

Groundwater Supply and Demand in Illinois:
Water Supply Planning in an Uncertain Future

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Illinois State Water Survey
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Presentation Overview

- Background
- Supply and Demand Framework
  - Shallow Groundwater
  - Deep Groundwater
- Retrospective of Progress
- Emerging Narratives

Supply and Demand Framework

Background

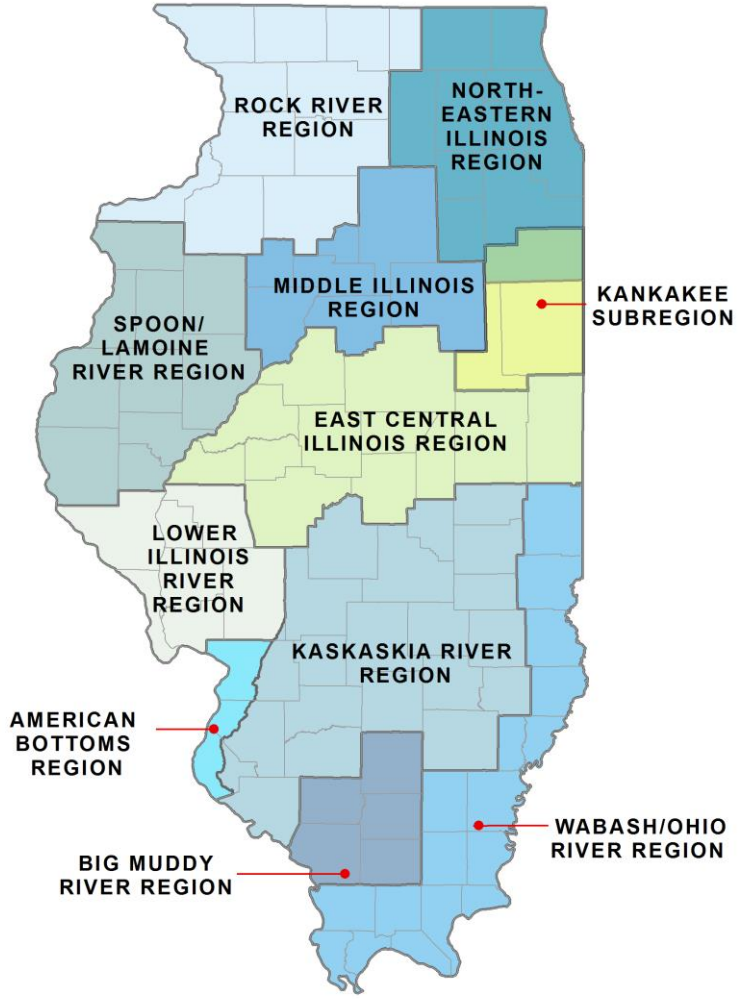
- Illinois updated its State Water Plan in 2022, with the following mission: *"For state agencies to develop a concise plan for addressing the water issues facing the state in an efficient and unified front"*

- Illinois Department of Natural Resources Office of Water Resources (IDNR-OWR) teamed with the Illinois State Water Survey (ISWS) to *"ensure Illinois has a **sustainable water supply** for all communities and users."*

Previous Water Supply Investigations

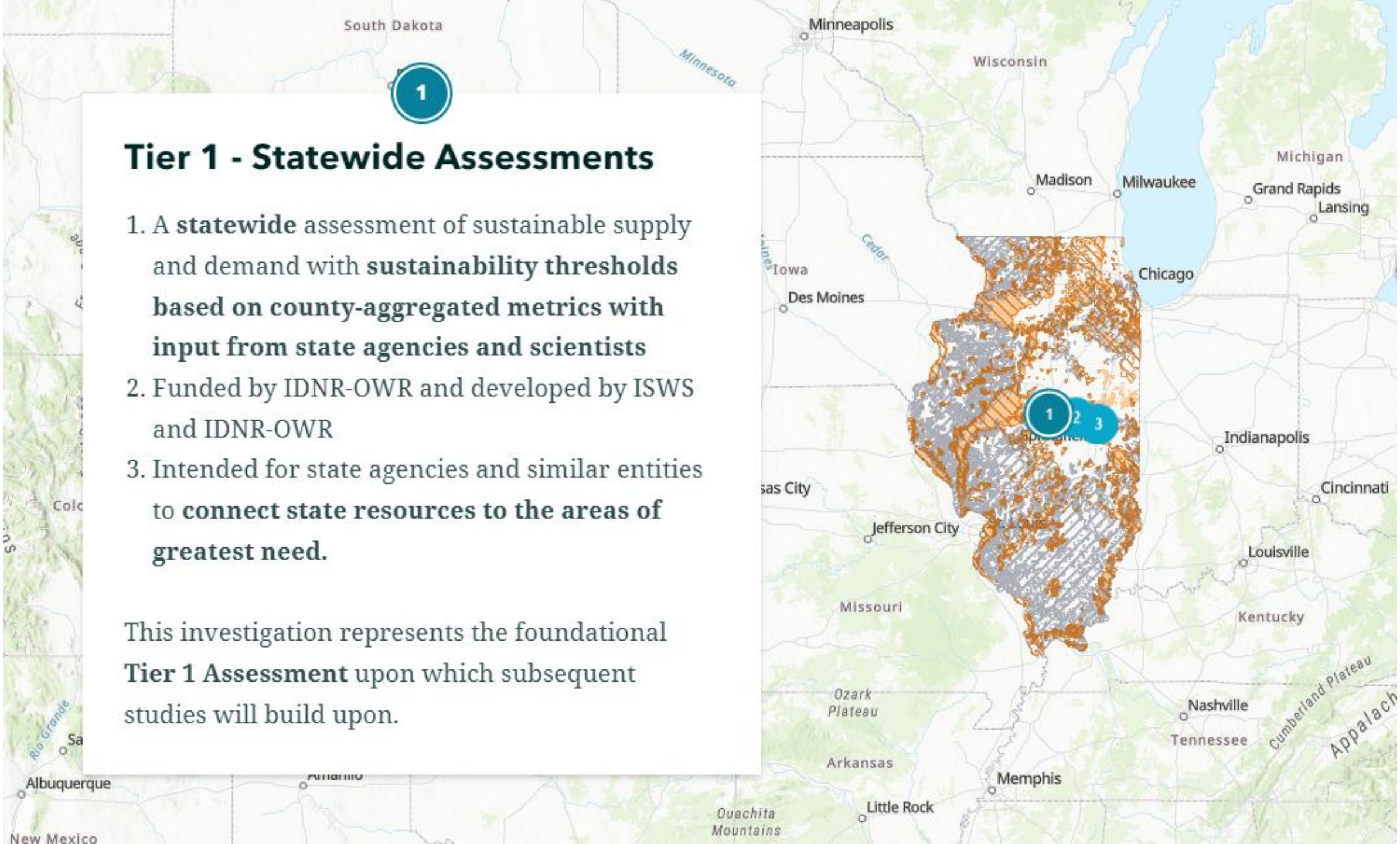
- Previous studies have focused on Planning Regions, with input from regional stakeholders to evaluate sustainability and risks in their regions.

