

Groundwater Recharge in Northeastern Illinois

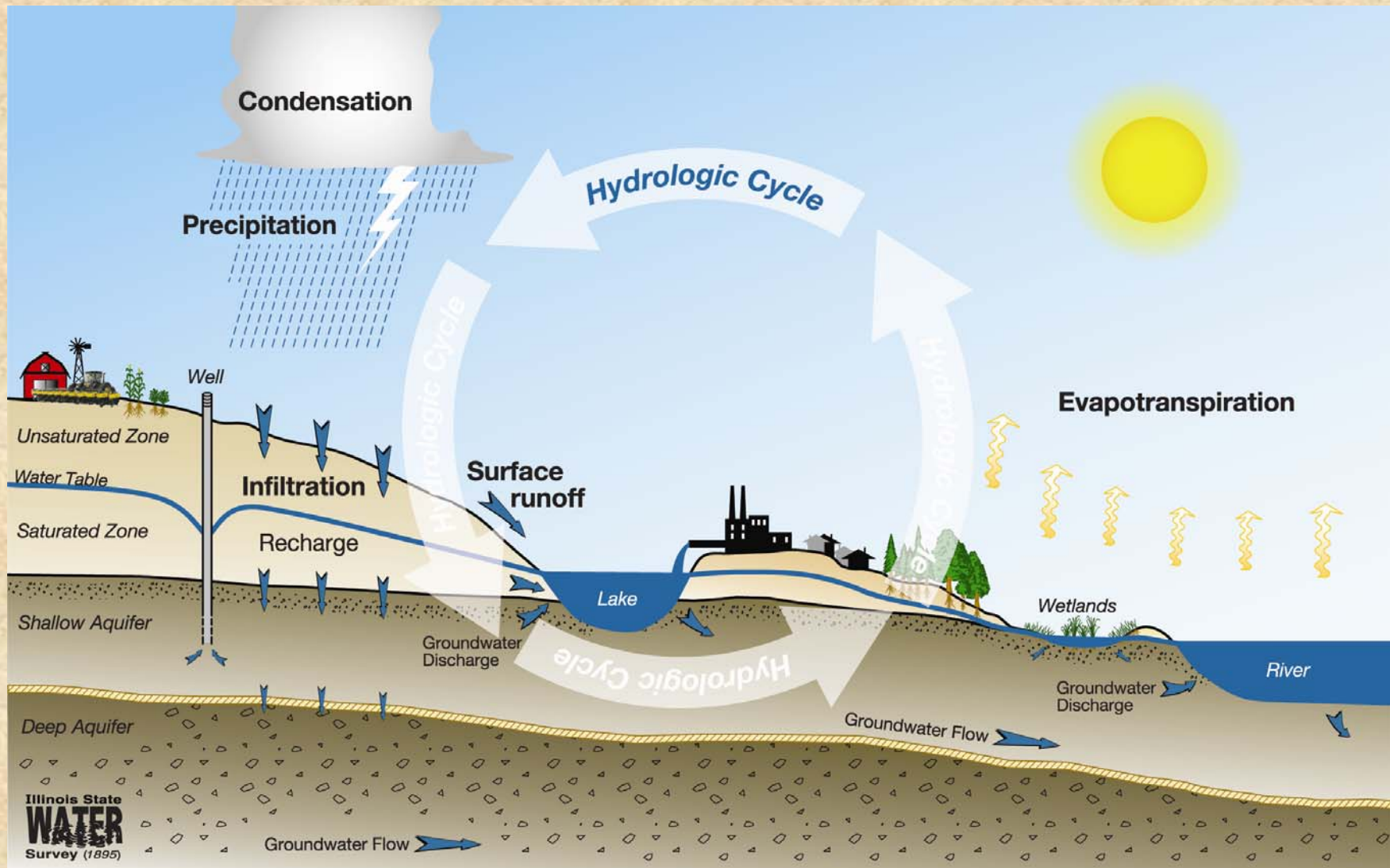
*NE Illinois Regional Water Supply Planning Committee
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Belvidere, IL*

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The Water Cycle

Climate, surface water, and groundwater are linked



Key Concepts

- Infiltration
- Recharge
 - Groundwater Recharge
 - Aquifer Recharge
- Discharge
- Recharge Zone
- Discharge Zone
- Local Flow System

Natural Recharge of Groundwater in Illinois, Bruce Hensel, 1992. Illinois State Geological Survey, EG142.

www.isgs.uiuc.edu

Factors Affecting Infiltration and Recharge

- Rainfall intensity and duration
- Texture and permeability of soil/geologic materials
- Soil moisture/depth to water table
- Slope and landscape position
- Land cover
 - Vegetation (row crop, grasses, trees, etc.)
 - Impervious surface (building footprint, streets, driveways, sidewalks, parking lots, etc.)
 - Retention/detention basins
- Presence and type of water sources or sinks (e.g., leaky water supply pipes, storm sewers)

Methods to Estimate Recharge

- Point Measurements
 - Lysimeter
 - Water-table fluctuation (specific yield required)
 - Soil-moisture budgets
- Areal Estimates
 - Geologic map analysis
 - Water budgets
 - Flow-net analysis
 - Baseflow separation
 - Geochemistry
 - Numerical/digital flow models

Geologic Mapping Approach

- Originally developed to predict likelihood of uppermost aquifers to contamination from surface or near-surface sources
- Surrogate for estimate of aquifer recharge potential
- Screening tool for prioritizing resources and guiding planning (e.g., IEPA, Winnebago County Health Dept.)

