Groundwater Occurrence & Movement:
An Introductory Discussion with Application to East-Central Illinois

East-Central Illinois Regional Water Supply Planning Committee
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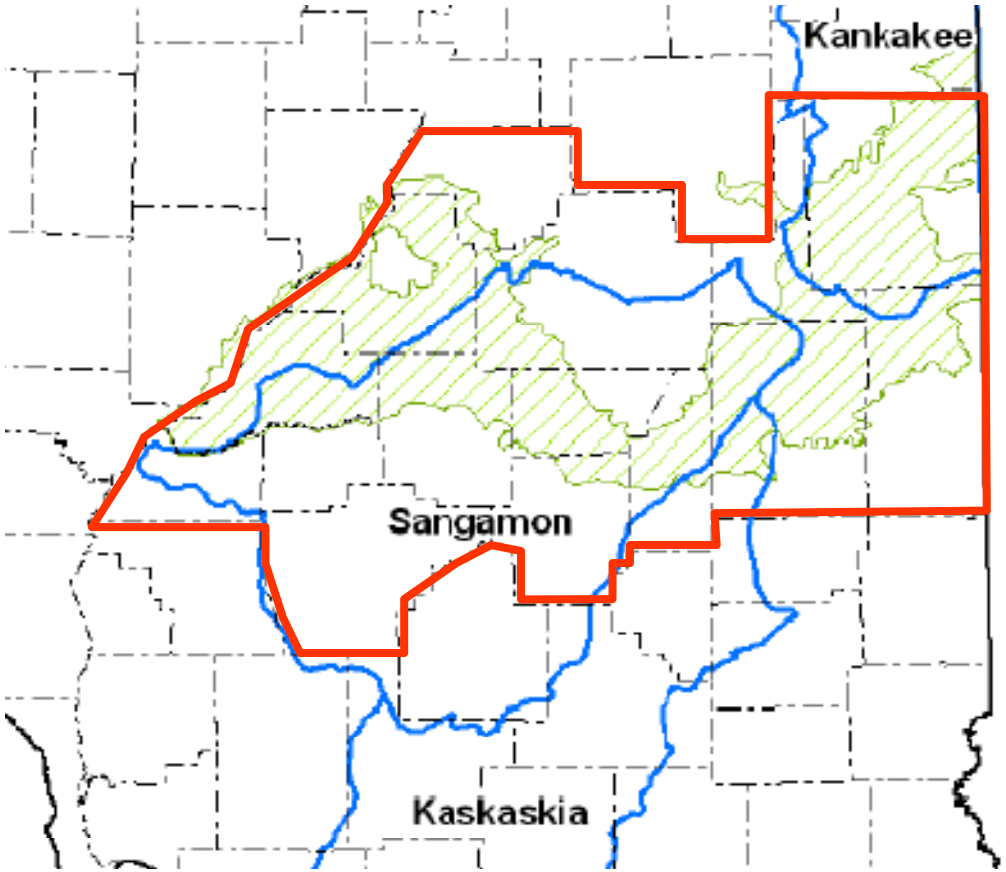
Hydrogeology Section
Illinois State Geological Survey

Steve Burch & George Roadcap, Ph.D.
Center for Groundwater Science
Illinois State Water Survey

East-Central Illinois
Water Supply Planning Area



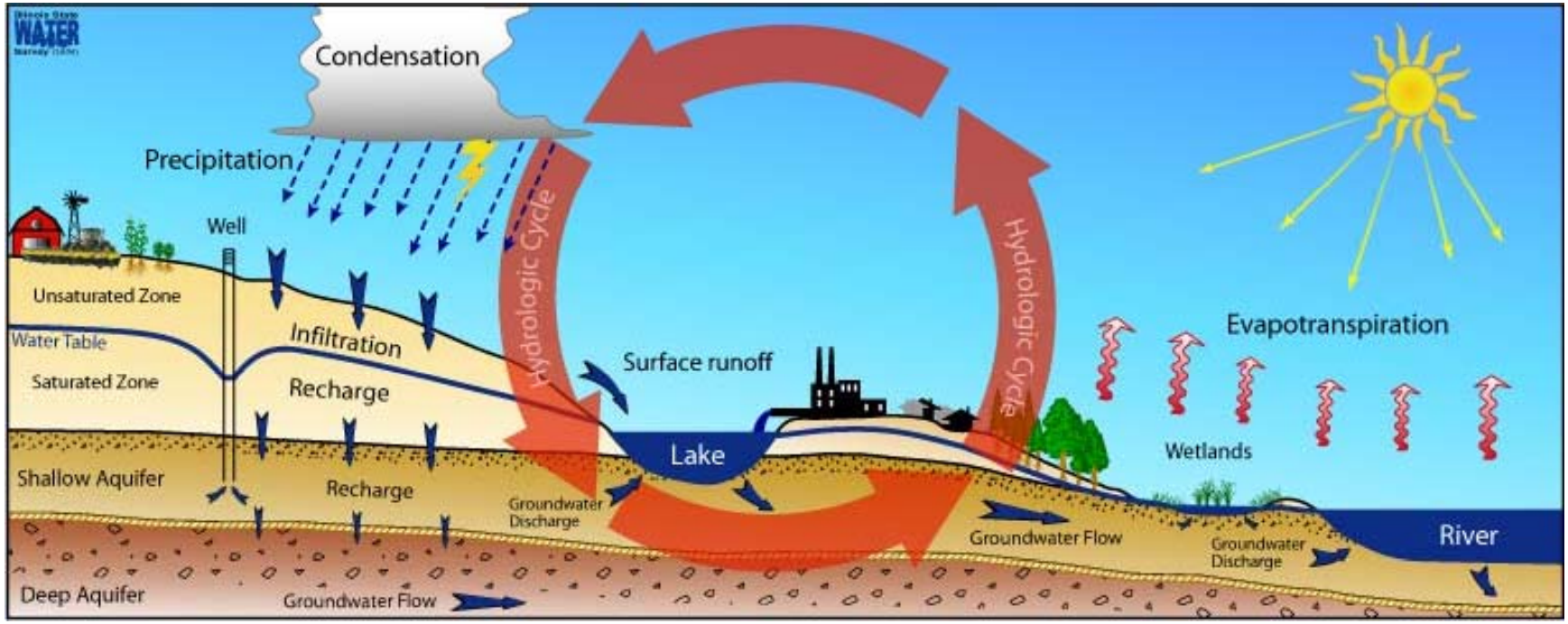
Topical Presentation Outline

Basic Concepts and Definitions

- **The Hydrologic Cycle**
  - What is groundwater?
- **Concepts & Definitions**
  - Porous Flow vs. Fractured Flow
  - Aquifers vs. Aquitards
  - Artesian vs. Water Table Conditions
- **Regional Groundwater Flow Systems**
- **Well & Aquifer Hydraulics**
- **Groundwater Modeling**

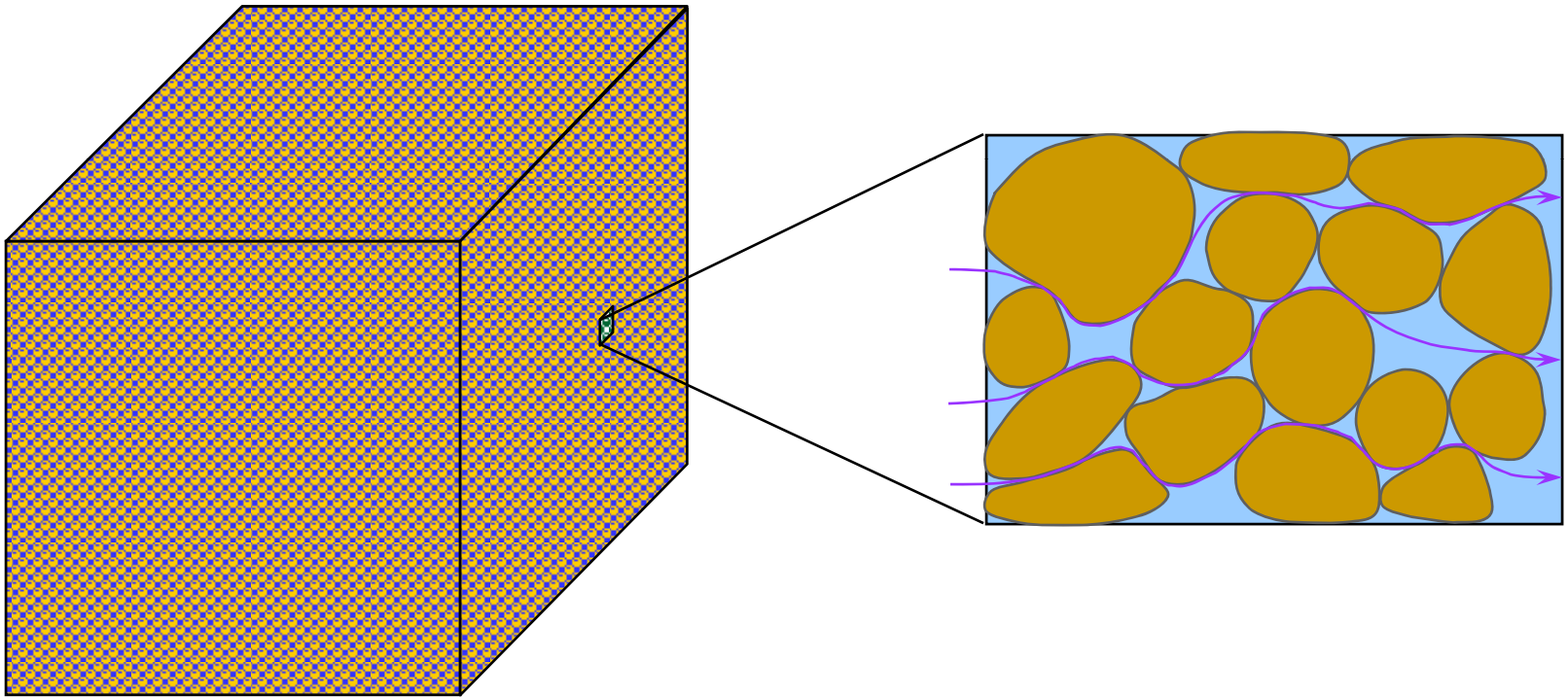
The Hydrologic Cycle

Climate, surface water, and groundwater are linked

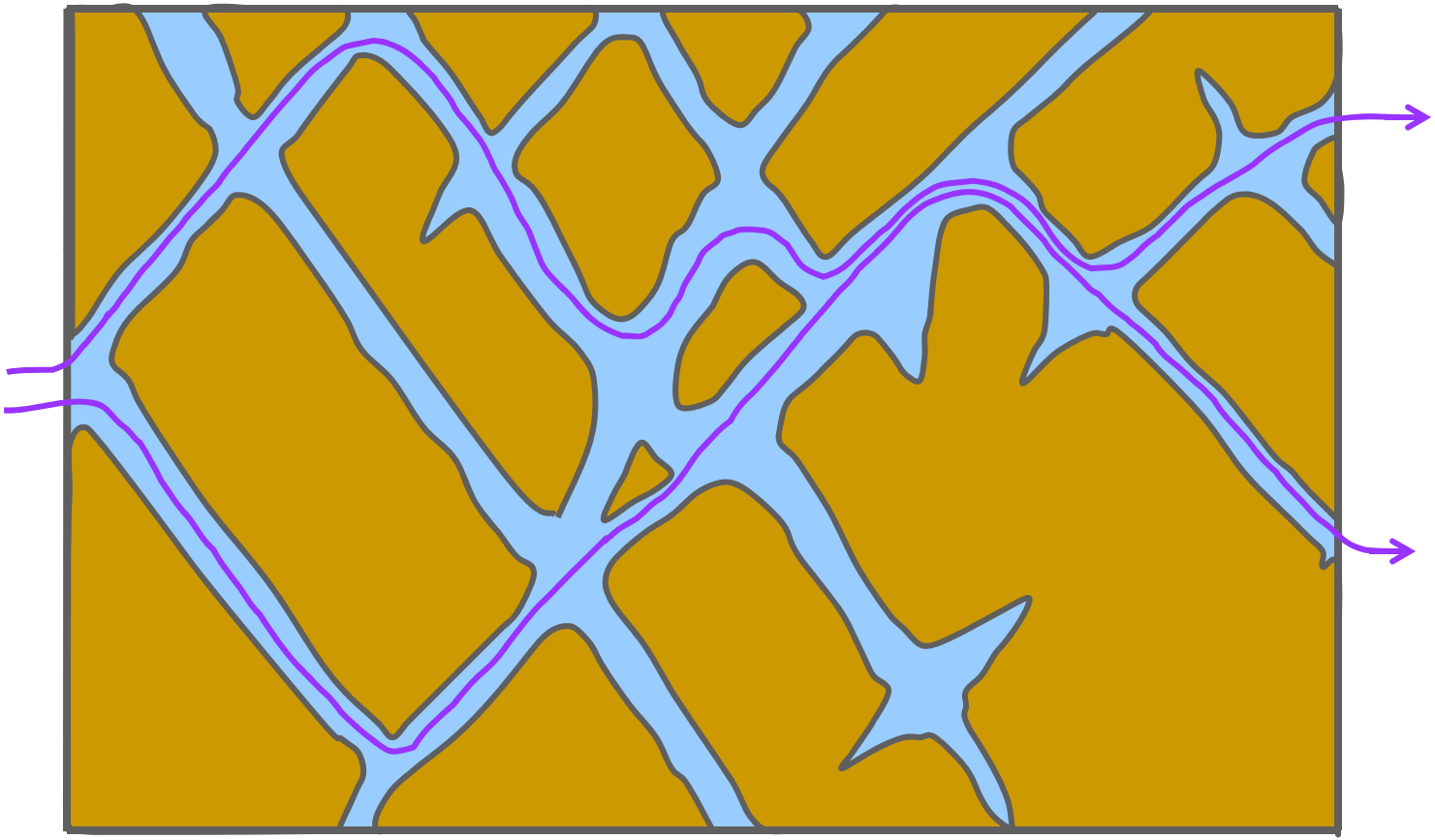


Porous Systems

Porosity = volume of pore space / total volume of porous material



Fractured Systems



Fractured Limestone or Dolomite

Porosity & Effective Porosity Ranges

Material	Porosity (%)	Eff. Porosity (%)
Silt	34 - 61	0.1 – 10
Clay	34 - 60	0.1 – 10
Sand/Gravel	24 – 55	10 - 55
Limestone/dolomite	5 - 15	0.1 – 5
Shale	1 - 10	0.5 – 5
Sandstone	5 - 15	0.5 – 10

Aquifers vs. Aquitards

An ***aquifer*** is a saturated bed, formation, or group of formations which yields water in sufficient quantity to be of consequence as a source of supply.