- However, three challenges emerged
  1. Consensus on sustainability targets is elusive.
  2. A uniform framework was needed to evaluate needs across regions
  3. Studies were not always keeping pace with emerging concerns



Tiered Assessment Approach

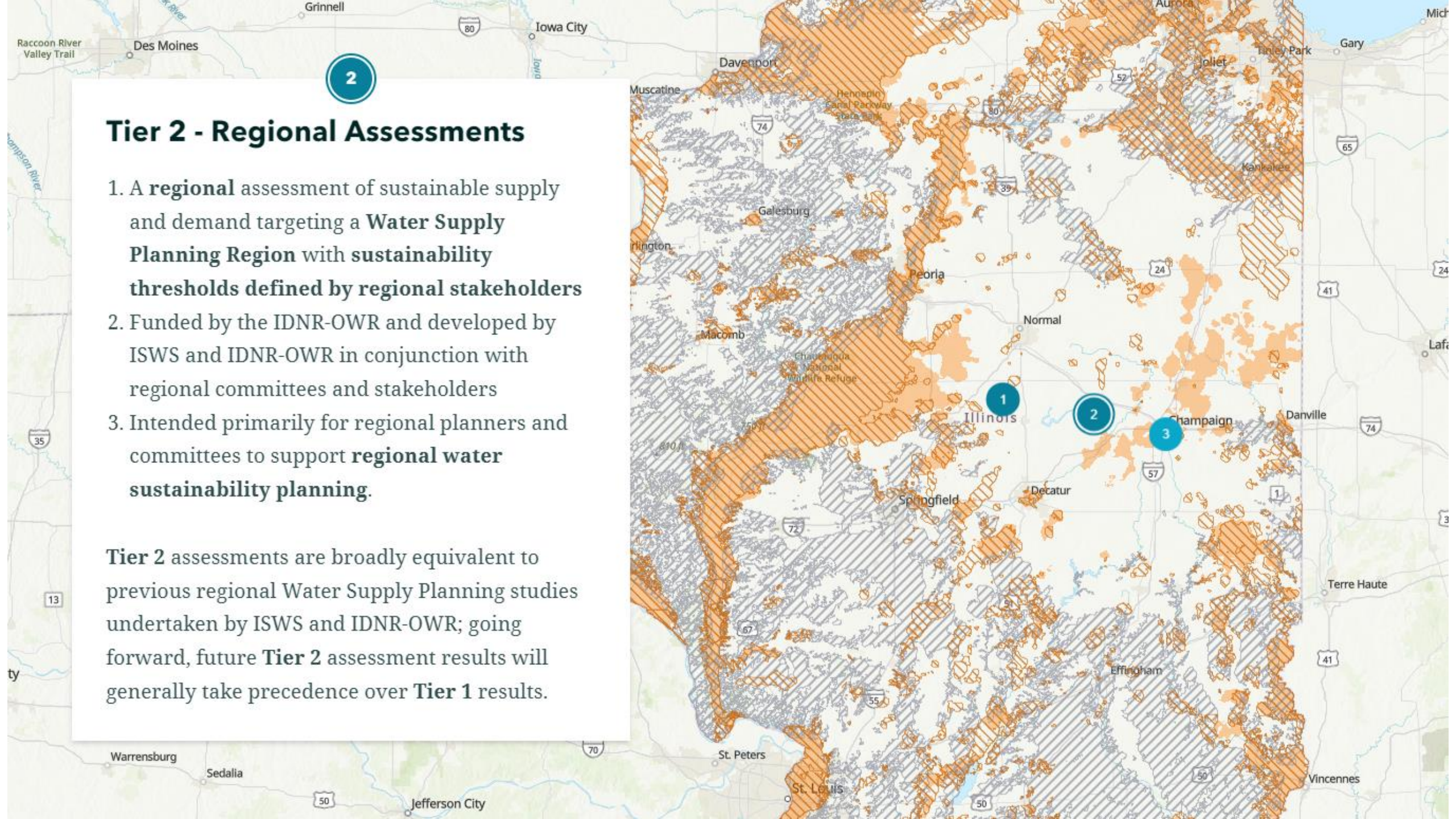
- To meet these goals, we developed the Water Supply Planning **Tiered Assessment** approach with a few primary objectives:
  - Give more control to local and regional planning groups to increase buy-in and adoption of sustainability goals
  - Better allocate resources towards needs at different scales
  - Create more continuity between studies and update analyses with the latest data



Tier 1 - Statewide Assessments

1. A **statewide** assessment of sustainable supply and demand with **sustainability thresholds based on county-aggregated metrics with input from state agencies and scientists**
2. Funded by IDNR-OWR and developed by ISWS and IDNR-OWR
3. Intended for state agencies and similar entities to **connect state resources to the areas of greatest need.**

This investigation represents the foundational **Tier 1 Assessment** upon which subsequent studies will build upon.



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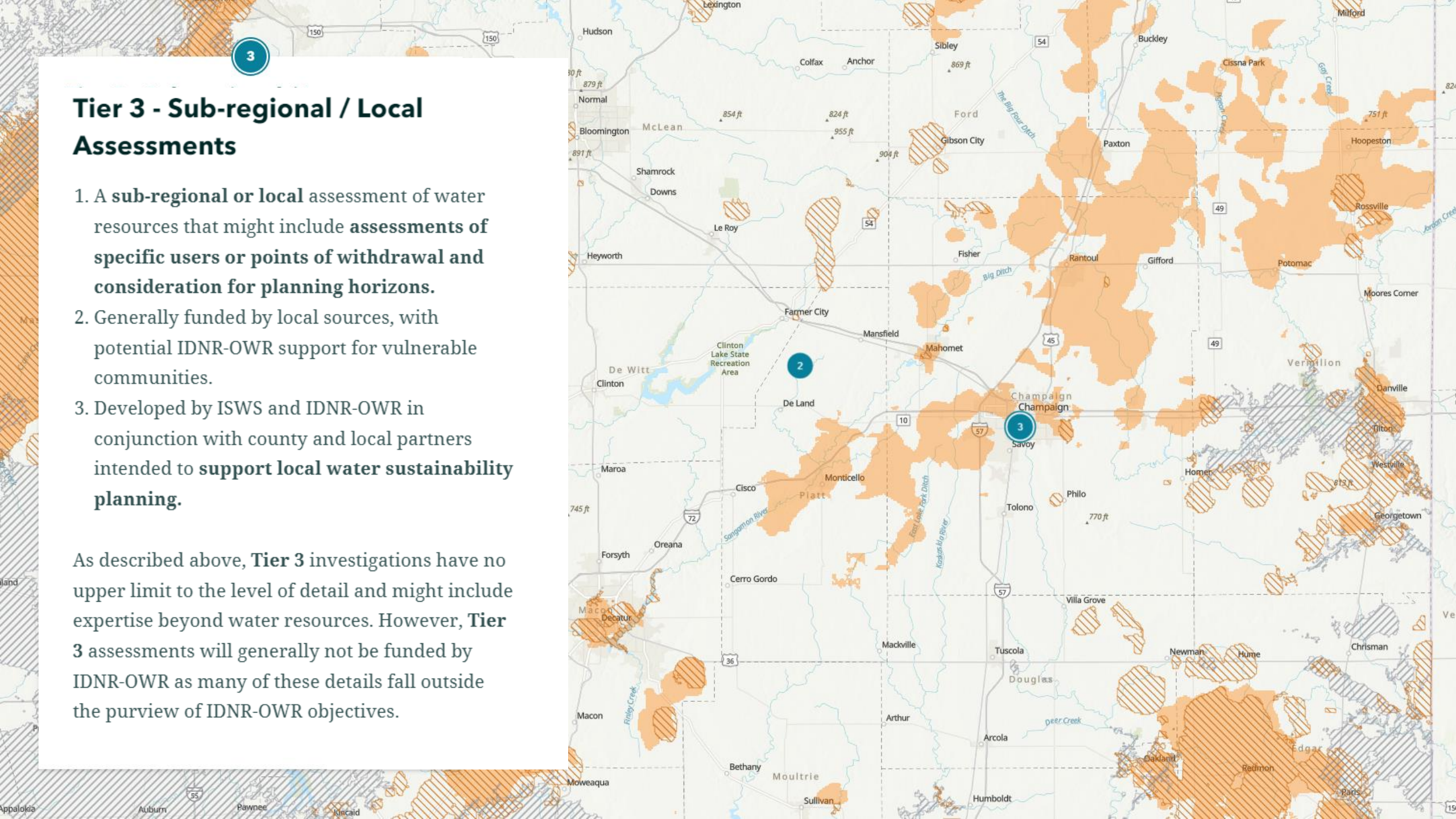
Tier 2 - Regional Assessments

1. A **regional** assessment of sustainable supply and demand targeting a **Water Supply Planning Region** with **sustainability thresholds defined by regional stakeholders**
2. Funded by the IDNR-OWR and developed by ISWS and IDNR-OWR in conjunction with regional committees and stakeholders
3. Intended primarily for regional planners and committees to support **regional water sustainability planning**.

Tier 2 assessments are broadly equivalent to previous regional Water Supply Planning studies undertaken by ISWS and IDNR-OWR; going forward, future **Tier 2** assessment results will generally take precedence over **Tier 1** results.