Geologic Mapping Approach

- Depth to uppermost aquifer material is primary criteria
- Geologic materials viewed as either aquifer or non-aquifer material
- Assumed vertical flow through non-aquifers
- Assumed generalized permeability for all materials

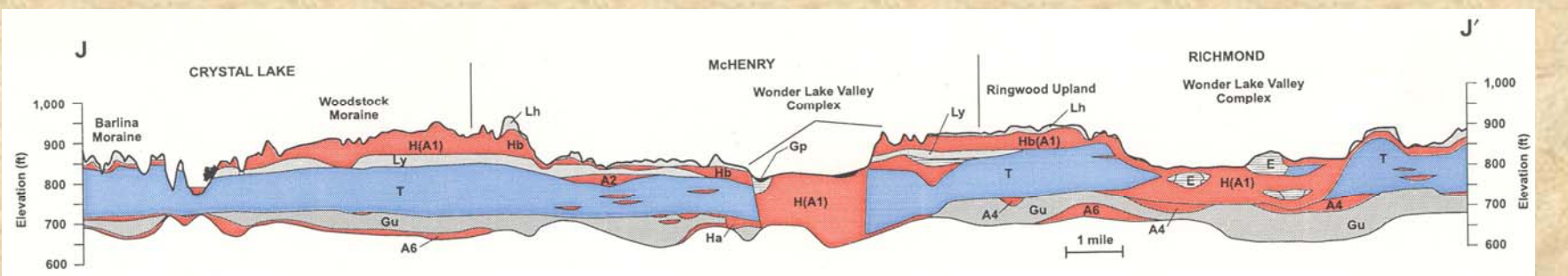
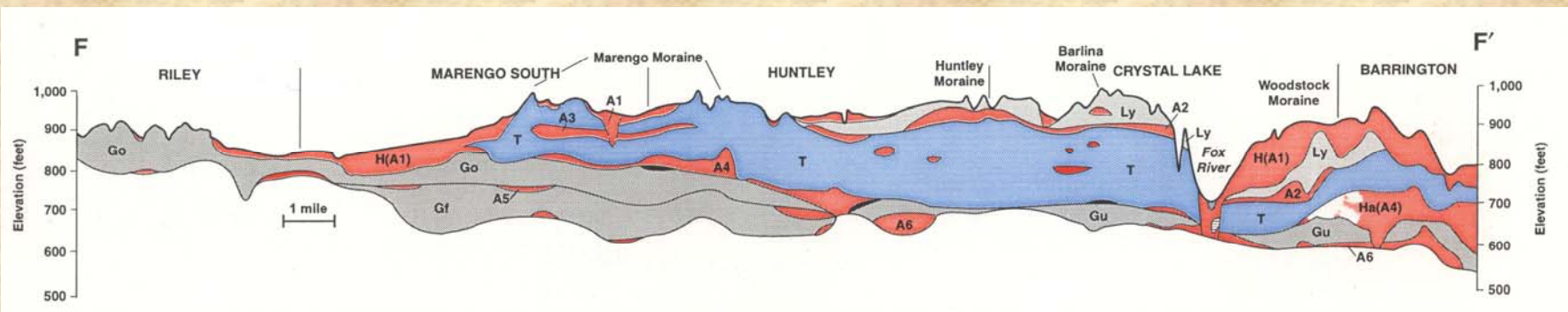
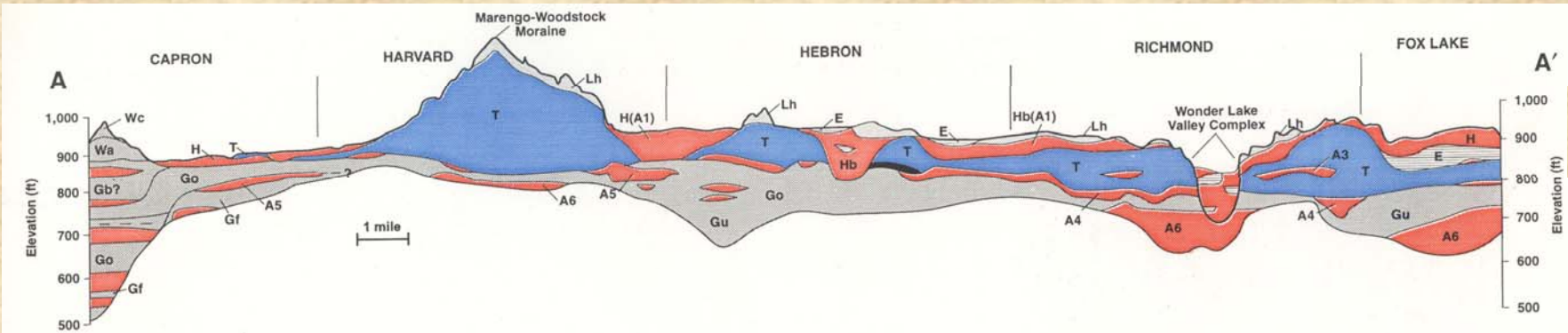
Commonly used permeabilities for typical geologic materials in Illinois

