Chippewa County Groundwater Study

2nd Stakeholders Group Meeting

Stakeholders Group Meeting
Chippewa Falls, WI
02/26/2013

USGS science for a changing world

Chippewa County Land Conservation and Forest Management "Stewardship for Sustainability"

UW Extension Cooperative Extension

Wisconsin Geological & Natural History Survey

Today's outline

- Brief review of project proposal *(WGNHS)*
- Progress to date *(WGNHS / USGS / Chippewa Co.)*
  - Data collection
    - Streamflow measurements
    - Maps / regional datasets
    - (hydro)geologic data → preliminary interpretations
    - Mine specific data collected by County LCFM
- What's next? *(WGNHS)*
  - Soil-water-balance (SWB) modeling (estimating recharge)
  - Continue data collection and interpretation
  - Visits to mine sites this week
- Upcoming meetings

Review of project proposal

- Objectives
  - Develop soil-water-balance (recharge) and groundwater flow models to evaluate current and future water use and landscapes on the hydrologic system
  - Disseminate the study results to stakeholders and the general public
  - Transfer the study results to similar geologic/hydrologic settings as appropriate
- Limitations
  - Model solution is valid only within the Area of focus
  - Steady state model (not transient)

Review of project proposal

- Technical investigation and modeling *(5 Tasks)*
  - Data collection *– working on this now*
  - Recharge modeling (SWB model) *– Starting in next couple weeks*
  - Groundwater modeling *– 2014 - 2016*
  - Scenario testing *– 2016*
  - Transferability *– 2016*

Review of project proposal

- Public outreach and reporting *(3 Tasks)*
  - *Fact sheet – Just published by WGNHS – Available now!*
  - *Public outreach and stakeholders meetings – Next meetings Q1 2014*
  - *Interim and final reporting – 2014 and 2017 respectively*

Managing Chippewa County's groundwater—today and tomorrow

Evaluating the impacts of industrial sand mines and irrigated agriculture on the county's water resources

Michael J. Parsen and Madeline B. Gotkowitz, Wisconsin Geological and Natural History Survey
Factsheet 07 | 2013

Groundwater is an important natural resource that is fundamental to our environment and quality of life.

In western Wisconsin, groundwater serves as the source of our drinking water supply and is used extensively by agriculture and industry to grow and manufacture products that are vital to the economy.

Wisconsin's groundwater is plentiful but supplies are finite.

Understanding and managing this resource is critical to ensuring continued availability for future generations. Careful management is particularly important in areas that are experiencing increased demand for groundwater.

The expansion of industrial sand mines and irrigated agriculture will require large volumes of water and will place additional long-term demands on available water resources.

To sustainably manage groundwater resources, Chippewa County has taken a proactive approach. In 2012, the county commissioned the Wisconsin Geological and Natural History Survey (WGNHS) and the United States Geological Survey (USGS) to conduct a 5-year study of groundwater resources in western Chippewa County (fig. 1).

The goal of the study is to answer two important questions:

1. How does pumping of high-capacity wells (wells capable of pumping more than 70 gallons of water per minute) affect water levels in nearby wells and flows in streams today?
2. How might changes in pumping rates, placement of new high-capacity wells, and changes to the landscape affect wells and streams in the future?

To answer these questions, scientists at the WGNHS and USGS will prepare

(continued on p.3)

Figure 1. Map of the study area in western Chippewa County.

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Progress to date - Workflow overview

TABLE 1 - Project Workflow and Activities Schedule

Calendar Year	2012				2013				2014				2015				2016				2017			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Data collection / Interp.																								
- Collect and compile well & geophysical data			X	X	X	X																		
- Analyze & process				X	X	X	X	X																
- Interpretation (i.e., build model layers)							X	X	X	X														
Soil-water-balance model																								
- Collect climate/soils data			X	X	X	X																		
- Collect land use and elevation data			X	X	X	X																		
- Build model						X	X																	
- Review model							X	X																
- Define scenarios							X	X																
- Conduct model runs								X	X															
- Complete/Format results									X	X														
Groundwater model, calibration																								
- Construct model grid and decide on modeling packages					X	X	X	X																
- Build hydrological model								X	X	X	X	X	X	X										
- Calibrate model												X	X	X	X									
- Compile/Format results														X	X	X	X							
Scenario testing																								
- Define test scenarios										X	X	X	X	X	X	X	X	X						
- Conduct model runs																X	X	X	X					
- Compile/Format results																		X	X	X				
Transferability																								
- Conduct analysis																	X	X						
- Compile/Format results																			X	X				
Fact sheet																								
- Identify purpose/content (WGNHS)			X	X																				
- Prepare & finalize drafts (WGNHS)				X	X																			
- Print & distribute (WGNHS)					X																			
Public outreach meetings																								
- Identify purpose/content			X	X																				
- Conduct public outreach meetings					X																			
- Conduct stakeholders meetings - Specific times TBD					X		X			X				X				X						
Reporting																								
- Complete annual report (Chippewa Co LCFM)					X				X				X				X							
- Complete interim project report (WGNHS)												X												
- Complete final project report (WGNHS / USGS)																							X	
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Federal Fiscal Year (USGS)					2013				2014				2015				2016				2017			
State Fiscal Year (WGNHS)				2013				2014				2015				2016				2017				

