Romeoville, IL: Sandstone Water Supply Summary

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Risk to the Southwestern Suburbs' deep sandstone water supply

In 2018, modeling by the Illinois State Water Survey (ISWS) indicated a high likelihood that Joliet would be unable to meet its drinking water demands from the deep aquifer by the year 2030[1]. The Southwest Water Planning Group (SWPG) formed in response to these findings, enabling ISWS scientists to closely collaborate with the region's water operators and engineers, consultants, and the Chicago Metropolitan Agency for Planning. **The updated scientific modeling indicates that if growth continues at the Current Trend demand scenario, then many communities in the Southwestern Suburbs of Chicago will be at risk of not meeting their drinking water demands in the coming decades.**

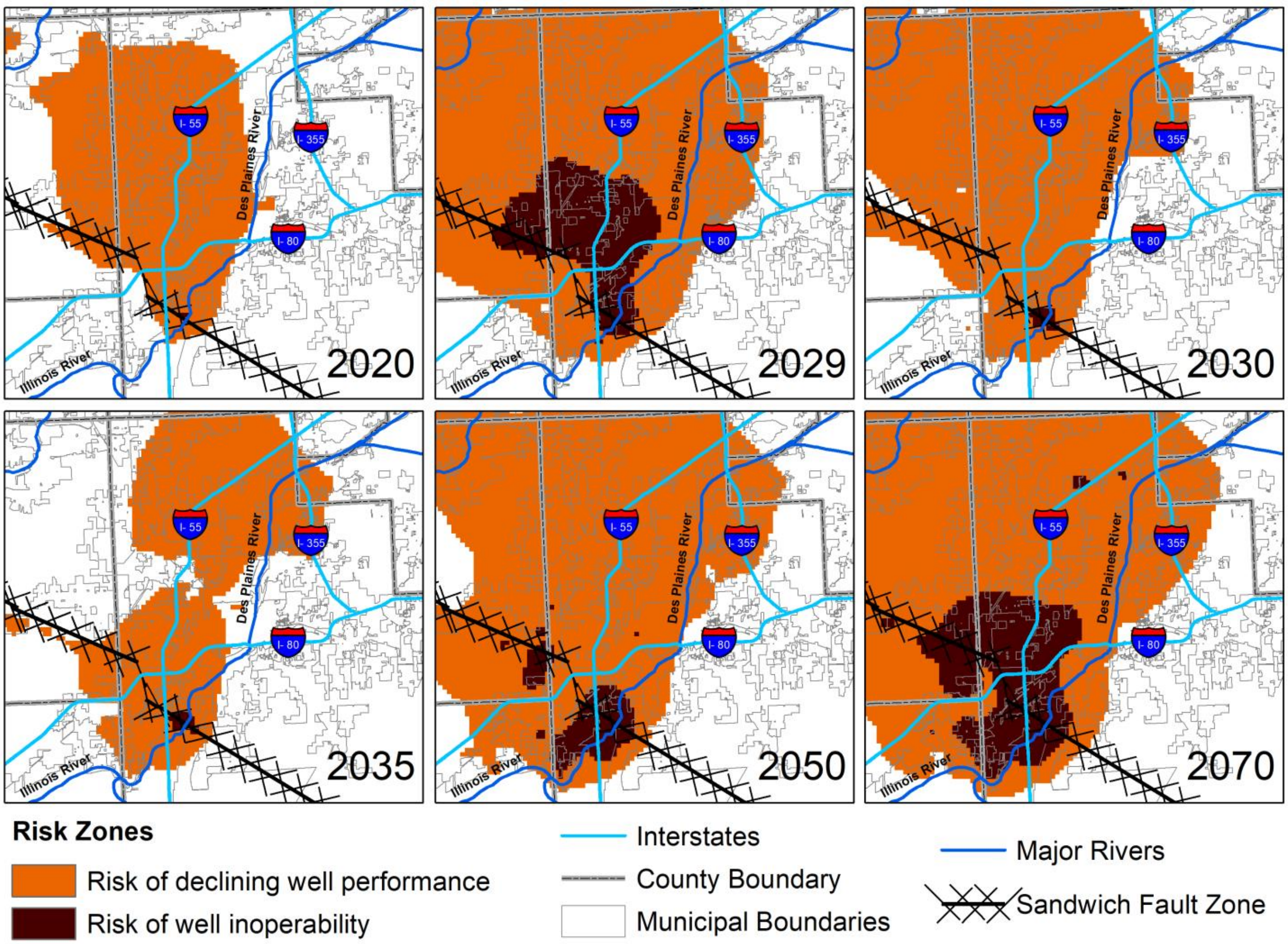

Figure 1. Risk associated with declining water levels in the deep sandstone aquifer in the Southwestern Suburbs of Chicago. The maps depict the following years: 2020 (current conditions), 2029 (before Joliet switches off the sandstone aquifer to Lake Michigan), 2030 (after Joliet switches), 2035 (after Oswego, Yorkville, and Montgomery are assumed to switch), 2050 and 2070 (future peak demand conditions).

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 the Current Trend scenario*. Wells located in the orange zone are at-risk of declining performance as water levels fall. Every SWPG community with active sandstone wells reaches this category by the year 2070. Most have at least one well in the deep red zone, where wells are at severe risk of being unable to meet demands and becoming inoperable. **The model simulation indicates large areas of the Southwestern Suburbs will experience this risk in 2050 and 2070, despite the assumption that Joliet switches off the aquifer by 2030 and Oswego, Yorkville, and Montgomery switch off by 2035.**

* The Current Trend scenario is based on CMAP population projections[2] with the assumption that other factors, such as water use per person, water loss and conservation, will not change. For communities extending into Grundy County, demands were modified with community input. This scenario also assumes an increasing proportion of withdrawals from the sandstone where another source (typically shallow aquifer wells) has limited expansion capacity or long-term water quality challenges. This assumption is based on the observation that shallow aquifers have increasing chloride contamination from road salt or very limited water quantity remaining in the area.

