Siting Data Centers with Groundwater in Mind

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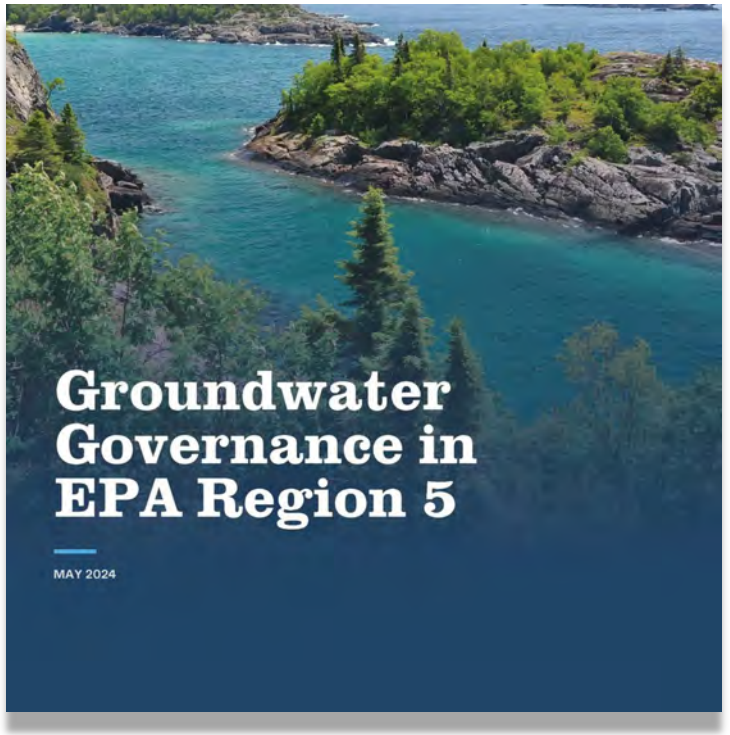
Learning Objectives

Put proposed water use in the context of :

- Groundwater distribution
- Groundwater use
- Water scarcity/abundance
- Priorities for groundwater use and existing groundwater policy
- Alternatives to groundwater



FRESHWATER

WATER 365 LLC

MUSKINGUM WATERSHED CONSERVANCY DISTRICT

UNIVERSITY OF MINNESOTA
Driven to Discover®

U.S. DEPARTMENT OF THE INTERIOR 1824 BUREAU OF INDIAN AFFAIRS

Great Lakes Indian Fish & Wildlife Commission

The Joyce Foundation

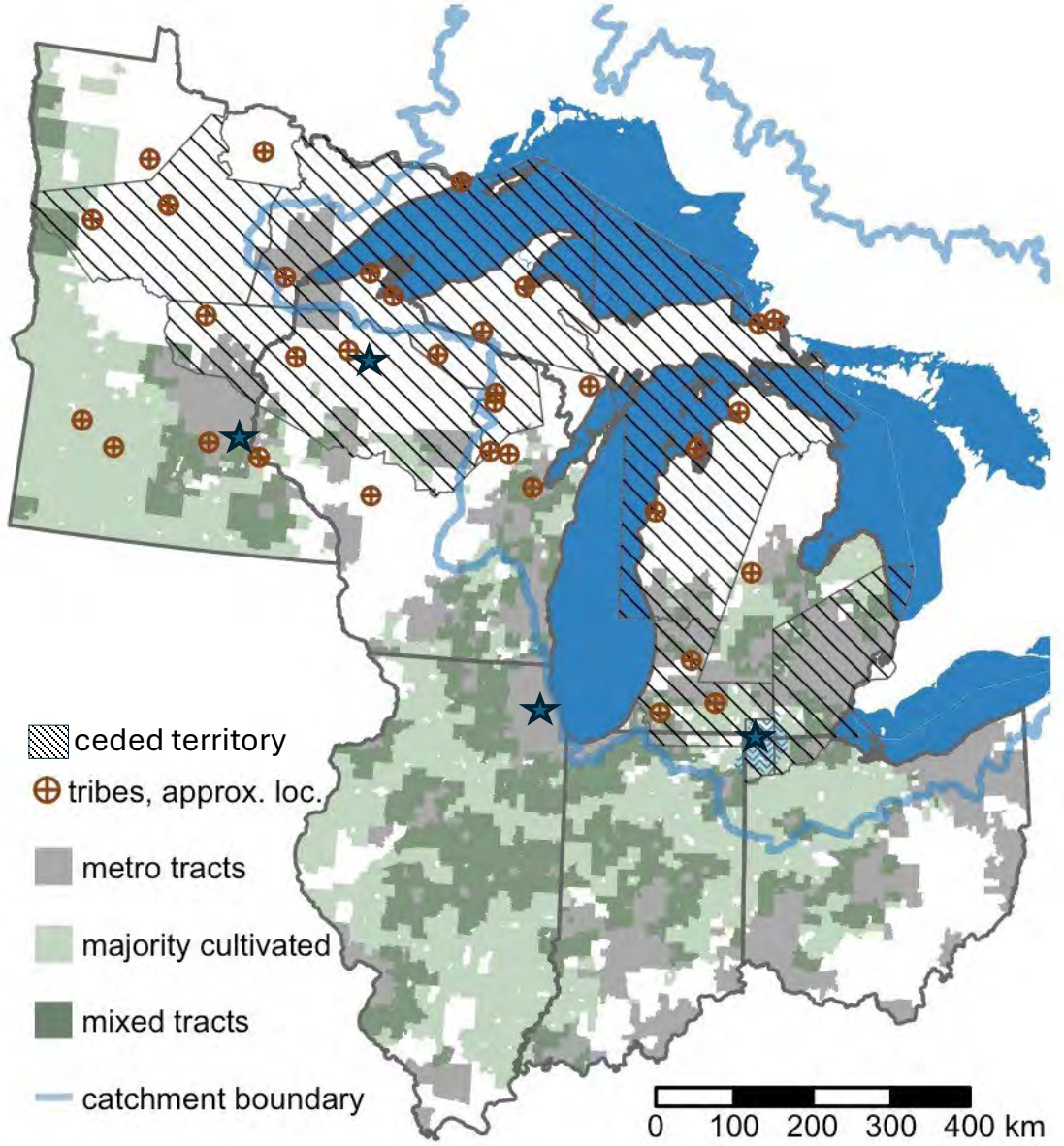
1. **Describe the system** of groundwater governance surrounding the Great Lakes.
2. **Assess its adequacy** to support sustainable use, mindful of existing and future challenges.

Overview of:

- hydrogeologic knowledge production
- current groundwater institutions
- governance approaches
- challenges

Second Phase of Work:

Aquifer Conversations



Data Center Water Use

1 megawatt data center can use up to the daily water consumption of 300,000 people or 7 million gallons for cooling

A medium-sized data center (15MW) consumes as much water as three average-sized hospitals or more than two 18-hole golf courses.

GPT-3, an AI model, is estimated to consume 2 cups of water per 10-50 responses. Multiply by billions of users.

By 2027, global AI demand is expected to account for 1.1 to 1.7 trillion gallons of water.

https://www.weforum.org/stories/2024/11/circular-water-solutions-sustainable-data-centres/

Other water-intensive industries

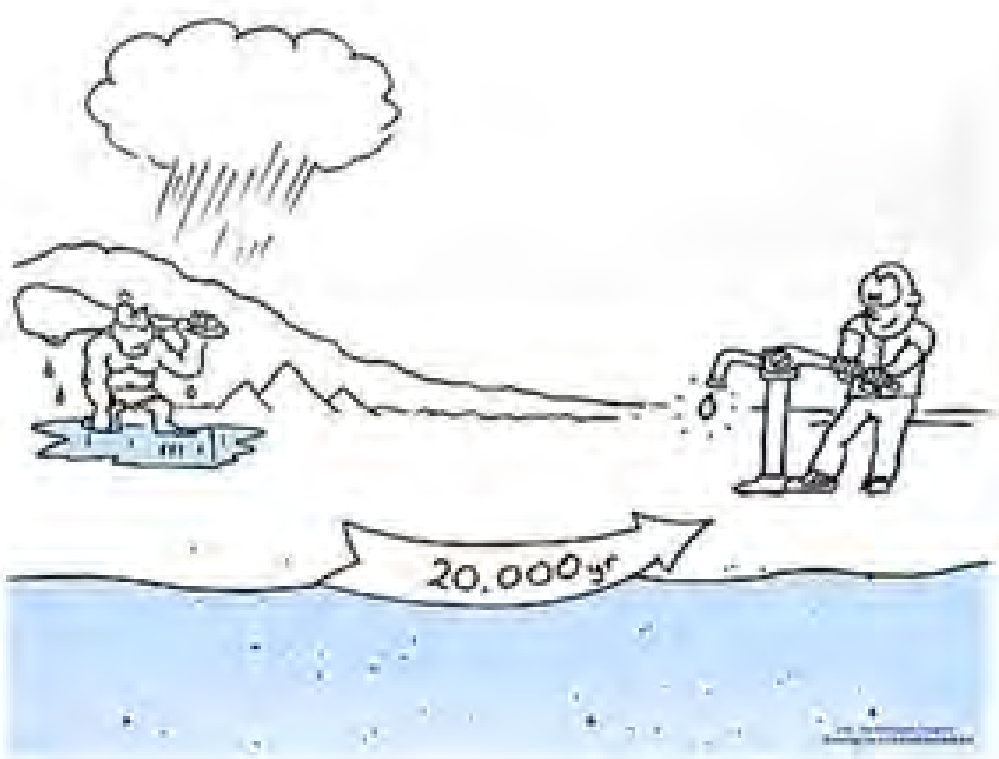
- Agriculture
- Textiles
- Biofuels (ethanol, sustainable aviation fuel)
- Green Hydrogen
- Beverages
- Biotechnology/pharmaceuticals
- Electric power
- Forest products
- High-tech (semi-conductor manufacturing)
- Metals
- Mining

https://www.epa.gov/sustainability/lean-water-toolkit-chapter-2#:~:text=Industrial%20water%20users%20include%20facilities,petroleum%20refining%2C%20and%20transportation%20equipment.