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Progress to date - Streamgaging

USGS gaging stations

- Streamflow measurements
  - Collected following stakeholders meeting in October 2012
  - USGS has compiled and formatted data

Manual measurements

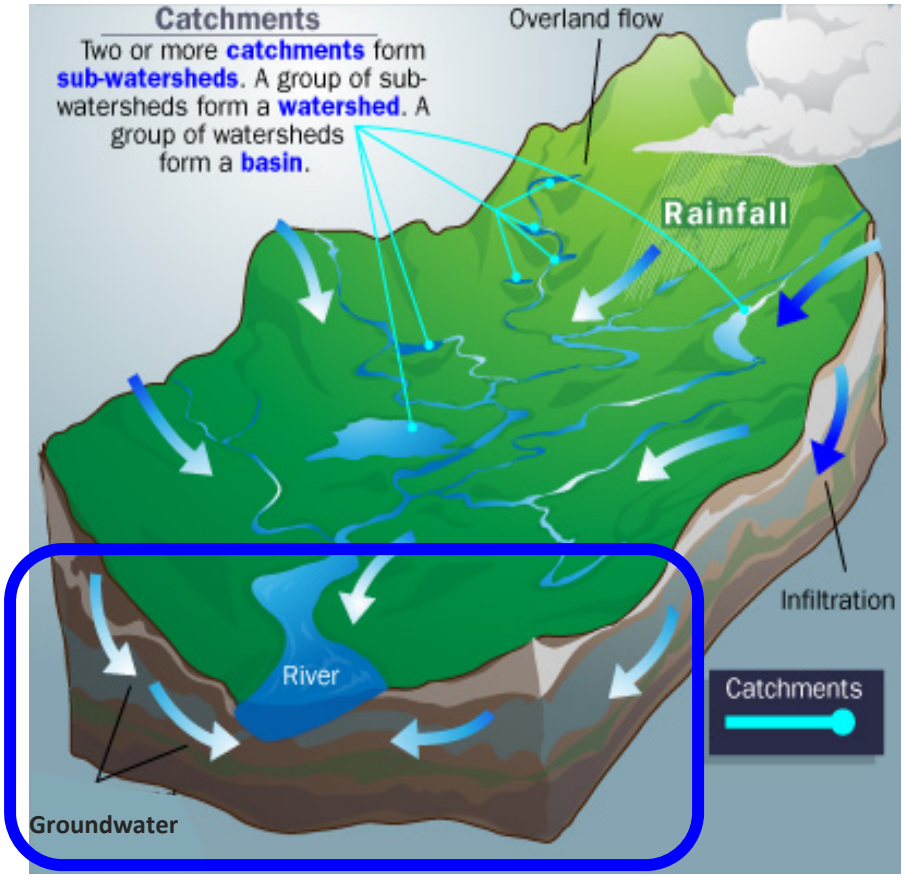
Now to an overview of streamgaging data collection…

