Sandstone Aquifer Water Supply Summary for Sugar Grove, IL: Data Center Analysis

Daniel R. Hadley, Cecilia Cullen, and Daniel B. Abrams ***Illinois State Water Survey***

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Risk to Sugar Grove's Deep Sandstone Water Supply

The Village of Sugar Grove is evaluating their water supply in anticipation of future growth and increased water demand. They have contracted the Illinois State Water Survey (ISWS) to use their established groundwater model[1,2] to evaluate local risk to the deep sandstone aquifer based on adding future wells to meet the demands of a potential data center located near the Route 47 and I-88 interchange, north of Sugar Grove . **The updated modeling indicates that Sugar Grove could be at risk of declining performance for wells reliant on the Ironton-Galesville aquifer, particularly at proposed data center wells.**

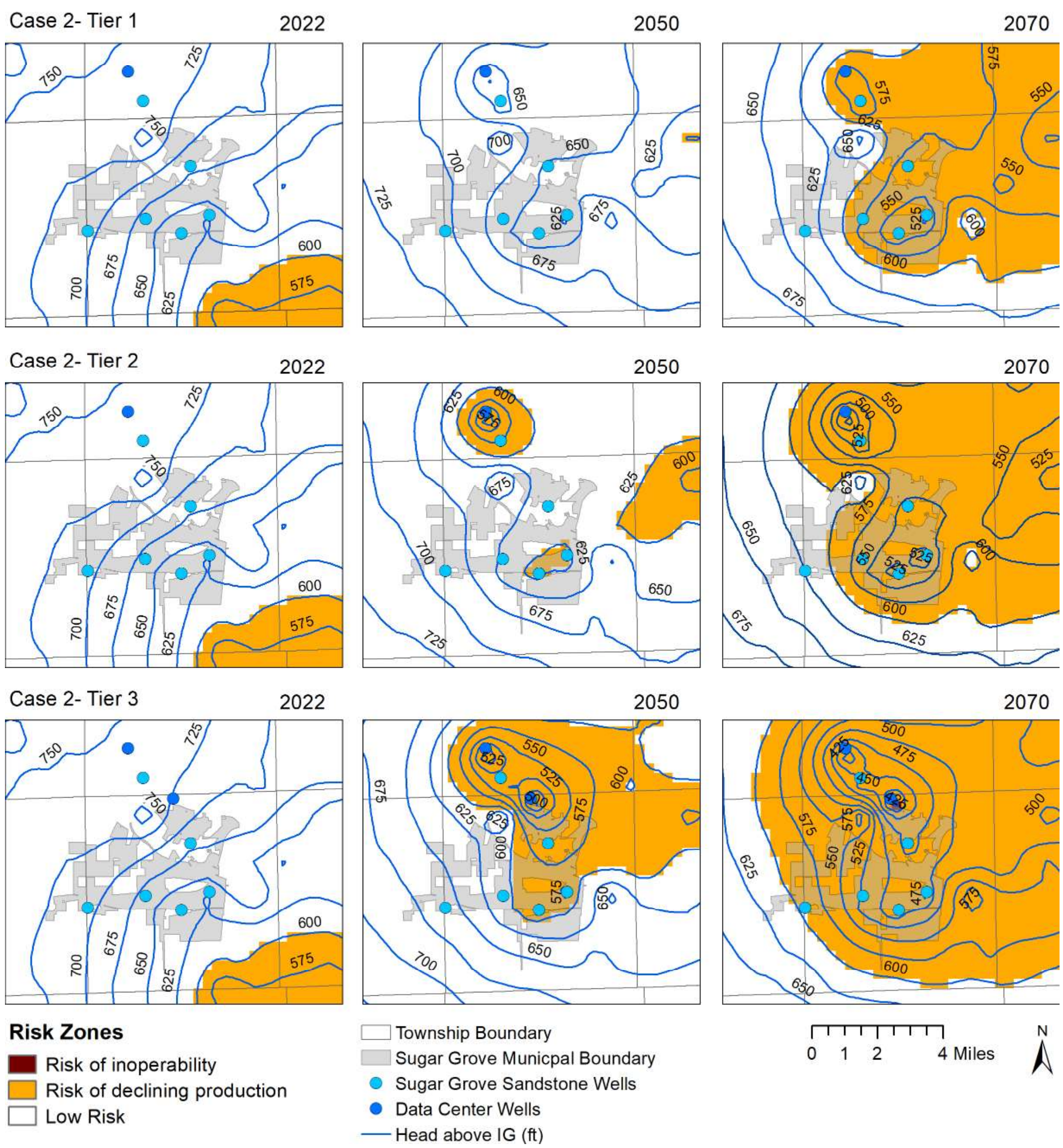

Figure 1. Risk associated with average conditions in the deep sandstone aquifer in the Sugar Grove area. The maps depict simulated heads above the top of the Ironton-Galesville aquifer (IG) for the Case 2-Tier 1, 2, and 3 scenarios for the following years: 2022, 2050, and 2070.