What is groundwater?

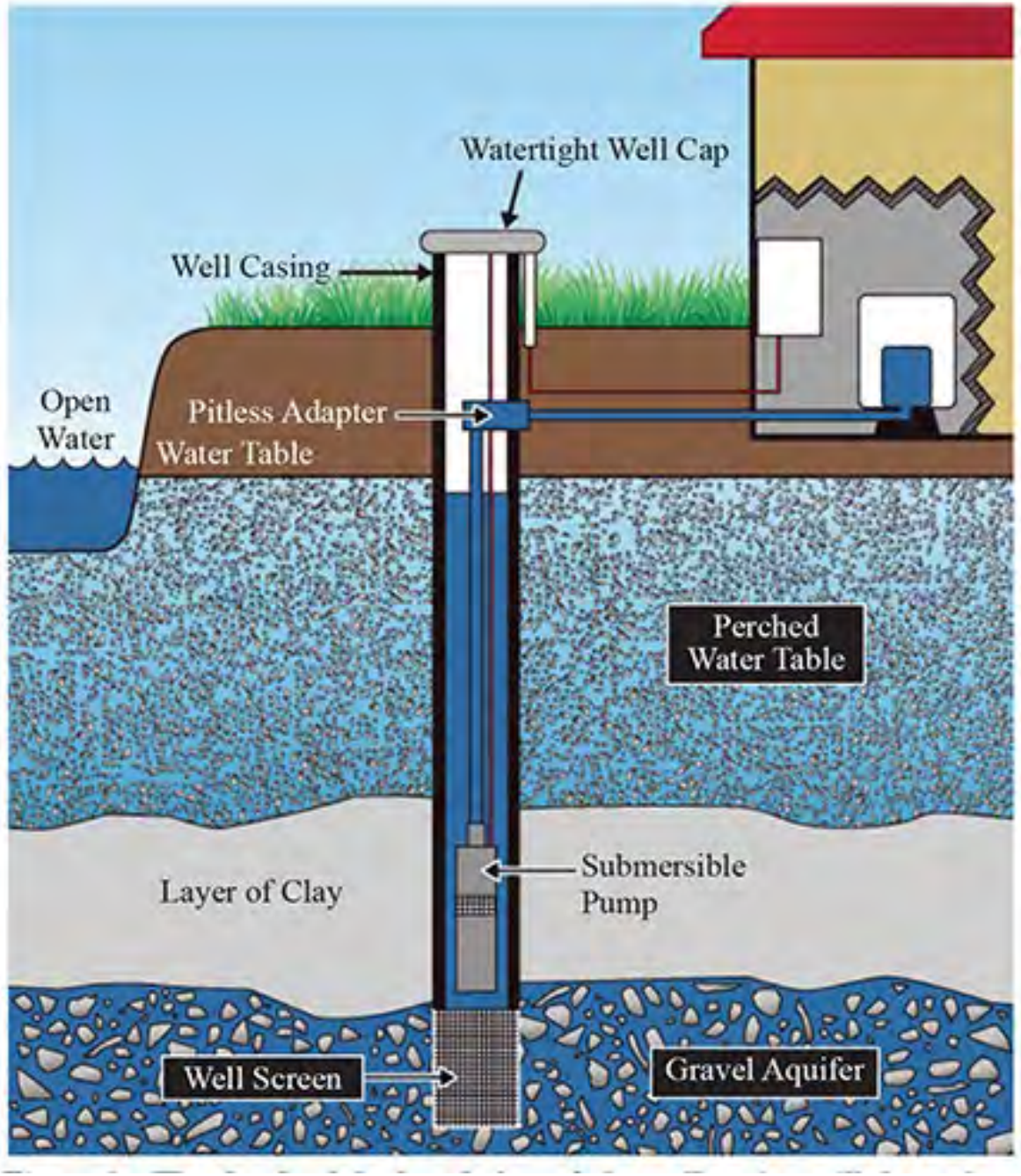
Groundwater 101

- Groundwater began as precipitation (and glacial meltwater)
- Stored in pore spaces of sediment and rock
  - Pore connections impact how available the water is
  - Rare to have large open caverns
- Insulated from seasonal temperature change
  - Water temp ~ average annual temperature
- May be connected to surface water features
  - Lakes
  - Perennial streams
  - Wetlands
  - Springs
- May be confined and disconnected from surface water
  - Not easily replenished by precipitation
  - May be under pressure (artesian)
- Age of water can range from years to 10,000’s of years

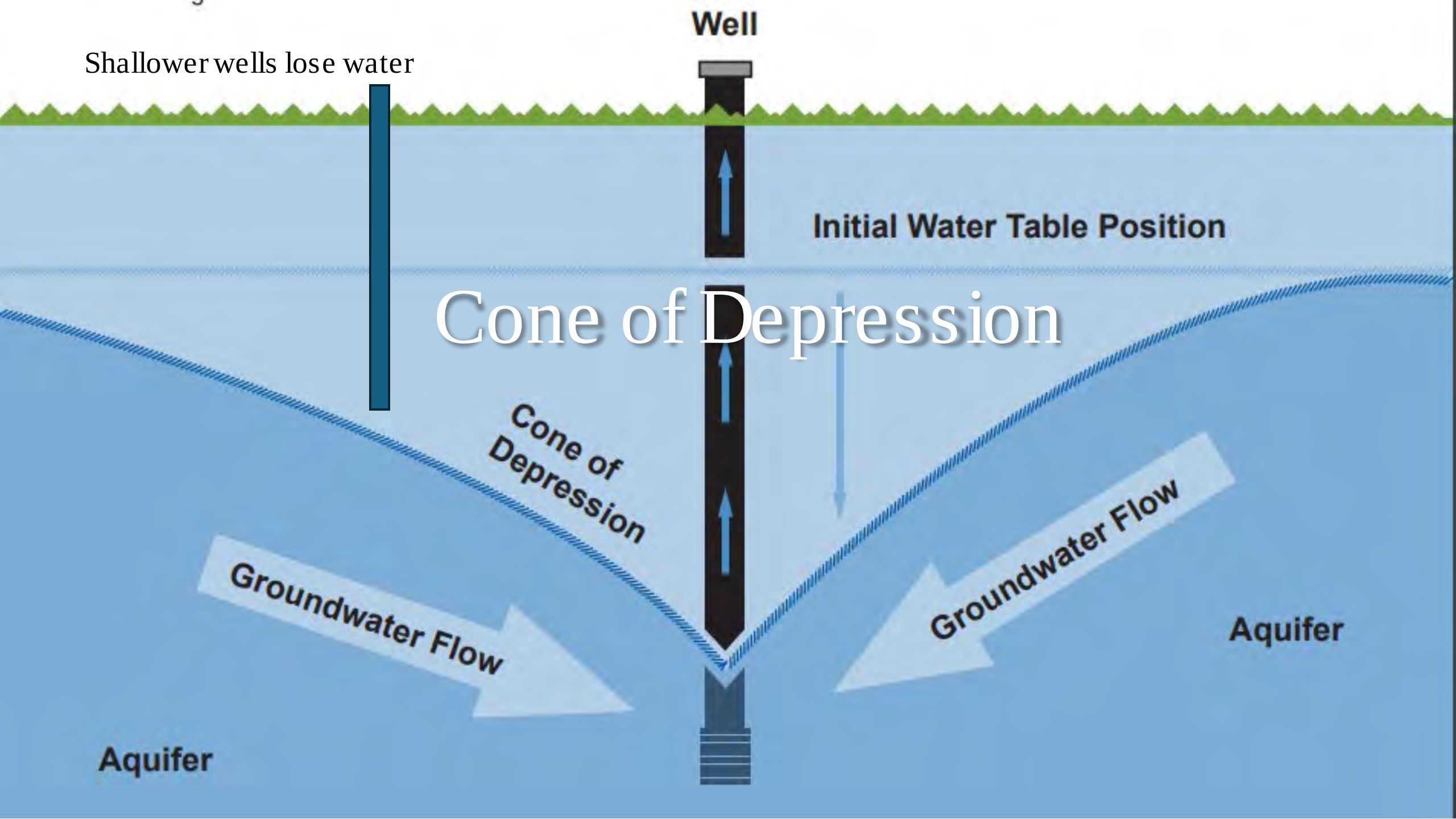


Wells

- Typically regulated by a Health Department or Department of Natural Resources
- Permit may specify construction details
- Licensed water well contractors typically required
- Drilling and pumping records are valuable information
- Maintenance and testing are a private well owner’s responsibility.
- A well can become a contamination point for the aquifer so un-used wells may require sealing



Shallower wells lose water



What questions should be asked?

