Groundwater Simulation Modeling and Potentiometric Surface Mapping, McHenry County, Illinois: Summary

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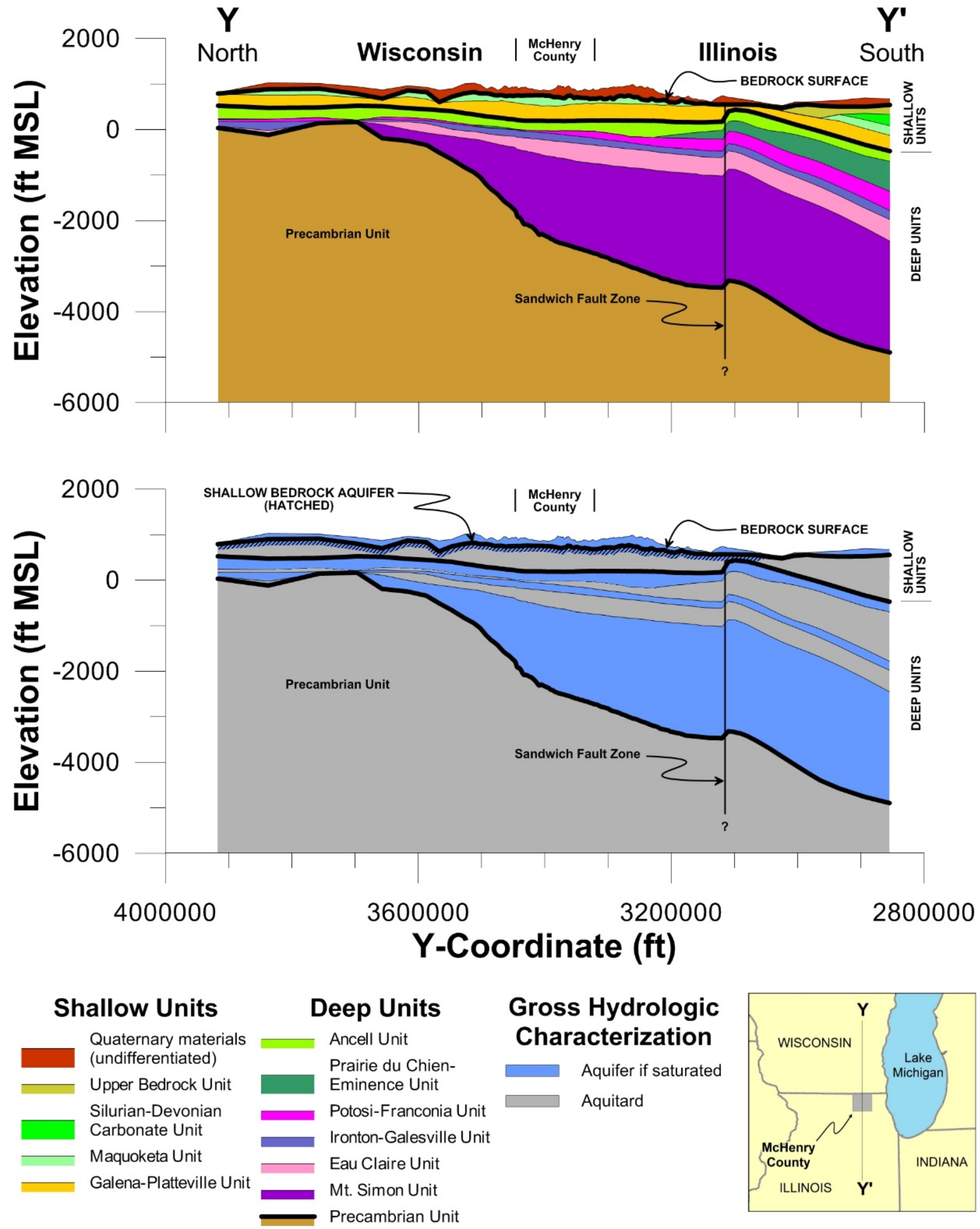
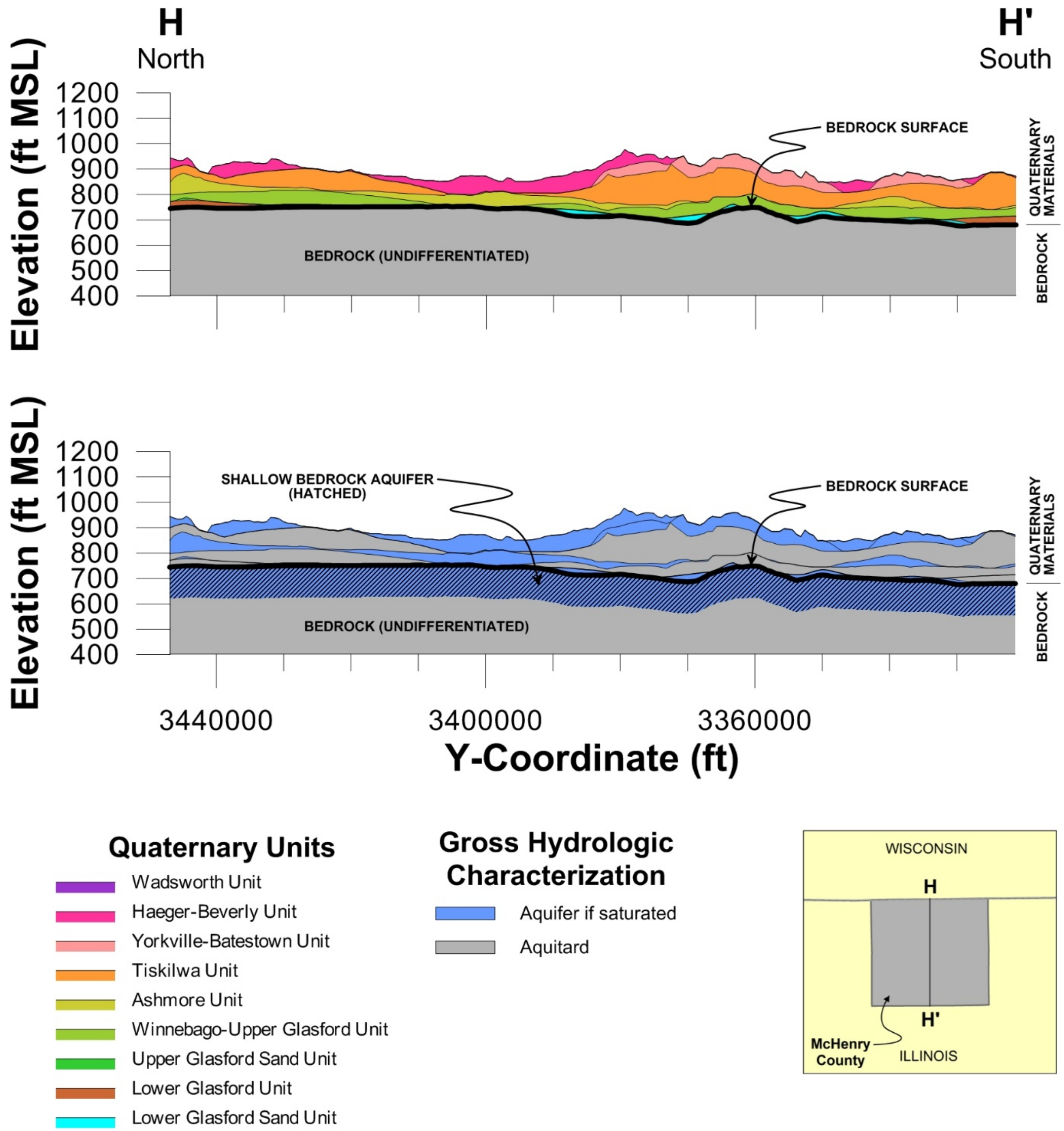
Organization