Water levels at Romeoville 10: Current Trend

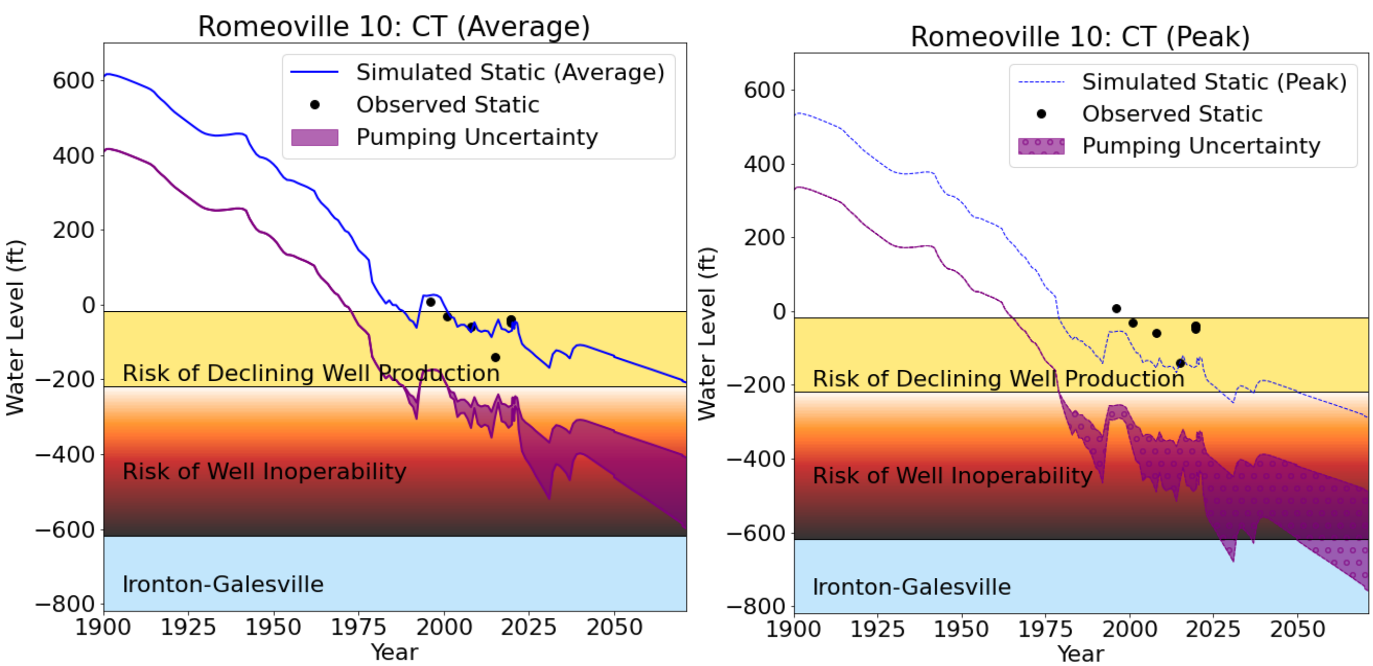

Figure 2. Hydrographs for Romeoville 10, showing both average and peak pumping conditions. Under the Current Trend scenario, water levels in Romeoville will continue to decline and be at-risk of well inoperability. Additional future withdrawals beyond the Current Trend demands, such as a new sandstone water user, will exacerbate this risk.

Hydrographs are used to plot the water level of a well through time and compare to risk thresholds, shown in Figure 2 for both average and peak pumping conditions. When the blue line (representing the static, or non-pumping, water level in the well) reaches the top of the orange risk zone, the well is at-risk of declining well performance. Water levels at Romeoville 10 have already reached this threshold under average pumping conditions. Similarly, pumping water levels have already fallen into the red risk zone and the model indicates that they will continue to lower. The deeper a pumping water level falls into this zone, the greater the risk of well inoperability.

Severe risk occurs when static water levels fall into the red zone. Over time, water levels at Romeoville 10 decrease. Average water levels at Romeoville 10 approach the "Risk of well inoperability" zone in the late 2020's, but Joliet leaving the aquifer in 2030 and Oswego, Yorkville, and Montgomery's exit in 2035 gives Romeoville a combined recovery in water levels of approximately 100 ft. This simulated recovery is lost in the following decades as Will County grows at the current trend, and by 2070 water levels are on the threshold of the well inoperability zone. In peak demands, water levels enter the well inoperability risk zone in 2027 before Joliet's exit and then return to stay in this risk zone in 2050. It's important to note that other Romeoville wells, in this model simulation and others, also exhibit severe risk by 2070 (Table 1, Table 2).