- What is the distribution of usable groundwater?
- Who is already using it and how much?
- Where is scarcity a concern / where is there extra capacity?
- What are the societal priorities for using groundwater?
- What are alternatives to groundwater?

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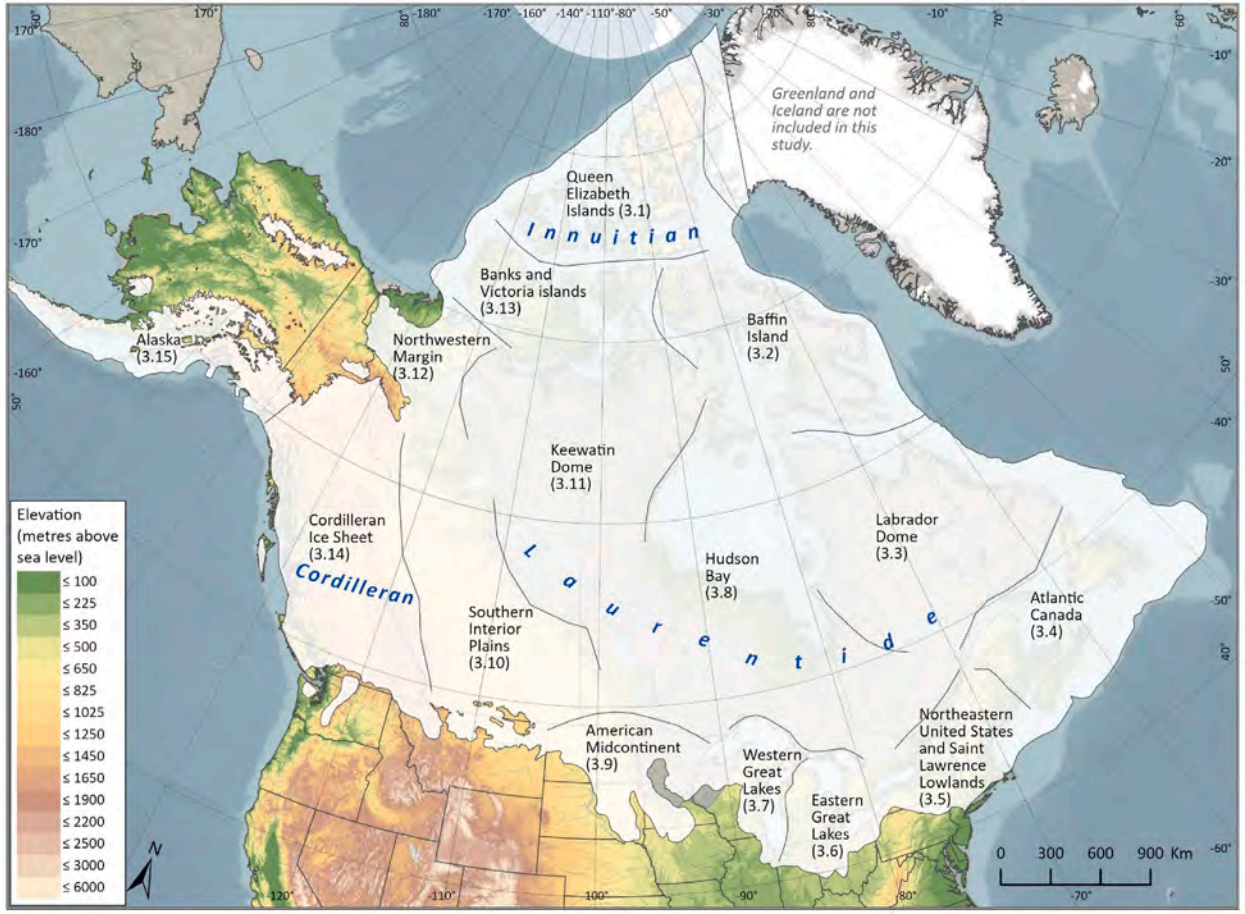
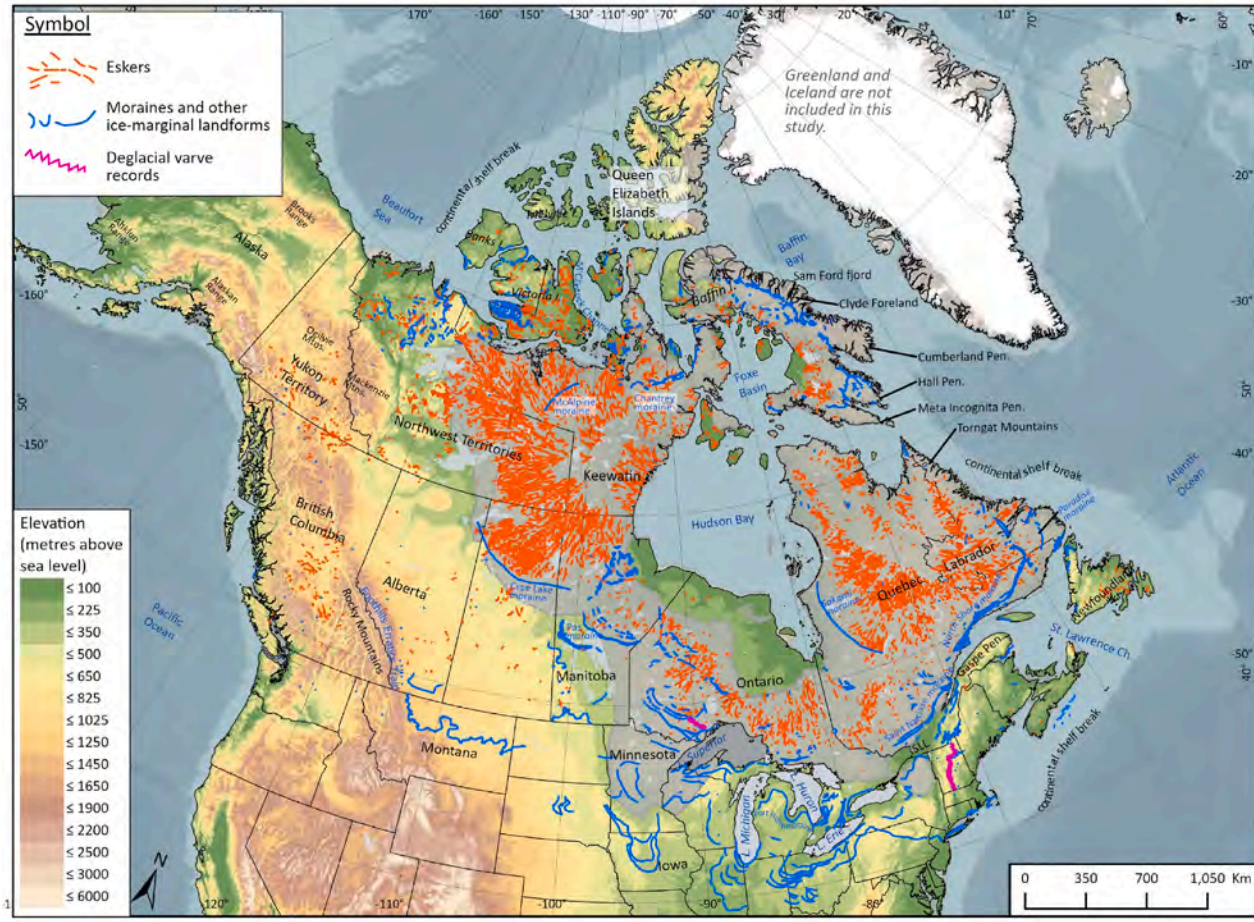
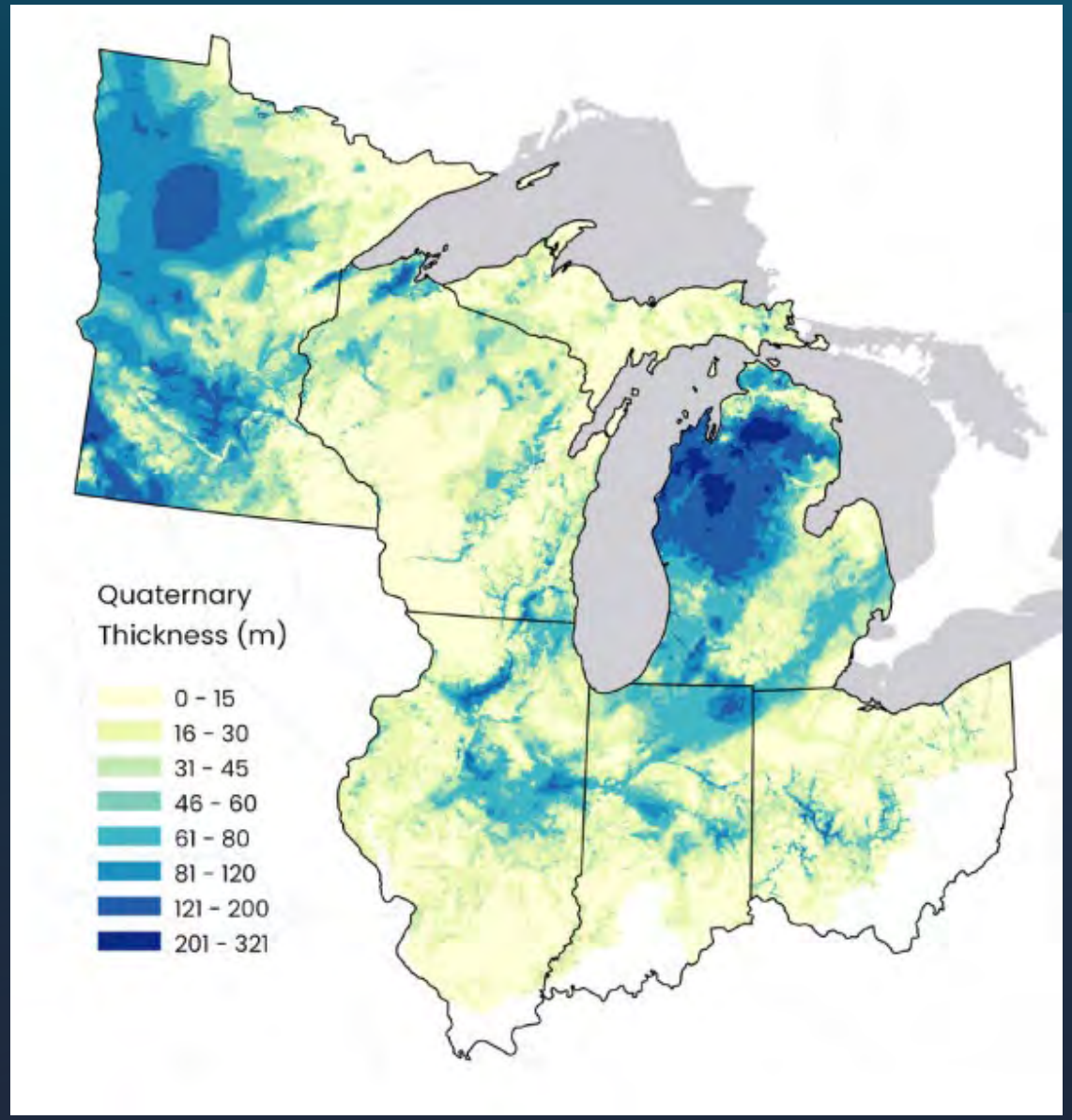
Bedrock Geology Controls Distribution of Water