Discussion of the Maps

The maps in Figure 1 show where sandstone water supply risk is currently present and where it will grow in the future under average pumping conditions for different tiers of water demands within the Case 2 scenario[2] (Joliet region switches off the deep aquifer in 2030 followed by Oswego, Montgomery and Yorkville switching off of the deep aquifer in 2035, with communities following current trend [CT] projections[3]). The ISWS evaluated three different Tiers of water demands for a hypothetical data center:

- Tier 1 – One sandstone well (Sugar Grove 13) is added in 2025 and pumped at 500 gpm. This new data center well is located to the northwest of the proposed Sugar Grove 12 sandstone well. The well is assumed to operate at 100% capacity from April to September and at 50% capacity from October to March
- Tier 2– Same as Tier 1, but demands increase to 1000 gpm starting in 2027. Seasonal use stays the same.
- Tier 3 – Same as Tier 3, but another data center well (Sugar Grove 14) is added in 2030 and pumped at 1000 gpm. This new data center well is located to the southeast of the proposed Sugar Grove 12 sandstone well. Seasonal use stays the same.

Wells located in the orange zone are at-risk of declining performance as water levels lower. In general, the addition of new wells to meet the demands of a data center create larger zones of risk in comparison to the standalone Case 2 scenario (in which no new data center wells are installed) and puts municipal wells at risk on a sooner timeline. In Tier 1, every Sugar Grove well (except for Well 4) reaches this category by the year 2070. In Tier 2, Wells 10, 11, 12 and 13 reach this category in 2050 and every well (except Well 4) reaches this category in 2070. In Tier 3, most wells (except for Wells 4 and 9) reach this category in 2050 and by 2070 Well 9 also reaches this category.