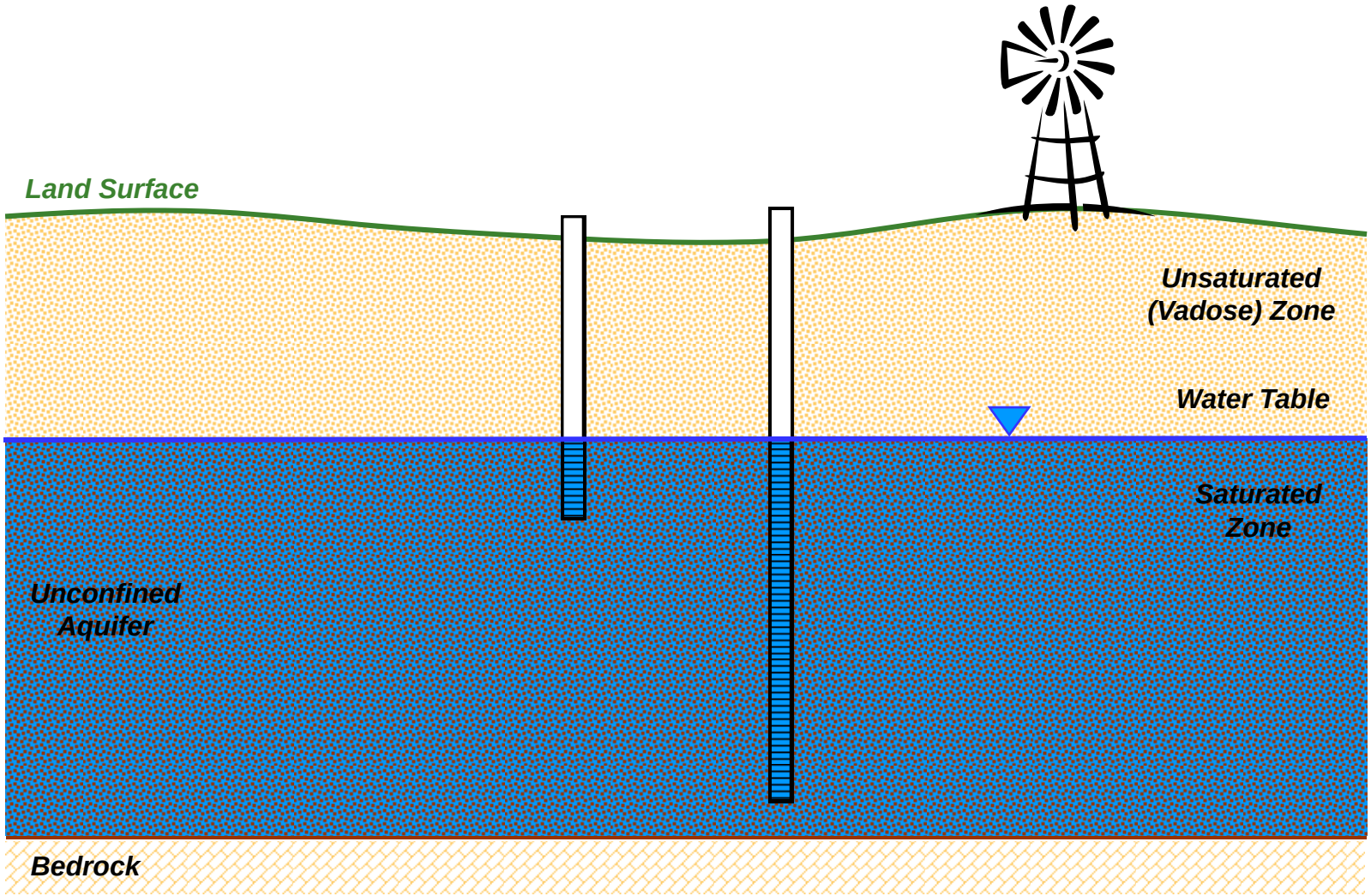
An ***aquitard*** yields *inappreciable* quantities of water to wells compared to an aquifer but through which *leakage* of water is possible. Aquitards often act as confining beds.

Unconfined vs. Confined Groundwater

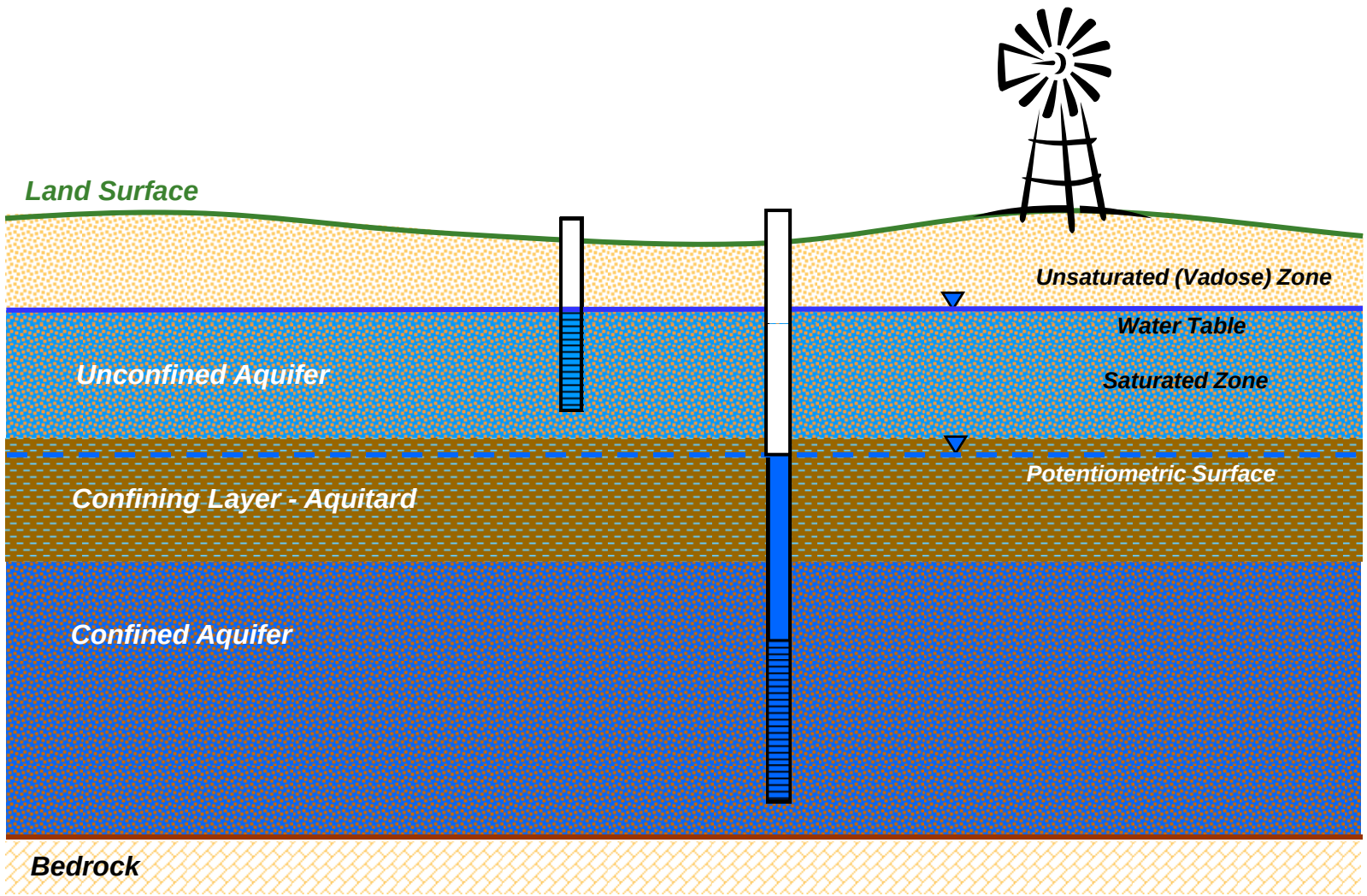
An ***unconfined*** aquifer is one in which groundwater possesses a free surface open to the atmosphere. The upper surface of the zone of saturation is called the ***water table***.

A ***confined*** aquifer is one in which groundwater is confined under pressure by overlying and underlying aquitards or aquicludes and water levels in wells rise above the top of the aquifer. Also called an ***artesian*** aquifer.