- Red and orange units do not host usable amounts of groundwater
- Purple and blue layers may host usable fluids (not always water)

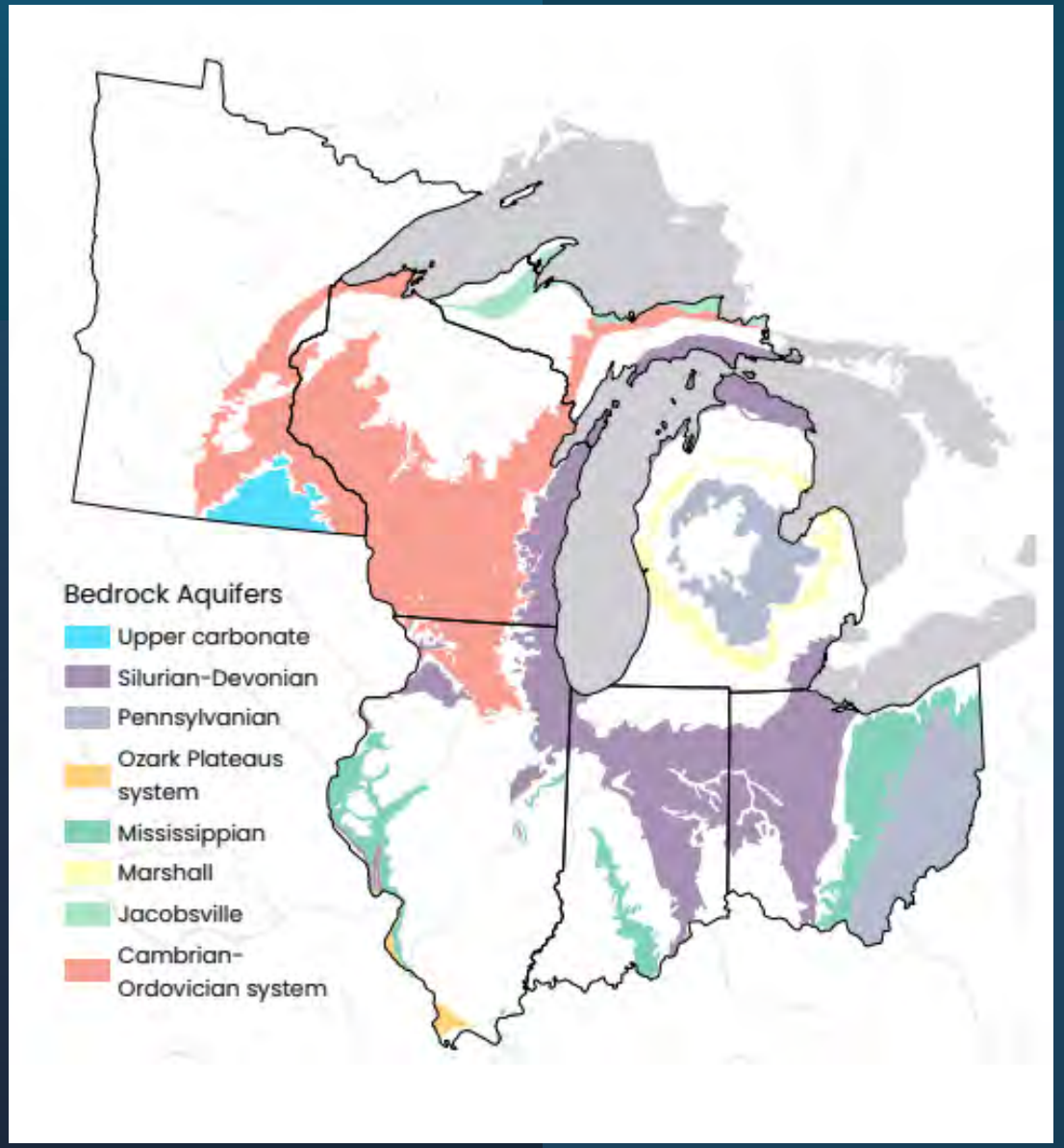
Glacial Sediment Covers Bedrock in Many Areas







Glacial Sediment Thickness



Available Bedrock Aquifers

Glacial Sediment Covering Bedrock, NW Ohio

Large Glacial Sand and Gravel Deposit

Table 6: Groundwater Knowledge Generation by State

	MN	WI	IL	MI	IN	OH
Geological Mapping	County Geologic Atlas Program, Minnesota Geological Survey (MGS), Univ. of Minnesota	Wisconsin Geological and Natural History Survey (WGNHS), University of Wisconsin Extension	Illinois Geological Survey (ISGS), Prairie Research Institute	State Geologist and a small staff at Western Michigan University (WMU)	Indiana Geological and Water Survey (IGWS) and IN DNR	Division of the Geological Survey, ODNR
Aquifer Characterization	Groundwater Atlas Program, Eco-Waters Division, MN DNR	WGNHS	Illinois State Water Survey (ISWS), Prairie Research Institute	State Geologist and a small staff at WMU	IGWS and IN DNR	Ohio EPA
Water Level Monitoring	Groundwater Unit, MN DNR	WGNHS with the WI DNR and USGS	ISWS	USGS in coordination with EGLE	IGWS and IN DNR with the USGS	USGS and ODNR
Groundwater Modeling	Groundwater Unit, MN DNR & Metropolitan Council	WGNHS with WI DNR	ISWS	EGLE	IGWS	ODNR and Ohio EPA

Notes: Common activities in groundwater science development are handled by a range of University and State Agency actors. Geological mapping involves the development of three-dimensional representations of the underlying rock layers in the state. Aquifer characterization is a related effort that refines the description of water-bearing rock and sediment bodies, including their chemical and flow characteristics. Water-level monitoring is achieved through consistent measurement of water levels in observation wells over time. Groundwater modeling involves computationally-intensive simulation of groundwater flow with a particular attention to hydrologic connections with surface water and human interventions.