Streamflow to Inform Modeling

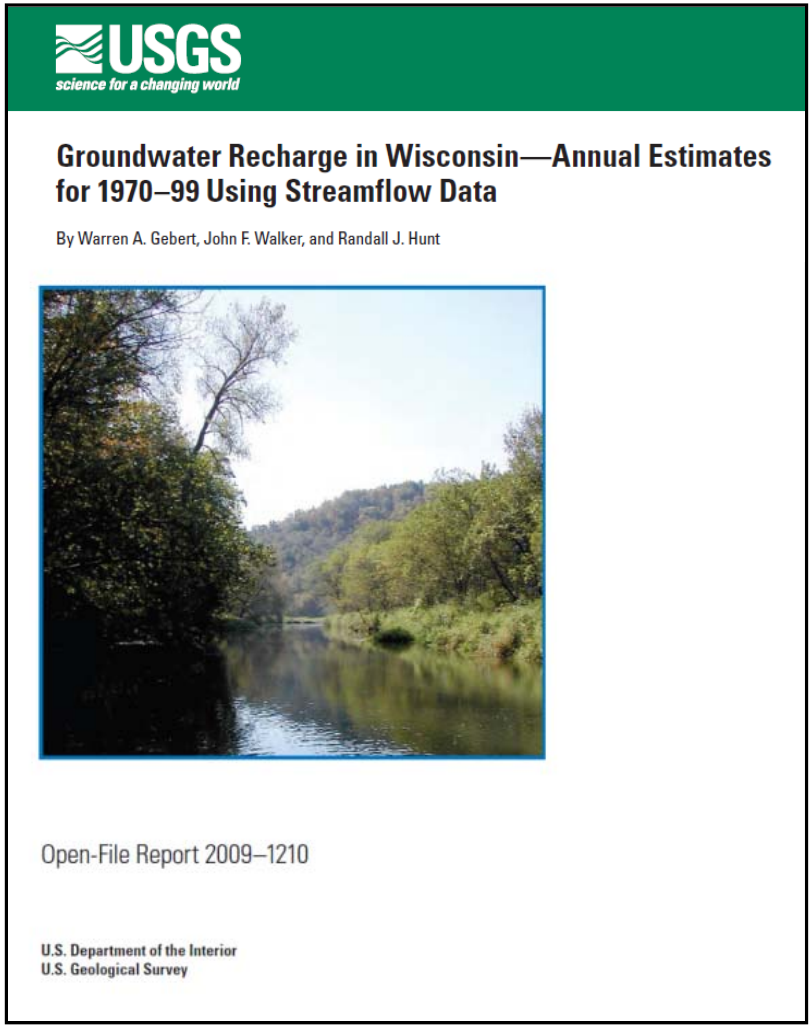
Modeling Needs:

1. Aquifer Permeability
2. Water throughput
   (input = output)

- Stream baseflow (output) can inform recharge to aquifers (input)
- Spatial surveys of baseflow can inform changes in aquifer permeability



Recharge Varies Across Wisconsin



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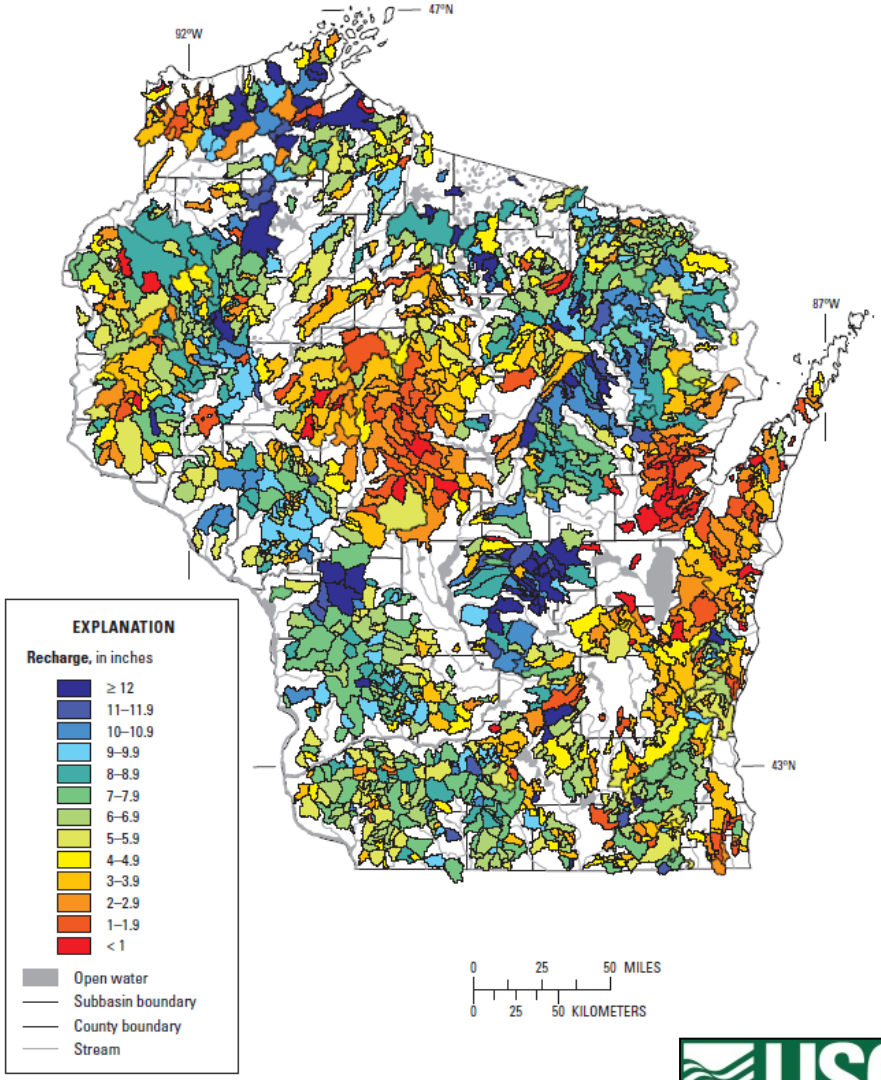
Groundwater Recharge in Wisconsin—Annual Estimates for 1970–99 Using Streamflow Data