Determine what constitutes aquifer material

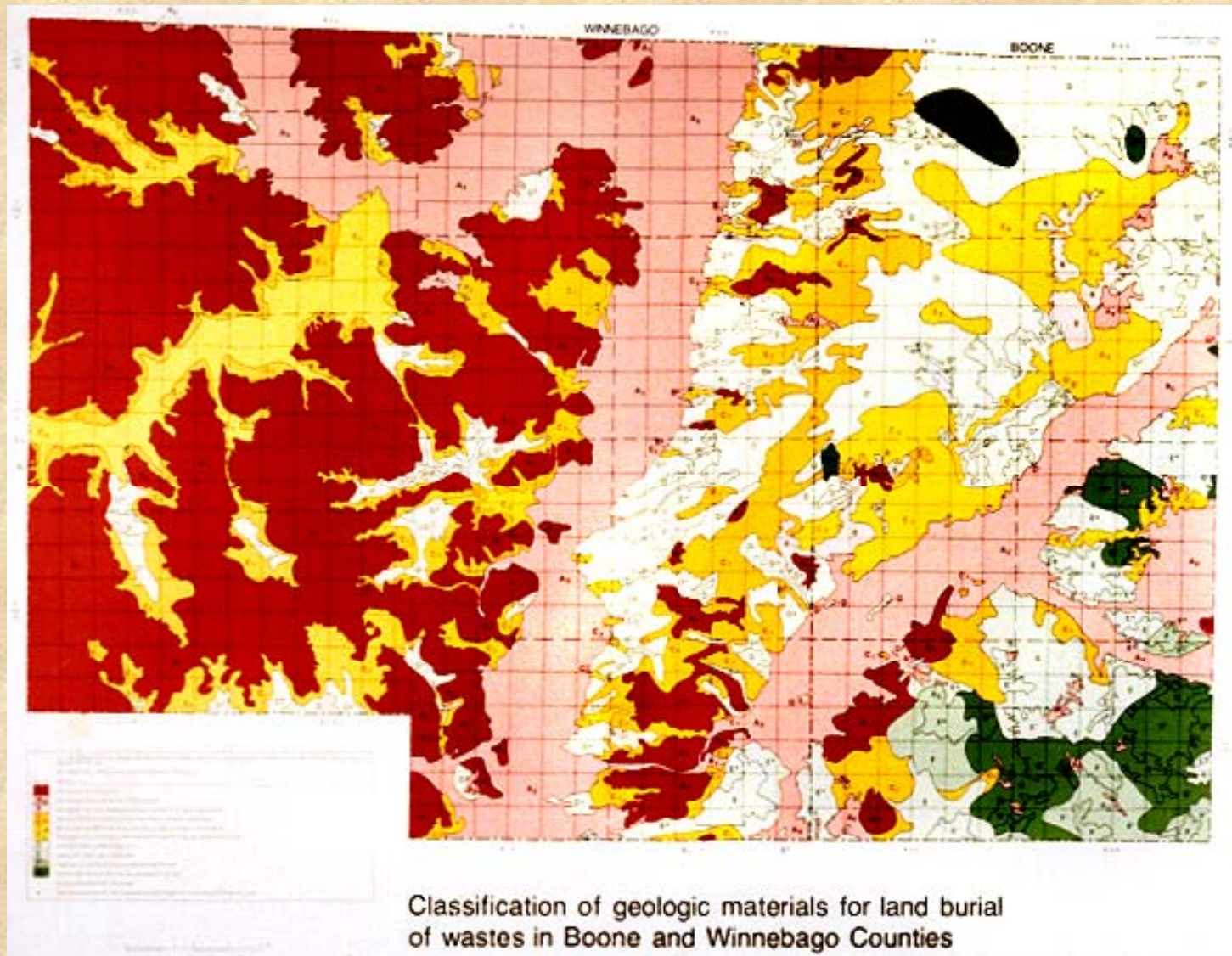
| Geologic material | cm/sec | Comments |
|-------------------------------|---|--------------------|
| Clean sand & gravel | 1×10^{-3} | Highly permeable |
| Fine sand and silty sand | 1×10^{-5} to 1×10^{-3} | |
| Silt (loess, colluvium, etc.) | 1×10^{-6} to 1×10^{-4} | |
| Gravelly dm, <10% clay | 1×10^{-7} to 1×10^{-5} | Sand lenses common |
| Loamy dm, 10-25% clay | 1×10^{-8} to 1×10^{-6} | Sand lenses common |
| Clayey dm, >25% clay | 1×10^{-9} to 1×10^{-7} | Sand lenses common |
| Sandstone | $>1 \times 10^{-4}$ | |
| Cemented fine sandstone | 1×10^{-7} to 1×10^{-4} | Some fracturing |
| Fractured rock | $>1 \times 10^{-4}$ | Highly fractured |
| Shale | 1×10^{-11} to 1×10^{-7} | Some fracturing |
| Unfractured carbonates | 1×10^{-11} to 1×10^{-8} | |

Geologic Settings of NE Illinois

- Variations across region
- Many areas of thick clay
- Many areas with thick sand
- Surface water / ground water interactions vary in importance across region
- Groundwater recharge and shallow aquifer recharge vary across region