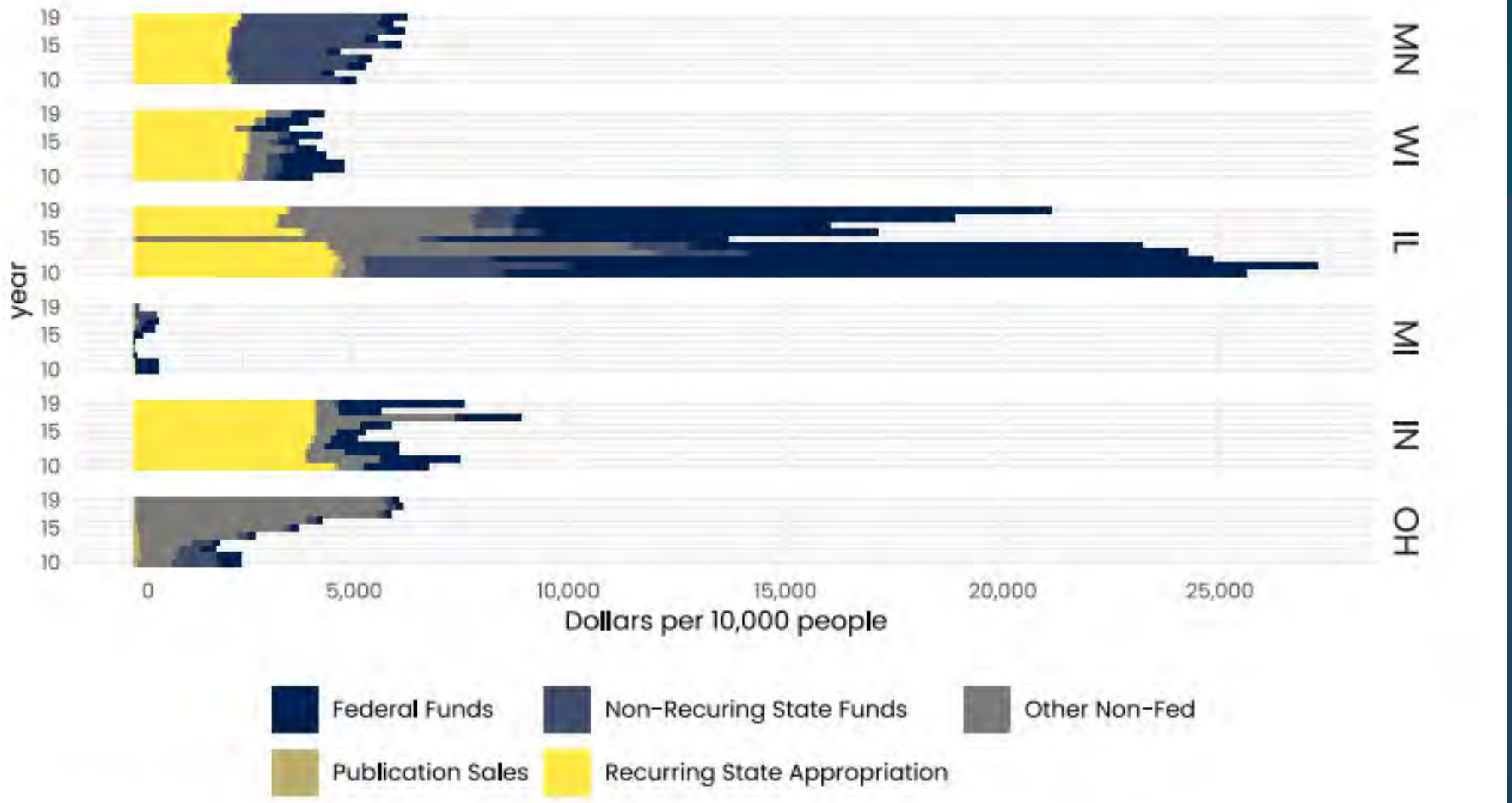
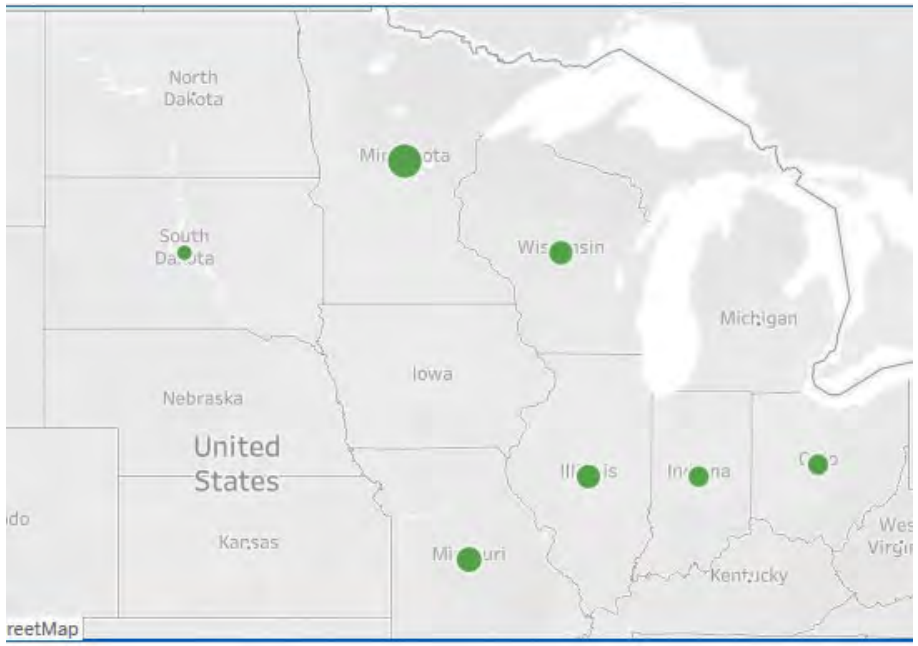


Figure 9: Funding to State Geological Surveys.

Other Upper Midwest Geological Surveys

- Kansas is at the University of Kansas in Wichita
- Nebraska is in the School of Natural Resources, Conservation and Survey Division
- North Dakota is with the Oil and Gas Division in the Department of Mineral Resources and under the North Dakota Industrial Commission
- South Dakota is in the Department of Agriculture and Natural Resources
- Iowa returned to the University of Iowa in the College of Engineering



Staffing levels

(Iowa and Nebraska not reporting) Source American Assoc. of State Geologists. https://www.stategeologists.org/dashboard

Geological Survey of Canada

Canada's governments depend on geoscience to inform policy, manage the country's landmass and develop its natural resources responsibly. The Geological Survey of Canada (GSC) is the national organization for geoscientific information and research. Our work supports exploration and decision-making in the mining and energy sectors as well as national sovereignty, hazards risk management and more. If you work in any of these areas, access the data and resources you need to make informed investments and land-use decisions.

Alberta Geological Survey

AGS
ALBERTA GEOLOGICAL SURVEY

Since the early 1920s, the Alberta Geological Survey has provided information and advice about the geology of Alberta to the Government of Alberta, provincial regulatory agencies, industry, and the public to support the exploration, sustainable development, regulation, and conservation of Alberta's resources. The Survey is part of the Alberta Energy Regulator and has 60 staff, headquartered in the provincial capital, Edmonton.

Manitoba Geological Survey

MANITOBA GEOLOGICAL SURVEY
MGS
1928

The Manitoba Geological Survey collects, analyzes, distributes, and archives information about Manitoba's geology and mineral resources to attract exploration investment, foster sustainable mineral and petroleum developments, inform government policy and land management, and contribute to the quality of life and economic prosperity of all Manitobans.