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Tier 3 - Sub-regional / Local Assessments

1. A **sub-regional or local** assessment of water resources that might include **assessments of specific users or points of withdrawal and consideration for planning horizons.**
2. Generally funded by local sources, with potential IDNR-OWR support for vulnerable communities.
3. Developed by ISWS and IDNR-OWR in conjunction with county and local partners intended to **support local water sustainability planning.**

As described above, **Tier 3** investigations have no upper limit to the level of detail and might include expertise beyond water resources. However, **Tier 3** assessments will generally not be funded by IDNR-OWR as many of these details fall outside the purview of IDNR-OWR objectives.

Tier 1 Methods - Demand

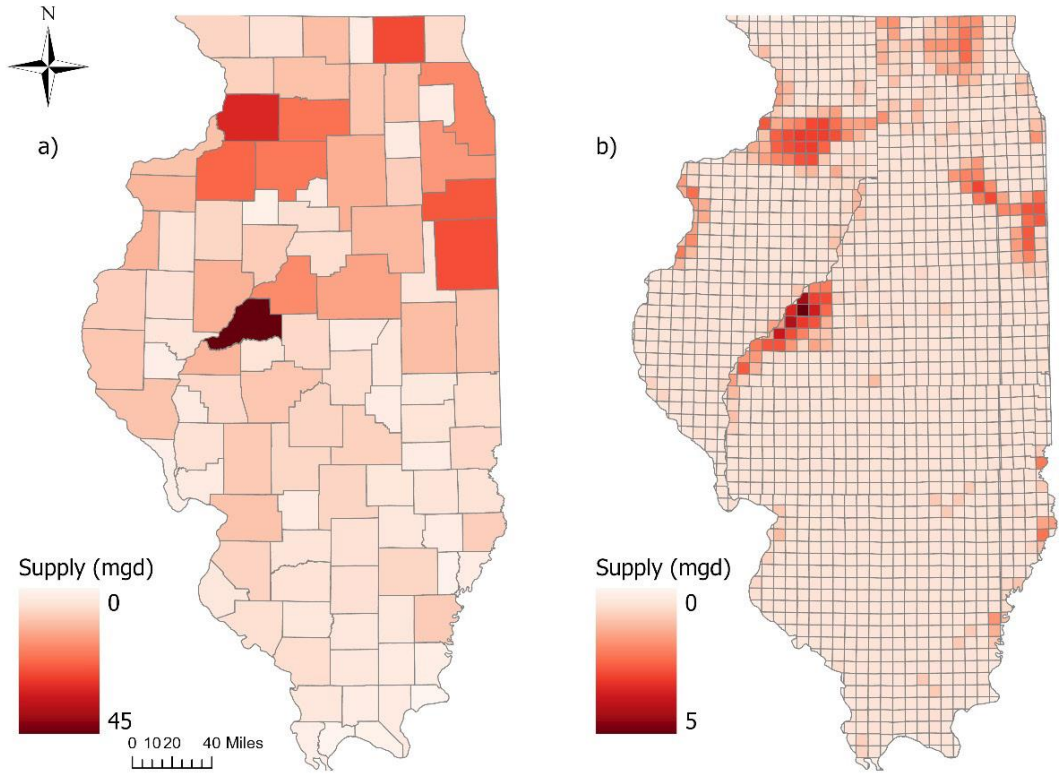
- Water **demand** was obtained from the Illinois Water Inventory Program (IWIP) and divided by sector, including *public supply, commercial and industrial, agricultural,* and *power generation*.
  - Groundwater demands were further divided based on well depth
    - < 500 ft were considered *shallow*
    - >500 ft were considered *deep*

- Future demands were estimated for public supplies by calculating the current gallons per capita water usage using reported demands and 2020 Census population data, then estimated through 2070 using population projections provided by IDNR-OWR.
  - Other demand sectors were held constant at 2020 levels due to challenges anticipating changes without local input

Shallow Groundwater Supply

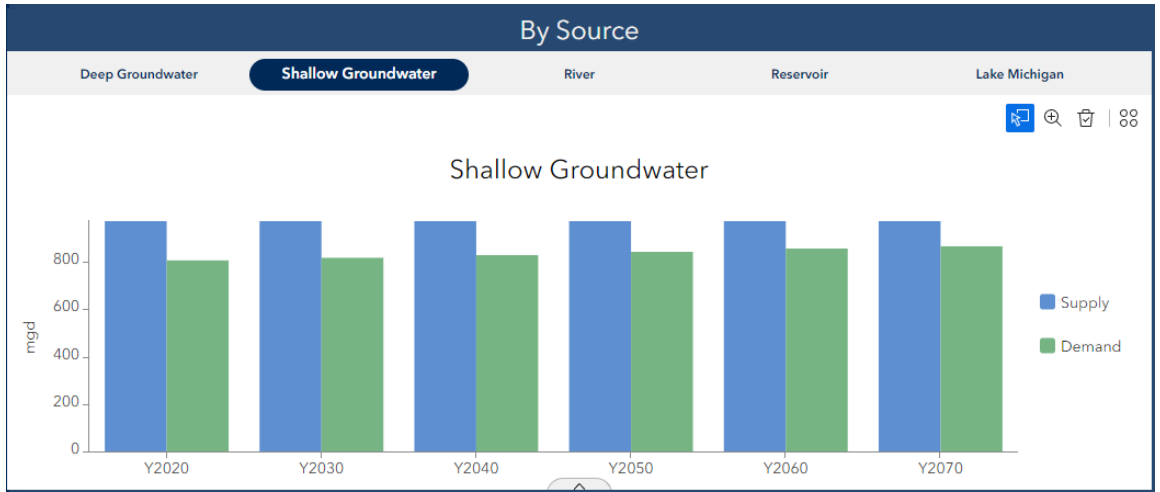
Wells shallower than 500 feet

Tier 1 Methods – Shallow Groundwater Supply



Shallow groundwater supply is guided by a study in Michigan by Zorn et al. (2012) showing that aquatic ecology can be impacted by a 10-20% reduction in natural groundwater discharge to streams.

As the shallow groundwater model is under development, a 15% reduction in modeled predevelopment recharge is used as a proxy for a reduction in groundwater discharge.