- Review of hydrogeology
- Potentiometric surface mapping
- Simulation modeling
- What does this mean?
- Discussion

Bedrock Hydrogeology



Shallow Hydrogeology



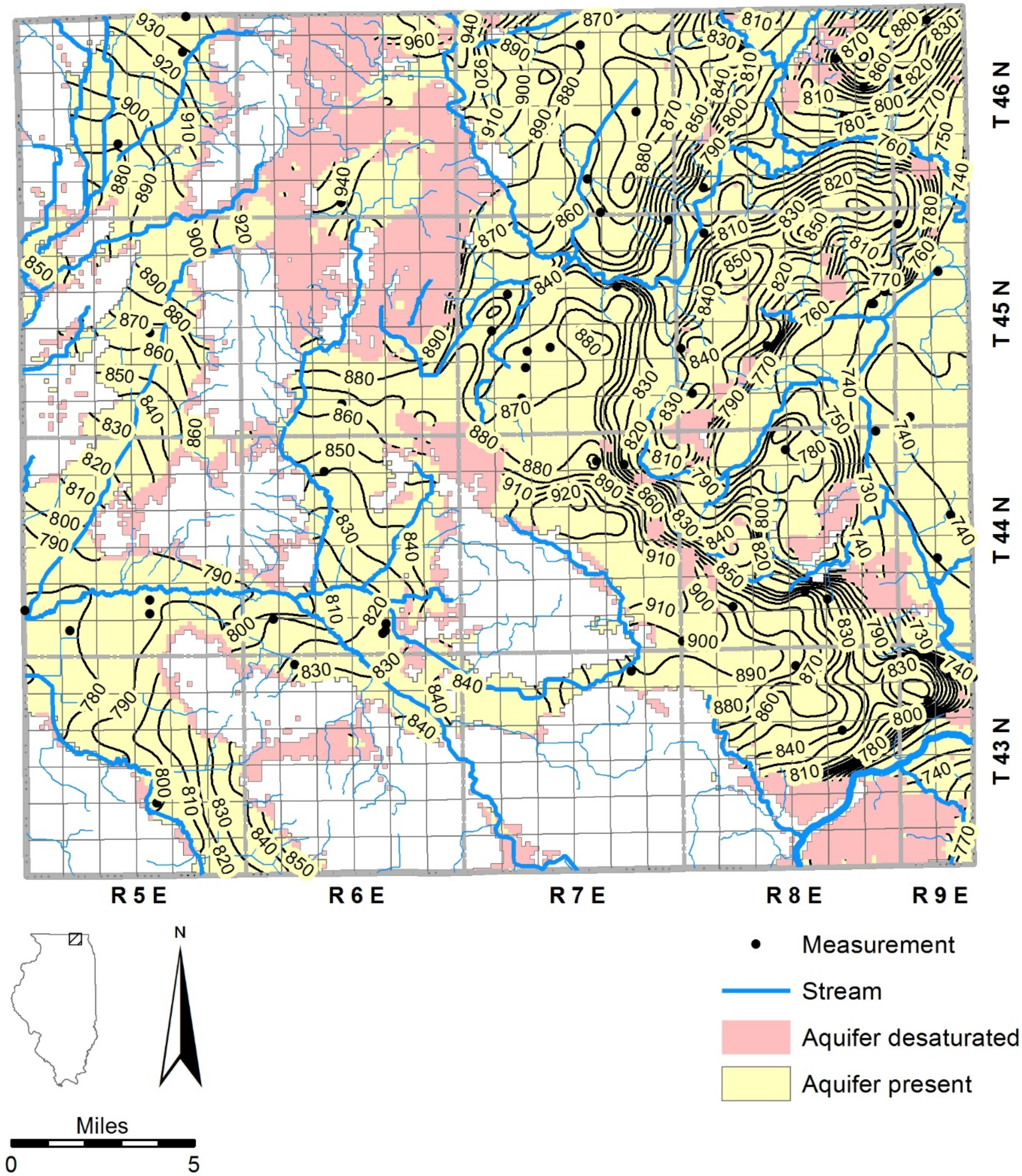
Potentiometric Surface Mapping

Definitions

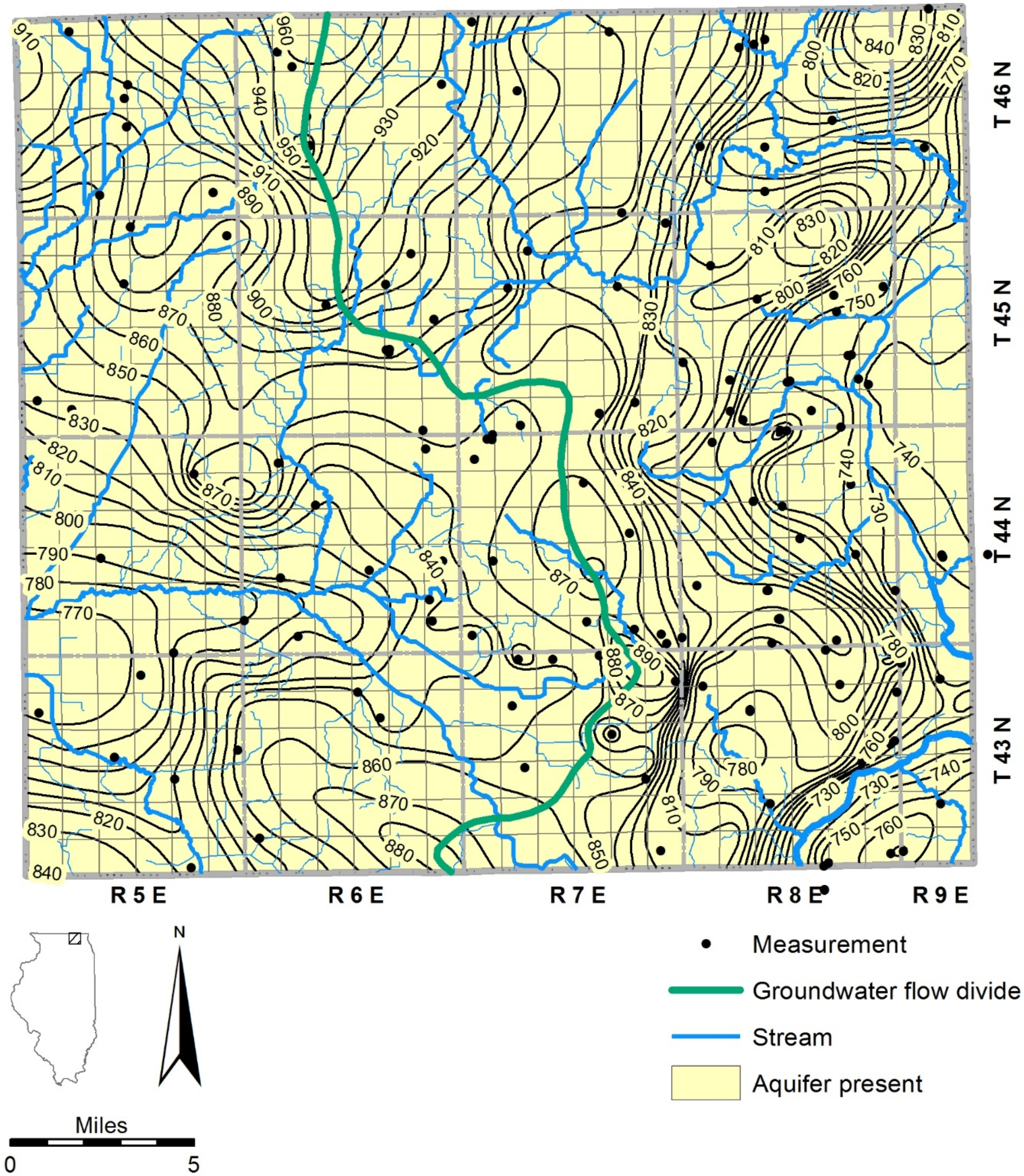
- *Potentiometric surface* – a surface representing the water levels in tightly cased wells open to an aquifer
- *Head* – the height above a datum plane (usually sea level) of a column of water. Water levels in tightly cased wells indicate head in the aquifer to which the well is open.

A potentiometric surface map is a map showing head (essentially the water pressure) in an aquifer.