Saskatchewan Geological Survey

SASKATCHEWAN GEOLOGICAL SURVEY
19 48

Saskatchewan

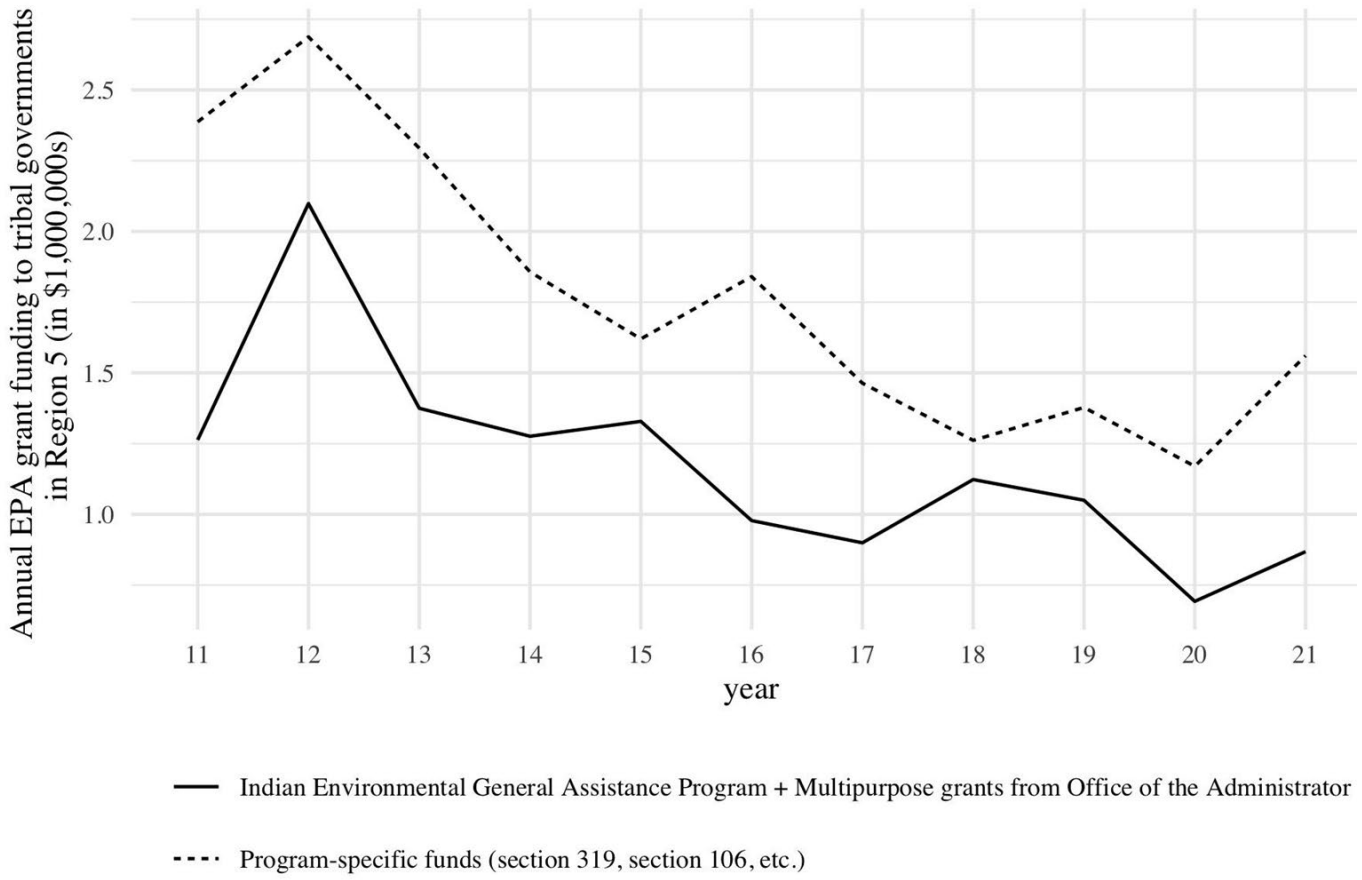
The Saskatchewan Geological Survey (SGS) has a mandate to provide high-quality, easily accessible geoscience data to inform and facilitate the responsible exploration for, and development of, Saskatchewan's mineral and petroleum resources, thereby advancing Saskatchewan's natural resource advantage. The SGS has forty staff and is based in Regina, with a northern satellite office in La Ronge.

Ontario Geological Survey

Ontario

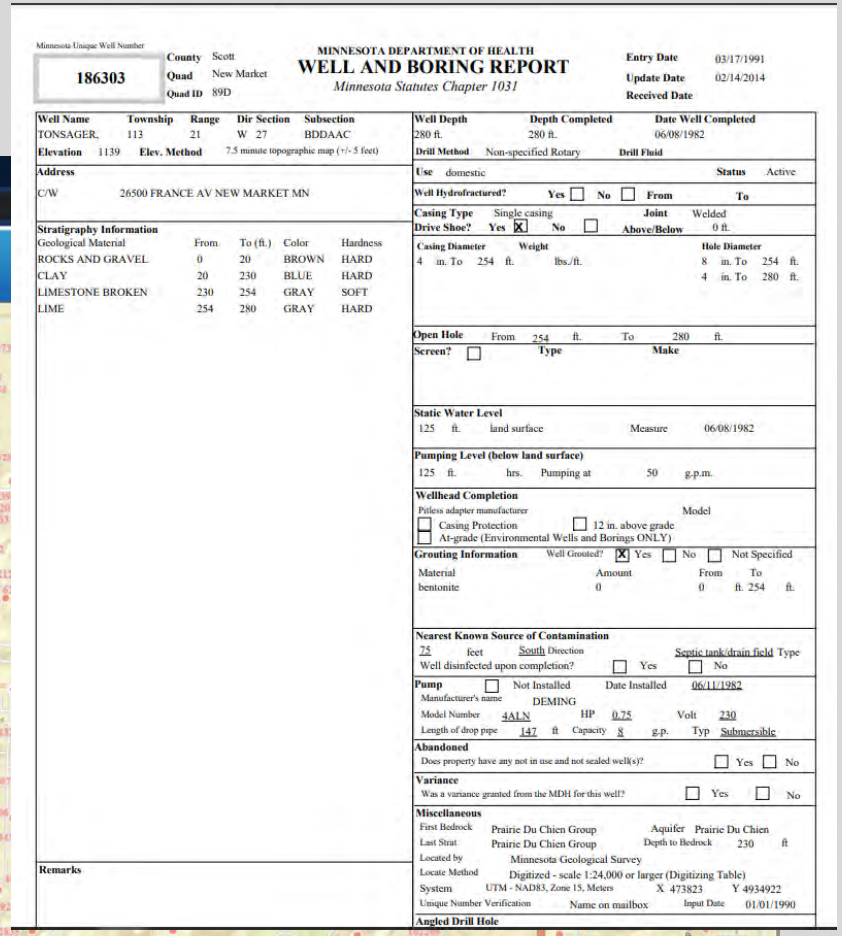
The Ontario Geological Survey is the provincial government organization responsible for documenting and distributing geoscience information. The survey has 115 staff and is headquartered in Sudbury. Eight satellite offices throughout the province serve the mineral exploration industry and a variety of other clients.

EPA Grant Funding for Tribal Nations



Well Data—fundamental information.

- Aquifer Depth
- Static Water Level
- Pump Test Results
- Well Construction
- Water Chemistry
- Interpreted Geology



Minnesota Unique Well Number: 186303
County: Scott
Quad: New Market
Quad ID: 89D

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 03/17/1991
Update Date: 02/14/2014
Received Date:

Well Name	Township	Range	Dir Section	Subsection
TONSAGER,	113	21	W 27	BDDAAC

Elevation: 1139 Elev. Method: 7.5 minute topographic map (+/- 5 feet)

Address: C/W 26500 FRANCE AV NEW MARKET MN

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
ROCKS AND GRAVEL	0	20	BROWN	HARD
CLAY	20	230	BLUE	HARD
LIMESTONE BROKEN	230	254	GRAY	SOFT
LIME	254	280	GRAY	HARD

Remarks:

Well Depth: 280 ft. Depth Completed: 280 ft. Date Well Completed: 06/08/1982
Drill Method: Non-specified Rotary Drill Fluid:
Use: domestic Status: Active
Well Hydrofractured? Yes ☐ No ☐ From To
Casing Type: Single casing Joint: Welded
Drive Shoe? Yes ☒ No ☐ Above/Below: 0 ft.

Casing Diameter	Weight	Hole Diameter
4 in. To 254 ft.	lbs./ft.	8 in. To 254 ft.
		4 in. To 280 ft.

Open Hole From 254 ft. To 280 ft.
Screen? ☐ Type Make

Static Water Level: 125 ft. land surface Measure 06/08/1982

Pumping Level (below land surface): 125 ft. hrs. Pumping at 50 g.p.m.

Wellhead Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
bentonite	0	0 ft.	254 ft.