The Sangamon River at Monticello
08-01-2012

Reductions in natural groundwater discharge

percent reduction

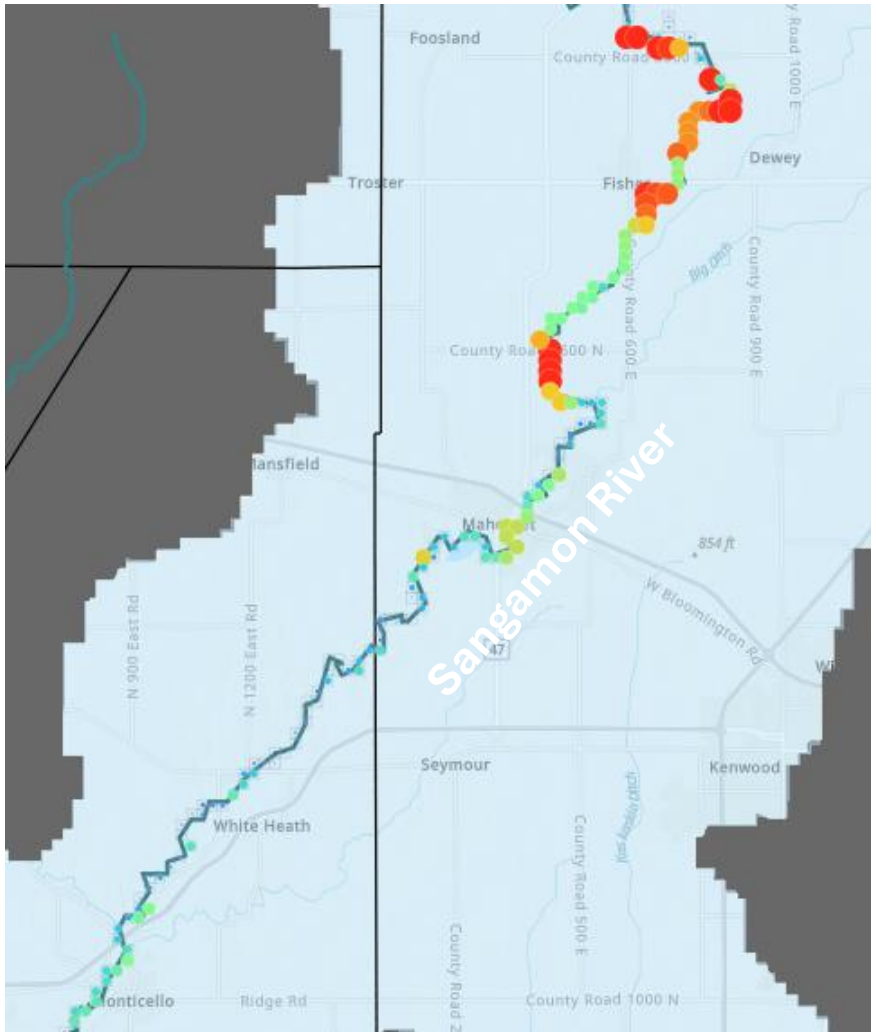
percent

> 80

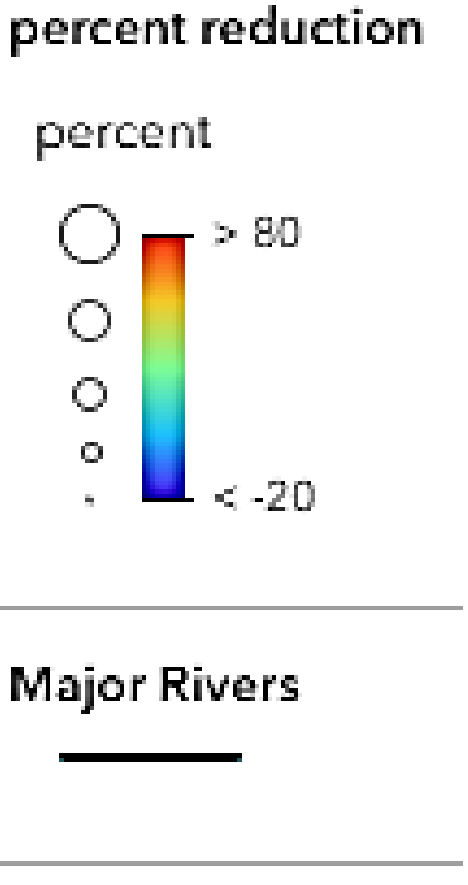
< -20

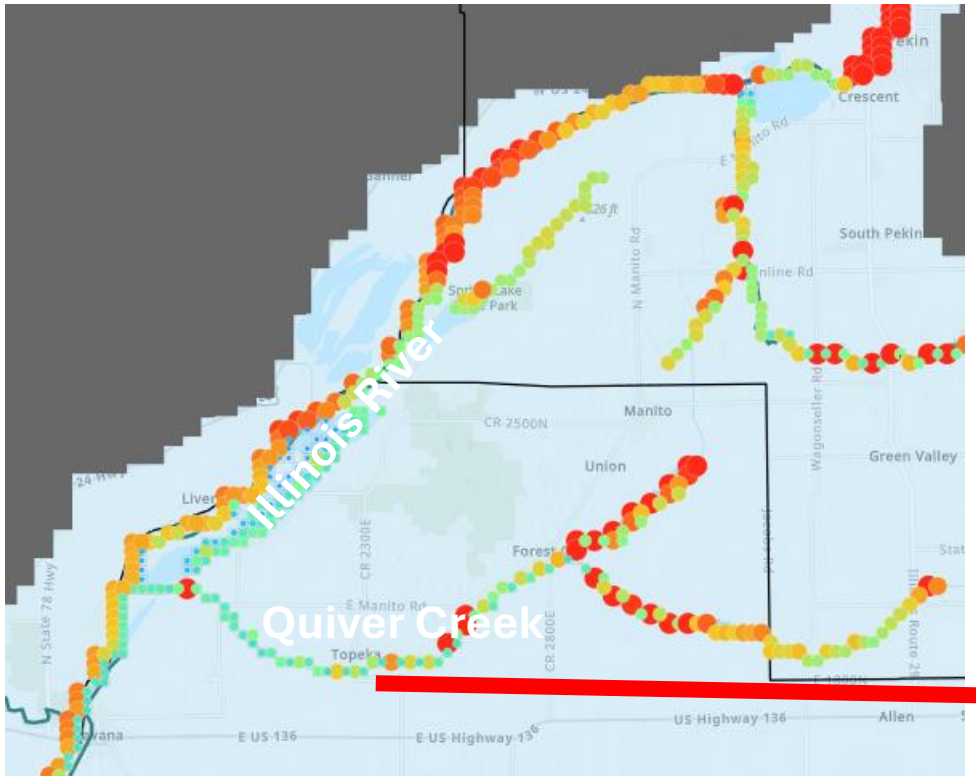
Major Rivers

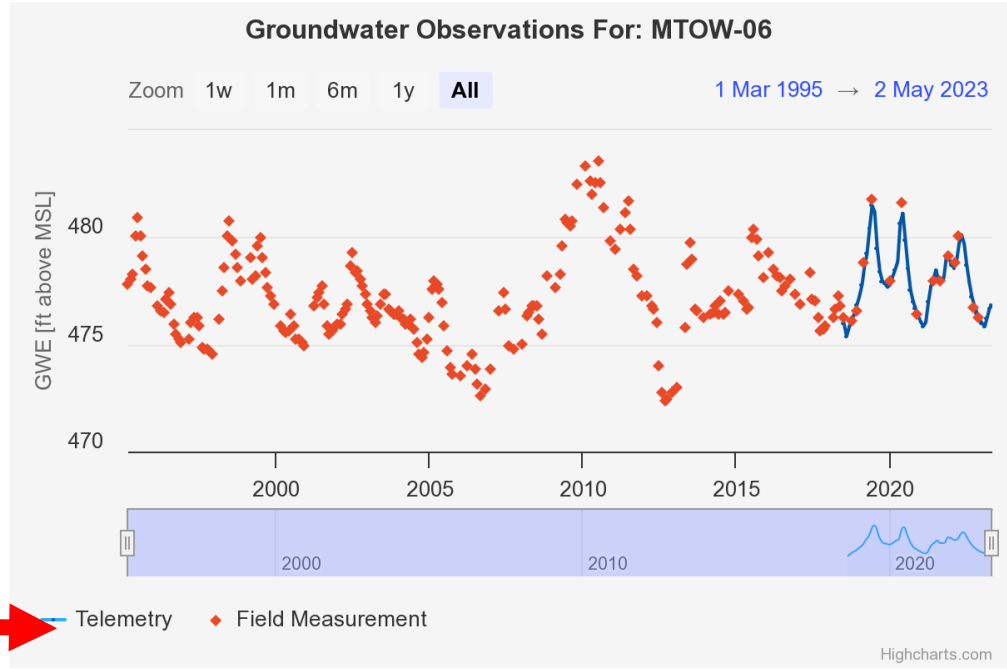
County Boundaries



Reductions in natural groundwater discharge







The model shows declines, but water levels in the aquifer have not changed much in over 30 years. On average, the low values are elevated in recent years from the 1990's.

Imperial Valley- Irrigation

- Estimated at ***over 1 billion*** gallons/day during peak irrigation season in drought years
- Nearly the rates of entire Chicago Metropolitan area
- Irrigation not consistently reported, rely on hours on/pump ratings

- Though Illinois is known for corn and soybeans, we are also the top pumpkin producer, with this area dominating