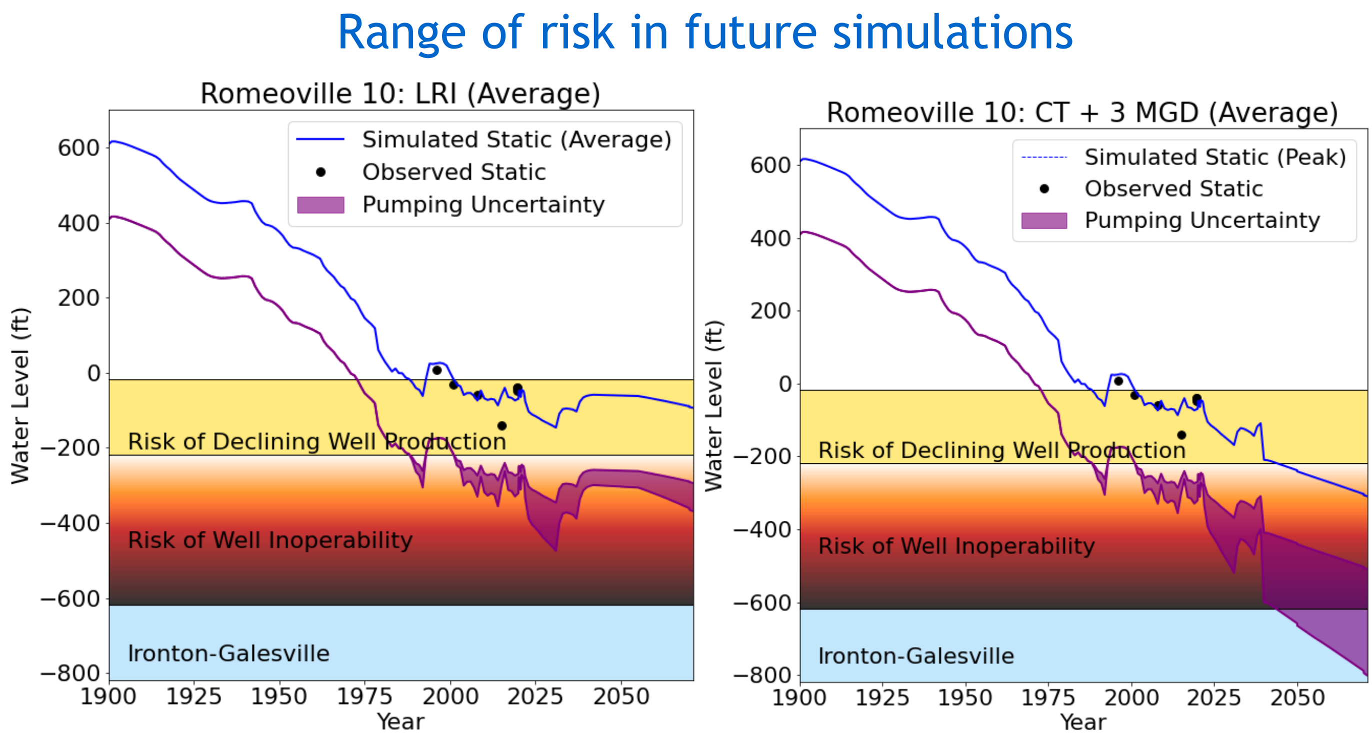

Figure 3. Hydrographs indicating the least severe and most severe simulations for Romeoville 10. The smallest simulated risk (left) for Romeoville 10 is under the LRI trend. The greatest simulated Romeoville 10 risk is in the CT conditions with a new 3 MGD user installing a well in 2039.

Because future water level simulations will vary with different amounts of water pumped, the ISWS evaluated a suite of model runs:

- LRI – *less resource intensive* this simulates little growth in Will County
- CT – *current trend* this projects the current trend of growth out over the next fifty years. In Romeoville, the CT uses 0.8 MGD (million gallons per day) more water than the LRI. This 0.8 MGD is in addition to increased pumping regionally, see long report for more information.
- CT + 3 MGD – simulates the CT with a 3.0 MGD user added in 2039 near the community. This new user is 1.6 miles from Romeoville 2, 1.5 miles from Romeoville 4, 3.4 miles from Romeoville 10, 3.5 Romeoville from Well 11, 4.0 miles from Romeoville 13, and 2.4 miles from Romeoville 14.

The highest future water levels for Romeoville 10 are associated with the LRI simulation, while the lowest future water levels are from the CT + 3 MGD projection, shown in Figure 3. The simulated range in future water levels is caused by the uncertainty associated with future pumping in the Romeoville area. The hydrographs only show average water levels throughout the year. Local decisions would need to also consider peak pumping (shown Figure 2 right), that in short durations lowers water levels by ~80 ft and exacerbates risk.

