Summary Report for ISWS Contract Report CR2020-05

Shorewood, 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 (CMAP). **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.**

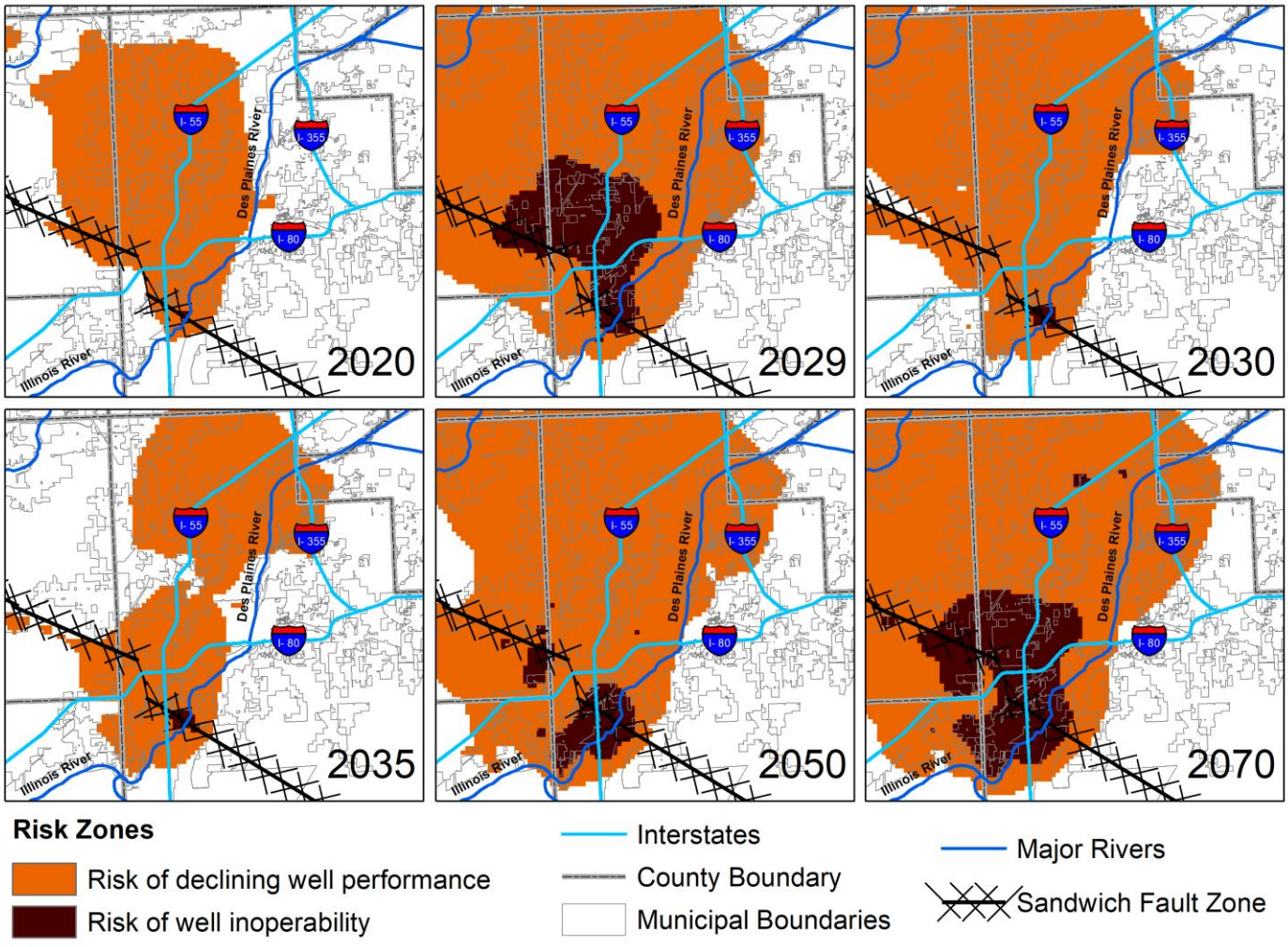

Figure 1. Risk associated with declining water levels in the deep sandstone aquifer in the Southwestern Suburbs of Chicago. The maps depict the following years: 2020 (current conditions), 2029 (before Joliet switches off the sandstone aquifer to Lake Michigan), 2030 (after Joliet switches), 2035 (after 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 continue to fall. Every SWPG community with active sandstone wells reaches this category by the year 2070. Most have at least one well in the red zone, where wells are at risk of being unable to meet demands and eventually 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. The model also simulated peak demands that include a 14 day return of Joliet to the aquifer in 2050 and 2070 to represent use of wells as an emergency back-up to the City's Lake Michigan supply.