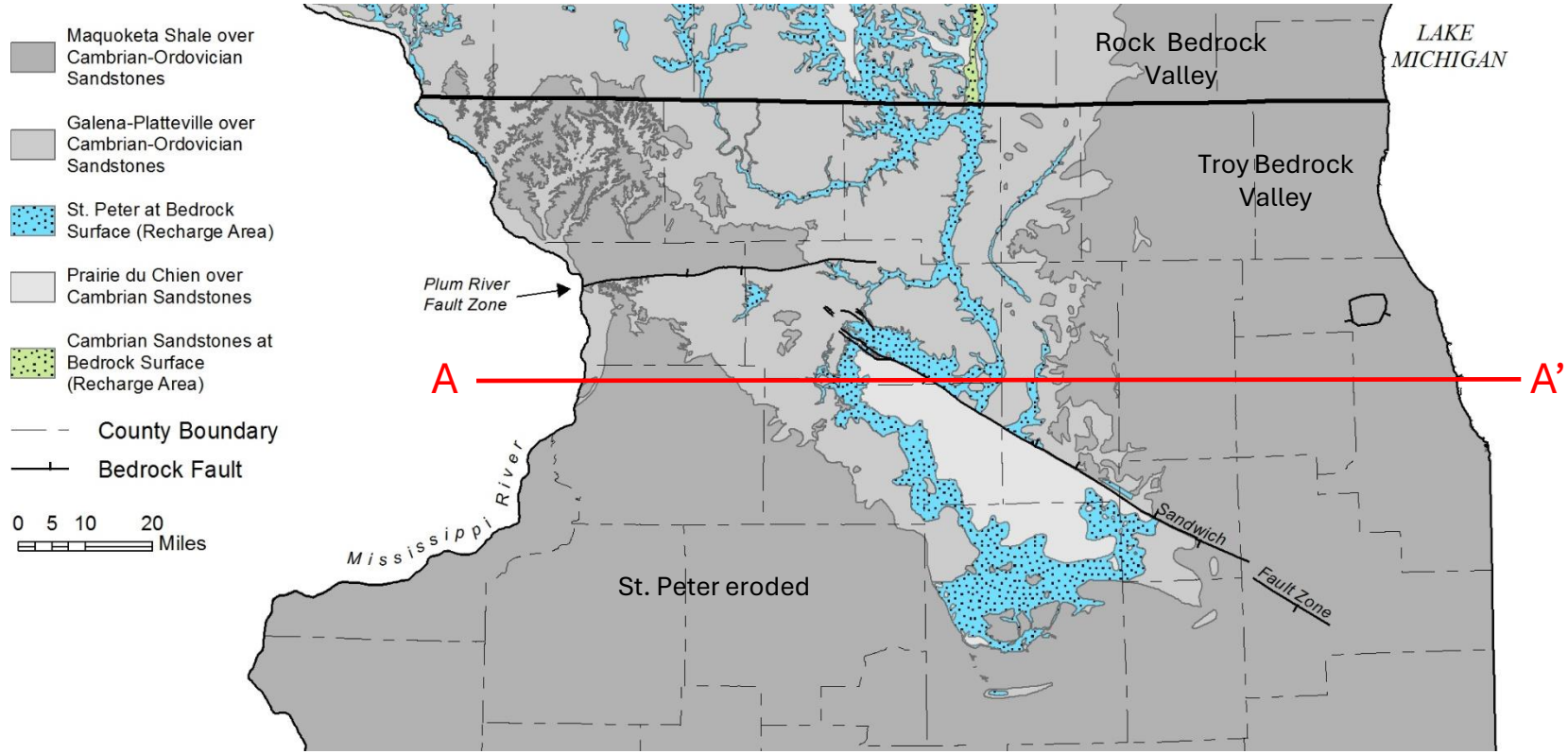
Deep Groundwater Supply

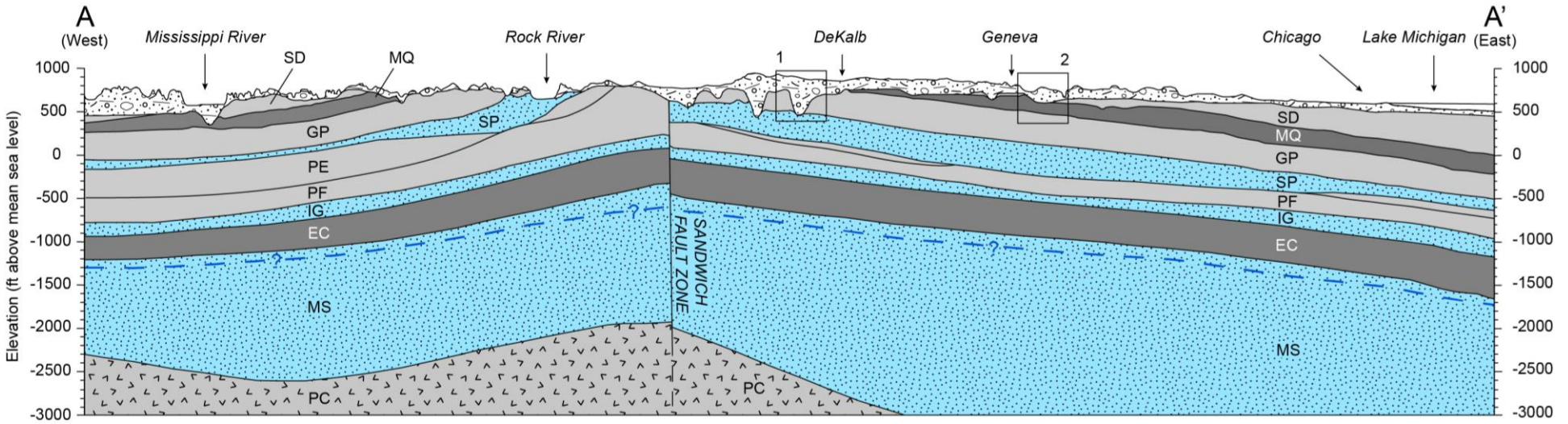
Wells greater than 500 feet depth

Cambrian-Ordovician Sandstone Aquifer System

- Confined bedrock aquifer system
- St. Peter Sandstone
- Ironton-Galesville Sandstone
- Mt. Simon Sandstone
- Recharge limited to bedrock valleys and isolated outcrops
- Extends into Iowa, Wisconsin, Minnesota, Indiana

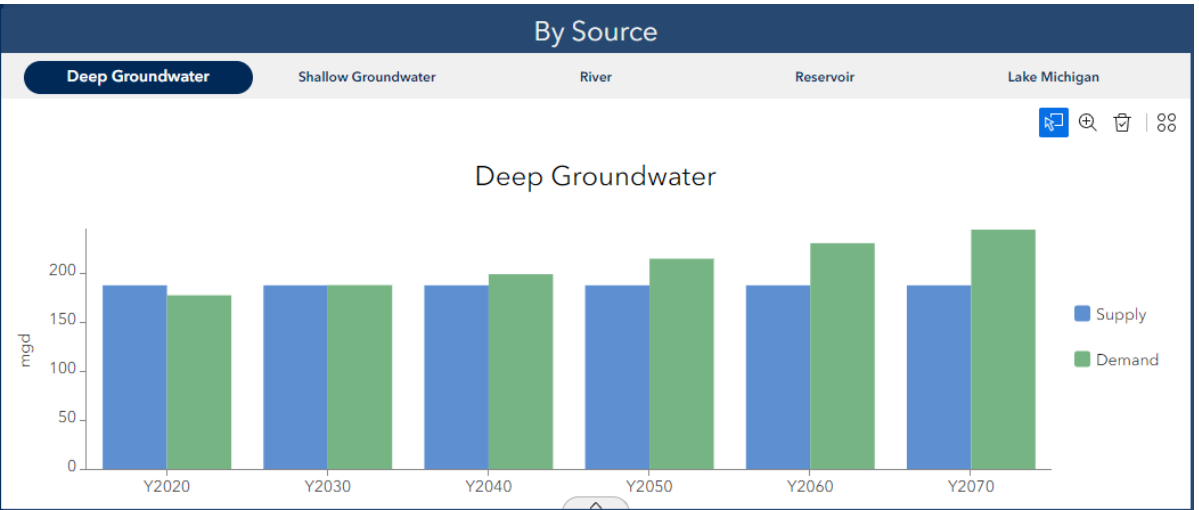
- Regional fault zone systems and structural arches