Representative Hydrographs for Sugar Grove under the Case 2-Tier 1 Scenario

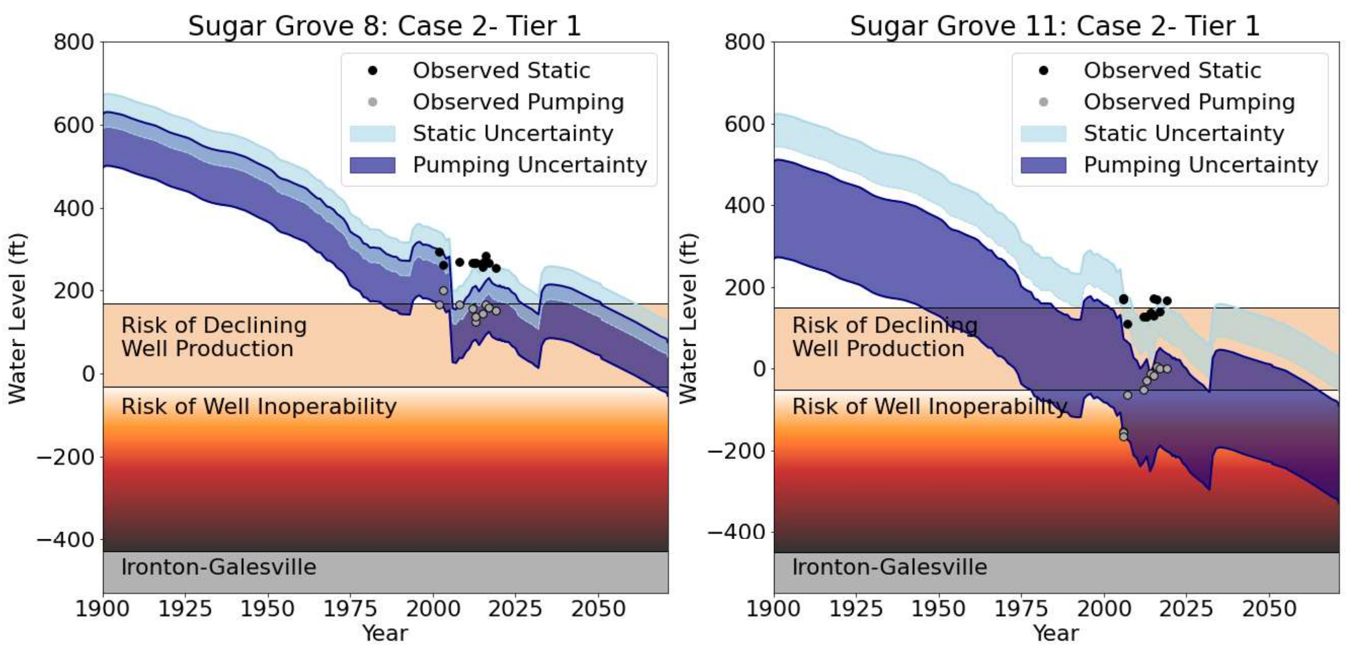

Figure 2. Representative hydrographs for Sugar Grove at Well 8 (left) and Well 11 (right). Under the Case 2-Tier 1 scenario, water levels in Sugar Grove will continue to decline and be at-risk of declining well productivity. The uncertainty of static and pumping water levels is highlighted in light blue and navy, respectively.

Hydrographs are used to plot the water level of a well through time and compare to risk thresholds, shown in Figure 2. Uncertainty accompanies projecting static and pumping water levels, thus we represent the possible range of future water levels in the hydrographs with highlighted bands based on observed data. Since the hydrographs account for uncertainty based on observed data at each well (wheras the simulated model results shown in Figure 1 do not), the hydographs are a more imprtant tool in the evaluation of risk. Risk to water levels is assessed based on feet above the top of the Ironton-Galesville unit, indicated by the grey block on the hydrographs. The light blue band represents the static (non-pumping) water level in the well where the upper bound indicates the static level in a particular well when surrounding wells are operating under average conditions, and the lower bound represents static level in a well when surrounding wells are operating under peak pumping.

When the light blue band reaches the top of the orange risk zone, the well is at-risk of declining well performance. Water levels at Well 8 and Well 11, shown in Figure 2, are projected to reach this threshold under average pumping conditions. It is important to note all operational Sugar Grove wells, in this model simulation, exhibit risk of declining well productivity by 2070 (Table 1). Greater risk occurs when static water levels fall into the most severe risk zone. Under peak demands (the lower bound of the light blue band), water levels at Well 11 enter the well inoperability risk zone in 2070.

Pumping water levels, shown by the navy band, are not used to explicitly define risk but are included in the hydrographs for additional perspective. The upper bound of the navy band is determined by the minimum drawdown observed (and assumes no change in future specific capacity); this would be the equivalent of maintaining the current pumping distribution, frequently rehabilitating a well, and potentially even redrilling older wells to avoid loss in specific capacity. The lower bound is estimated as the worst-case pumping level observed in the southwestern suburbs region. The deeper a pumping water level falls into the severe risk zone, the greater the risk of well inoperability.