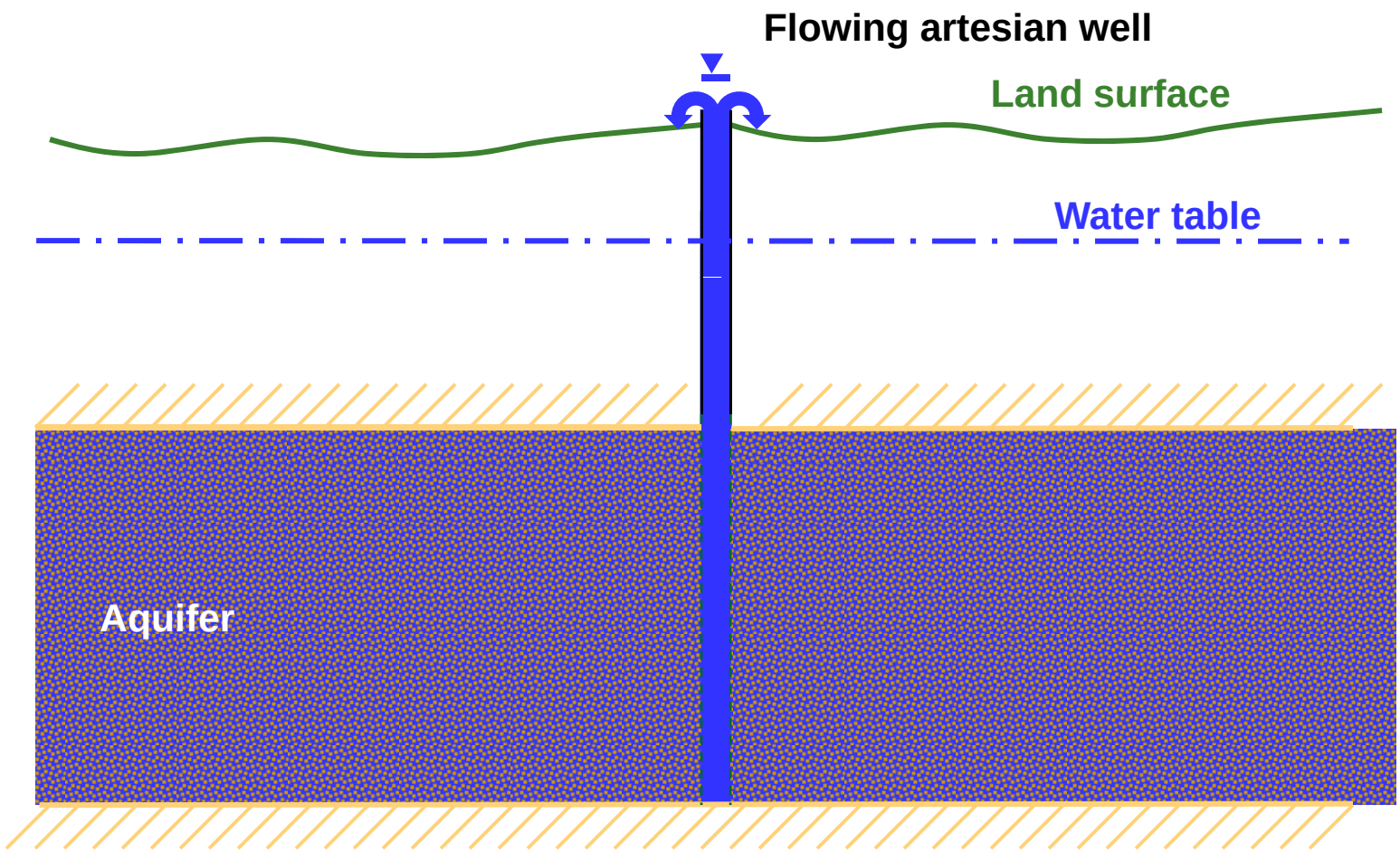
Unconfined Aquifers



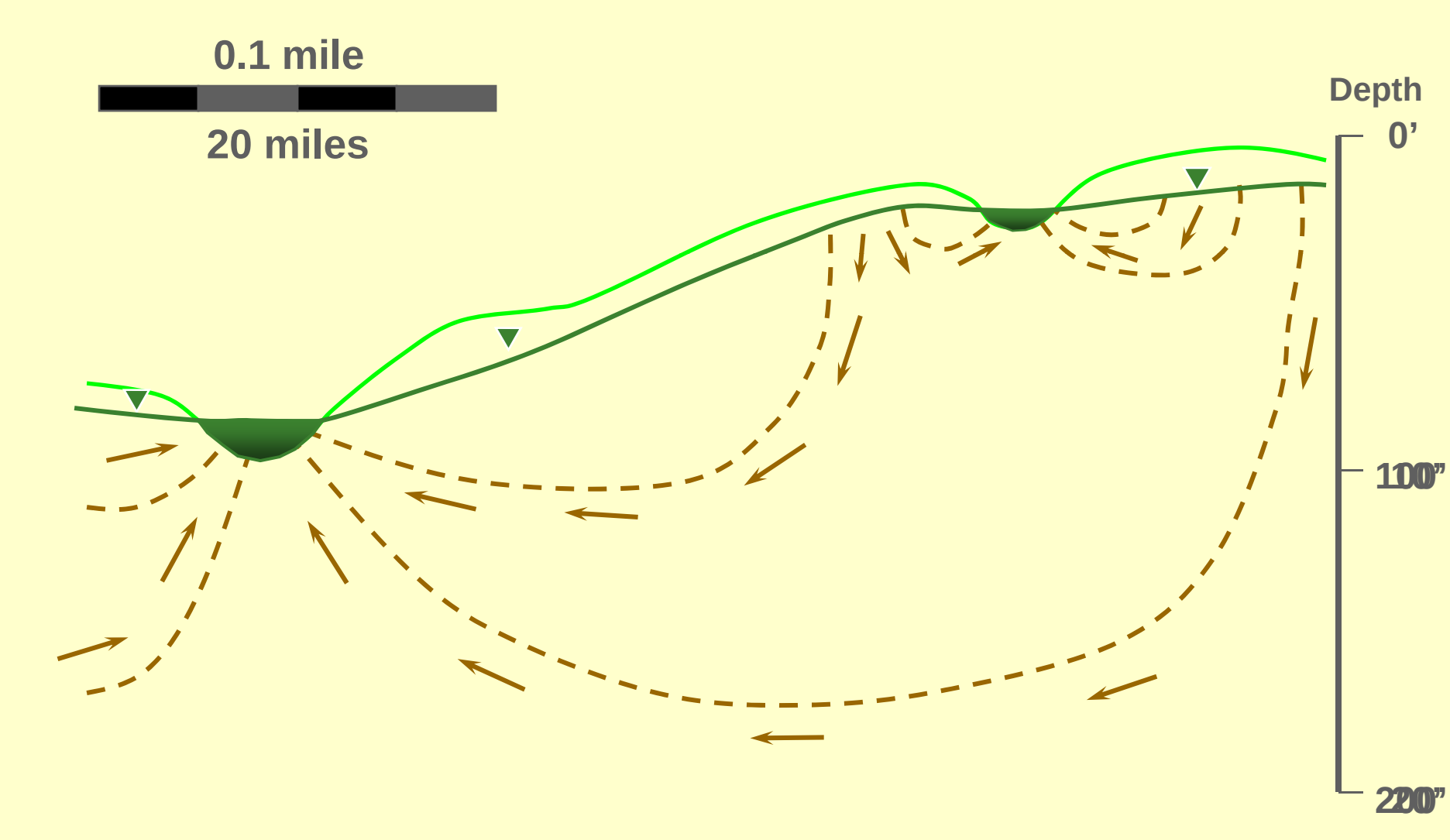
Confined Aquifers



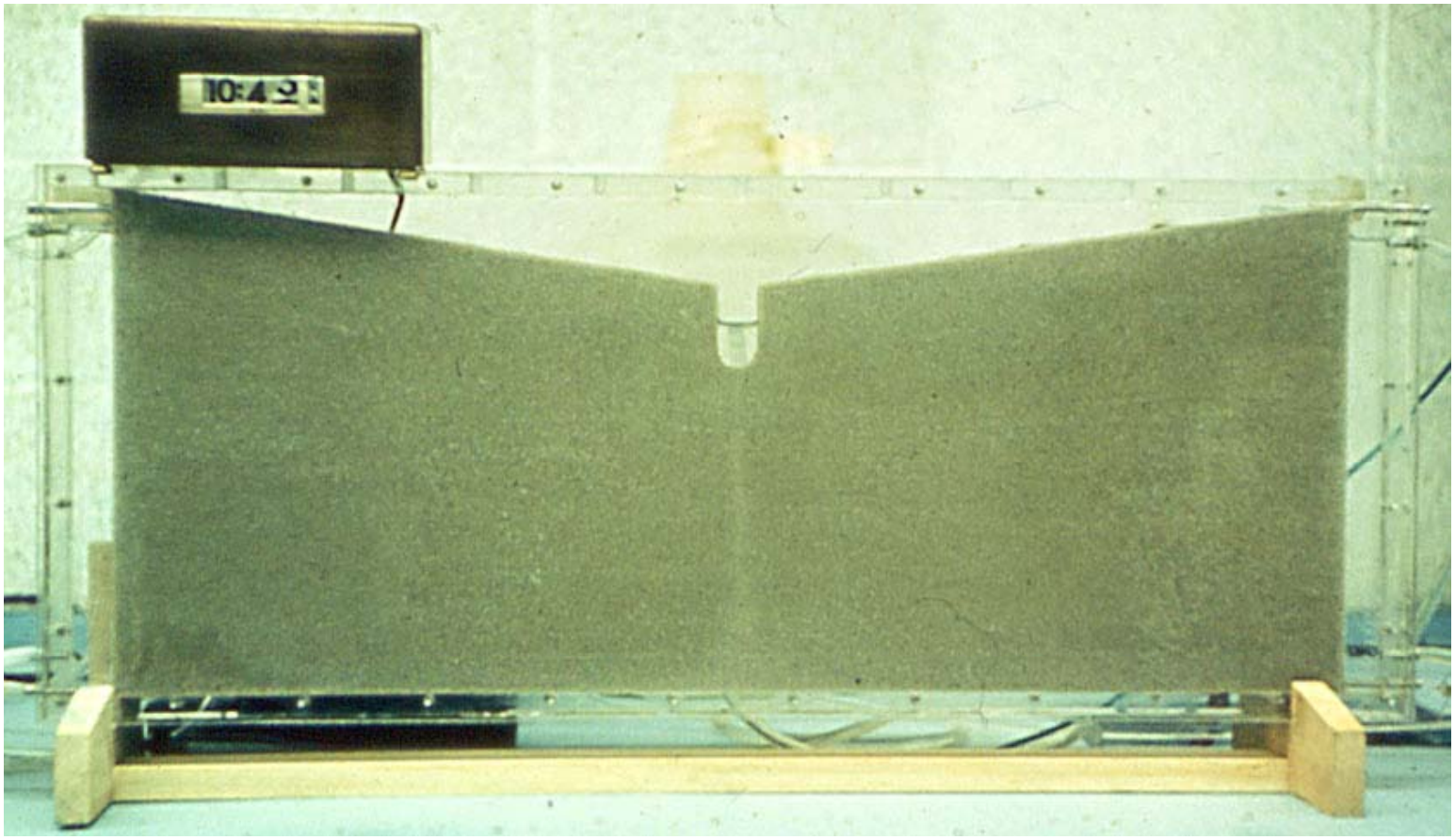
Confined Aquifers & Artesian Wells



Regional Groundwater Flow Systems



Groundwater – Stream Interaction



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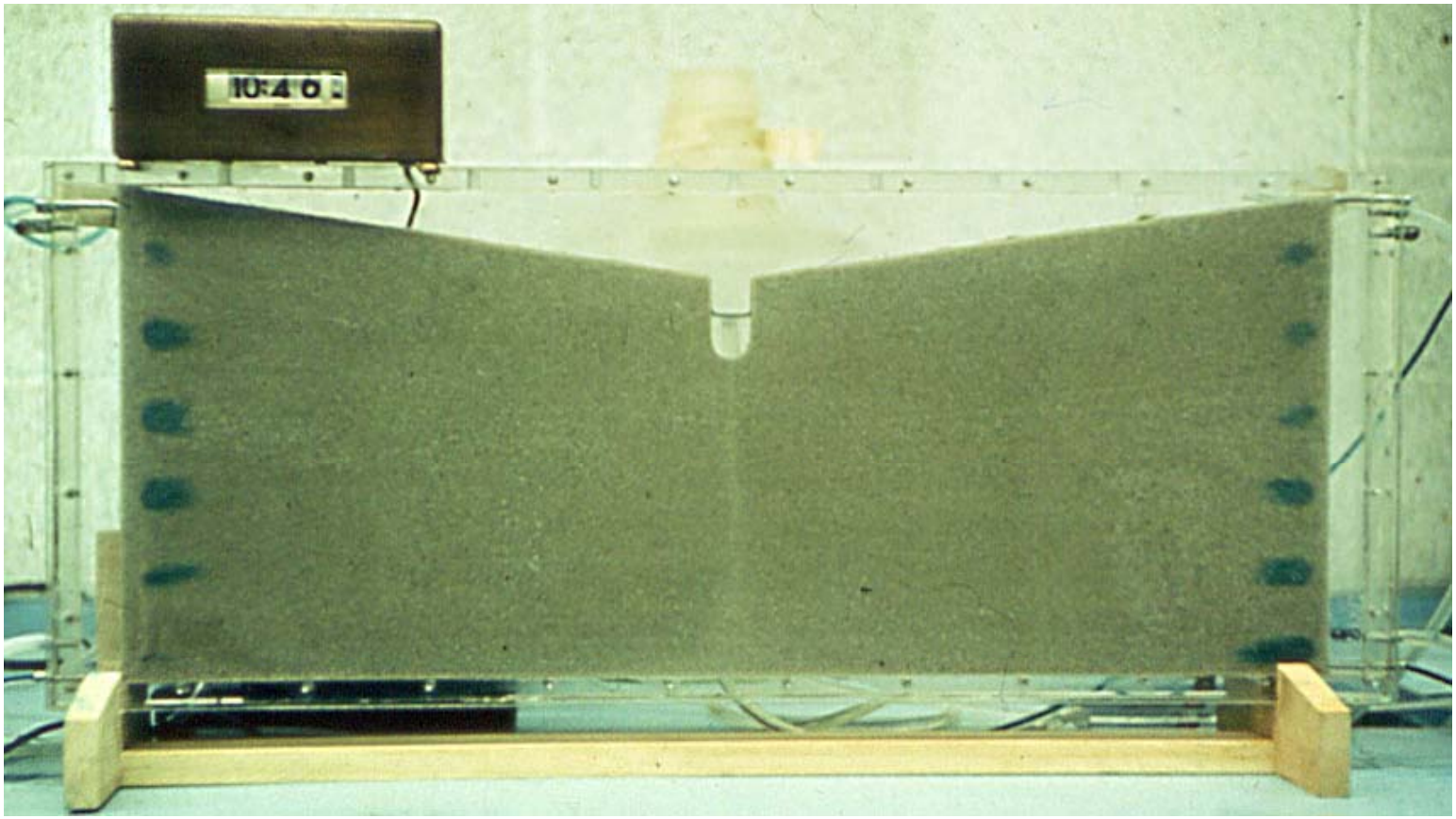

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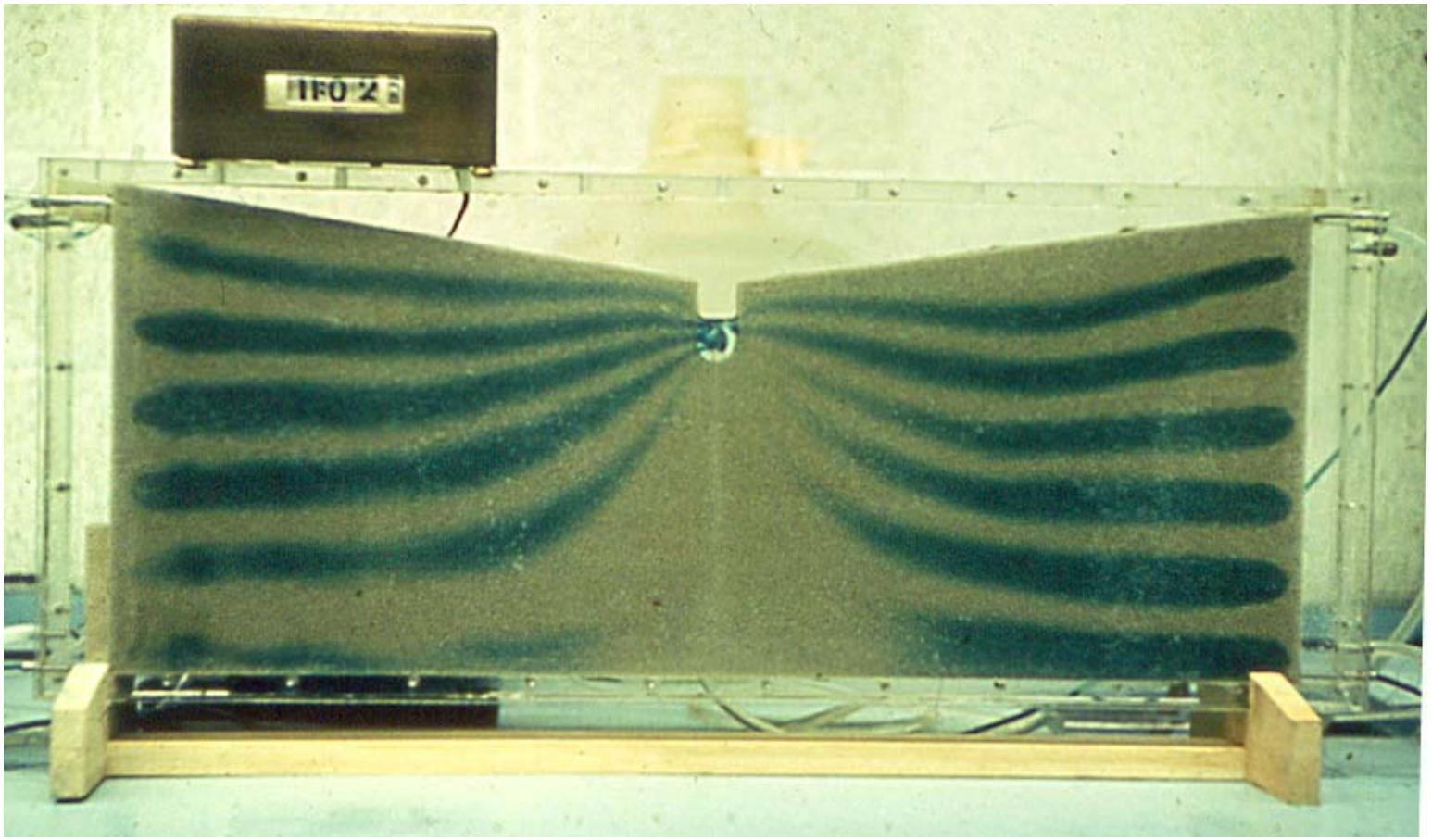

Regional Flow Systems

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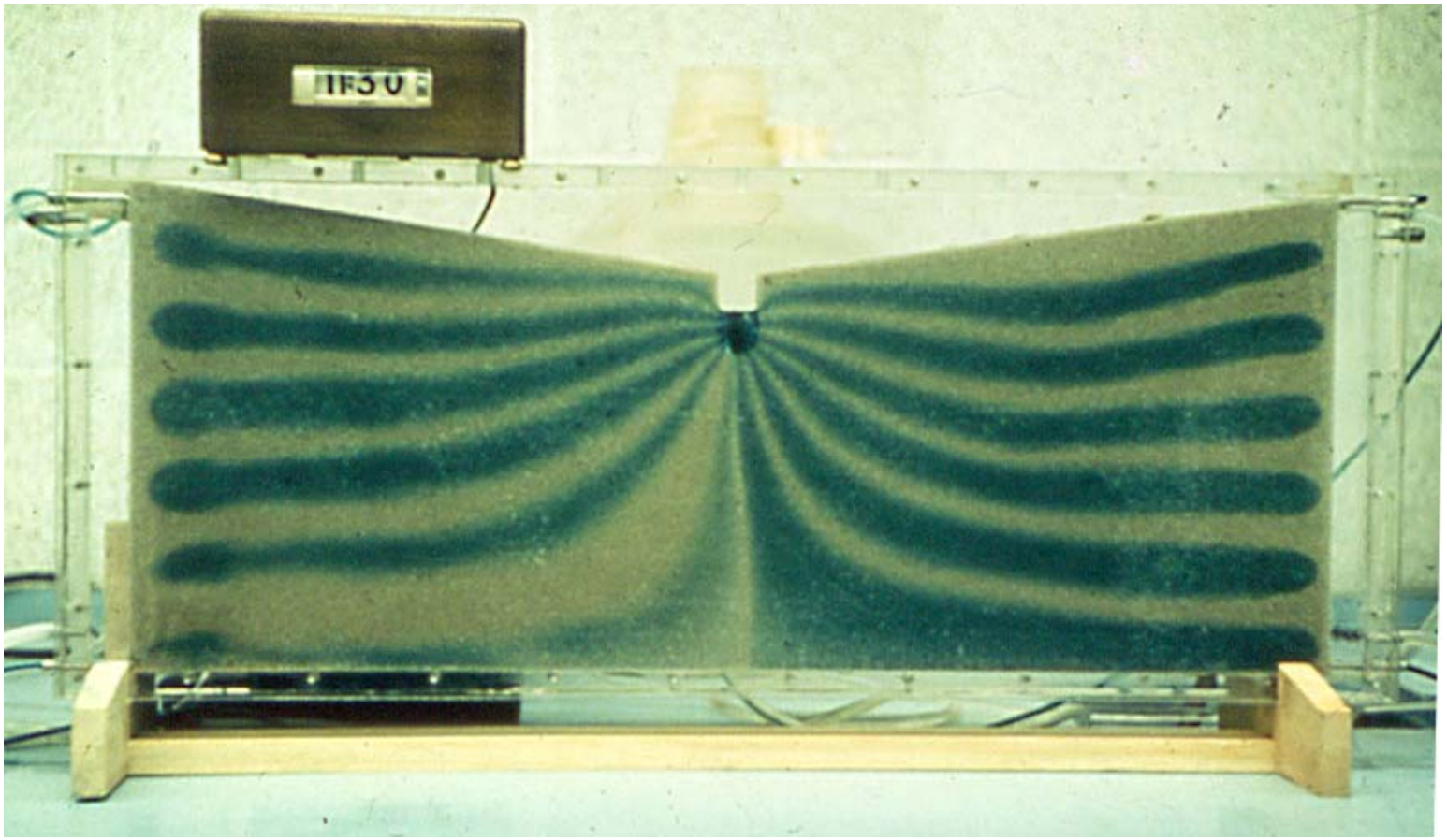