Water levels at Shorewood 9

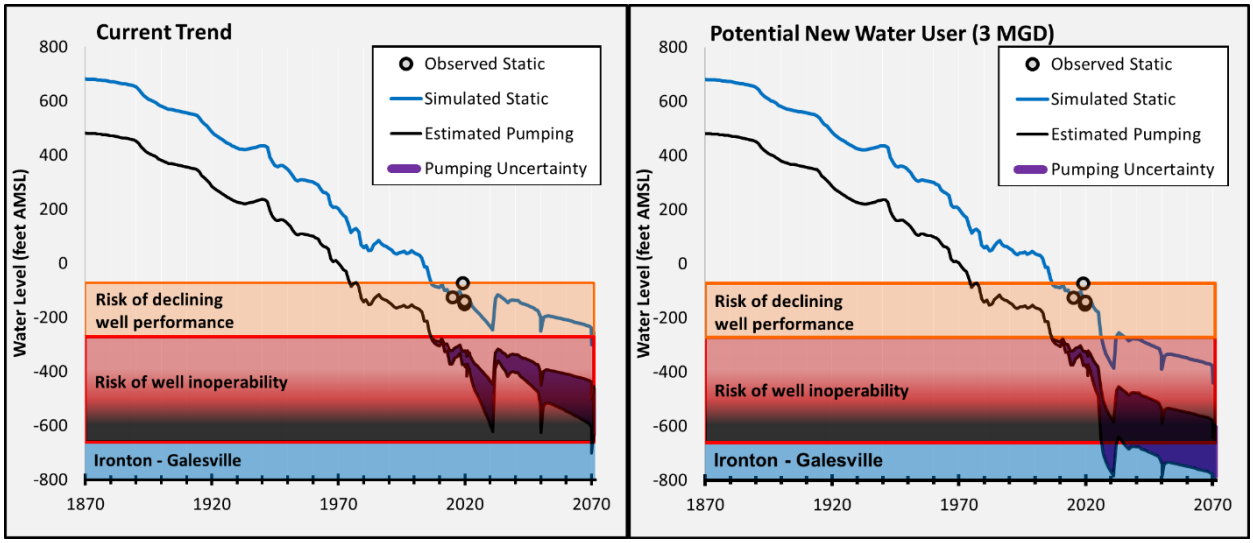

Figure 2. Hydrographs for Shorewood 9. Under the Current Trend scenario, water levels in Shorewood will continue to decline and be at-risk of well inoperability. Additional future withdrawals beyond the Current Trend demands, such as a new sandstone water user, will exacerbate this risk.

Another way to look at risk is to plot the water level of a well through time. This plot is referred to as a **hydrograph** and is very useful for indicating when water levels reach certain risk thresholds. In Figure 2, 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 Shorewood 9 have already reached this threshold. 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 the static water level falls into the red zone, which happens in 2070 in this scenario. This risk would be exacerbated by a new water user with sandstone wells; such new users were not considered in the Current Trend scenario. The ISWS considered the hypothetical scenario of a 3 Mgd sandstone user drilling wells 1.5 miles away from Shorewood 9. Model results with this new demand suggest that pumping water levels could fall into the deepest sandstone (the Ironton-Galesville aquifer), at which point it may be physically impossible to operate a high-capacity pump.

Technical Discussion of the Maps and Hydrographs

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 Figure 2 represents the **static** level, which is 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.

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 Shorewood's water supply?

Q1: Will Shorewood'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: Under the Current Trend scenario, can Shorewood meet needed supply from the sandstone?

A: Water levels will be lower than they currently are by the year 2050 with a downward trend after that. By 2050, water levels approach severe risk of inoperability during peak demands, reaching this level in 2070. A new water user or existing users that increase demands beyond the Current Trend scenario would exacerbate this issue greatly. Joliet, Oswego, Yorkville, and Montgomery switching off the aquifer only raises water levels in Shorewood by approximately 100 ft, which is a small gain when compared to the over 800 ft decline in static water levels since pumping began in the 1860s. Under this scenario, Shorewood's sandstone wells are at risk for declining performance by 2050 and may not be able to reliably supply water.

Q3: Were other scenarios considered?

A: Yes, and these maps can be found in Figures 26-30 of the full report. In the scenario with fewest demands (LRI), Shorewood's wells still fall into the "Risk of declining well performance" in both average and peak

pumping conditions. The wells remain vulnerable in this scenario, particularly to new, unsimulated demands (the likelihood of which increase since future pumping is muted in this scenario).

Take Home:

Shorewood's sandstone withdrawals are not sustainable. Future water level declines pose a risk to Shorewood'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

ACKNOWLEDGEMENTS:

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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.