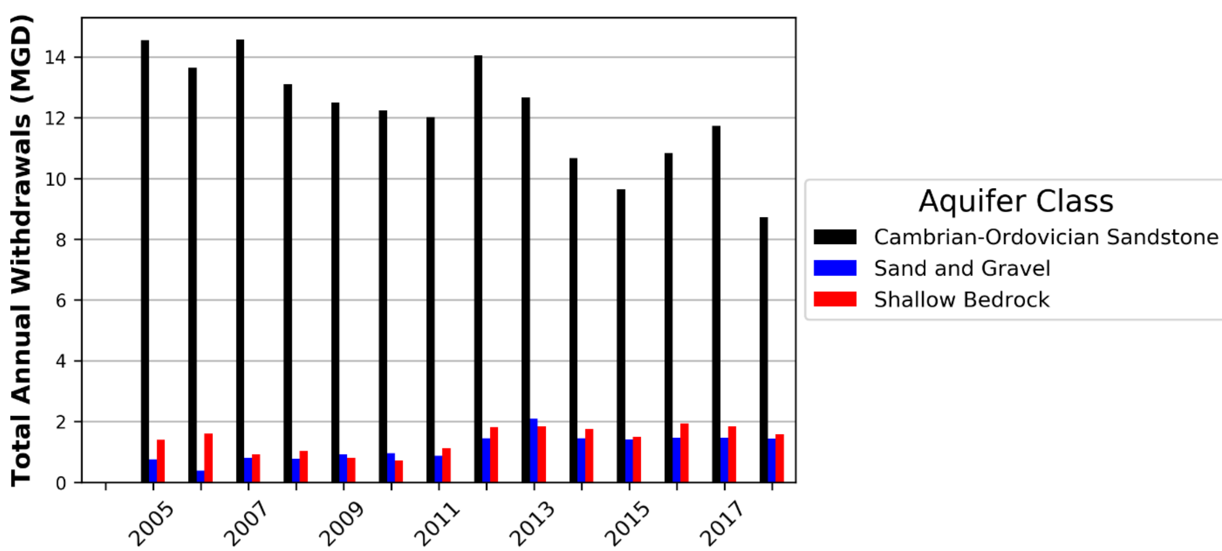


Figure 20. Total groundwater withdrawals from 2005 to 2018, classified by aquifer type. This total includes withdrawals from the Village of Sugar Grove, Aurora, North Aurora, Montgomery, and Yorkville. Note that 2018 is anomalously low due Yorkville not reporting for that year.

**Conclusions and Recommendations**

Data from the Illinois Water inventory Program shows an overall decline in water use at the Village of Sugar Grove and surrounding communities, but this decline is primarily due to less sandstone aquifer use by the City of Aurora. Since 2005, overall withdrawals from the sand and gravel and shallow bedrock aquifers has increased. Regional demand from the shallow aquifers is expected to increase into the future both locally at the Village of Sugar Grove and regionally within Kane, Kendall, and Will Counties. For example, Kane, Kendall, and Will Counties are expected to increase their overall water use by 26%, 51%, and 29%, respectively, out to 2050 according to demand forecasting by CMAP (CMAP 2019b). Long-term water supply planning will thus be necessary to ensure adequate supplies of water for municipalities and homeowners into the future. However, efforts to address long-term water supply planning is difficult to achieve in Northeastern Illinois considering that there are several different types of water sources used by communities (Lake Michigan, groundwater, and river water) and that there is little coordinated effort amongst communities to develop comprehensive and inclusive water planning goals. According to the "Drinking Water 1-2-3" guidebook developed by the Metropolitan Planning Council (MPC), there has historically been a fragmented approach by each community to develop long-term water supply plans. MPC developed the guidebook to help address this fragmentary nature of water supply planning in the region and to get local elected leaders to coordinate efforts and adopt sensible management strategies to achieve water sustainability.

Since 2017, the Sugar Grove Water Authority has partnered with the ISWS to establish a long-term groundwater monitoring network in Sugar Grove Township to support sustainable management of groundwater resources and to identify risks to the aquifers. This network allows for evaluation of seasonal and long-term trends in groundwater levels for the sand and gravel and shallow bedrock aquifers in Sugar Grove Township. Although the data collected by this monitoring program does not explicitly inform how much water is being used within the township, it does inform whether current municipal and domestic use is affecting water levels, if any, and how the aquifers respond to seasonal climate patterns. Threats to groundwater supplies may increase as suburbs continue to expand westward in the coming decades, and the data collected by this program can hopefully be used in effective ways by local officials and planning groups in achieving sustainable groundwater use.