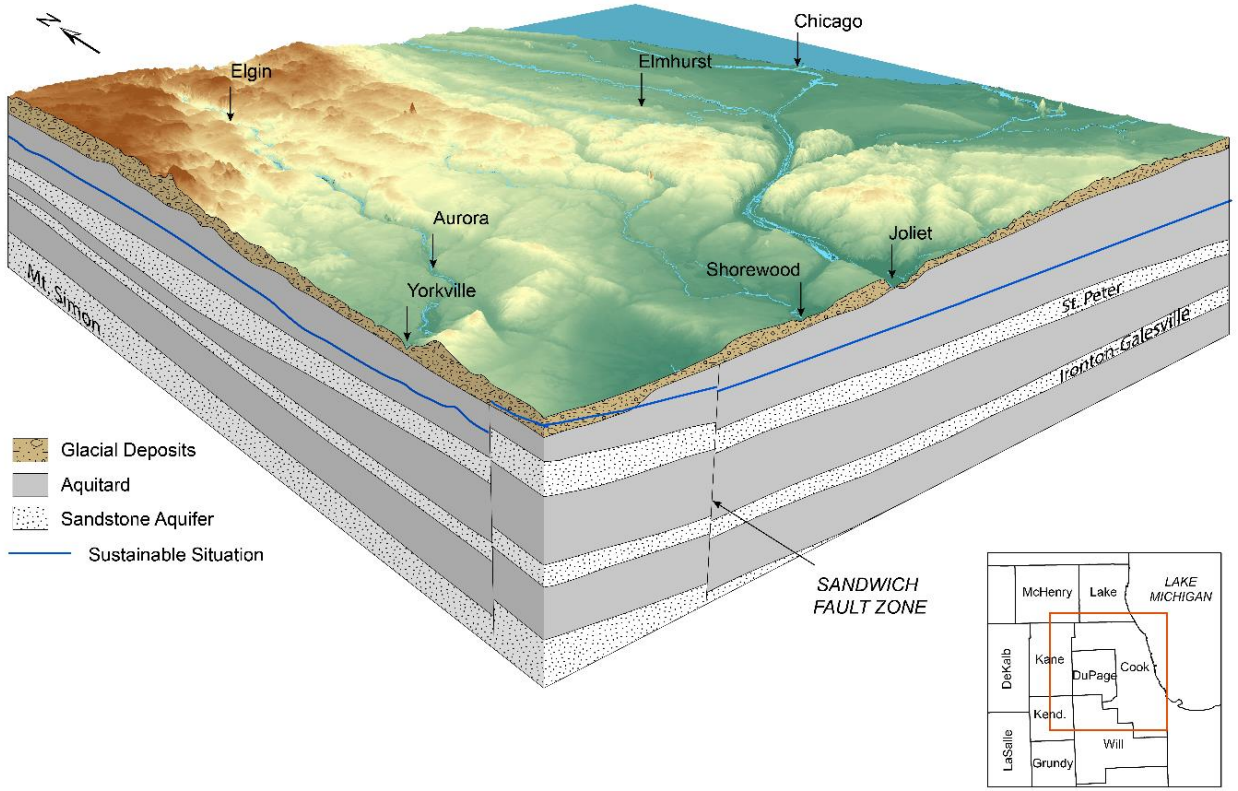




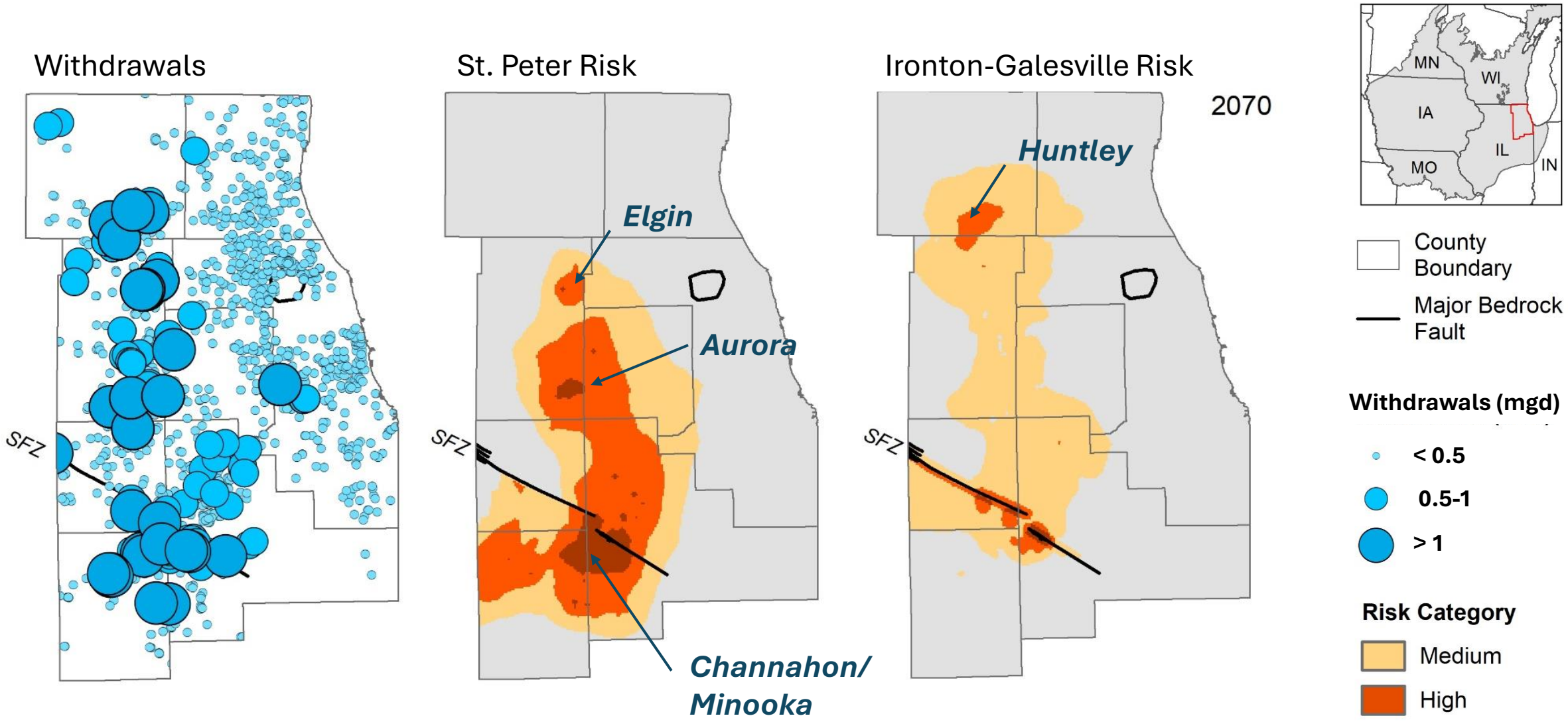
Tier 1 Methods – Deep Groundwater Supply

Deep groundwater supply is evaluated using a MODFLOW groundwater flow model calculating the maximum sustained recharge rate to the sandstone aquifers while limiting dewatering (200 ft above St. Peter Sandstone to allow for drawdown during pumping).





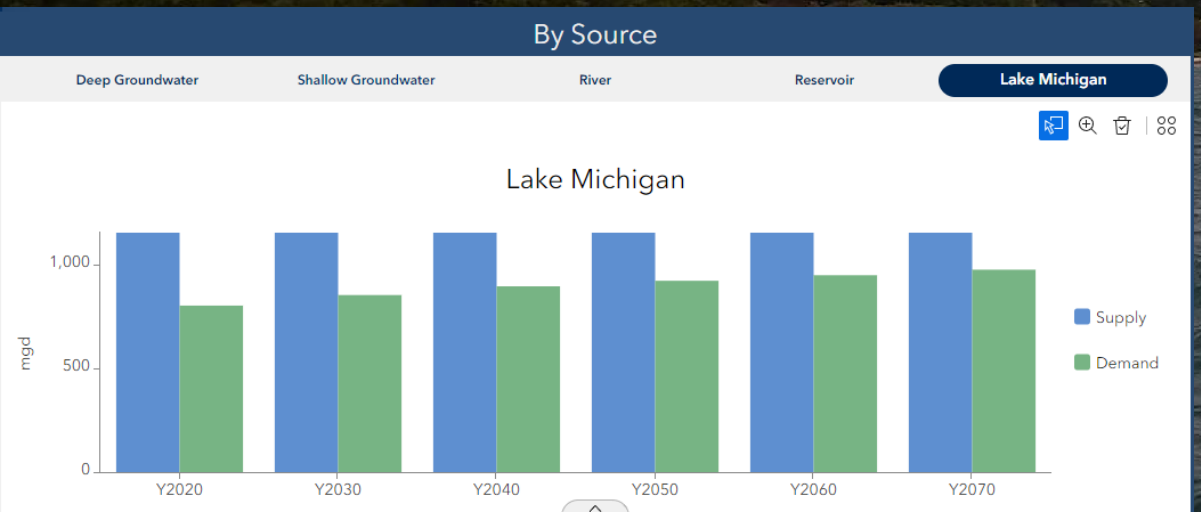
Sandstone Aquifer System-Community Risk



- Despite users switching to Lake Michigan, drawdown is expected to persist or increase
- Over a century of drawdown before negative impacts manifested, yet new development can locally accelerate depletion due to the history of groundwater mining: responsive confined system

Hadley and others (2021) *Water Resources Research*

Tier 1 Methods – Lake Michigan Supply



Lake Michigan supply is evaluated based on current IDNR-OWR allocation permittees (current to water year 2017, pending updates with additional permittees coming online)

Lake Michigan is unique in having a maximum allocation as determined by a previous Supreme Court decree, the supply is unavailable to those without both existing infrastructure and approved permits.