Potentiometric Surface of Haeger-Beverly Unit (2011)



Potentiometric Surface of Shallow Bedrock Aquifer and Lower Glasford Sand Unit (2011)



Potentiometric Surface Mapping

Applications

- Historical benchmark (e.g., median water level change in wells measured in 1994 and 2011 was +2.0 feet)
- Direction of groundwater flow
- Model development

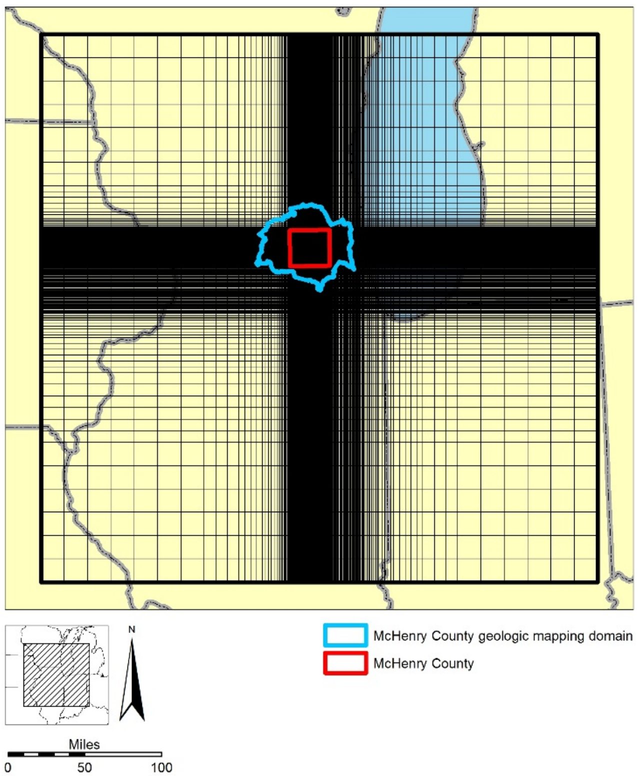
Simulation Modeling

Organization

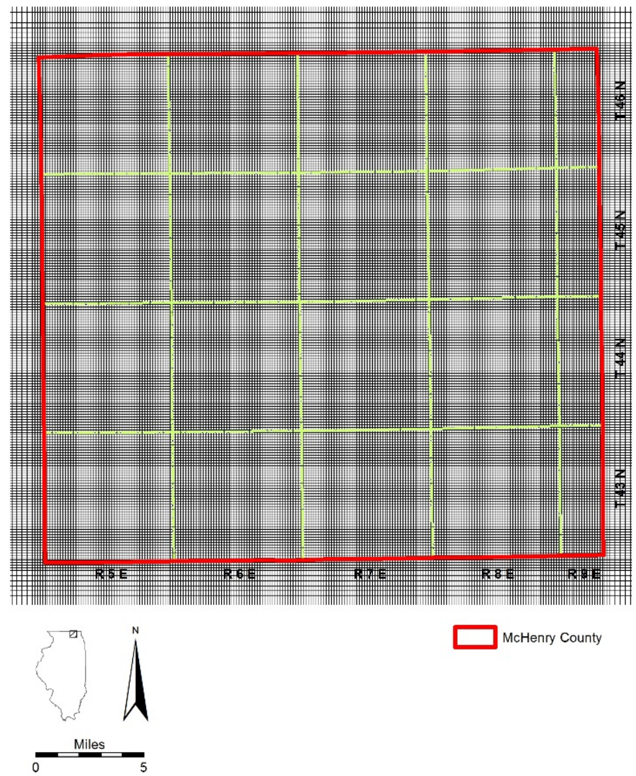
- Approach
  - Finite-difference (grid-based) modeling with MODFLOW
  - Calibration (match model output to observations)
  - Future pumping scenarios
- Results
  - Simulated drawdown
  - Reduction of simulated natural groundwater discharge to surface waters