Nearest Known Source of Contamination
75 feet South Direction Septic tank/drain field Type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed 06/11/1982
Manufacturer's name DEMING
Model Number 4ALN HP 0.75 Volt 230
Length of drop pipe 147 ft Capacity 8 g.p. Typ Submersible

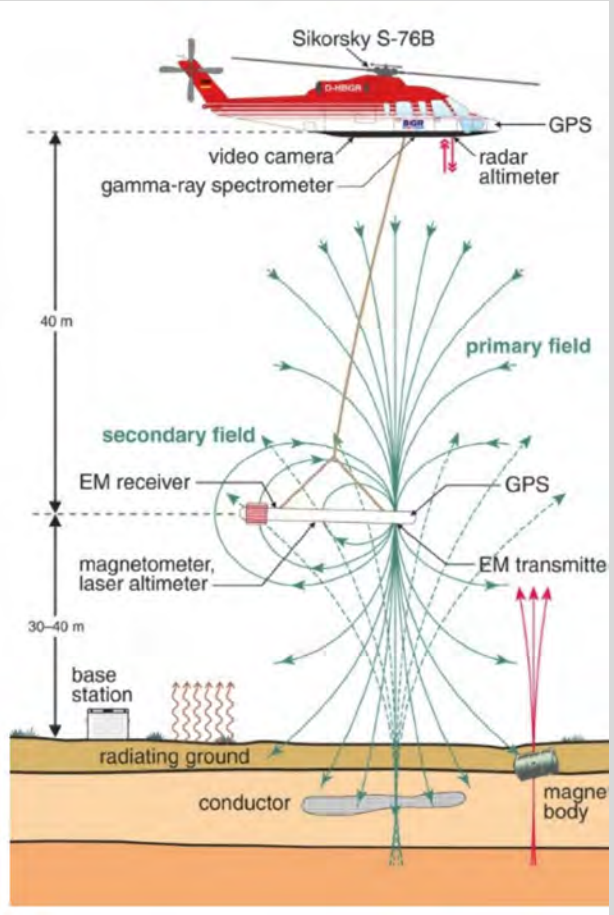
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance
Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Miscellaneous
First Bedrock Prairie Du Chien Group Aquifer Prairie Du Chien
Last Strat Prairie Du Chien Group Depth to Bedrock 230 ft
Located by Minnesota Geological Survey
Locate Method Digitized - scale 1:24,000 or larger (Digitizing Table)
System UTM - NAD83, Zone 15, Meters X 473823 Y 4934922
Unique Number Verification Name on mailbox Input Date 01/01/1990

Angled Drill Hole

Airborne Electromagnetic Surveys



- State of the art
- Detects differences in resistivity
  - Water
  - Conducting mineral deposits
- Helicopter makes it expensive
- Requires adequate consultation, especially with Sovereign Tribal and First Nations
- Perfected in Denmark
- Used by US Geological Survey and Nebraska
- https://www.mdpi.com/2072-4292/12/10/1629

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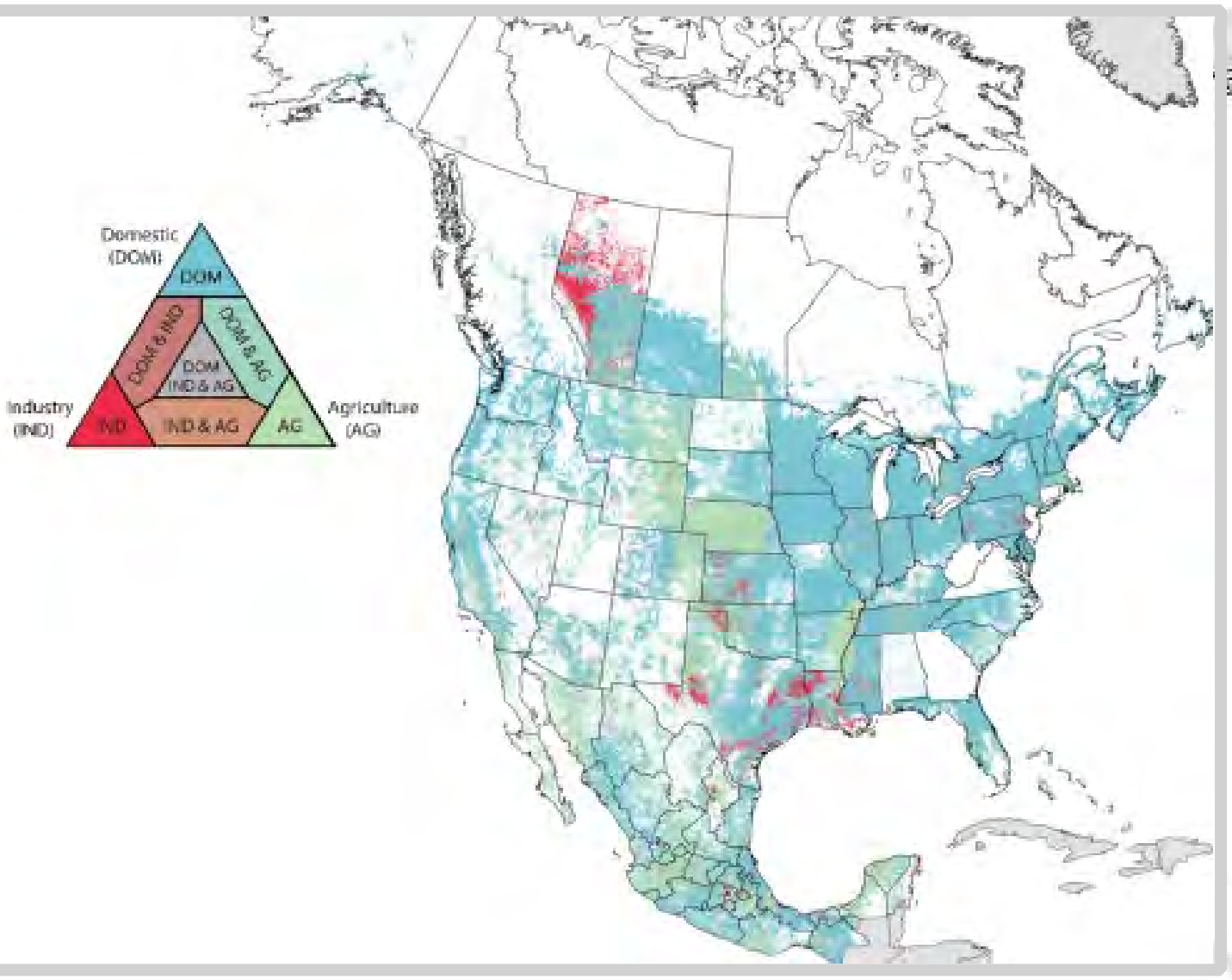
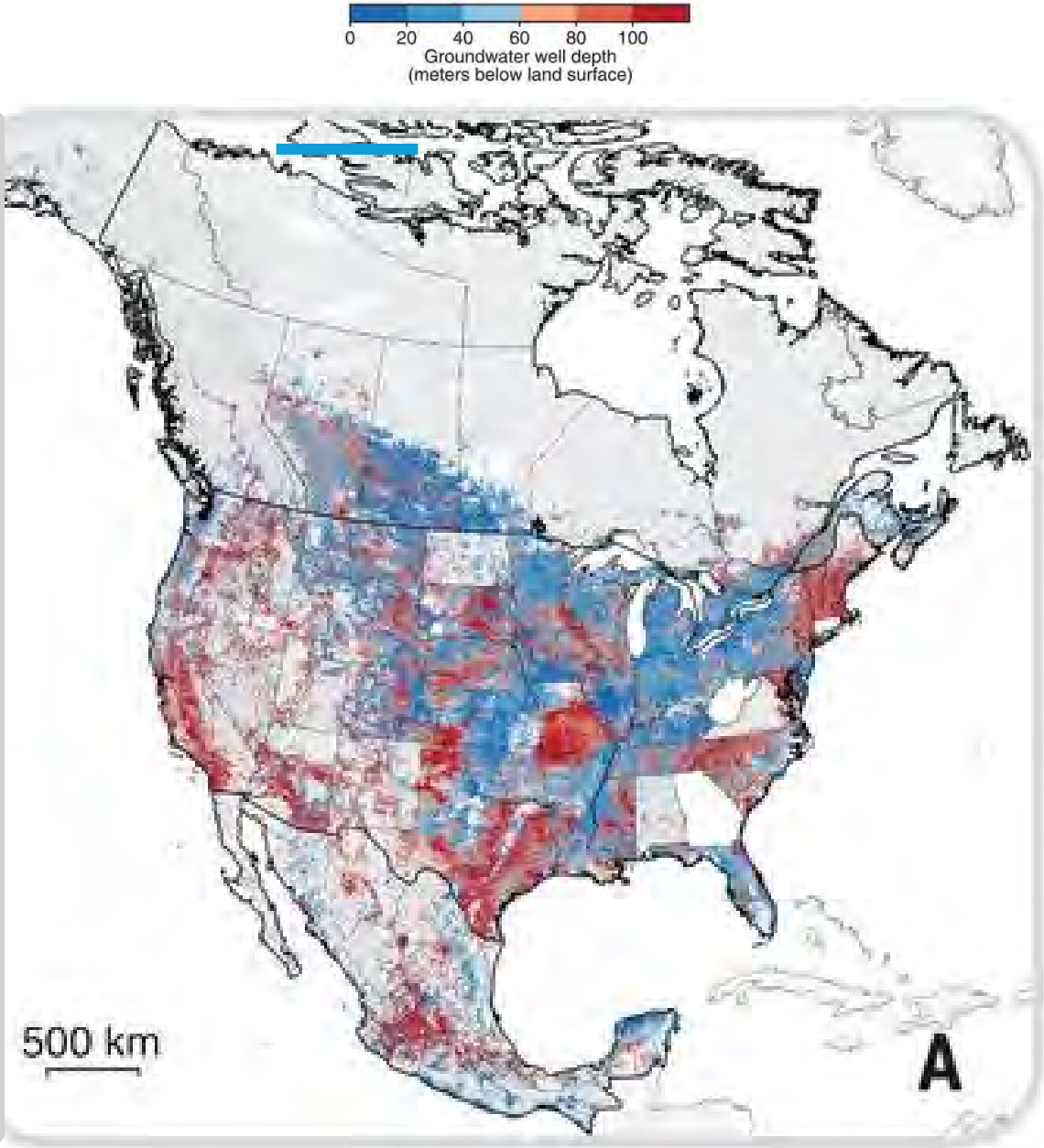
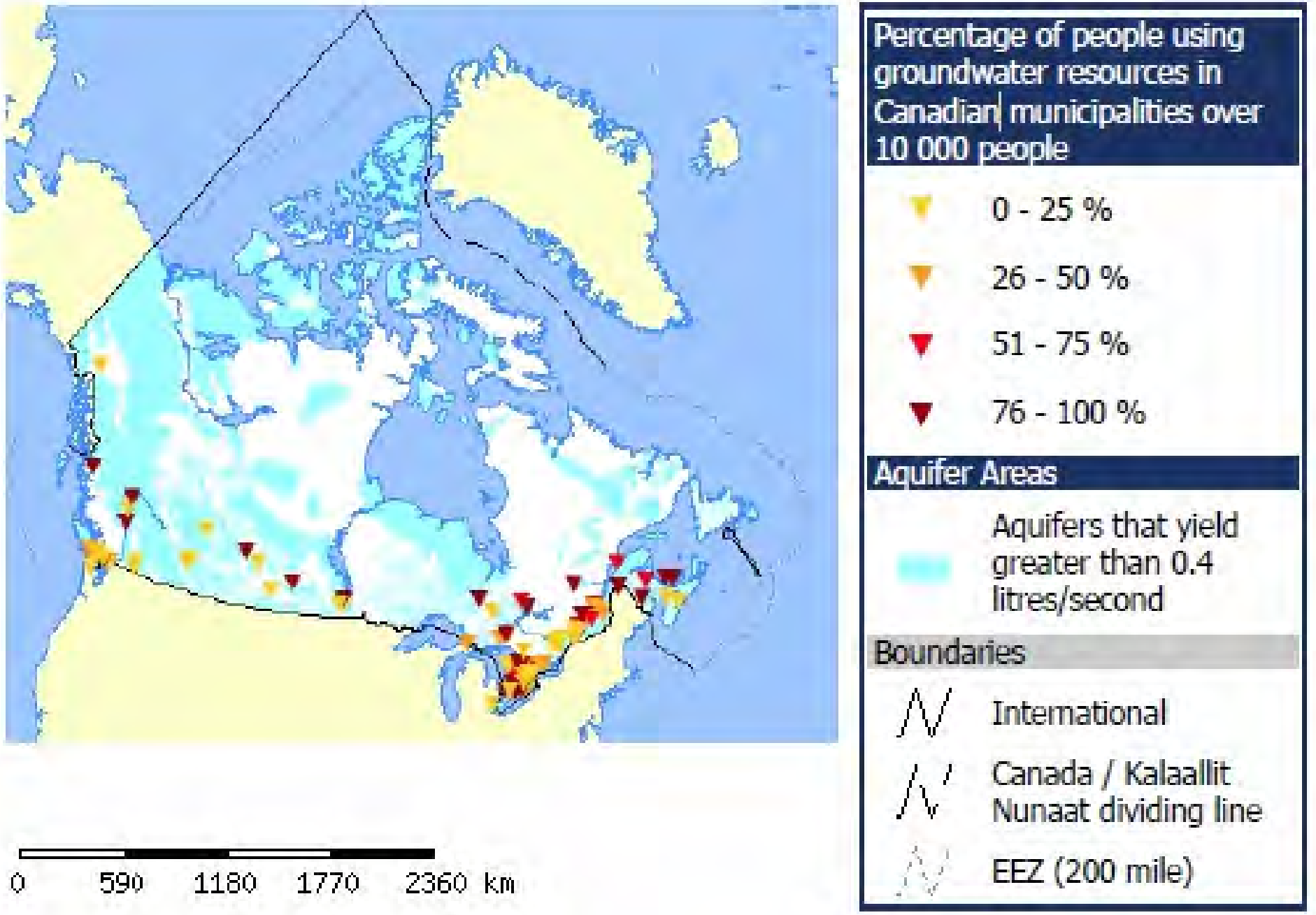