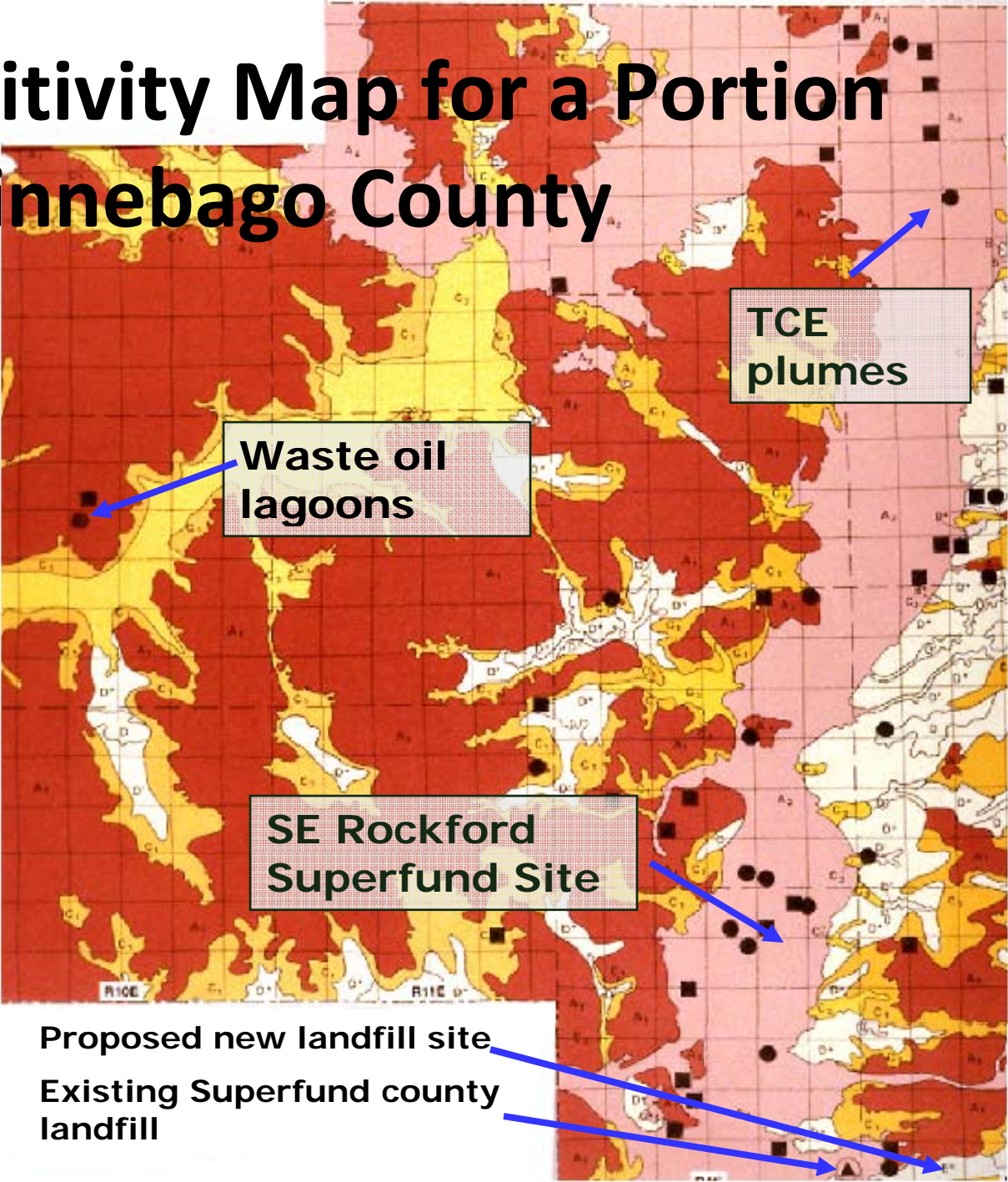
Aquifer Sensitivity



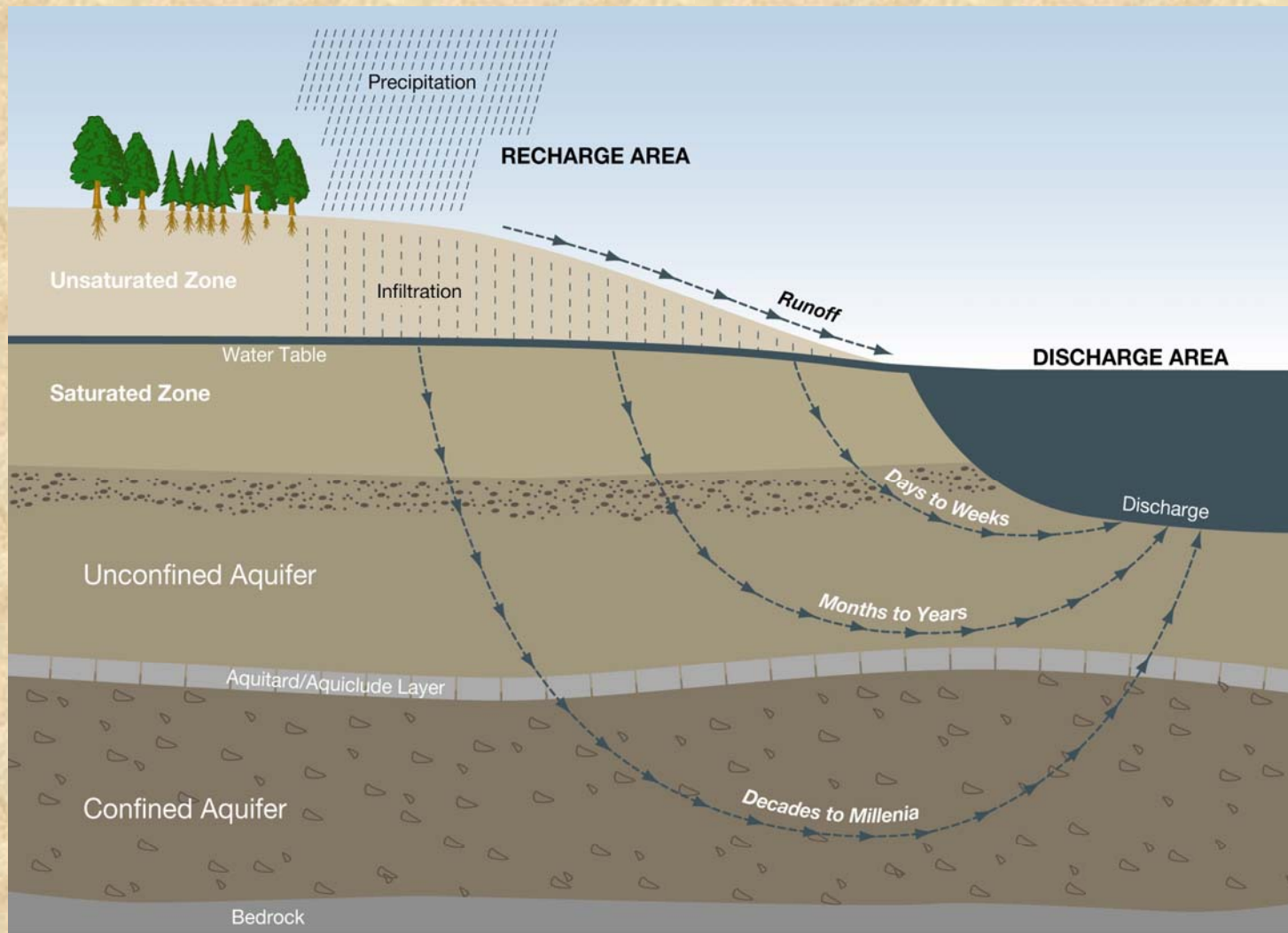
Aquifer Sensitivity Map for a Portion of Winnebago County