Risk Tables

*Table 1. Risk table for the model simulations representing **average** conditions*

	LRI		CT		CT + 1.5 MGD[1]		CT + 3 MGD[1]	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
2	1991	-	1991	-	1991	2068	1991	2039
4	1991	-	1991	-	1991	2064	1991	2039
10	1989	-	1989	~2070~[2]	1989	2059	1989	2043
11	2001	-	2001	-	2001	-	2001	2068
13	1990	-	1990	-	1990	~2070~	1990	2061
14	2020	-	2020	~2070~	2020	2053	2020	2039

*Table 2. Risk table for the model simulations representing **peak** conditions*

	LRI		CT		CT + 1.5 MGD[1]		CT + 3 MGD[1]	
	Risk of declining production	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*	*Risk of declining production*	*Risk of inoperability*
2	1979	-	1979	2066	1979	2039	1979	2039
4	1979	-	1979	2029 / 2062	1979	2029 / 2039	1979	2029 / 2039
10	1979	2029 / -[3]	1979	2027 / 2050	1979	2027 / 2039	1979	2027 / 2039
11	1982	2029 / -	1982	2027 / 2070	1982	2027 / 2057	1982	2027 / 2039
13	1979	2027 / -	1979	2025 / 2066	1979	2025 / 2047	1979	2025 / 2039
14	2020	-	2020	2035 / 2045	2020	2035 / 2039	2020	2035 / 2039

[1]Additional pumping is added in the year 2039

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

[3]The year that water levels reach a risk zone for different scenarios at each community well. If two years are listed, the first year indicates when risk conditions are reached before Joliet switches from the sandstone aquifer, while the second year indicates when water levels reach the risk zone again after an initial recovery in water levels. If the year listed is followed by a dash, then water levels rebound from the risk zone and do not return prior to 2070.