Finite-Difference Grid

Model Domain

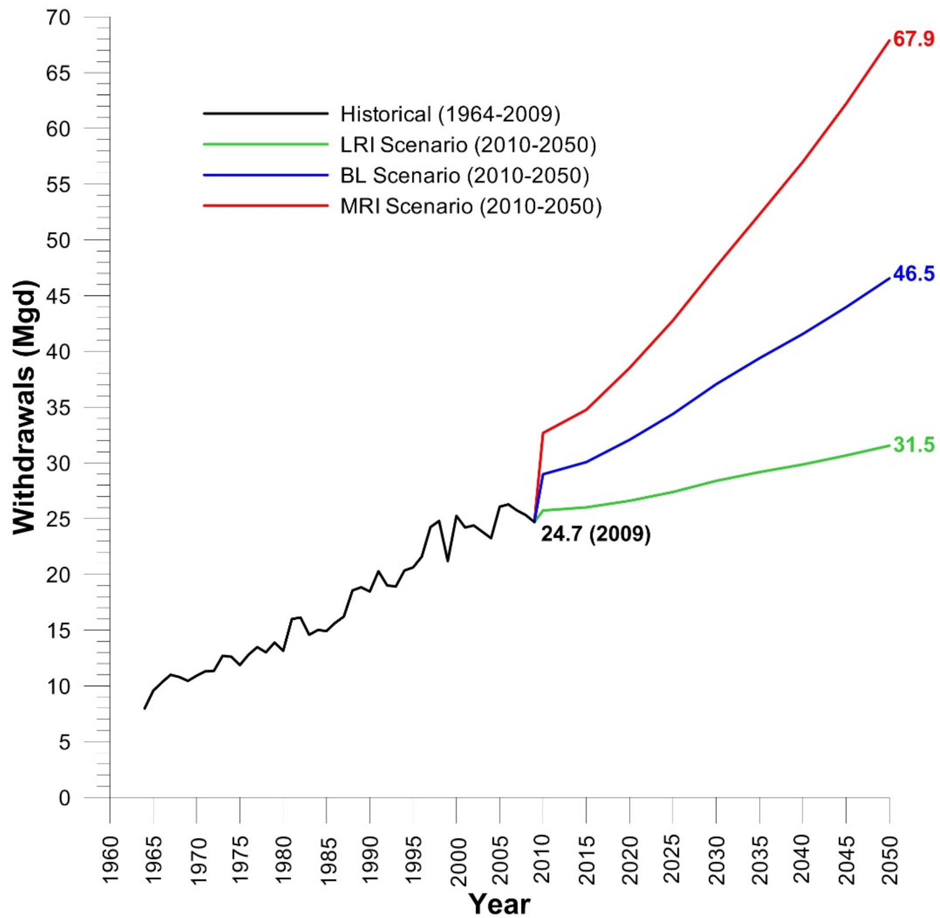


McHenry County Area



Simulated Pumping Scenarios

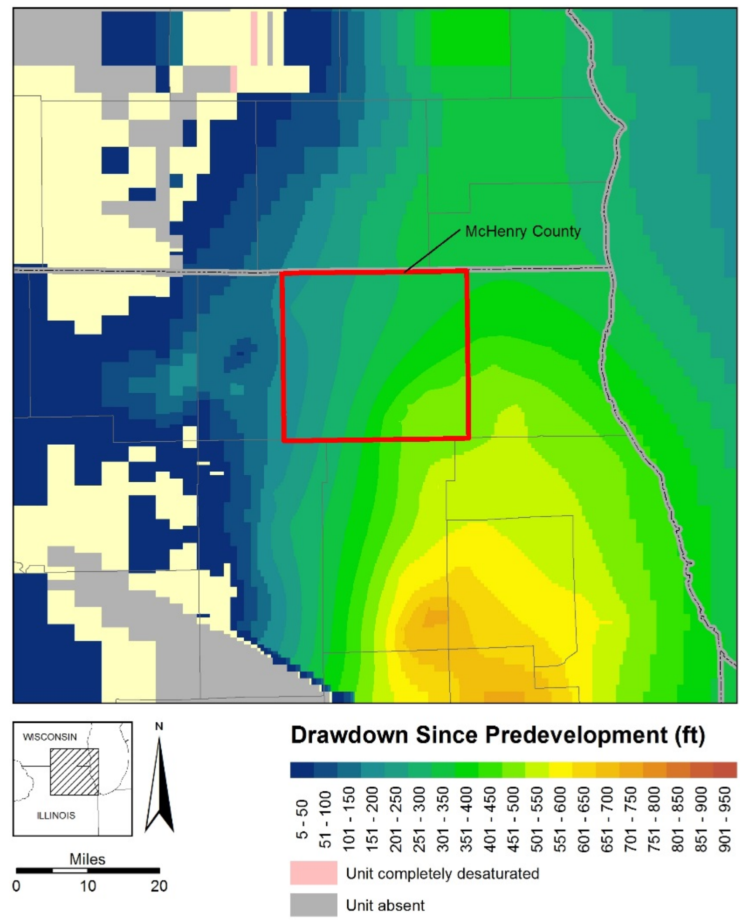
McHenry County Pumping Totals



Simulation Results

Deep Aquifers / Ancell Unit / 2009

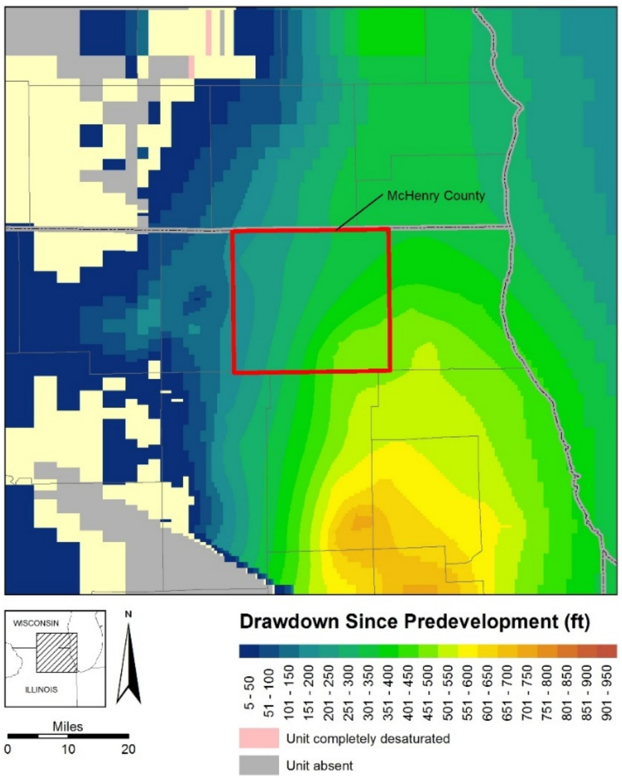
		HYDROSTRATIGRAPHIC UNIT	MODEL LAYER
QUATERNARY MATERIALS	SHALLOW UNITS	Wadsworth Unit	1
		Haeger-Beverly Unit	2
		Yorkville-Batestown Unit	3
		Tiskilwa Unit	4
		Ashmore Unit	5
		Winnebago-Upper Glasford Unit	6
		Upper Glasford Sand Unit	7
		Lower Glasford Unit	8
		Lower Glasford Sand Unit	9
BEDROCK		Upper Bedrock Unit	10
		Silurian-Devonian Carbonate Unit	11
			12
			13
		Maquoketa Unit	14
			15
		Galena-Platteville Unit	16
			17
	DEEP UNITS	Ancell Unit	18
		Prairie du Chien-Eminence Unit	19
		Potosi-Franconia Unit	20
		Ironton-Galesville Unit	21
		Eau Claire Unit	22
		Mt. Simon Unit	23
			24
			25
			26