Transition from Groundwater to Lake Michigan

- Chicago and its suburbs are increasingly reliant on Lake Michigan supply, transitioning off dwindling groundwater supplies
- Though we are on pace to remain below maximum allocation limits, future Lake Michigan permits likely to receive increased scrutiny
- New pipelines increasingly expensive as permittees move westward (latest: $1.2 billion)
- Lake Michigan still viewed favorably due to optics and ongoing costs of treating contaminated groundwater supplies (e.g. PFAS)

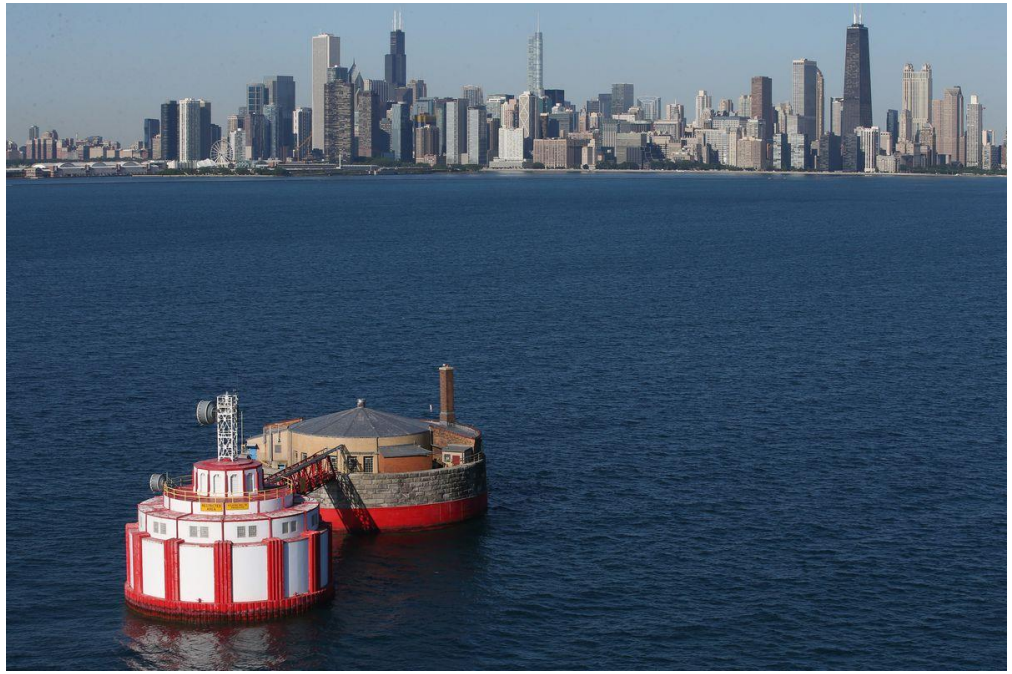


Photo Credit: Chicago Tribune

Abrams and Hadley (2015), Changing Groundwater Levels in the Sandstone Aquifers of Northern Illinois and Southern Wisconsin

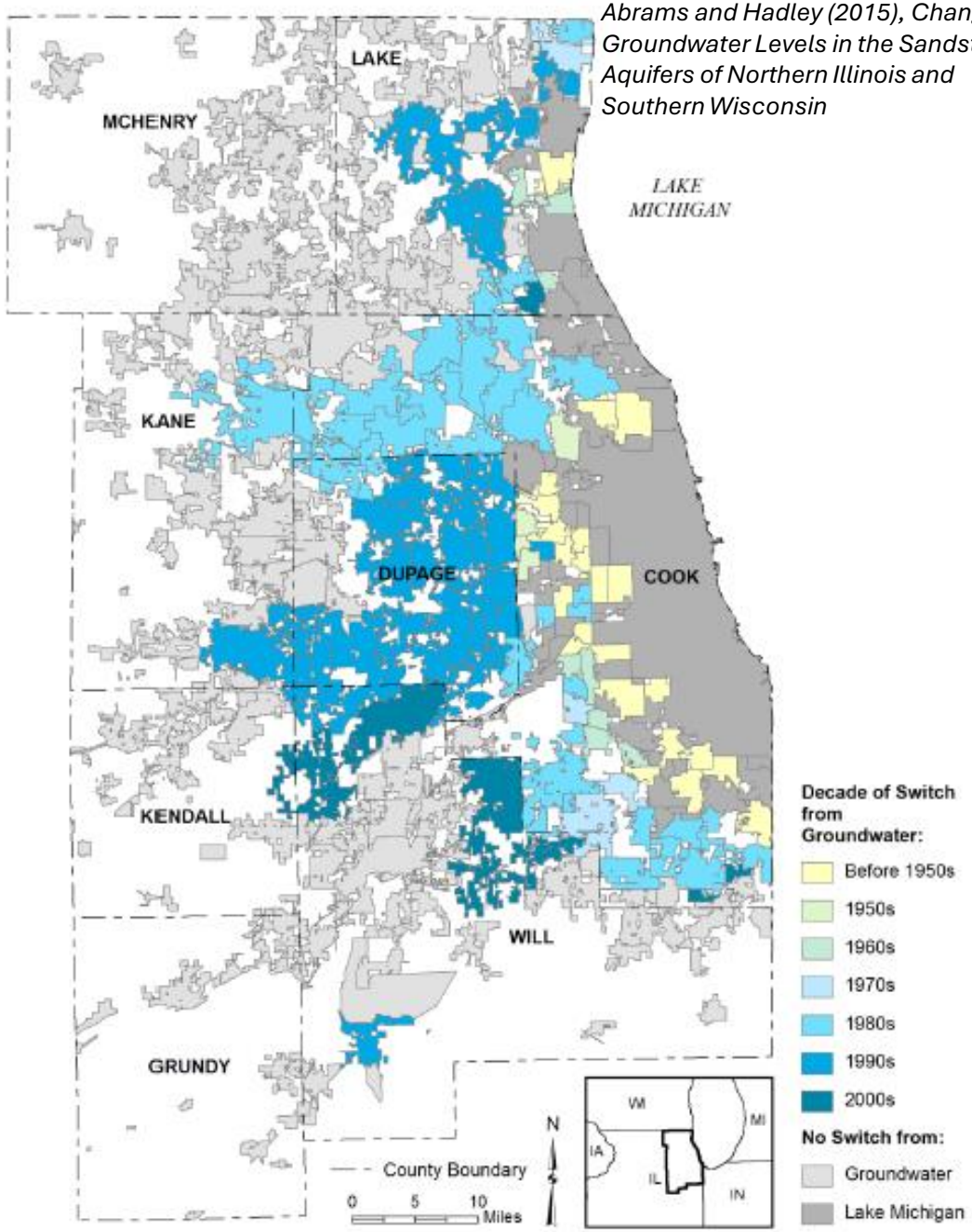


Figure 9: Decade of switch for northeastern Illinois communities that ceased using groundwater for an alternative water supply.