Increasing aquifer sensitivity ↑

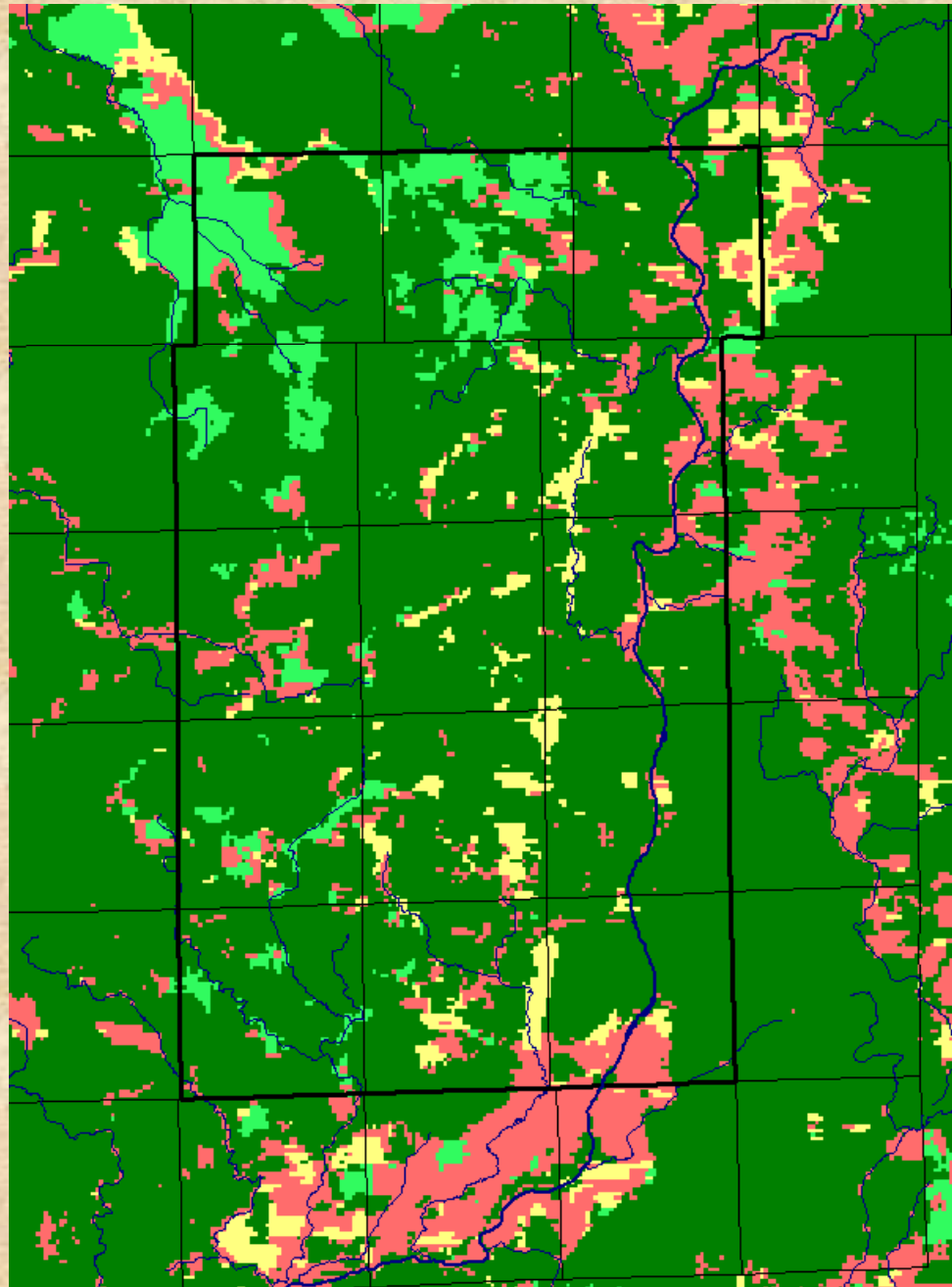
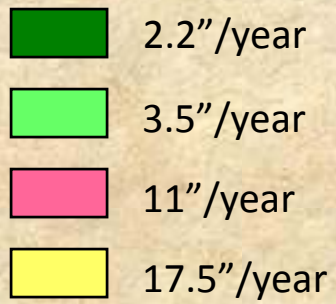
-  Highly permeable materials <20' (6m) from surface
-  Highly permeable materials 20-50' (6-15m) from surface
-  Sandy diamicton >50' (15m) thick
-  Loamy/silty clay diamicton >50' (15m) thick
-  Contamination problem areas