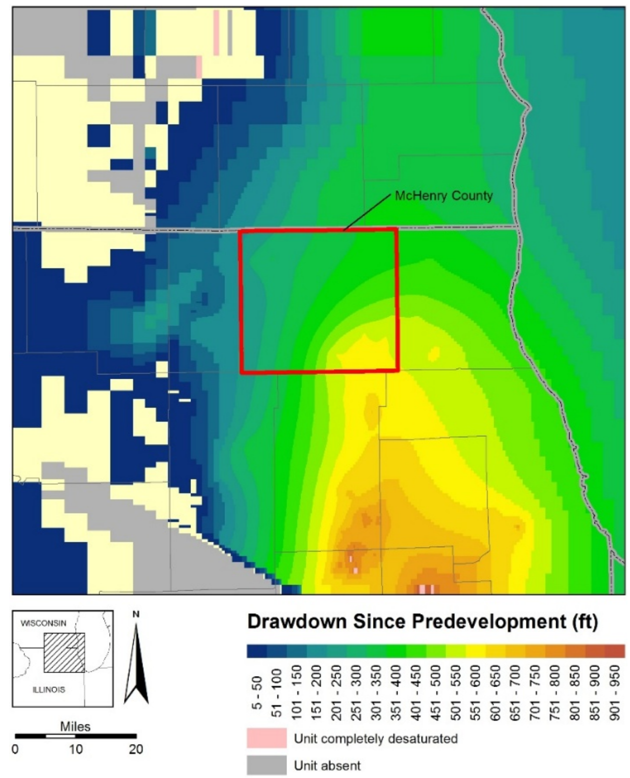
Simulation Results

Deep Aquifers / Ancell Unit / Simulated Drawdown

2009



2050 (Baseline Scenario)



Why worry about drawdown?

- Well interference
- Increased pumping expenses
- Interruption of supply
- Deterioration of water quality
- Reduction of natural groundwater discharge to surface waters

Simulation Results

Shallow Aquifers / Lower Glasford Sand Unit / 2009

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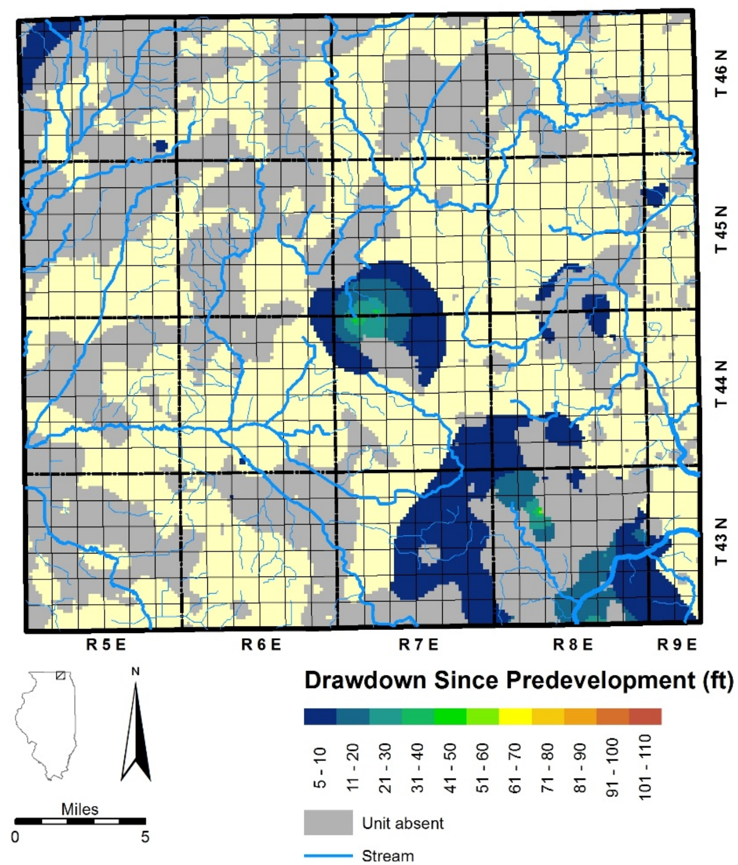
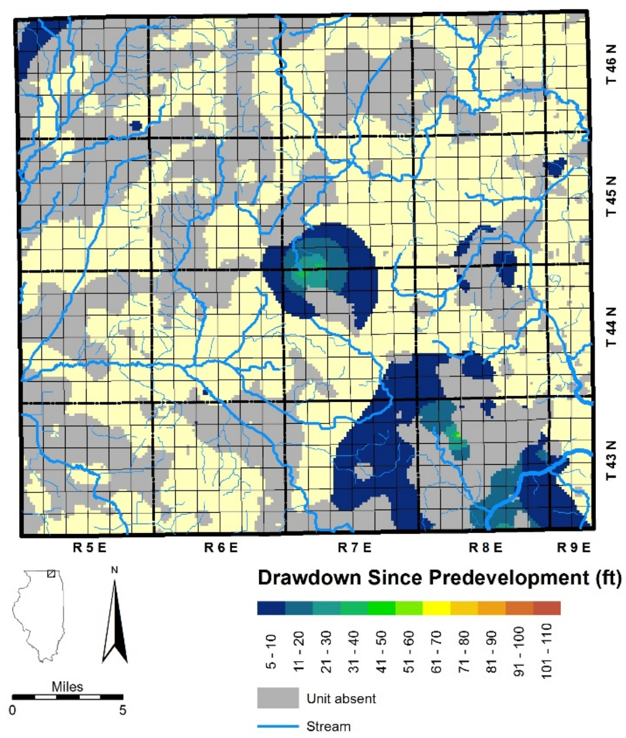