The hydrographs presented previously are for the well with the most-severe risk as simulated in the models, but long-term planning should account for risk to all wells. Risk tables are a simple way to present the years that the wells become at-risk in each of the model scenarios. As pumping increases, the time window into the future that Romeoville can safely withdraw water from the sandstone shortens. These tables help emphasize that planning based on a time-horizon of available water from an aquifer is very challenging due to how water levels are sensitive to minor changes in uncertain future demands. Additionally, as one or more wells become at-risk, communities will need to consider the possibility of failed wells. 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 additional pumping redistributed 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 with static water levels approaching the top of the "risk of well inoperability" zone have struggled to meet supply, particularly those in the hydrogeologically complex Sandwich Fault Zone.

The maps and hydrographs depict changing water level conditions through time as simulated by the ISWS for the Current Trend scenario. The blue line in Figures 2 and 3 represents the **static** level, the water level in a well when the pump is turned 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). The model was adjusted until the simulated values matched the observed static water levels (a process known as calibration). In contrast, the ISWS generally has limited observed pumping water levels to calibrate the model to. Consequently, there is greater confidence in the simulated static levels. The purple area in Figure 2 depicts the band of uncertainty of future pumping levels, which are difficult to predict as water levels decline.

Another uncertainty in the model is the distribution of future puming, complicated by the addition of 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 would cost years of the estimated time left for another.

As both static and pumping levels approach the top of the Ironton-Galesville aquifer, a few issues have been observed. Of primary concern is that the most extreme drops in water levels when pumps are turned on occur in wells with the lowest static observations. While the hydrogeologically complex Sandwich Fault Zone is likely a factor for the large difference between static and pumping levels, the extreme depth of pumping may be exacerbating this. It is important to note that other issues can occur as water levels decline, including: 1) limits on pump settings (specifically, can a pump even be lowered into the Ironton-Galesville aquifer?), 2) costs associated with lifting water over a greater distance, 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 Romeoville's water supply?

Q1: Will Romeoville's withdrawals ever be sustainable?

A: No. Withdrawals from the sandstone aquifer in the Southwestern Suburbs have been unsustainable for over a century. Sustainable withdrawals for the region are estimated to be only 2-7 MGD, which is exceeded by expected future industrial demand alone. 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 Romeoville meet needed supply from the sandstone?

A: **Planning based on a time-horizon of available water from an aquifer is very challenging due to how water levels are sensitive to minor changes in uncertain future demands.** Risk increases as demands increase, with the first well entering the "Risk of Inoperability" zone under average conditions around 2070 for the Current Trend Scenario and 2053 with an additional 1.5 MGD. Wells would enter this risk zone immediately with an additional 3 MGD. No wells entered this most severe risk zone in the Less Resource Intensive Scenario. The issue is exacerbated when considering peak demands, where this most severe risk zone is reached 1-2 decades sooner. It is important that communities understand the impact of one or more wells going off-line, either for a short period (during peak conditions) or long-term (during average conditions), on their ability to meet total demands.

Take Home:

Romeoville's sandstone withdrawals are not sustainable. Future water level declines pose a risk to Romeoville's sandstone water supply, and Joliet switching off the aquifer will not eliminate this risk.

Bottom line: Uncharted territory

Sandstone water levels in the state have never been as low as they are now in the Southwestern Suburbs. How further declines will manifest is difficult to say for certain, but the ISWS has observed that previously modeled time-ranges for the usable life in the deep sandstone aquifer of the region appear to converge on the low end. In other words, as water levels decline, previously unforeseen complexities emerge that are disadvantageous for a well, and this is the real danger of water levels declining 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 better understand the uncertainty associated with these depths.**

References

[1]Crawford, Murphy, & Tilly. 2019. City of Joliet Alternative Water Source Study, Phase 1 Final Report. Available at: https://www.rethinkwaterjoliet.org/reports

[2]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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In addition to funding the work by the Illinois State Water Survey, members of the SWPG have frequented monthly meetings over the last year to discuss the future demand scenario in the model and inputs and uncertainties surrounding the modeling. This participatory effort remains critical to building confidence in the modeling results.