Impact of Data Center Wells

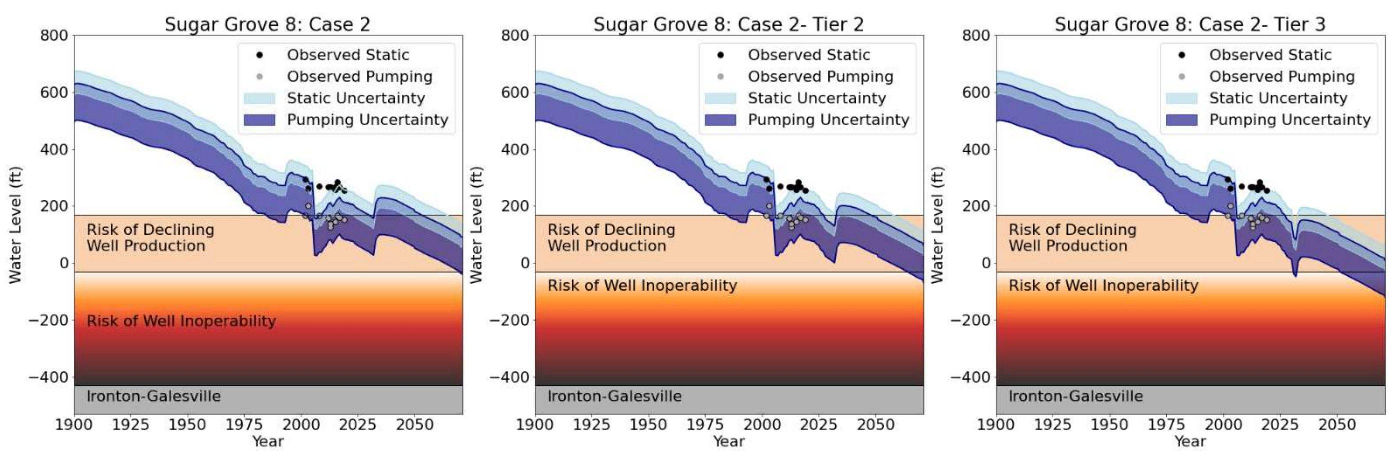

Figure 3. Hydrographs showing the impact of adding new data center demands for Sugar Grove 8. Left figure shows the case where no new data center wells are installed.

The addition of new data center wells increases drawdown at existing Sugar Grove wells into the future. For example, Figure 3 shows how these new demands manifest at Well 8, which was selected since this is the well that is in closest proximity to the proposed data center wells. The addition of 1000 gpm of withdrawals at Well 13 (Tier 2 scenario) adds on average 40 ft of additional drawdown at Well 8 by 2050. The addition of another 1000 gpm of withdrawals at Well 14 (Tier 3 scenario) adds on average 60 more feet of drawdown at Well 8 by 2050 (for a total of 100 feet of additional drawdown). Additional drawdown is less severe at Wells 11, 10, 9 and 4, since those are further away from the proposed data center.

Risk Tables

Table 1. Risk table for the model simulations representing ***a) average conditions*** *and* ***b) peak conditions****.*

a)	Case 2 Tier 1		Case 2 Tier 2		Case 2 Tier 3	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
Well 4	-	-	-	-	-	-
Well 8	2061	-	2058	-	2028 / 2045[a]	-
Well 9	2028 / 2063[a]	-	2027 / 2060[a]	-	2027 / 2052[a]	-
Well 10	2009 / 2040[a]	-	2009 / 2033[a]	-	2009	-
Well 11	2009 / 2039[a]	-	2009 / 2033[a]	-	2009	-
New Well 12	2062	-	2055	-	2046	-
New Well 13	2060	-	2027 / 2033[a]	-	2027	-
New Well 14	NA	NA	NA	NA	2030[b]	-

b)	Case 2 Tier 1		Case 2 Tier 2		Case 2 Tier 3	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
Well 4	-	-	-	-	2069	-
Well 8	2006 / 2041[a]	-	2006	-	2006	~2070[c]
Well 9	2008 / 2039[a]	-	2008	-	2008	-
Well 10	2006	~2070[c]	2006	2070	2006	2030 / 2064[a]
Well 11	2006	~2070[c]	2006	2069	2006	2030 / 2063[a]
New Well 12	2047	-	2027 / 2043[a]	-	2027	2069
New Well 13	2025[b]	-	2025[b]	~2070[c]	2025[b]	2060
New Well 14	NA	NA	NA	NA	2030[b]	2055

[a] In Sugar Grove, water levels reach the risk zones and then recover after 2030 when Joliet and other communities leave the aquifer. We indicate when water levels enter the risk zone both before and after this major change in water use.

[b] Indicates that well was installed in this year and is already in the zone of risk at data of installation

[c] Indicates that water levels are close to the “Risk of well inoperability” zone and would likely enter that zone in the years following 2070.

Long-term planning should account for risk to all wells. Thus, the risk table (Table 1) represents when wells become at-risk in each of the model scenarios. As pumping increases, the length of time that Sugar Grove can safely withdraw water from the sandstone shortens. Additionally, as one or more wells become at-risk, communities will need to consider the possibility of wells failing to meet supply.

Sugar Grove has four current wells and several proposed wells over which pumping can be distributed. It is possible that a couple of wells can become less operable and the village could experience declining well production. As a result, a few questions should be asked when considering this risk table:

- Can the local water system withstand a well that temporarily cannot meet demands during peak pumping conditions?
- What wells can absorb the additional pumping of a failed well?
- How will redistributed pumping from failed wells exacerbate risk at operating wells?