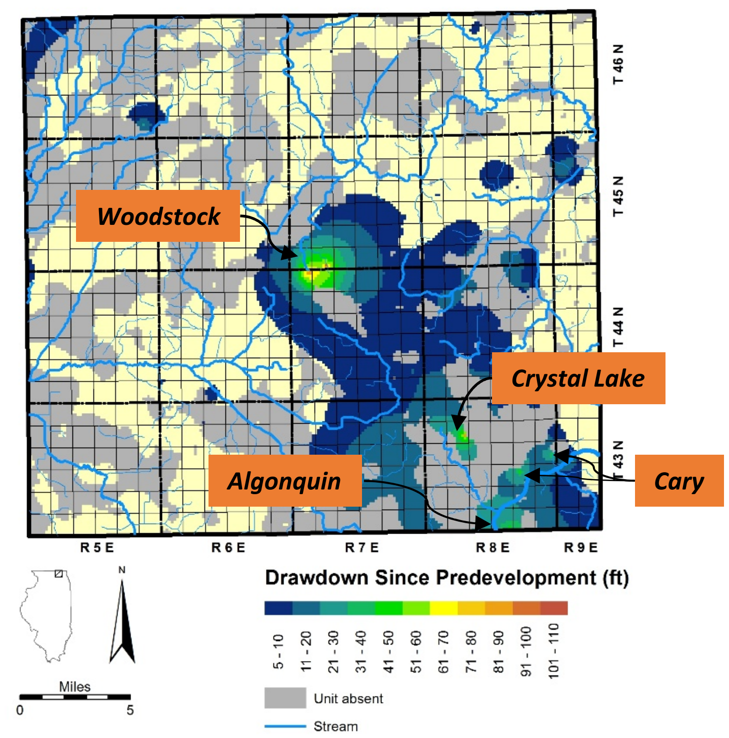
Simulation Results

Shallow Aquifers / Lower Glasford Sand Unit / Simulated Drawdown

2009

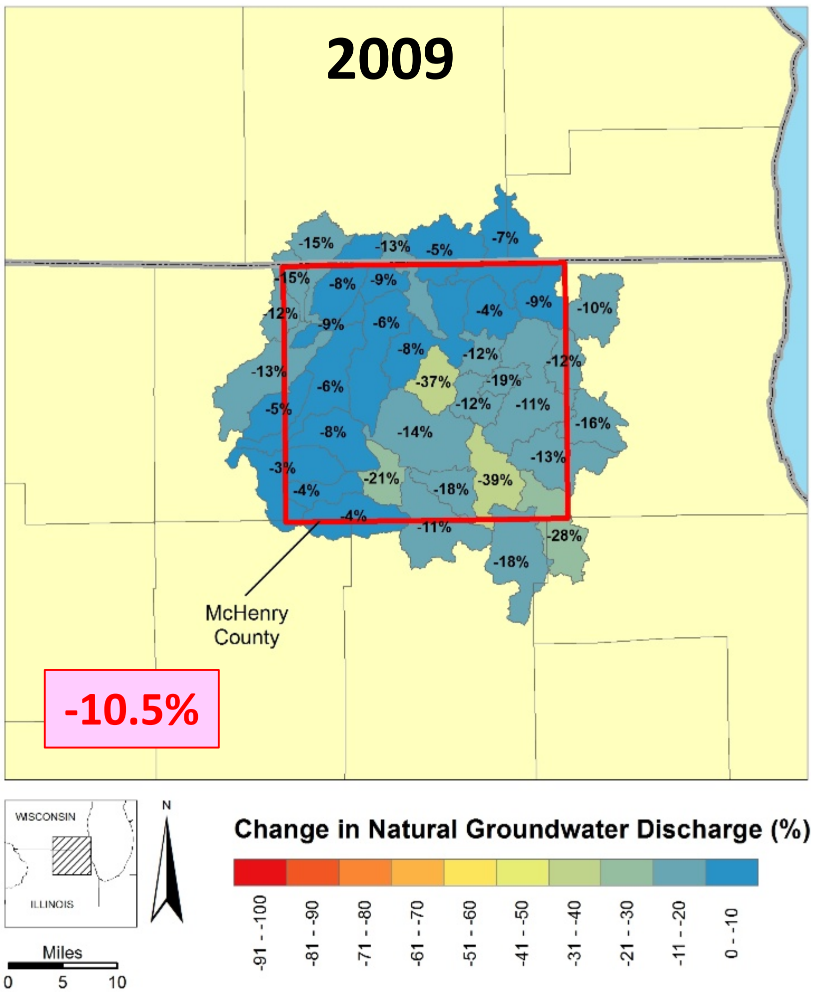


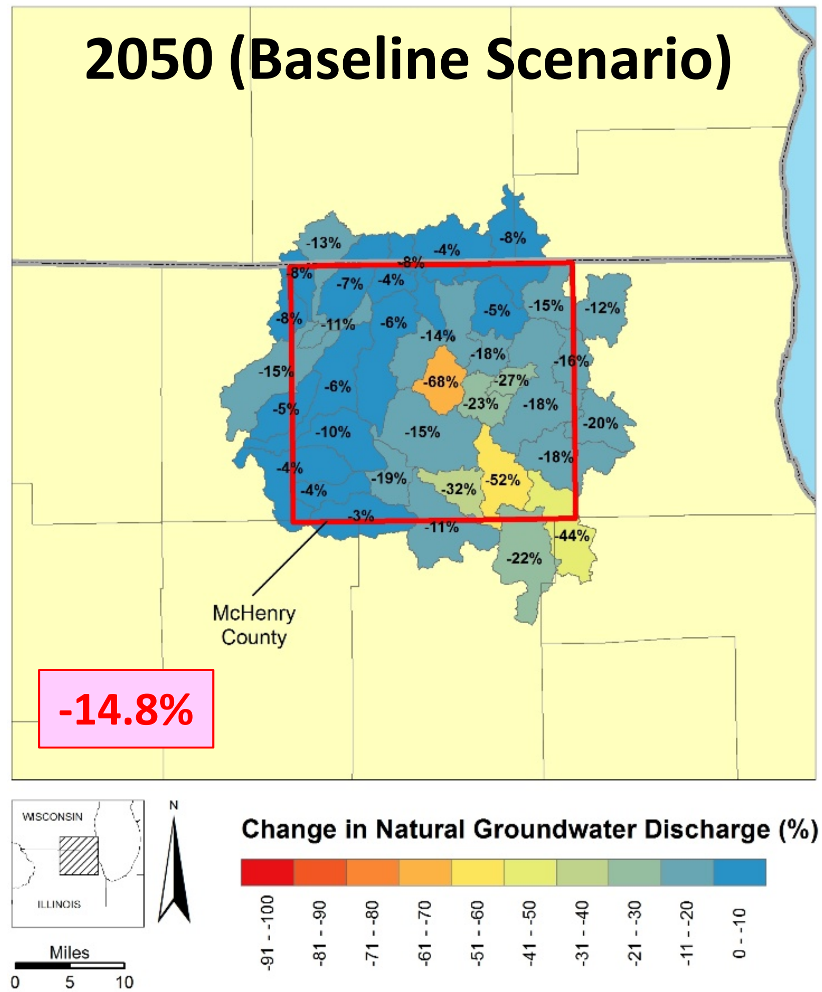
2050 (Baseline Scenario)