Retrospective of Progress

10 years working on water supply studies

Lessons from Stakeholder Engagement

- Engagement and communication specialists are critical
  - Hydrogeologists are not trained to be grief counselors
  - Having a diverse team with “knowledge brokers” leads to more effective engagement
- Stakeholders want agency over water planning decisions
  - Many resistant to formal governance
- Planners are generally optimistic about the future
  - Strong belief that technological and efficiency improvements will pave the way for sustainability
  - Scenario planning an important tool for navigating uncertainty

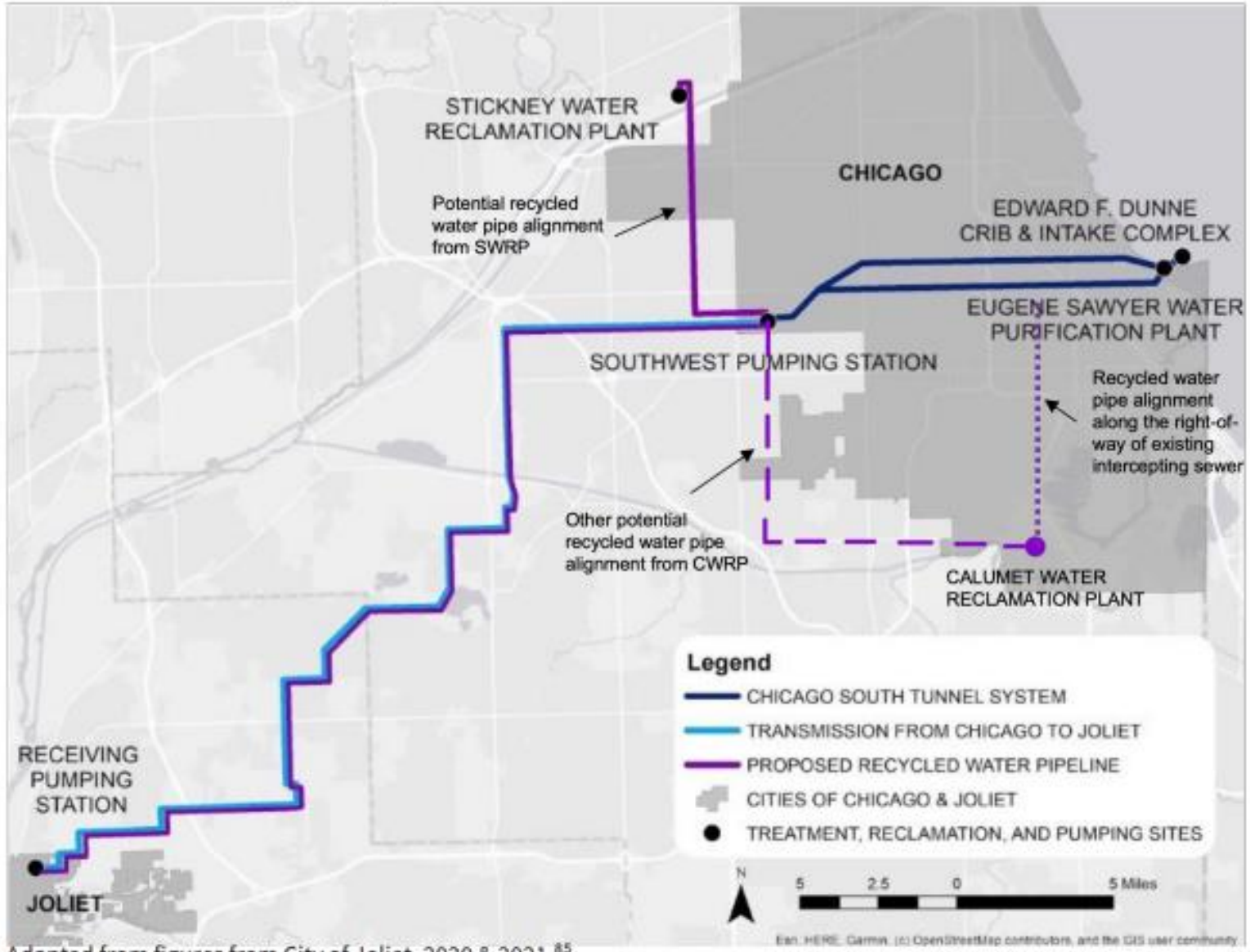
Emerging Narratives

Beyond existing supplies to meet new demands

Water reuse

- Though groundwater supplies may be abundant, demands are not always aligned with where supply is available
- Water reuse is increasingly being proposed to supplement natural water supplies, such as a recent proposal to use treated wastewater from Chicago to supplement industrial demands (Havrelock et al., 2023)

Figure 9(b). Proposed Dual-Pipeline Infrastructure Pathways Connecting Joliet to Treated Lake Michigan Water (CDWM) and Recycled Water from Calumet WRP (MWRD).



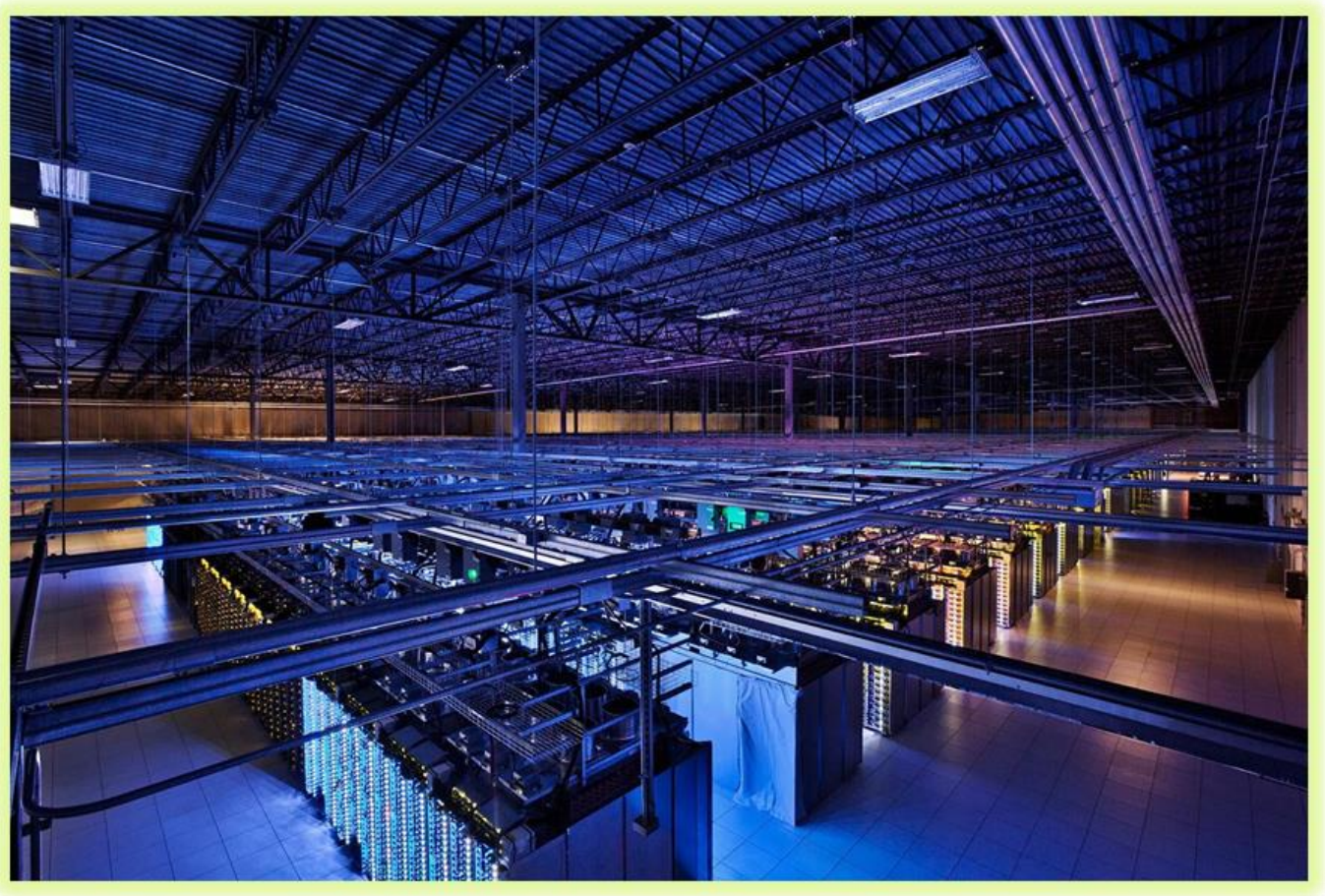
Adapted from figures from City of Joliet, 2020 & 2021.[85]

Water reuse

- Recent Illinois rules change allows for potable reuse of treated wastewater in Illinois pending rulemaking
- Select communities already using treated wastewater for irrigation on a strictly permitted basis
- Even though the Midwest has seen limited adoption of water reuse to date, we expect it will become common especially where it can satisfy demands for nonpotable uses (e.g., irrigation, industry, etc.)

Growth of new industry

- As the Midwest positions itself to be the “silicon prairie”, growth of data centers in Illinois puts the focus on consumptive usage for cooling operations
- Other emerging industries (e.g. carbon sequestration) necessitate revisiting future water demands



Questions?

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