Groundwater Linkages to Surface Waters



Kane County Model Groundwater Recharge Zonation



Kane County Shallow Aquifer Model

Kane
County

Flow Budget

Inflows (MGD)

Recharge 92

Lat/vert flow 12

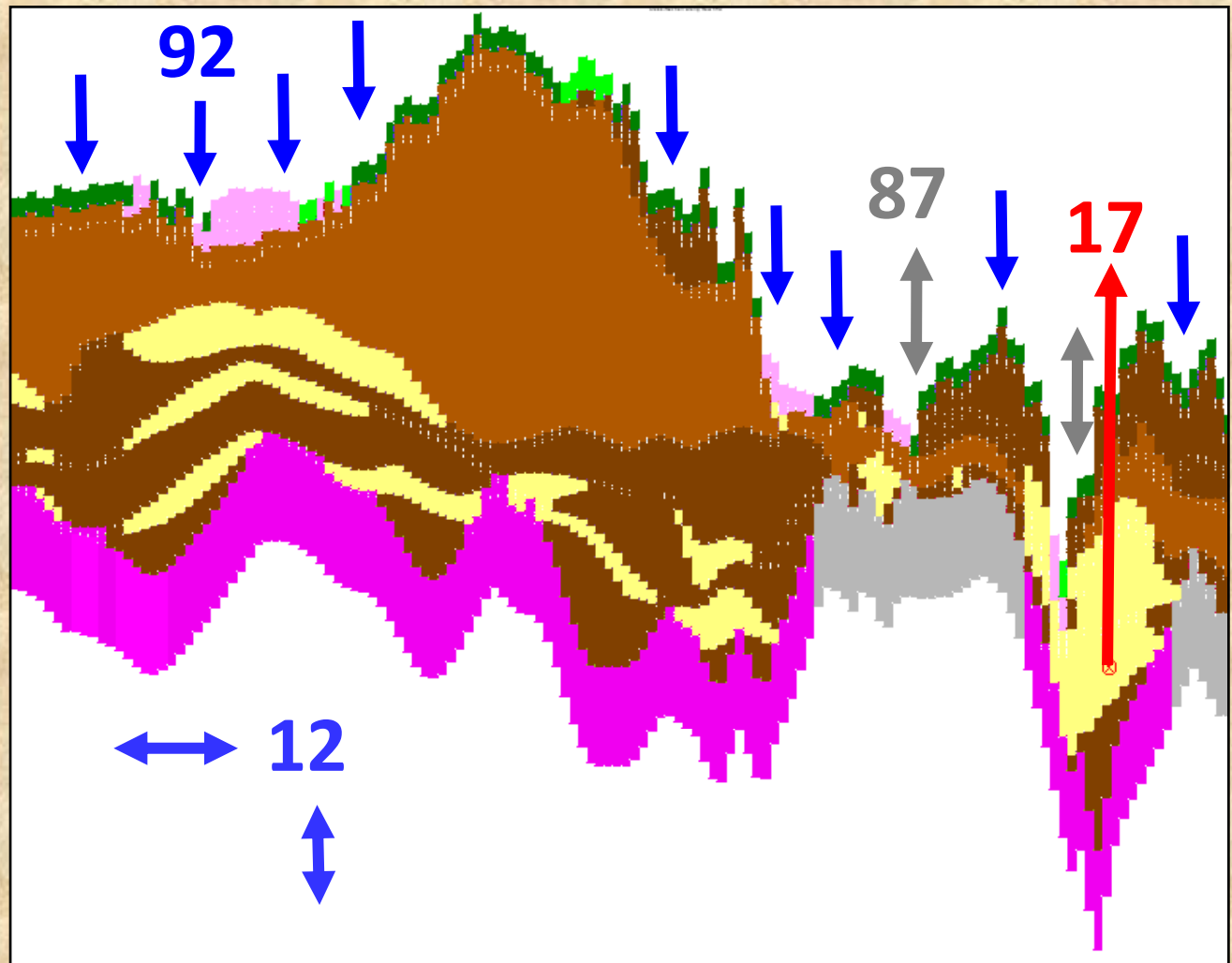
Total 104

Outflows (MGD)

Streams 87

Wells 17

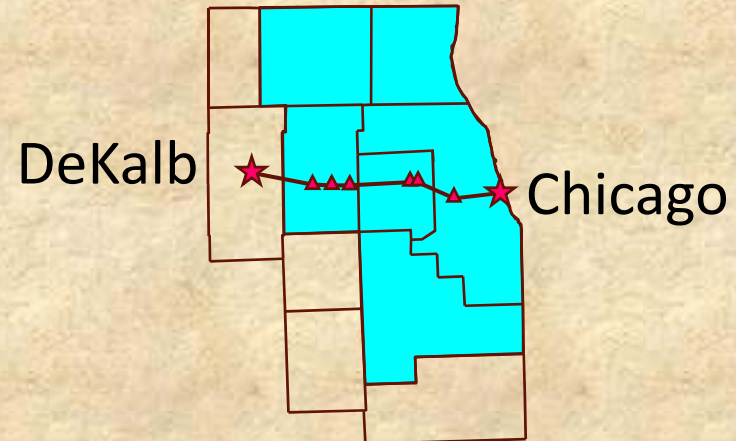
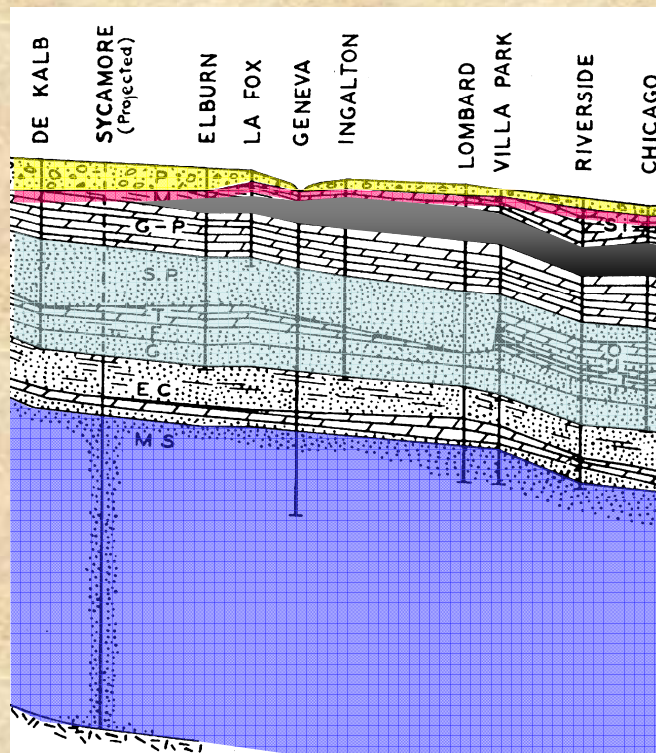
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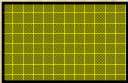