Regional Flow Systems

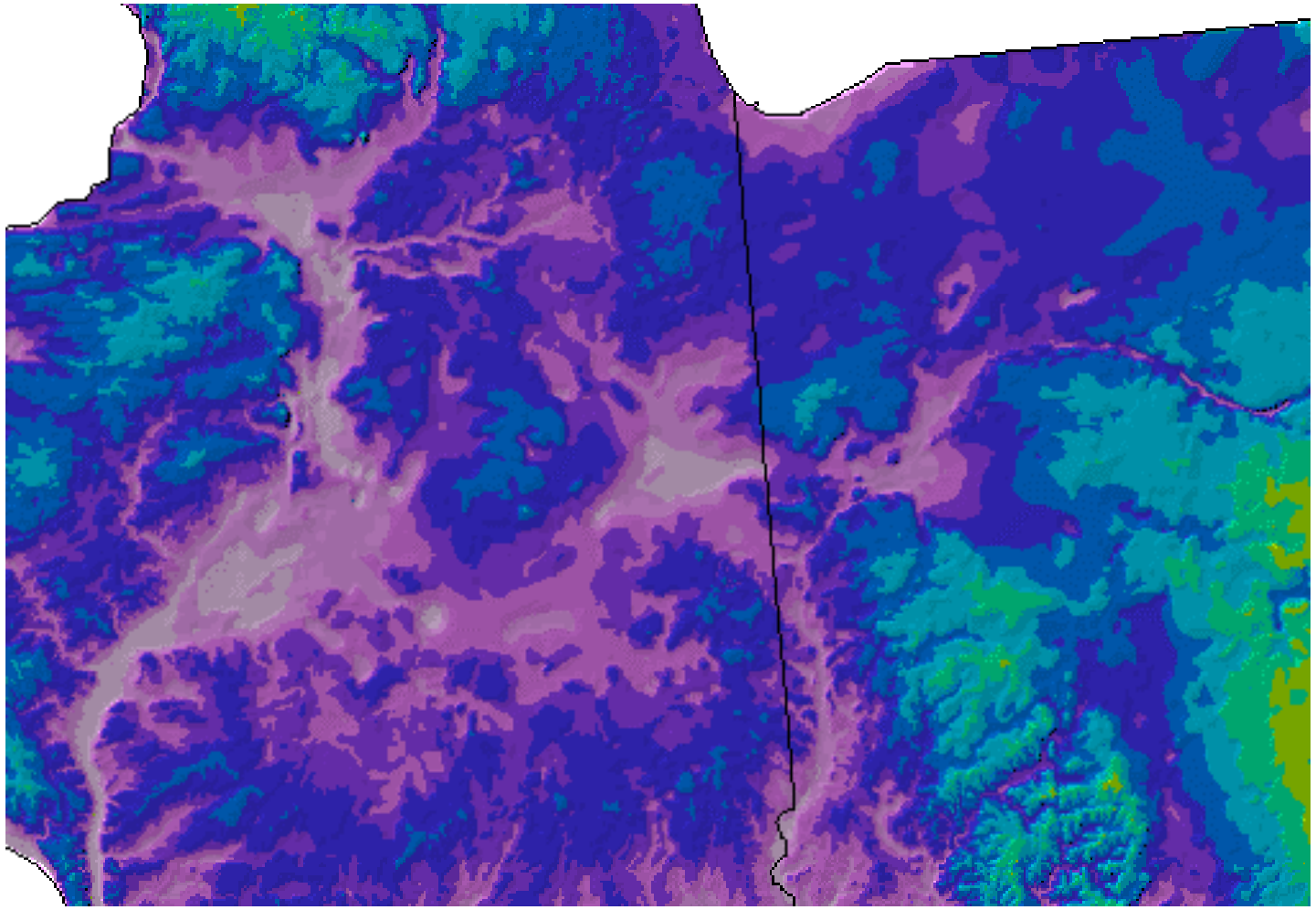
Groundwater Flow Velocities

Material	Velocity
Gravel	5-10 feet per day
Clean sand	1 – 5 feet per day
Clayey sand	0.1 – 0.5 feet per day
Clay	< 0.1 feet per day
Sandstone	< 0.5 feet per day
Highly fractured limestone	10 – 1000's feet per day