Based on the hydrographs at the six monitoring wells in Sugar Grove township and the current elevation of groundwater levels, the following conclusions can be made about the sand and gravel and shallow bedrock aquifers:

- In general, depth to water is very shallow at all of the dedicated monitoring wells, indicating that there is available head in these confined shallow aquifers.
- Comparison of water levels from drilling records indicate that current water levels are similar to historic water levels, however only two out of the six monitoring wells (Elliott and Aurora Municipal Airport) have historic water level data available.
- At all monitoring wells, groundwater levels are typically highest in the April and May months and decline in the summer and fall months. This indicates that the aquifers are primarily being recharged in the winter and spring months and then gradually decrease in response to drier summer and early fall conditions.
- Two of the monitoring wells, the Elliott well and the Hannaford Trail well, show small drawdowns due to nearby pumping, but these withdrawals are short in duration and have not led to sustained groundwater level declines.
- There is no clear downward trend over the course of the three-year monitoring study to indicate that current withdrawal rates by municipalities, private businesses, or homeowners with private wells are negatively affecting water levels in either aquifer at a regional scale. Long-term

declines could be occurring at a local scale at less productive portions of the shallow aquifers within the township, but the current monitoring well network has not detected this. However, this three-year study period is a fairly short time scale to make definitive conclusions about the long-term sustainability of current groundwater withdrawals and there has not been a significant drought since the monitoring well network has been established in which to see how a major stress affects these aquifers.

- The shallow bedrock system responds rapidly to changes in Blackberry Creek at the Elliott well monitoring site. This indicates that Blackberry Creek and the shallow bedrock aquifer in this area of the township are hydraulically connected and that Blackberry Creek is an important source of recharge to the aquifers. The groundwater elevation at the Elliott well and the stage elevation of Blackberry Creek are nearly identical.
- In the northern part of the township, the sand and gravel aquifer within the St. Charles Bedrock Valley and the surrounding shallow bedrock aquifer (Silurian Dolomite) behave very similarly as evidence by the hydrographs at the Aurora Municipal Airport, Heartland Drive, and Hannaford Trail monitoring sites. This indicates that the two aquifers are hydraulically connected in this portion of the township.
- There is a drawdown response at the Elliott well when Aurora 101 turns on, which is further evidence that the sand and gravel and shallow bedrock aquifers are well connected hydraulically and behave similarly.
- The rapid responses of groundwater elevation to precipitation events at the Aurora Municipal Airport, Heartland Drive, and Hannaford Trail monitoring sites indicates that there is fast recharge to both the sand and gravel and shallow bedrock aquifers.
- The groundwater elevation at the Ratos well (on average around 678 feet AMSL) is similar to the elevation at Mallard Park pond (around 671 feet AMSL) located about 1,800 feet away to the southeast. Several homes within the subdivision located east of the Mallard Park pond have previously dealt with basement flooding. Given the groundwater elevation at the Ratos well, the Mallard Park pond is likely a source of discharge for the shallow aquifers. At this location, groundwater elevations are close to land surface elevation, and thus basement flooding will likely be a long-term issue for homeowners in this subdivision.

Based on the above conclusions, we recommend the following items for the Sugar Grove Water Authority to pursue to support long-term water supply management in Sugar Grove Township and to continue their efforts to understand the hydrogeology of the different aquifers:

- Future projected climate change, which will lead to wetter springs but hotter and drier summers, will likely affect the magnitude and timing of recharge to the shallow aquifers in Sugar Grove Township. Droughts may also become more common and prolonged. Groundwater withdrawals from the shallow aquifers are expected to increase both within the township and in within Kane County and surrounding counties. We therefore recommend continued monitoring of shallow groundwater conditions within the township to ensure that withdrawals rates are not having detrimental effects on the aquifers and to support long-term water supply planning.
- Acoustic sensors seem to be less accurate and at certain times have considerable data “noise”. If future sites are selected to expand the monitoring network, pressure transducers and telemetry systems should be deployed as a priority over acoustic sensors when possible.
- Given rapid recharge rates to the shallow sand and gravel and shallow bedrock aquifers, groundwater is more susceptible to contamination than that of deep aquifers. Recent studies in Kane County (Kelly et al. 2015) and Will County (Kelly 2020) show that chloride levels have

increased locally due to road salt applications. The shallow aquifers in more rural areas of Sugar Grove Township may also be susceptible to higher nitrogen and phosphorous levels due to fertilizer applications on farm fields. We recommend that baseline water quality conditions be established in Sugar Grove Township to identify any risks to water quality in the shallow aquifers. Results should be compared to the recent studies by Kelly et al. (2015) and Kelly (2020) and put in the context of regional water quality trends.

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**Appendix**

Service records and well logs associated with Sugar Grove monitoring sites available upon request from the authors.