Aquifers of Northeastern Illinois

West

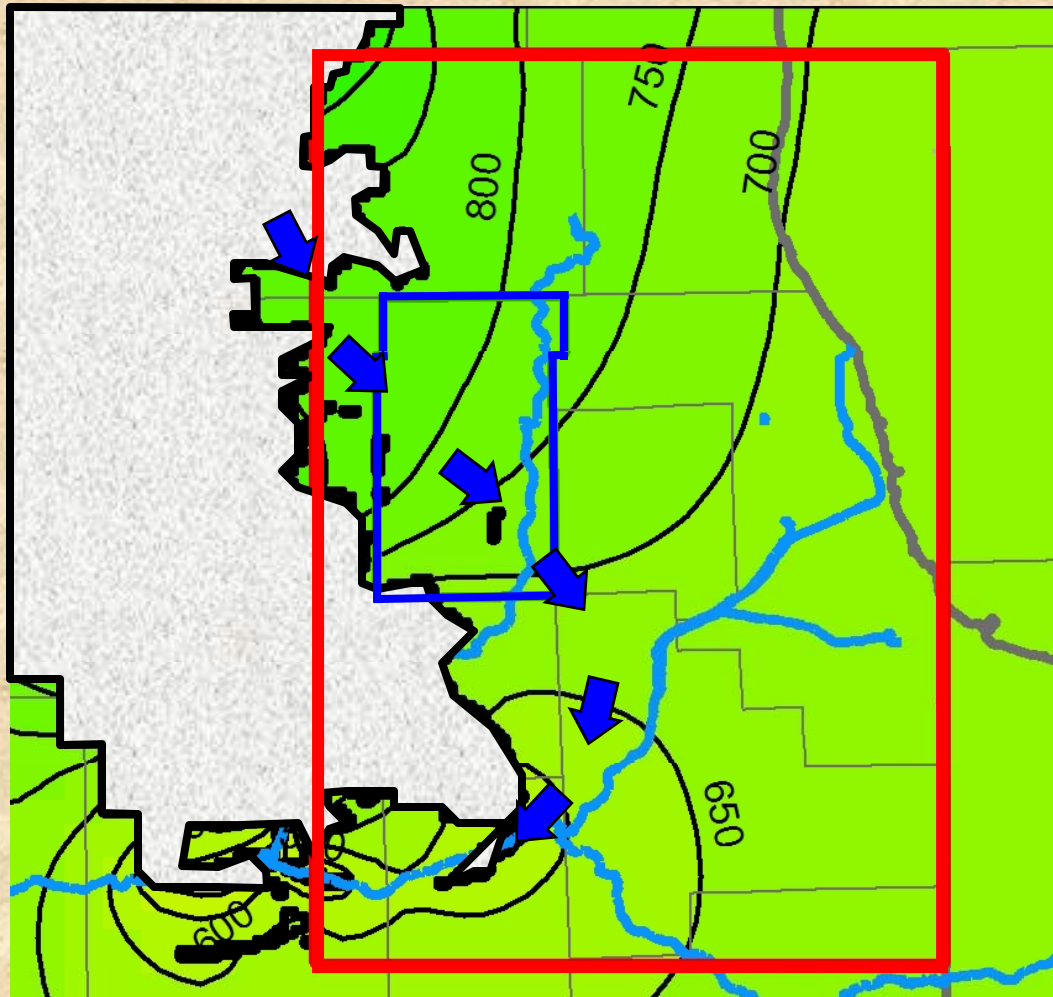
East



-  Unconsolidated Aquifer System
-  Shallow Bedrock Aquifer
-  Deep Bedrock Aquifer System
-  Elmhurst-Mt. Simon Aquifer