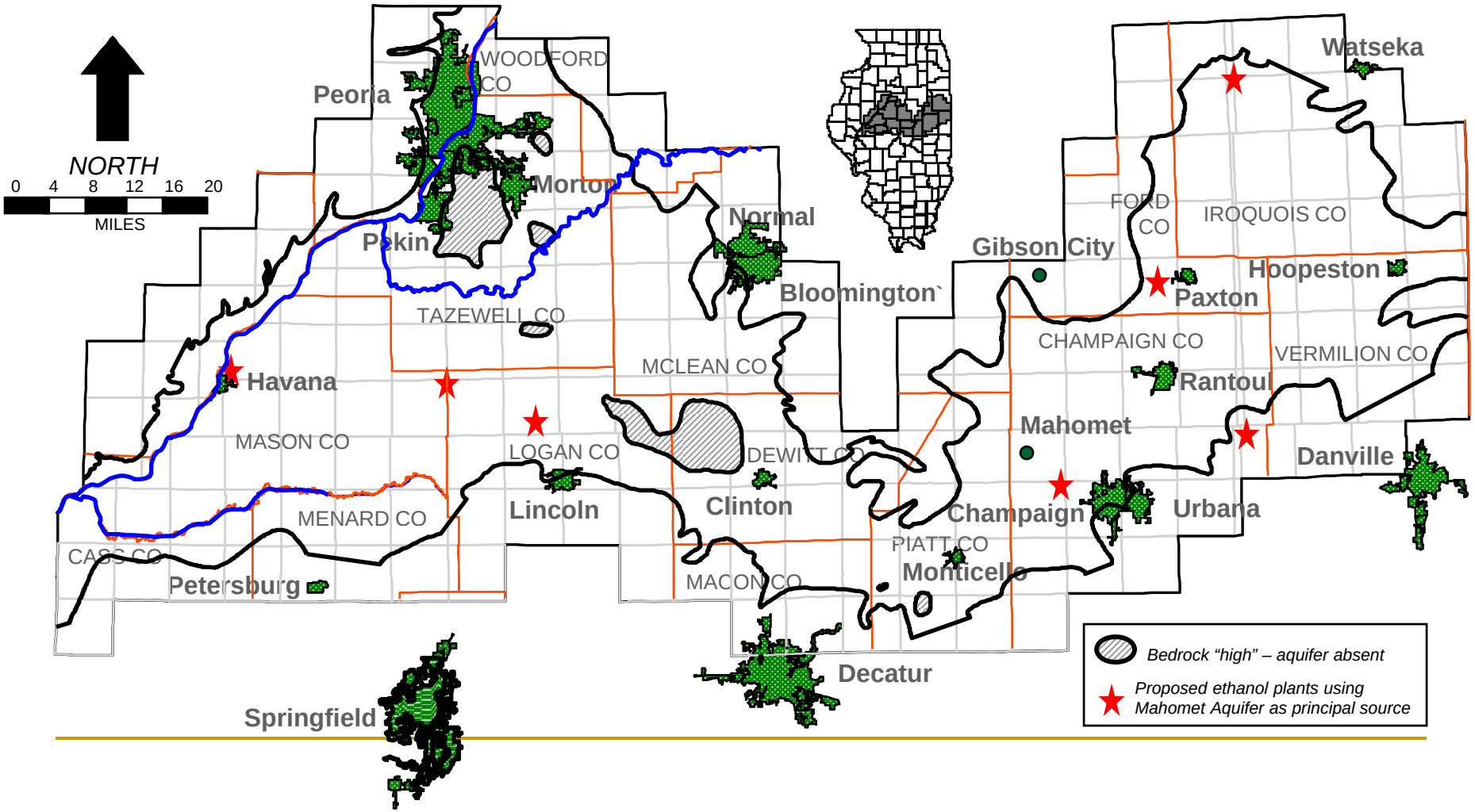
Regional Bedrock Topography

Green= higher elevations

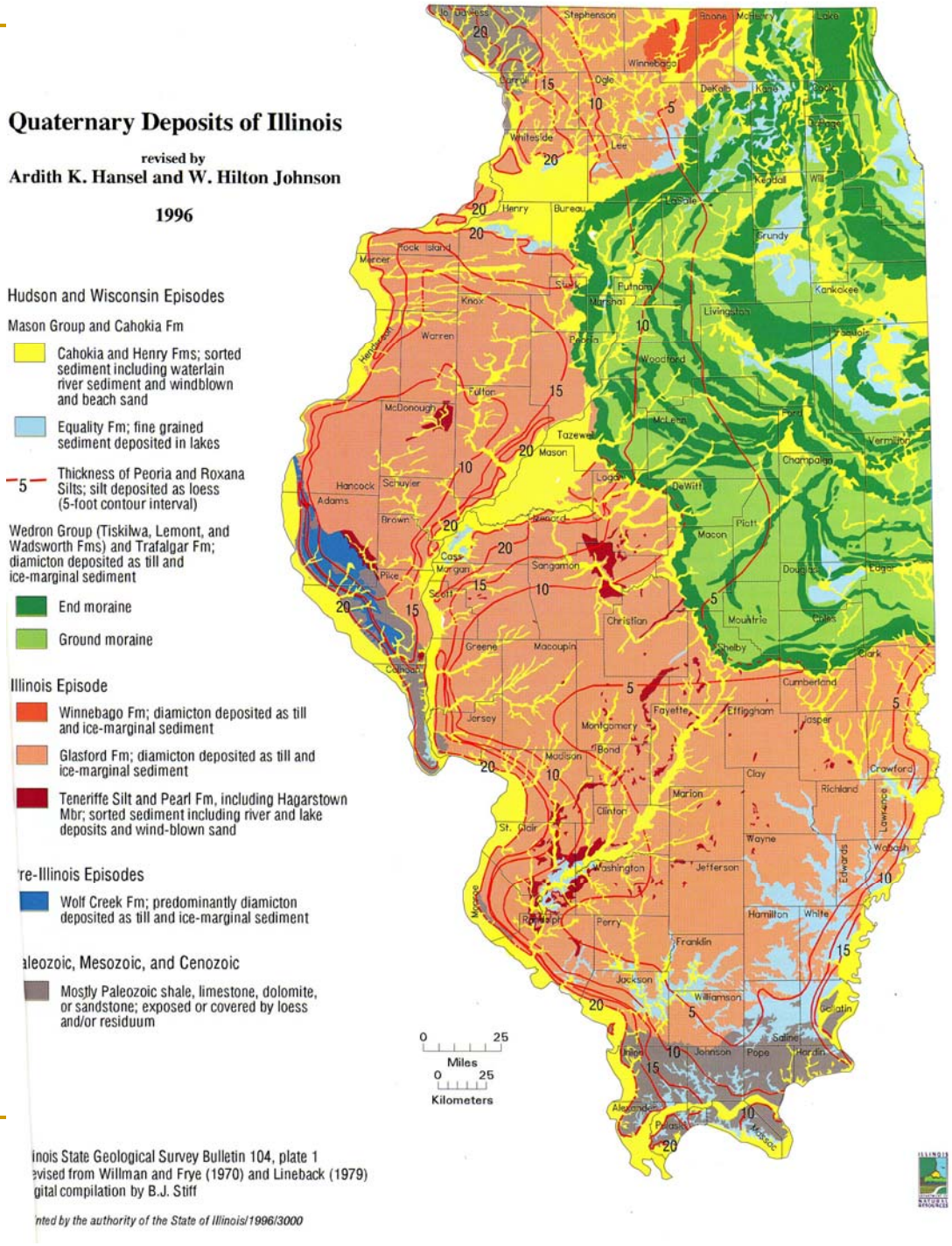
Light violet= lower elevations



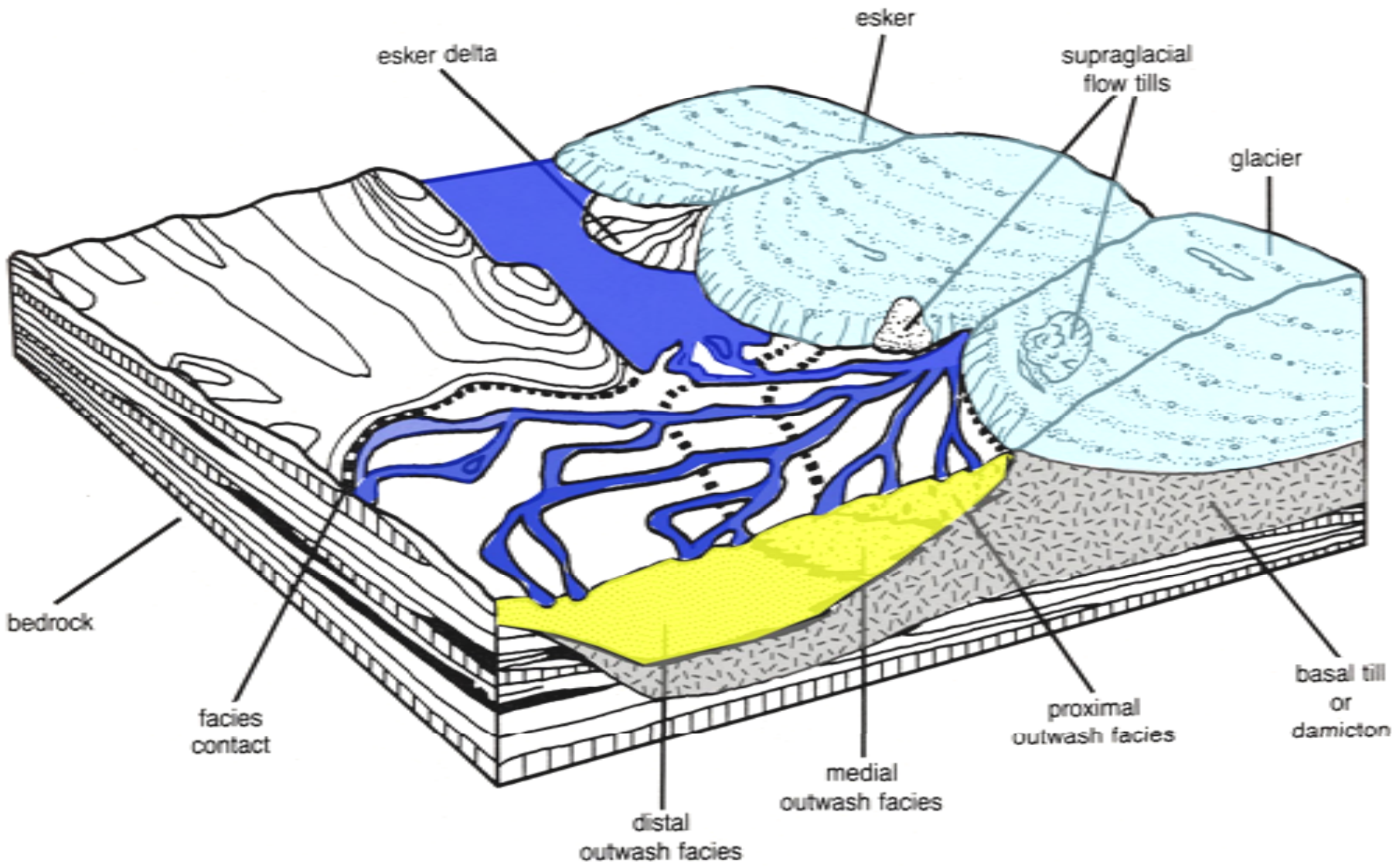
The Mahomet Aquifer Region



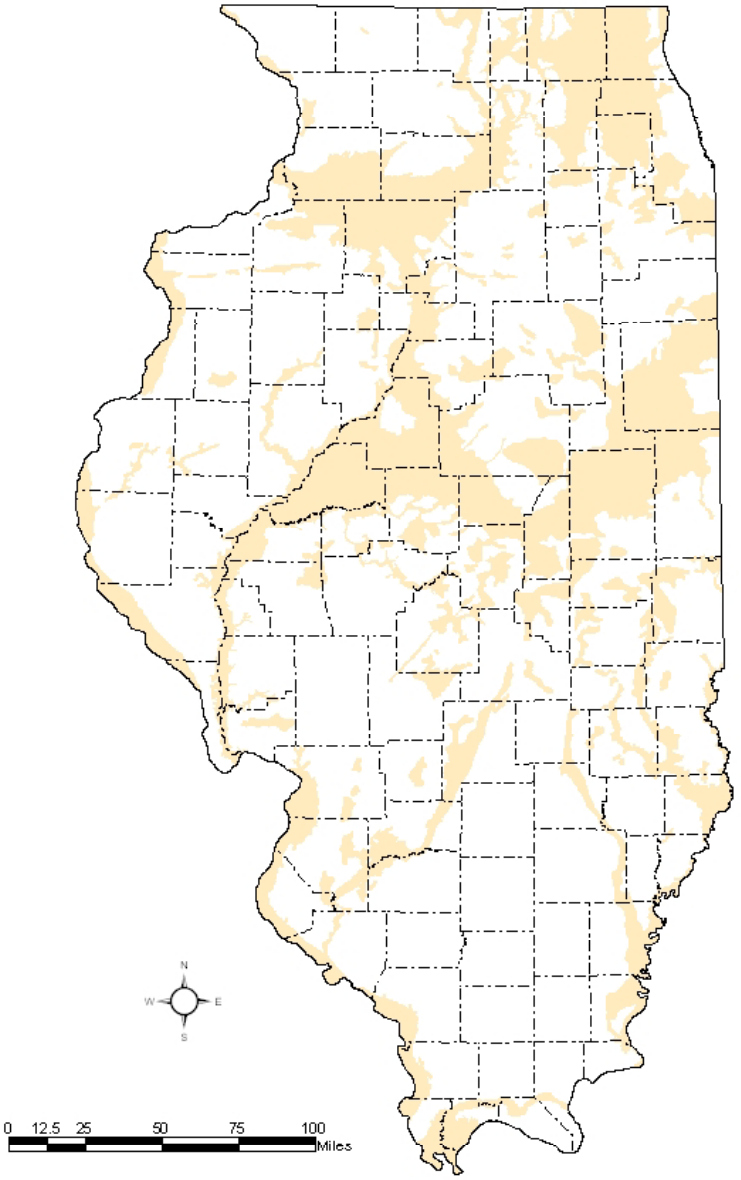
Illinois Geology: glacial materials



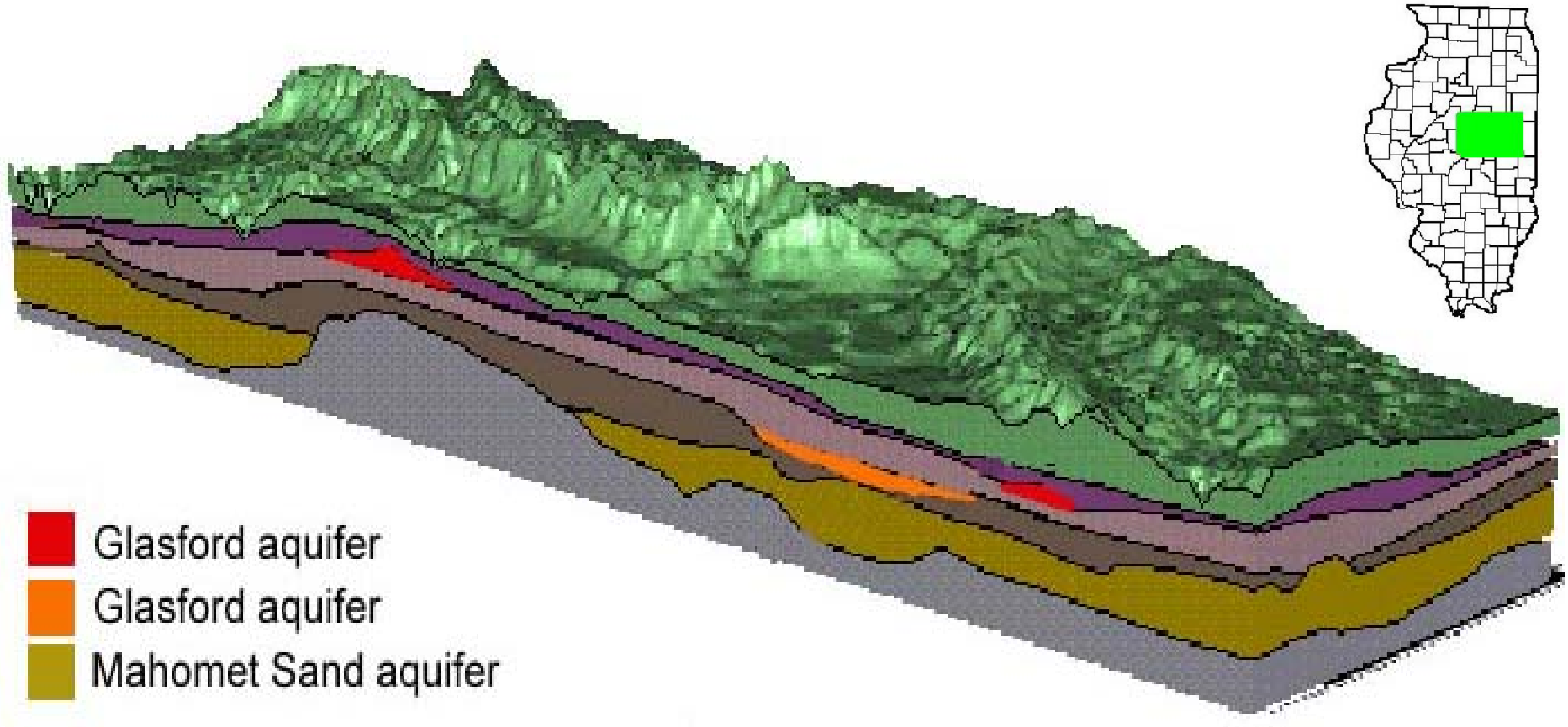
Glacial Depositional Processes



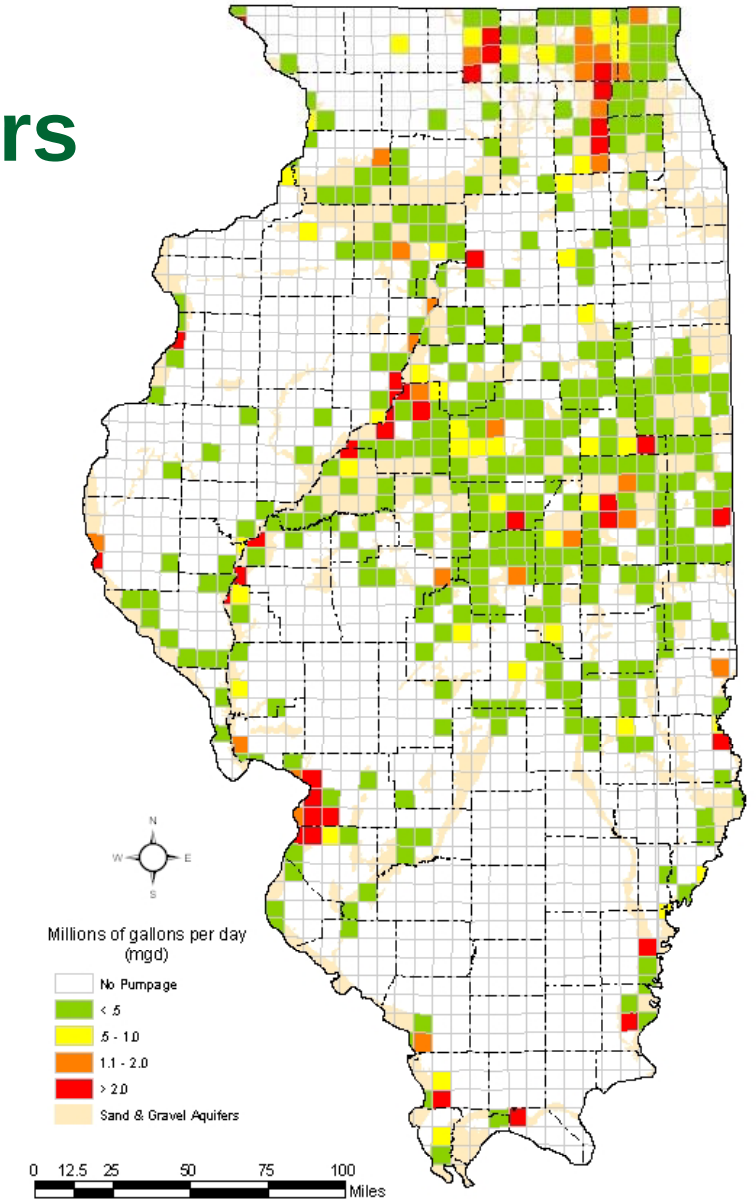
Major Sand & Gravel Aquifers



Geology of the Mahomet Aquifer



Withdrawals from Sand & Gravel Aquifers

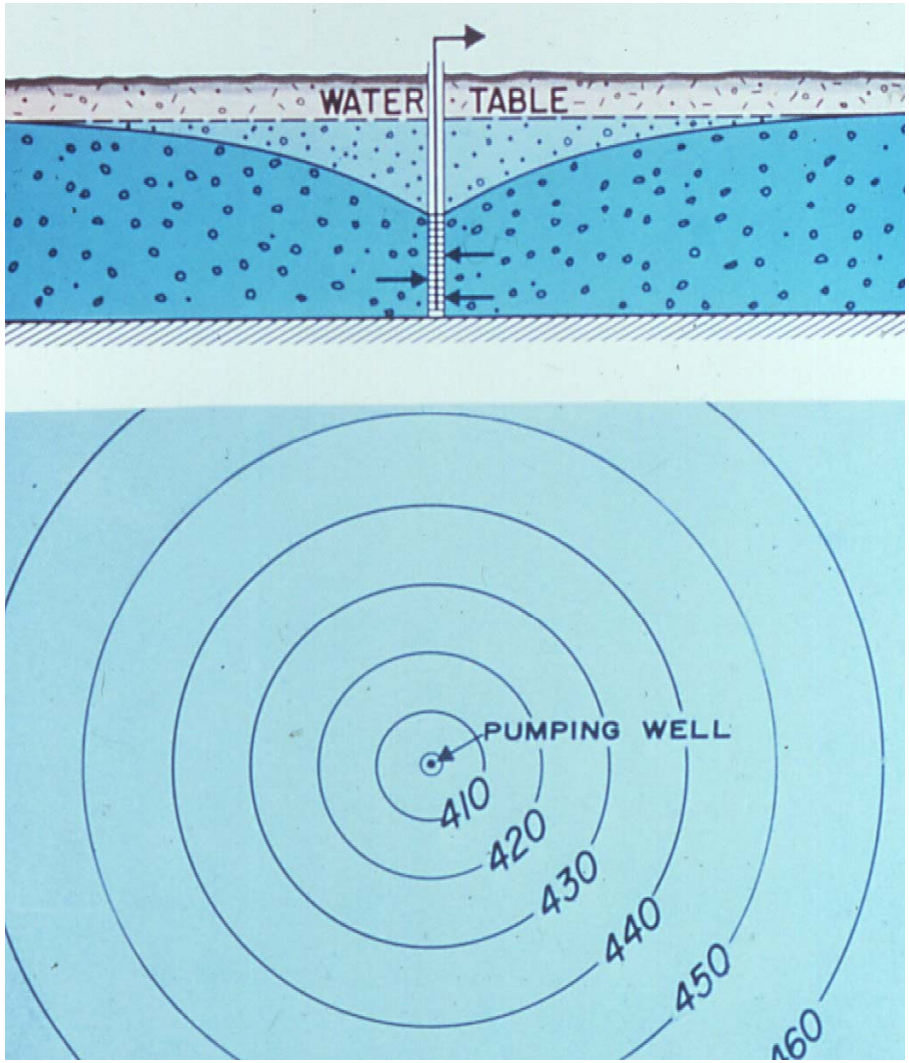


Total use ~ 400 mgd
+ ~200 mgd for irrigation

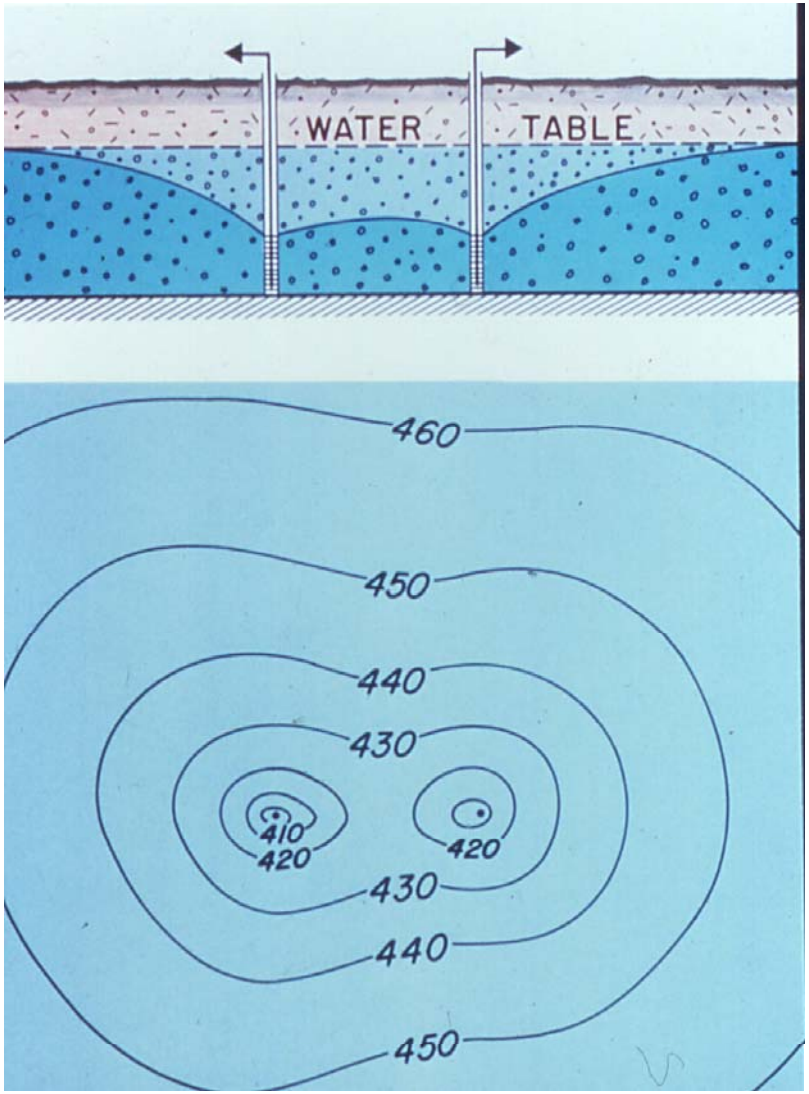
Regional Community Groundwater Use

	2004 Water Use (gpd)
Gibson City (not Mahomet Aquifer)	730,000
IL-American Water Co.	21,000,000
Mahomet	500,000
Monticello	700,000
Normal	4,100,000
Paxton	650,000
Rantoul	1,600,000
Stone Ridge Dairy (near Bellflower)	~1,200,000
White Heath	50,000