Simulation Results

Change in Natural Groundwater Discharge





Why worry about reduction in natural groundwater discharge?

- Reduced streamflows and surface-water elevations
- Reduced saturated conditions in wetlands
- Ecological disturbance
- Reduced surface water availability for water supply

Effluent may offset some effects

What does this mean?

- Shallow heads have not declined countywide since 1994
- Locations and magnitudes of present-day drawdown and reduction of natural groundwater discharge are estimated
- Locations of future impacts are less well known because our simulations base the future pumping distribution on present-day (2009) pumping
- Impacts can be reduced by reducing withdrawals and/or shifting withdrawals to other locations
- Drawdown magnitudes are large enough to cause well interference, reduce well yield, increase pumping costs, and cause water quality deterioration
- Reduction of natural groundwater discharge may have contributed to alteration of stream ecology
- Future directions
    - Local input regarding future pumping configurations
    - Studies of tolerance of stream and riparian environments to assess impacts of base flow reduction
    - Studies of water quality impacts resulting from drawdown
    - Inventory of existing wells (locations, depths, pump settings) to assess drawdown impacts
    - Simulation of alternative pumping configurations
    - Simulation of contaminant transport and fate (e.g., road salt)
    - Identify and formulate plans to overcome institutional barriers to meaningful water planning (e.g., combine public water systems—at the expense of system autonomy—to distribute impacts)

Future Directions

- Alternative simulations
- Model improvement
  - Computational capabilities constantly improving
  - Local forecasts of future water withdrawals are needed
  - Additional observations of aquifer properties, water levels, stream base flow are recommended
  - Studies of tolerance of stream and riparian environments to base flow reduction are needed
  - New IDNR contract will improve model simulations

What does this mean?

- Shallow water levels have not declined countywide since 1994
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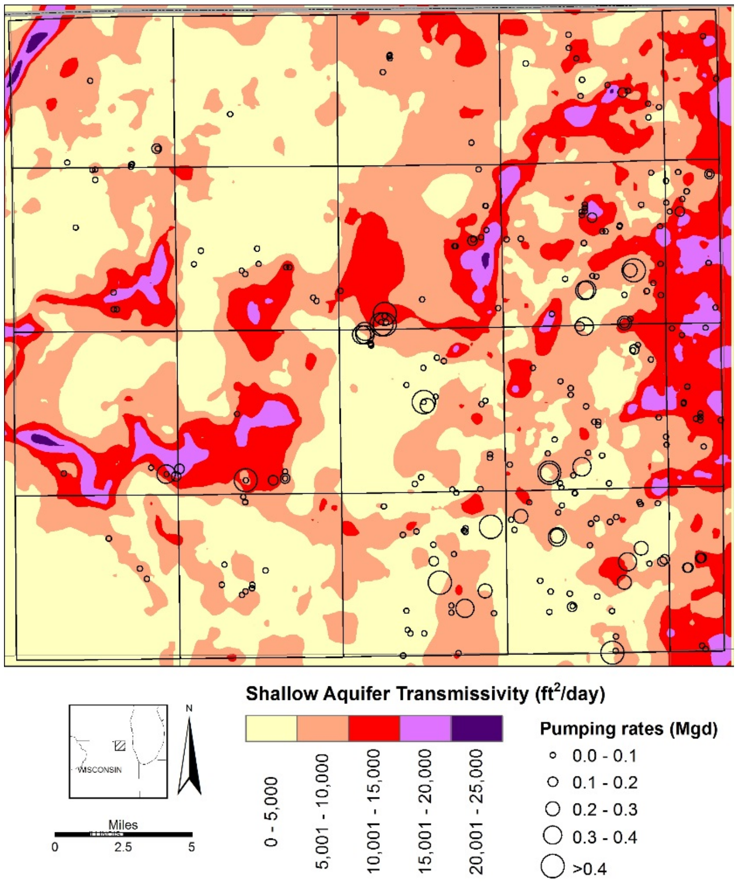
Shallow Aquifer Transmissivity

2009 Pumping Rate Superimposed



Future directions

- Local input regarding future pumping configurations
- Studies of tolerance of stream environments to assess impacts of decreased groundwater contribution
- Studies of water quality impacts resulting from drawdown
- Inventory of existing wells (locations, depths, pump settings) to assess drawdown impacts
- Simulation of alternative pumping configurations
- Simulation of contaminant transport and fate (e.g., road salt)
- Identify and formulate plans to overcome institutional barriers to meaningful water planning (e.g., combine public water systems—at the expense of system autonomy—to distribute impacts)