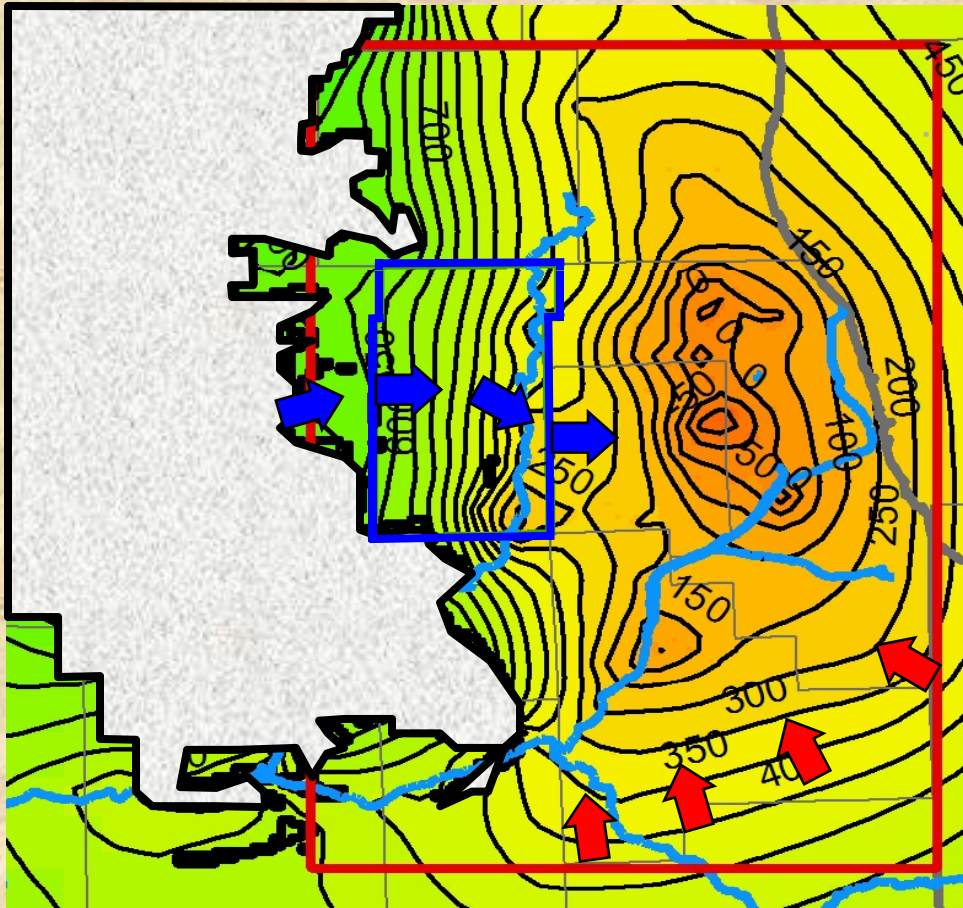
Cross-Section Modified from Bretz (1939)

Regional Model: Ancell Aquifer Predevelopment



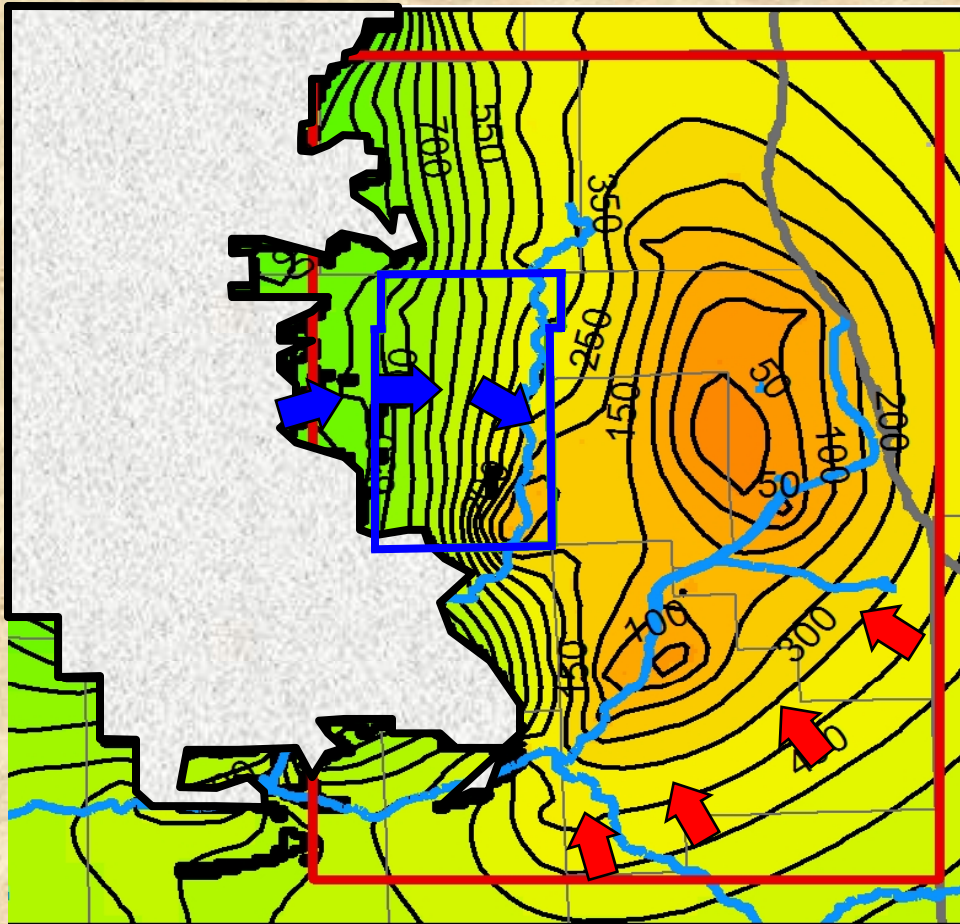
- Recharge where Maquoketa is absent
- Flow from central Wisconsin and DeKalb Co. to Illinois River
- Flowing artesian conditions in Chicago

Ancell Aquifer: 1985



- Steep cone of depression
- Flow eastward to Cook and DuPage Counties
- Northward flow from saltwater regions
- Similar cone of depression surrounding Milwaukee

Ancell Aquifer: 2002



- Cone of depression flattens, shifts west with pumping
- Flow eastward to Cook and DuPage Counties
- Northward flow from saltwater regions
- Upper layers dewatering (Galena-Platteville overlying the Ancell)