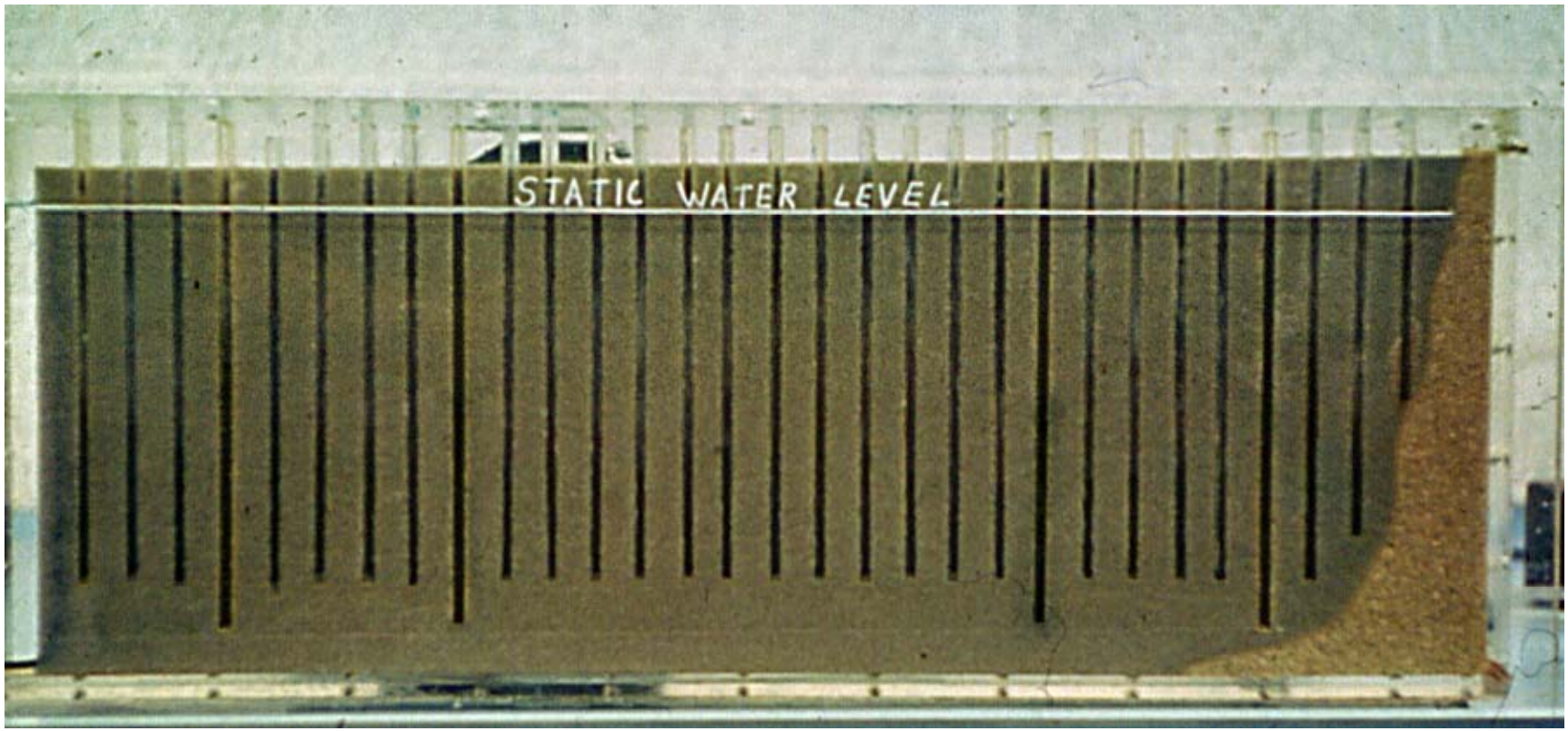
Cone of Depression



Overlapping Cones of Depression



Overlapping Cones of Depression: Well Interference



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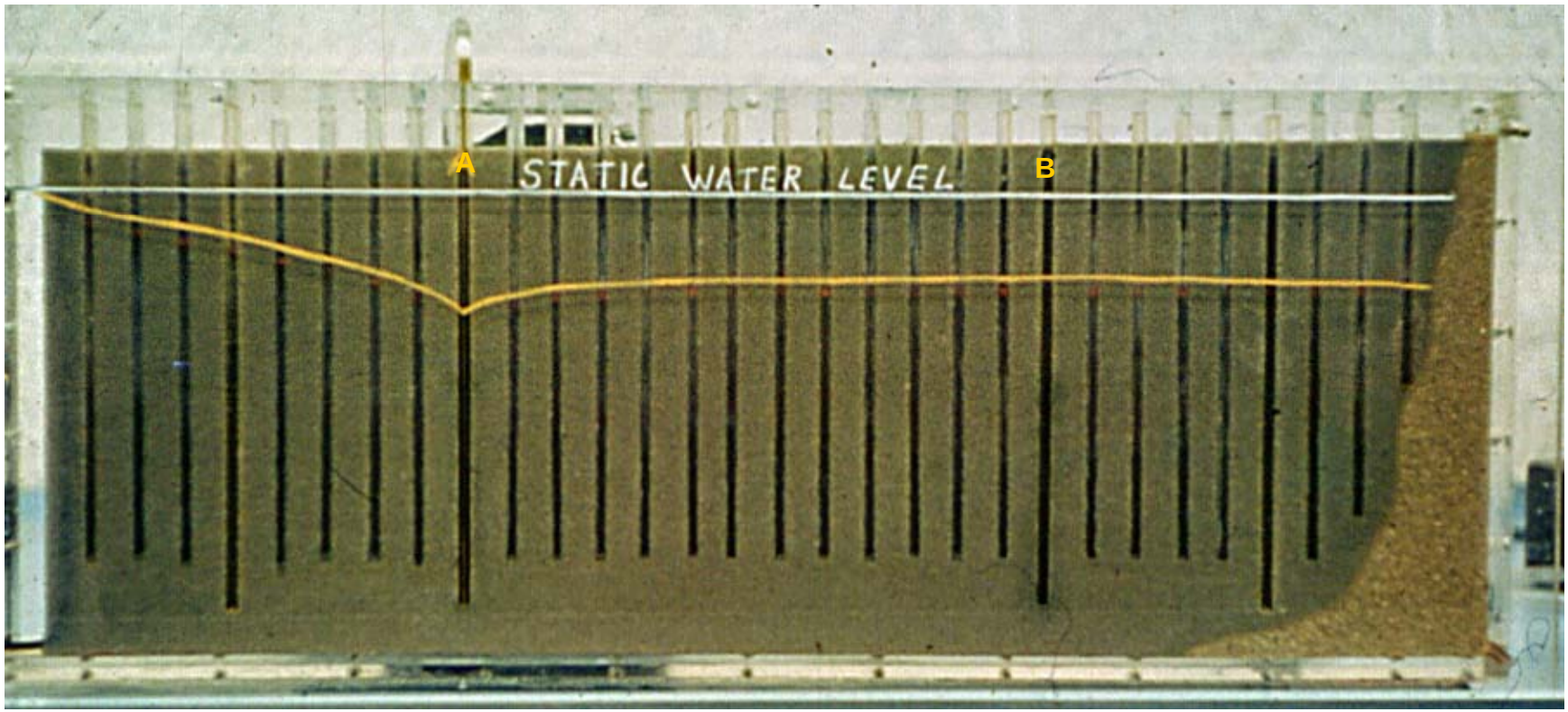

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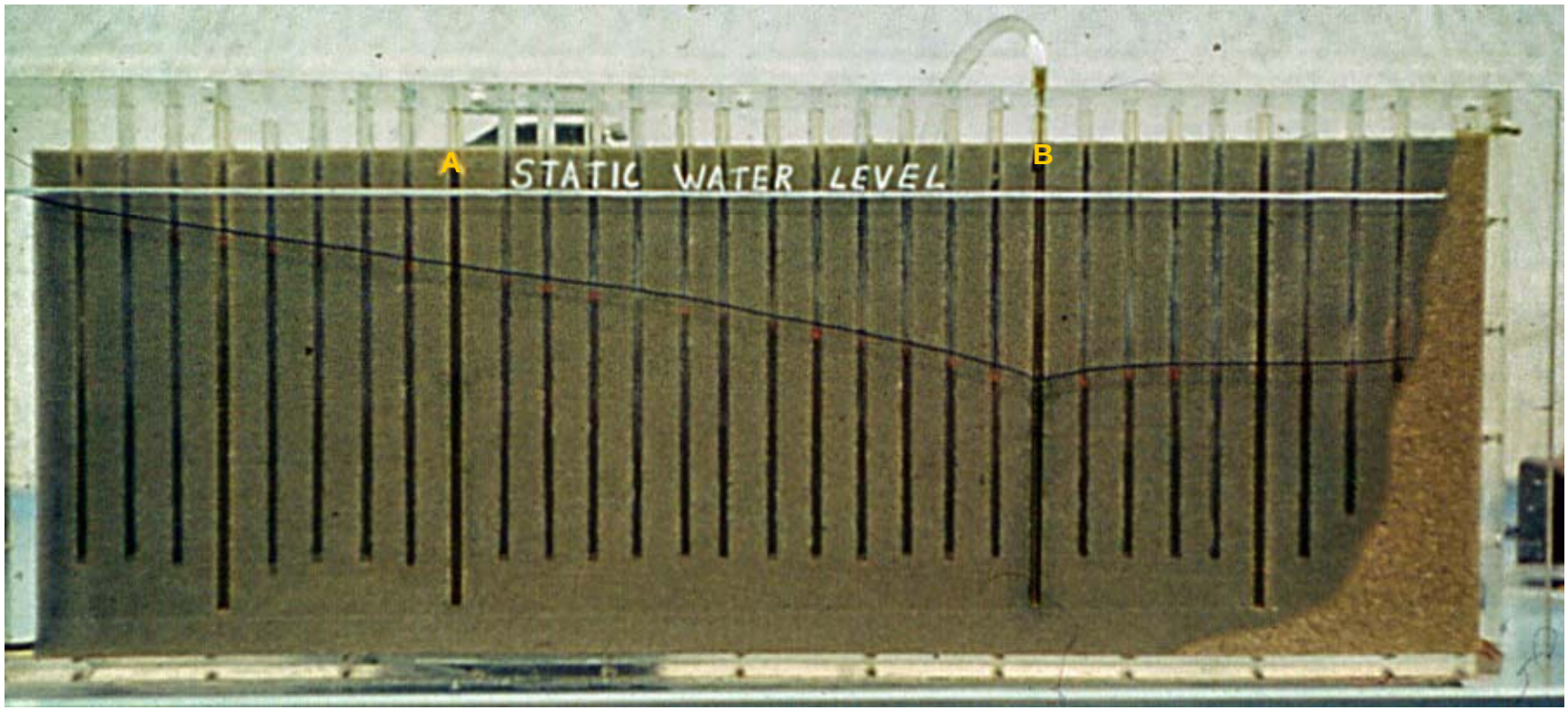
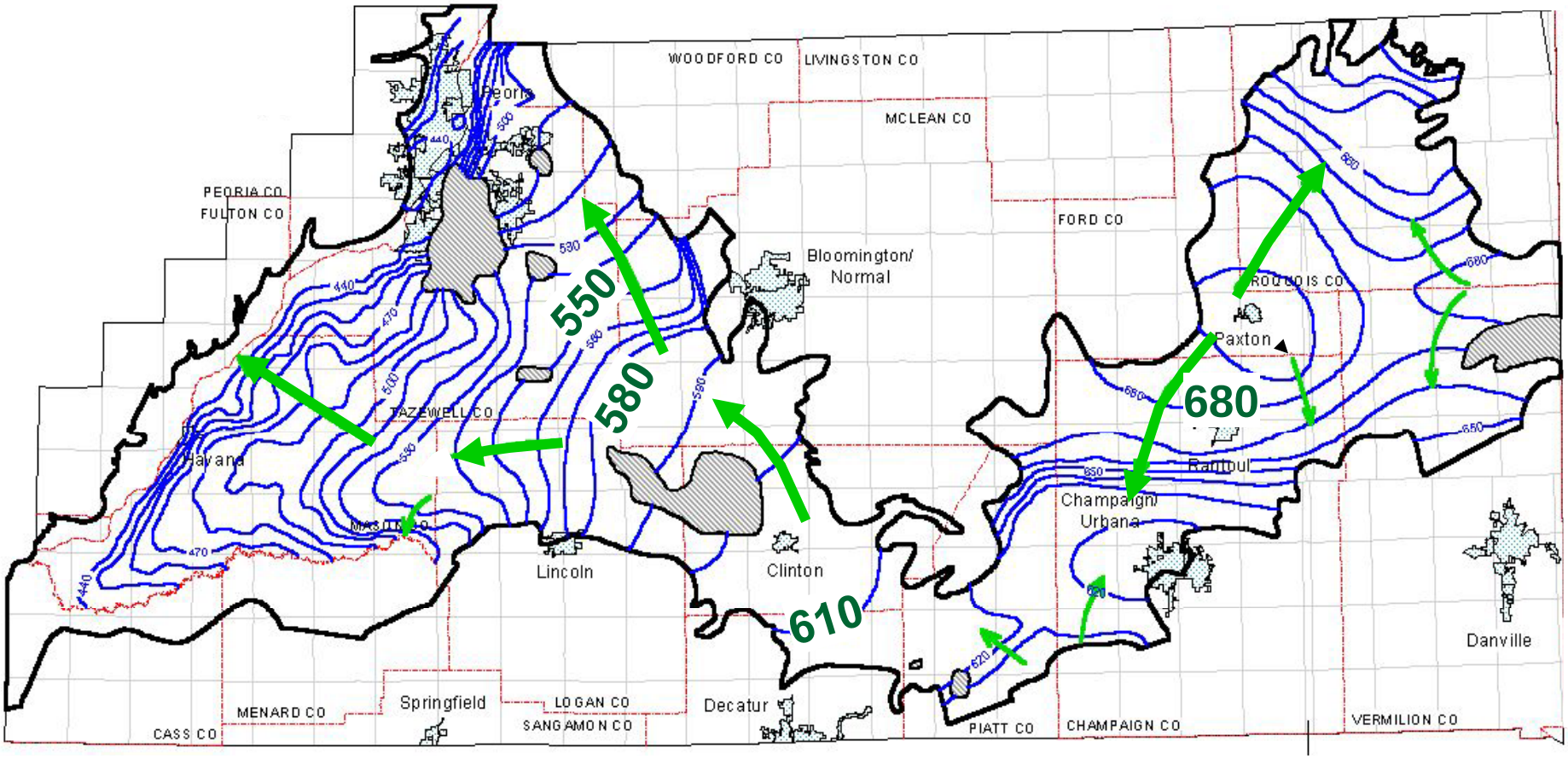