Technical Discussion of Maps, Hydrographs, and Tables

Take-Home: As sandstone water levels decline, uncertainty is magnified. The small sample of wells in Northeastern Illinois with static water levels approaching the "Risk of Well Inoperability" zone have struggled to to provide adequate supply.

The maps (Figure 1) and hydrographs (Figures 2 and 3) depict simulated water level conditions through time under the three scenarios. The light blue band in Figures 2 and 3 represents the range of **static** levels—the water level in a well when the pump is off. When the pump is turned on, water levels generally fall an additional 200 to 400 ft for most high capacity wells in this region (**pumping** level) —represented by the navy band. The offset between the static and pumping levels in the hydrographs was based on observed measurements of Sugar Grove water levels sent in by the community. The model was adjusted until the simulated values matched observed static water levels (via a process known as calibration).

Another uncertainty in the model is the distribution of future pumping, complicated by the addition of possible not-yet-drilled community wells. Moving or shifting pumping would redistribute risk. While this would likely extend the life of the aquifer at one well, it could cost years of the estimated time left for another. We also removed multi-aquifer wells in Kane County based on historic trends extrapolated to the future, resulting in an additional loss of water to the deep Ironton-Galesville. These well removals usually only affect water levels at nearby neighboring wells.

As both static and pumping levels approach the top of the Ironton-Galesville aquifer, a few issues have been observed. A predominant concern is that wells with low static levels tend to also have the most extreme drawdown under pumping conditions. It is important to note that other issues can occur as water levels decline, including: 1) limits on pump settings (specifically, whether a pump can even be lowered into the Ironton-Galesville aquifer), 2) costs associated with lifting water from a greater depth, 3) the need to rehabilitate wells more frequently and aggressively, 4) the increased risk of pumping sand, 5) potential for caving the deeper sandstone formation, and 6) reduced production capacity of the well.

What do these results mean for Sugar Grove's water supply?

Q1: Will Sugar Grove's withdrawals ever be sustainable?

A: No. Withdrawals from the sandstone aquifer in the northeast Illinois have been unsustainable for over a century. Over the decades, the aquifer has slowly depleted and now many supply wells are threatened. If withdrawals continue to exceed sustainable supply, irreparable declines in water levels will occur, impacting the already limited timeline of availability for this water source.

Q2: How long can Sugar Grove meet needed supply from the sandstone?

A: **Planning based on a time-horizon of available water from an aquifer is challenging due to the sensitivity of projected water levels to minor changes in future demands.** Risk increases as demands increase, but for all scenarios simulated here, most Sugar Grove wells have water levels dropping into the zone of declining well production. These results indicate that Sugar Grove will most likely have adequate groundwater supplies from the Ironton-Galesville aquifer out to 2050, but this supply is at increasing risk by 2070 and beyond. The Village of Sugar Grove should continue to closely monitor their sandstone water supply.

Take Home:

Sugar Grove's sandstone withdrawals are inherently not sustainable. Future water level declines pose a risk to Sugar Grove's sandstone water supply source.

Bottom Line: Uncharted Territory

Sandstone water levels in the northeastern Illinois have never been as low as they are now. How further declines will manifest is difficult to say for certain, but the ISWS has observed water level declines that are greater than what is modeled. In other words, as water levels decline, previously unforeseen complexities emerge that are disadvantageous to well productivity and shorten the lifespan of a well. These emerging complexities, such as declines in specific capacities or constraints on pump settings, are the real danger as water levels decline into "uncharted territory". As a result, it is critical not to immediately dismiss the model results as overly conservative. **It is imperative that monitoring and modeling continue as water levels decline into this uncharted territory over the next decade to improve our understanding of the uncertainty associated with these depths.**

References

[1]Abrams, Daniel B.; Cullen, Cecilia. 2020. Analysis of Risk to Sandstone Water Supply in the Southwest Suburbs of Chicago. Available at https://www.ideals.illinois.edu/handle/2142/109174

[2]Hadley, Daniel R.; Cullen, Cecilia, Abrams, Daniel B. 2022. Sandstone and Shallow Water Supply Risk at Sugar Grove, IL, ISWS letter report, 3/22/2022

[3]Chicago Metropolitan Agency for Planning. 2018. 2050 Forecast of Population, Households, and Employment. Available at: https://www.cmap.illinois.gov/data/demographics/population-forecast

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