Well Distribution and Purpose



Well Depth



https://www.safewater.org/fact-sheets-1/2017/1/23/groundwater

Groundwater Uses

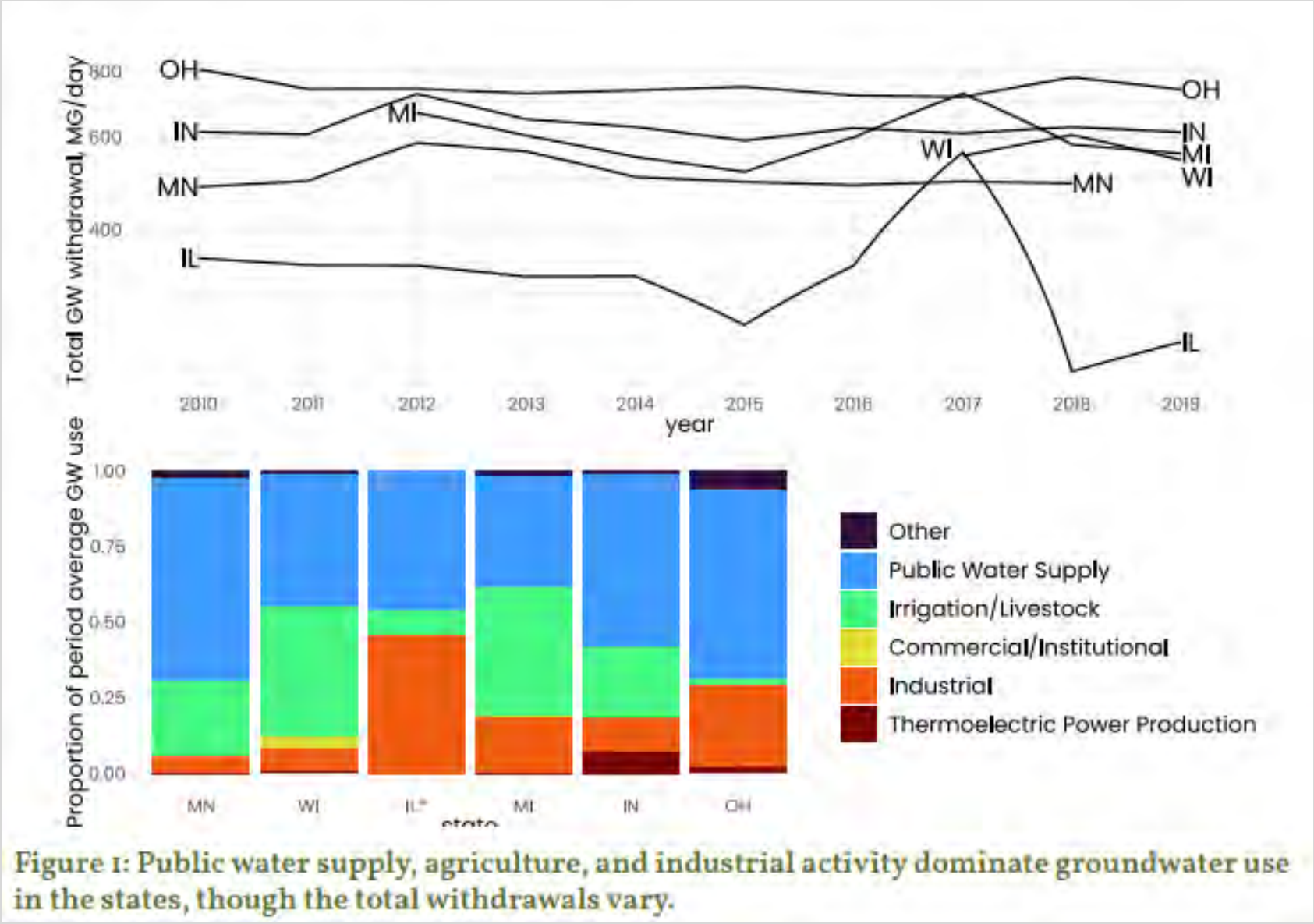


Figure 1: Public water supply, agriculture, and industrial activity dominate groundwater use in the states, though the total withdrawals vary.