Overlapping Cones of Depression: Well Interference

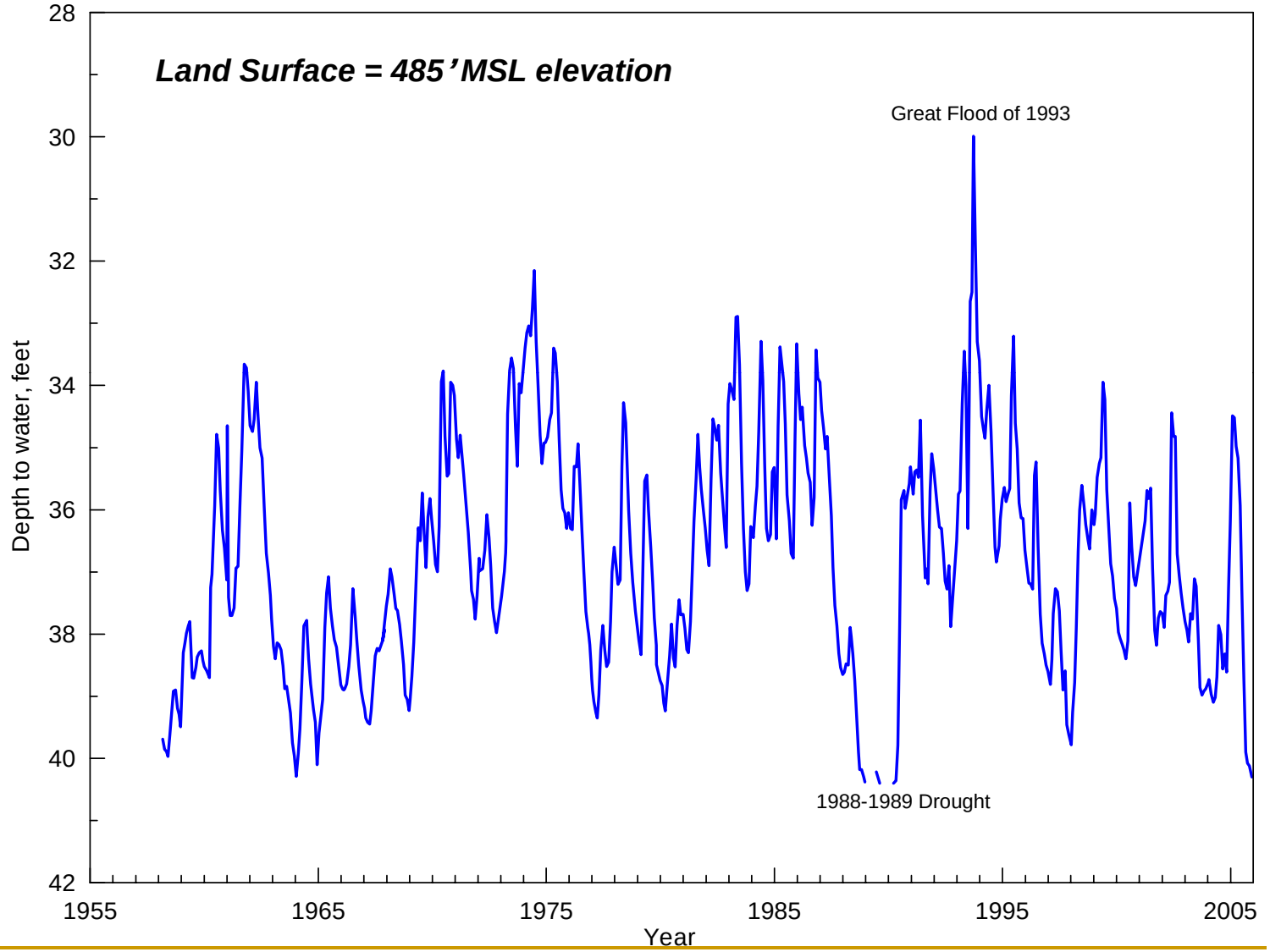
Mahomet Aquifer Groundwater Levels



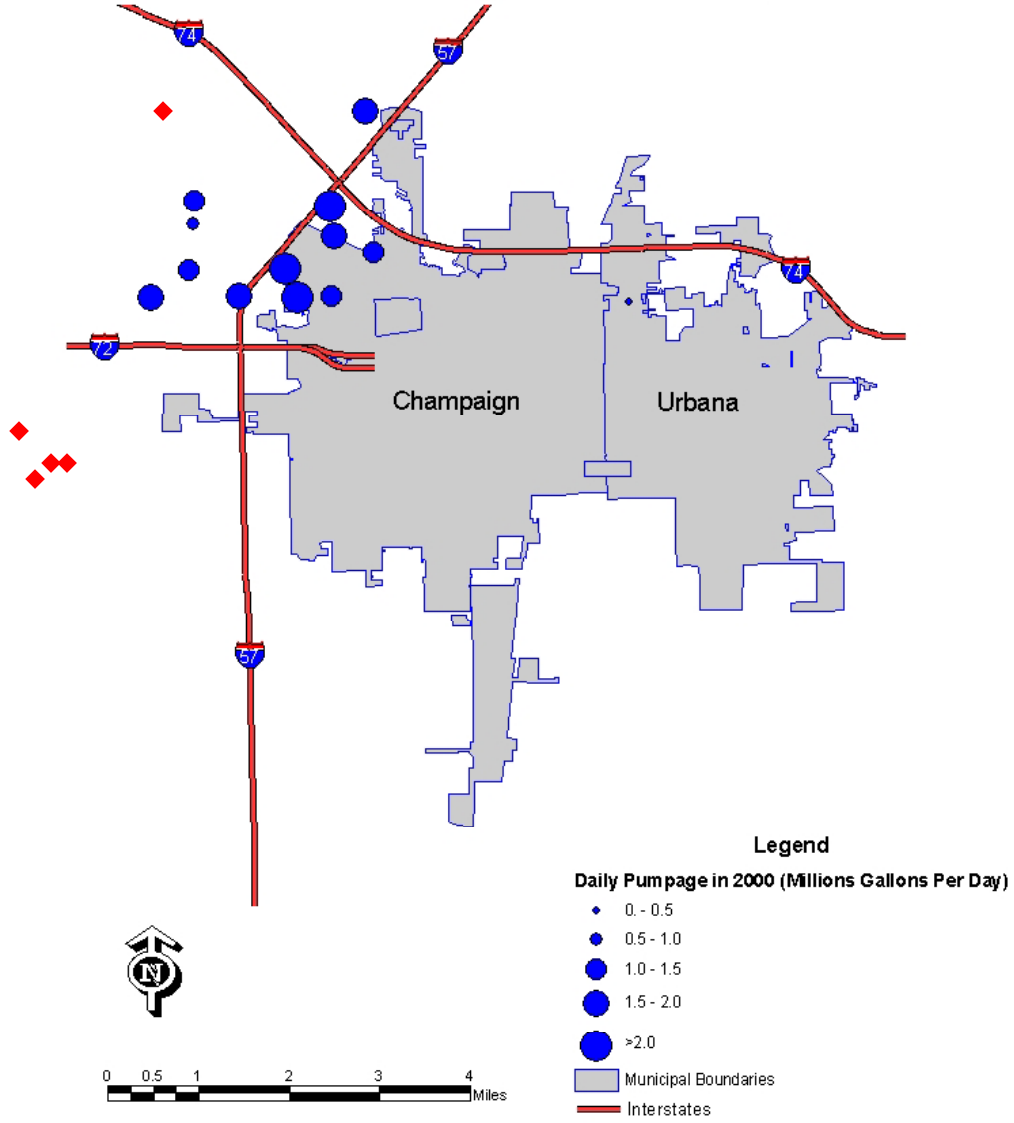
10-foot contour

Flow direction

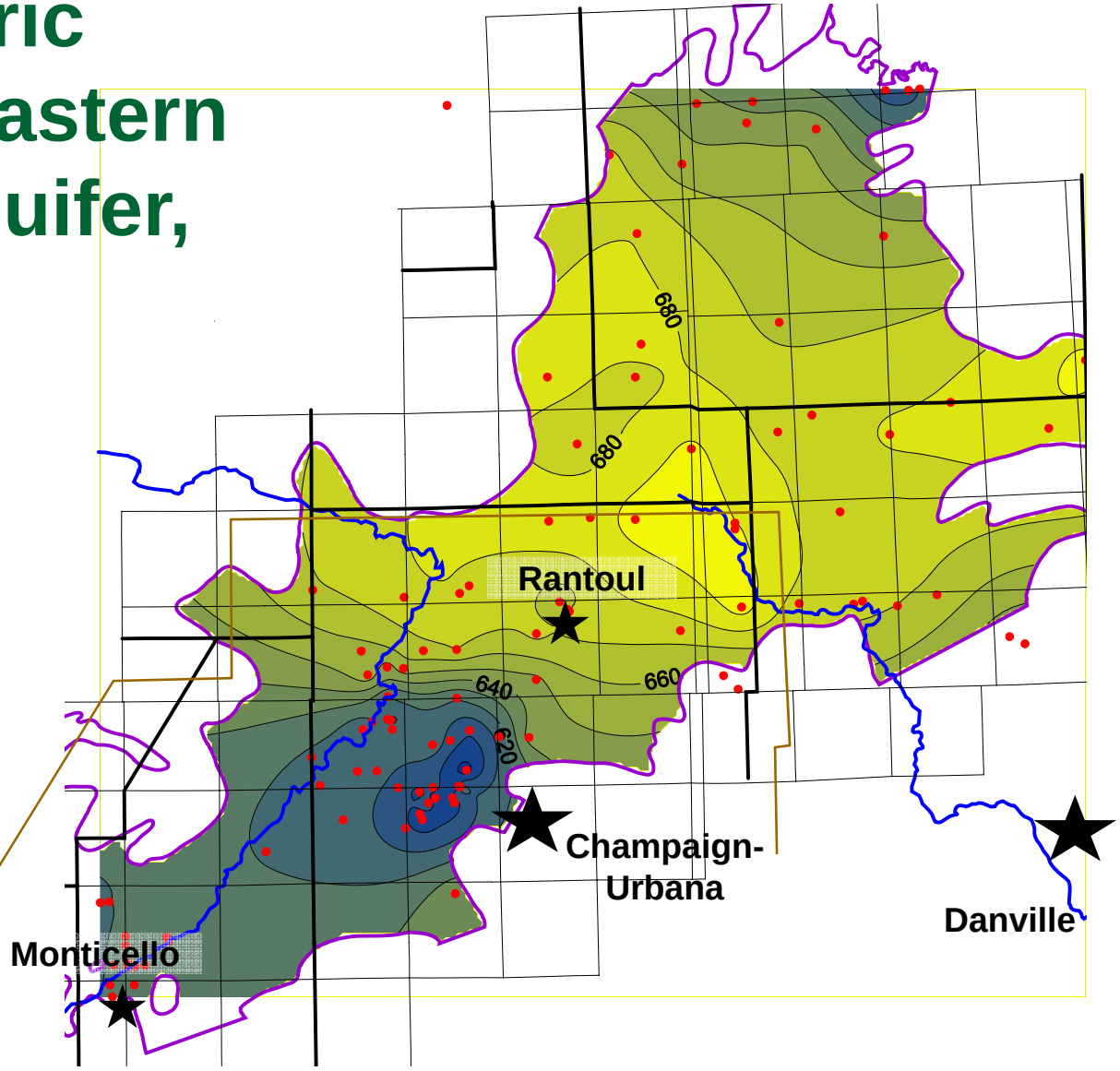
Mahomet Water Levels by the Illinois River



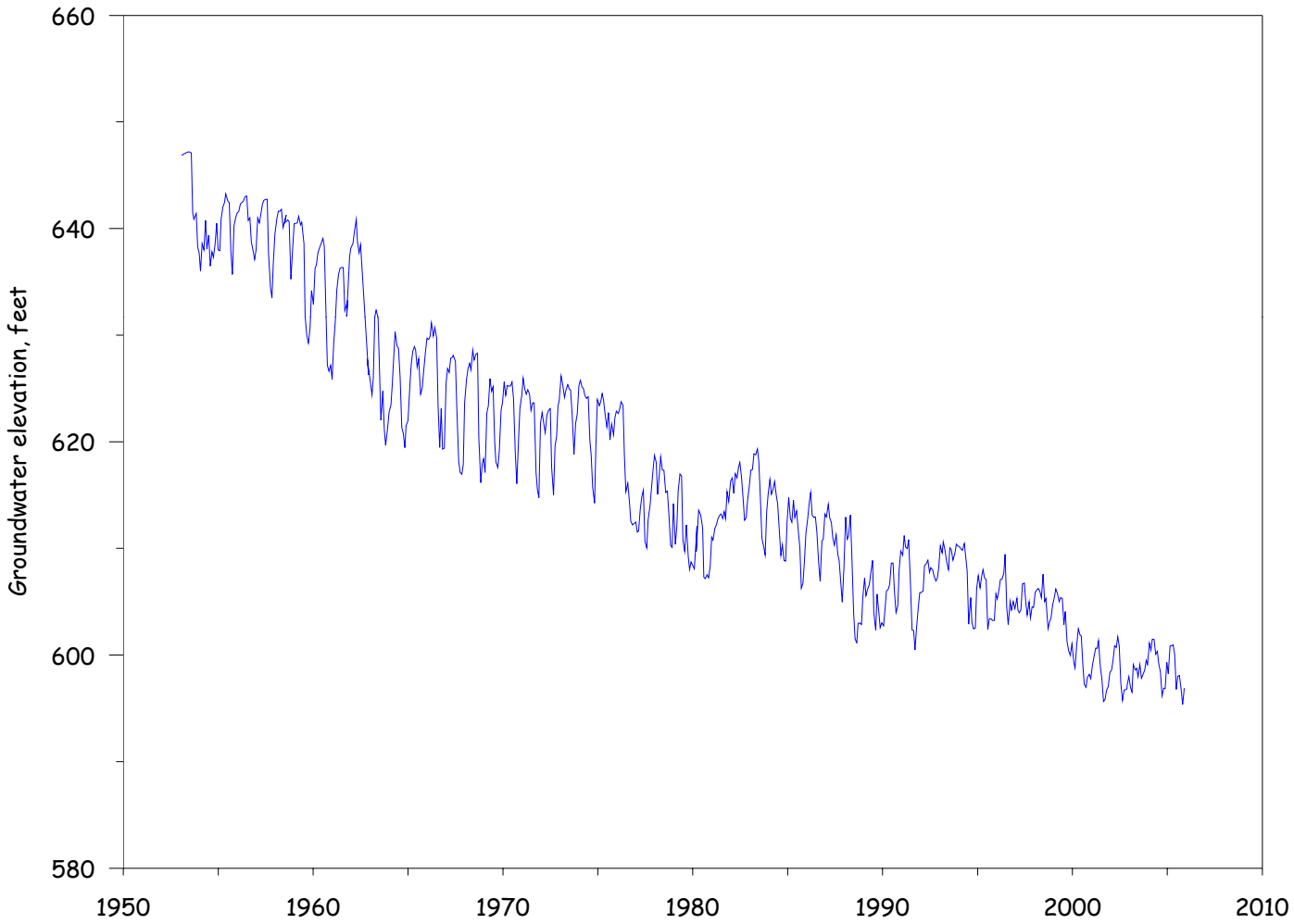
Top Producing Wells Owned by Illinois American Water Comany



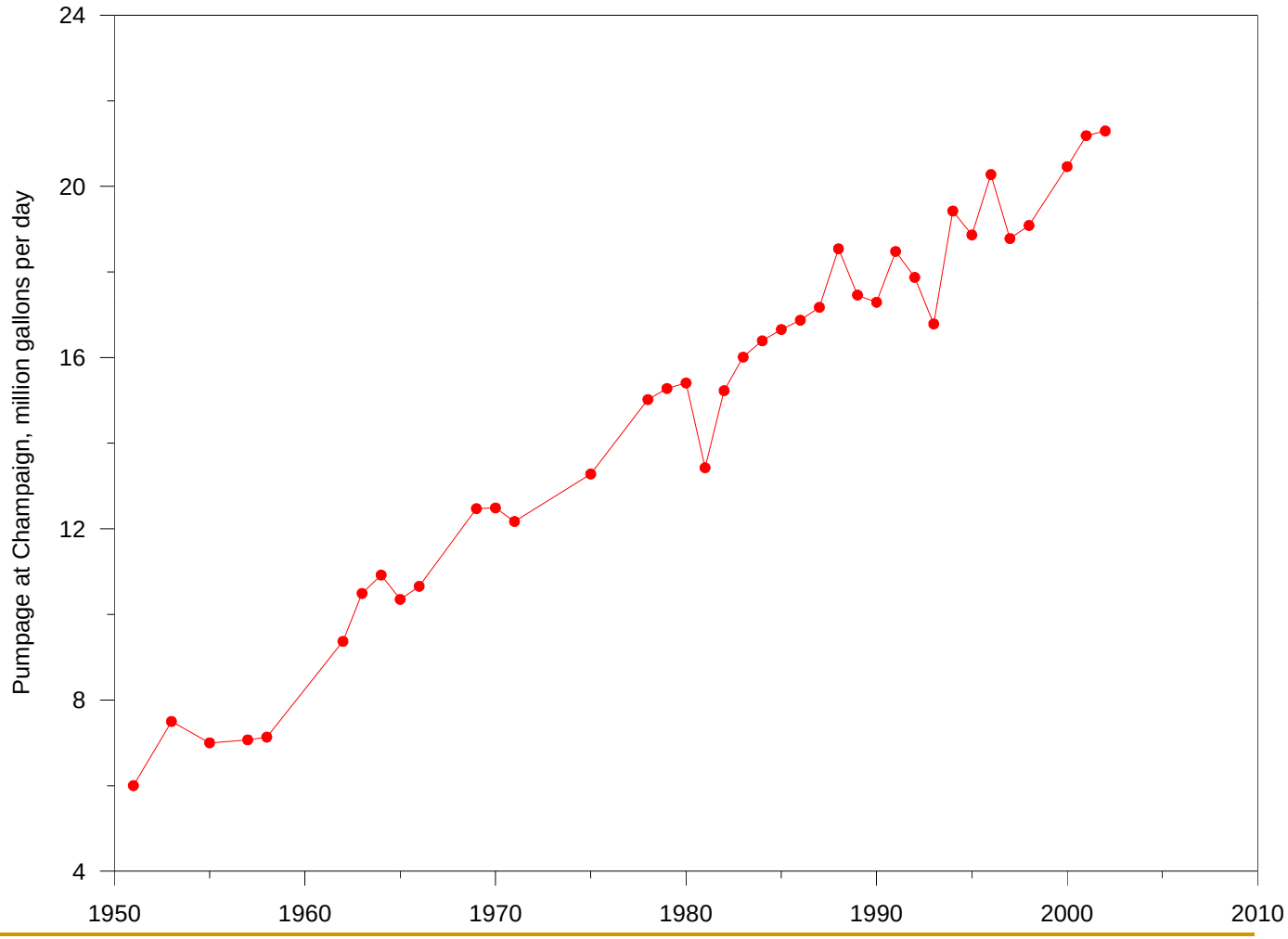
Potentiometric Surface of Eastern Mahomet Aquifer, 2005



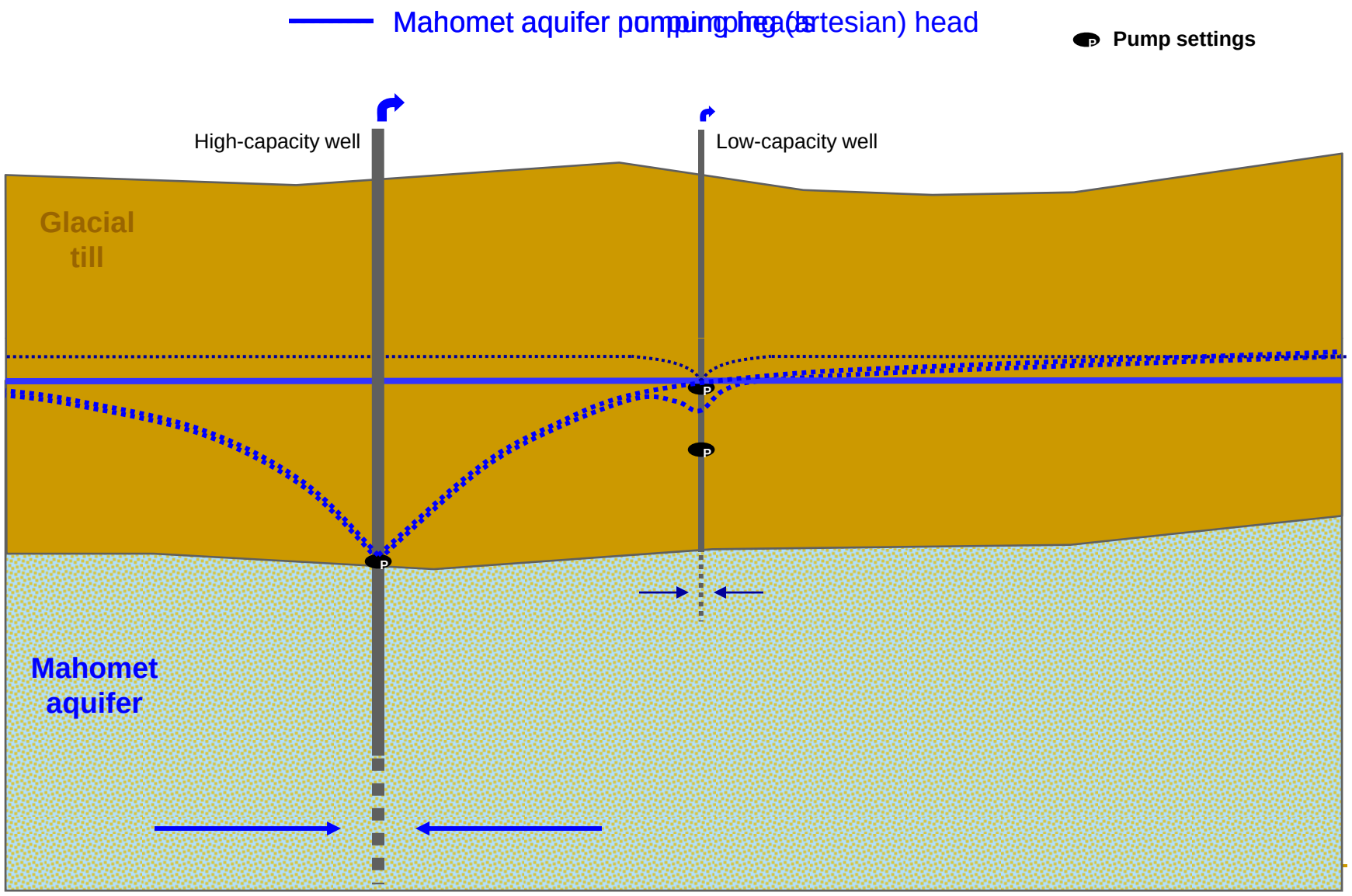
Mahomet Potentiometric Heads near Champaign



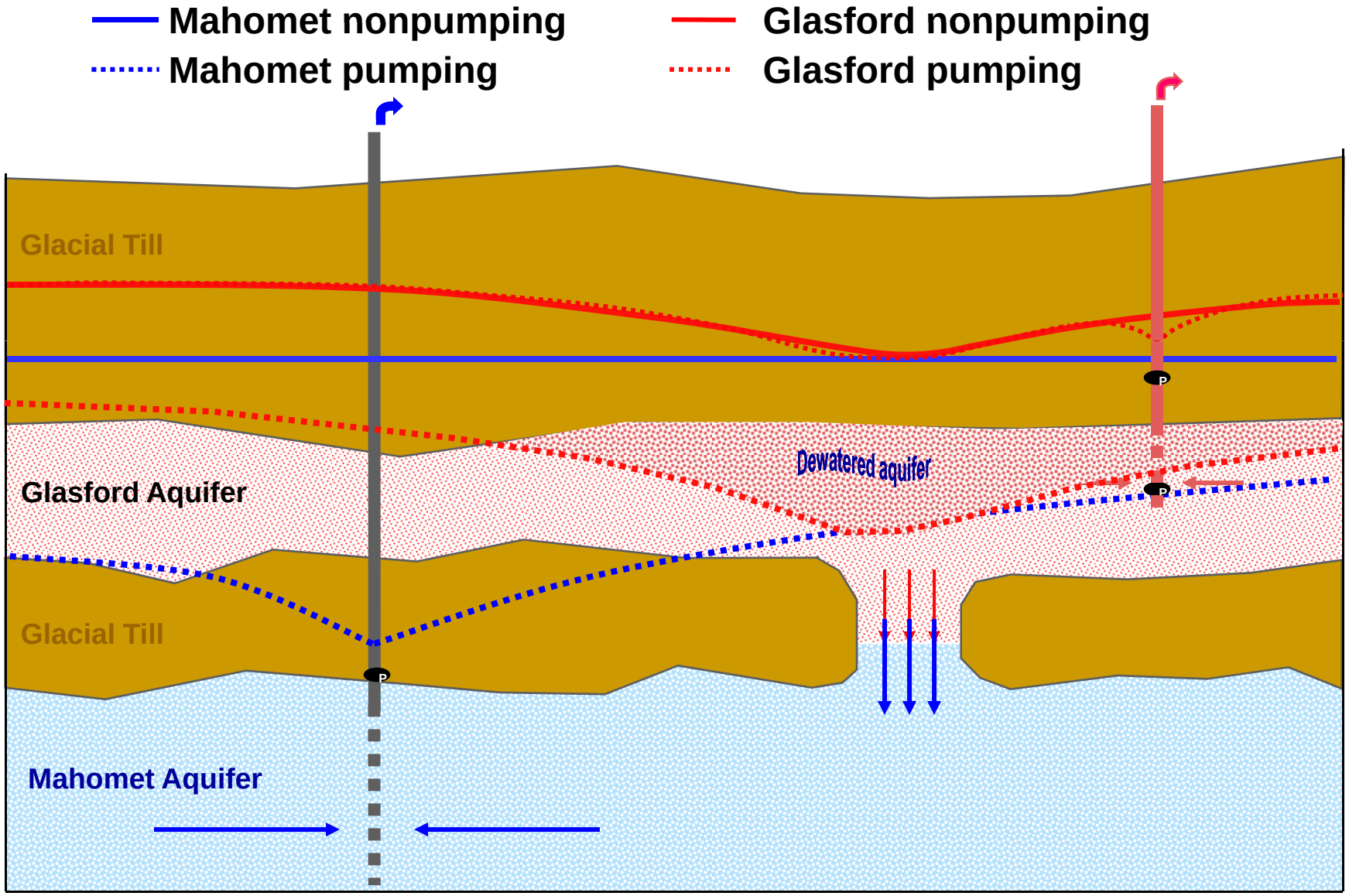
Water Use Trend at Champaign



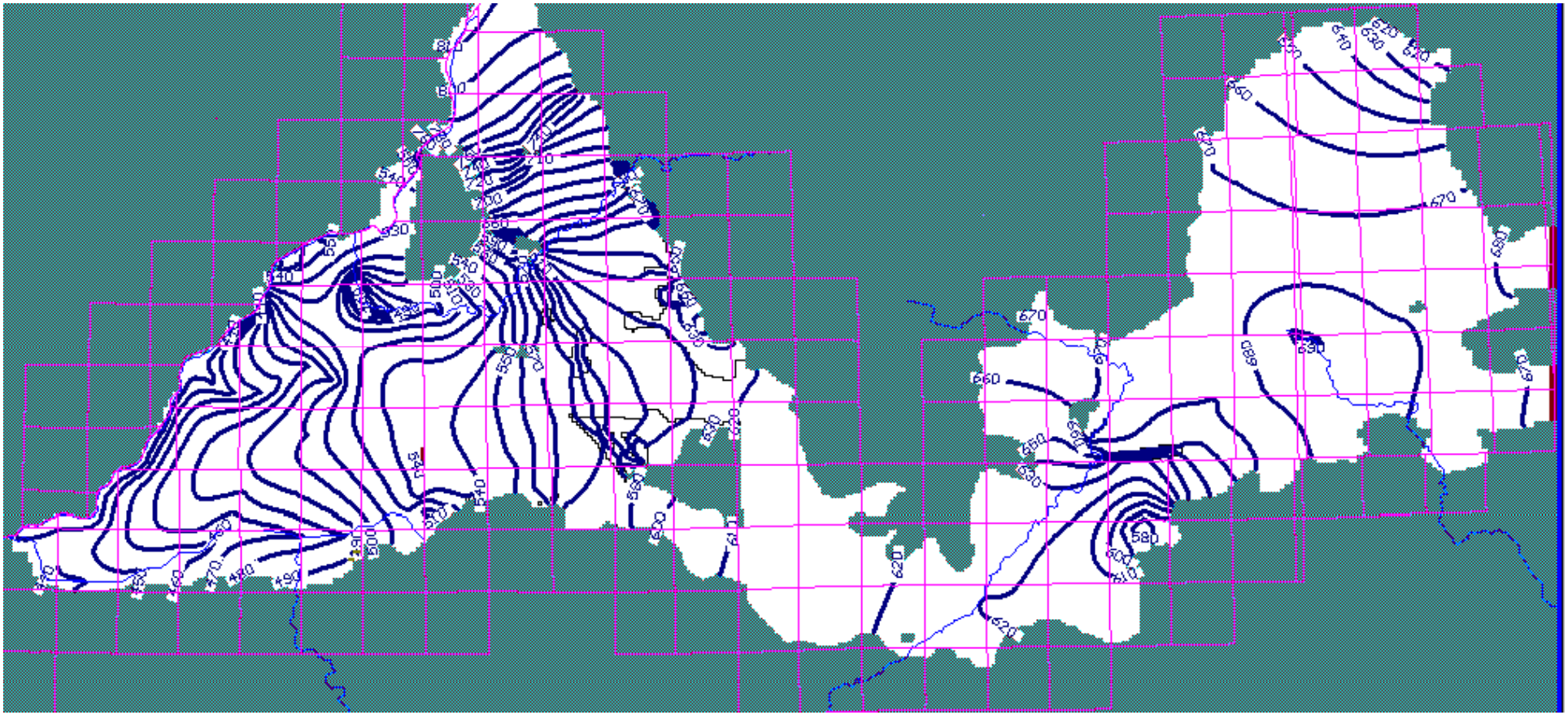
Impacts of pumping on water levels (head)



Impact of pumping hydraulically linked aquifers

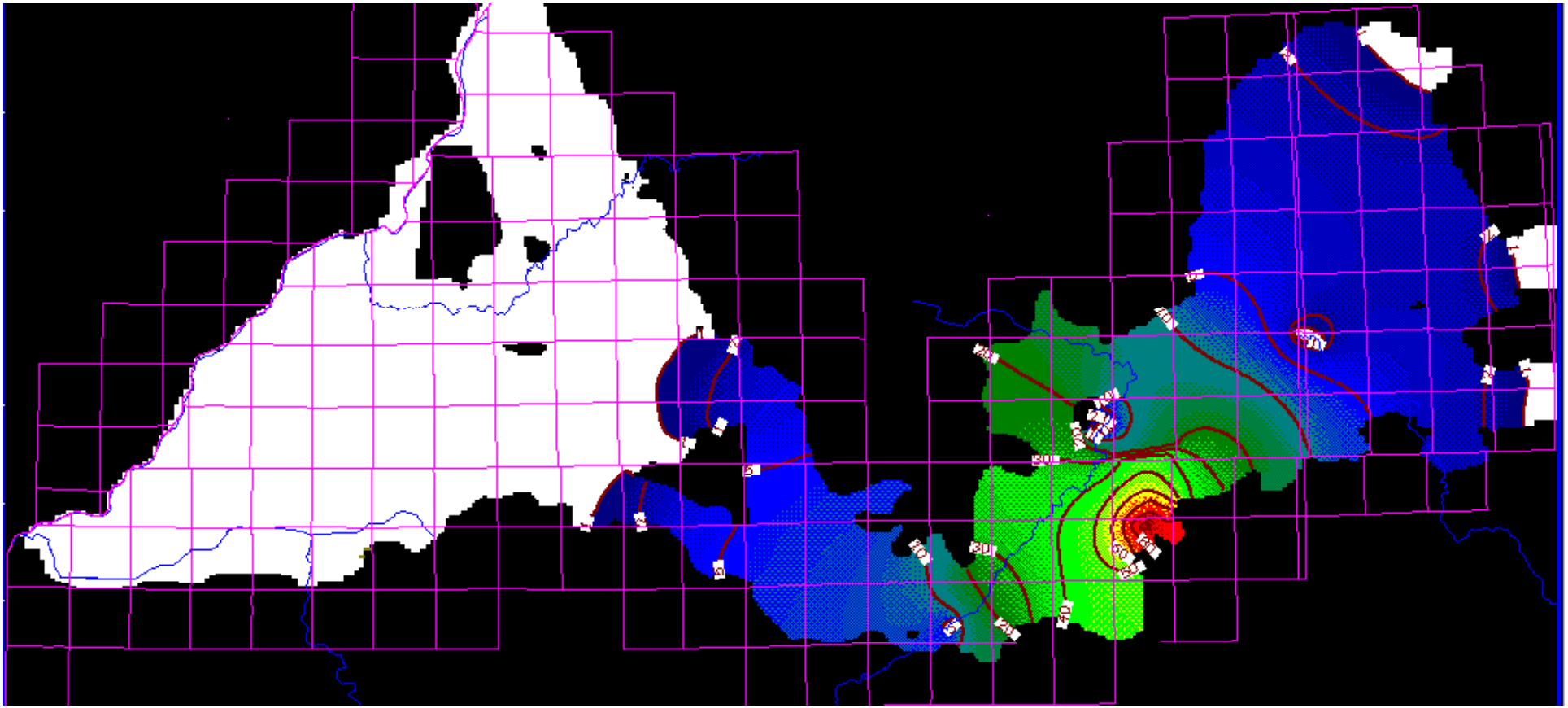


ISWS Regional Flow Model Predicted Heads



Model-Predicted Drawdown

Q = 23 mgd at Champaign



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