By Warren A. Gebert, John F. Walker, and Randall J. Hunt

Open-File Report 2009–1210

U.S. Department of the Interior
U.S. Geological Survey



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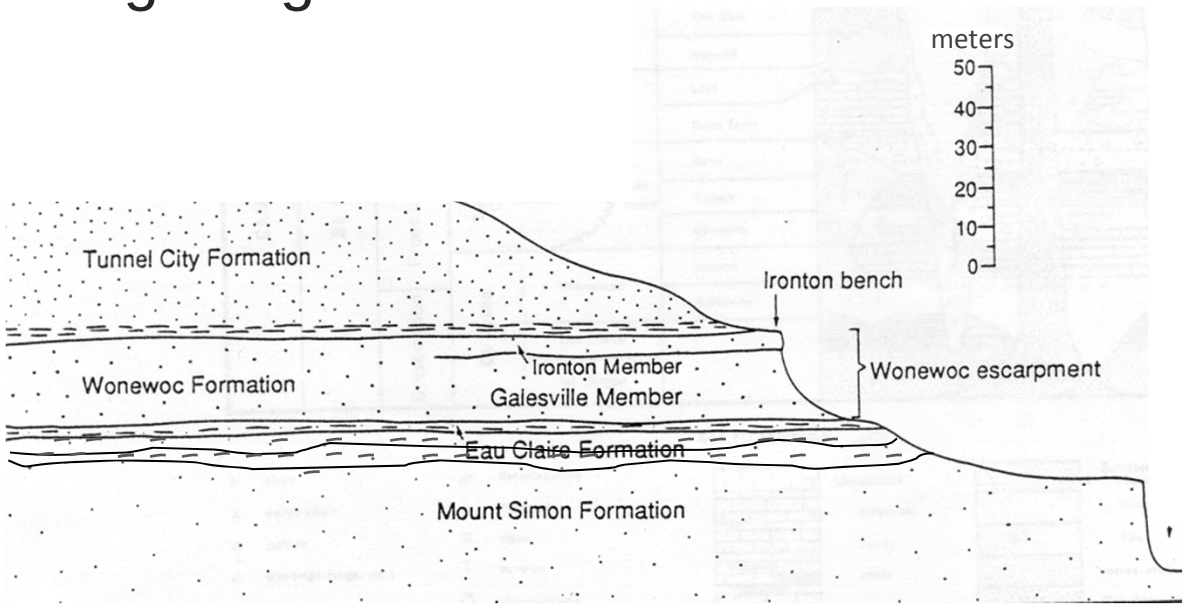
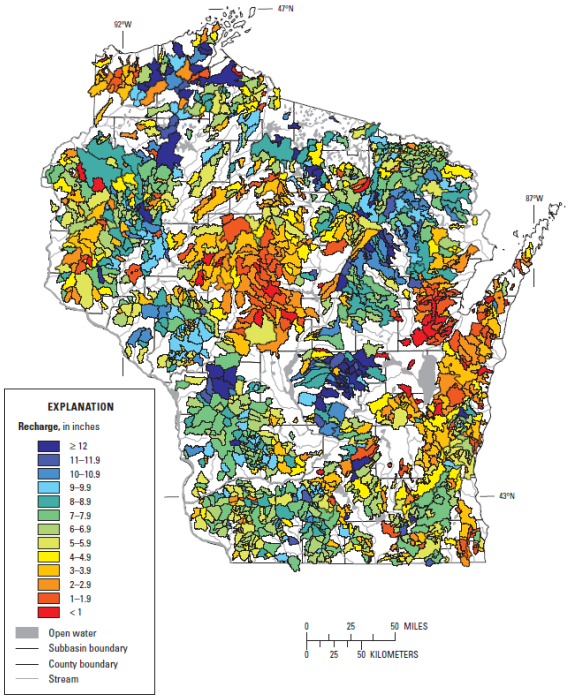
Recharge Varies Across Wisconsin

- Changes in baseflow *can* reflect changes in geology
- Streams often gain or lose water as they flow over geologic contacts





Recharge Varies Across Wisconsin

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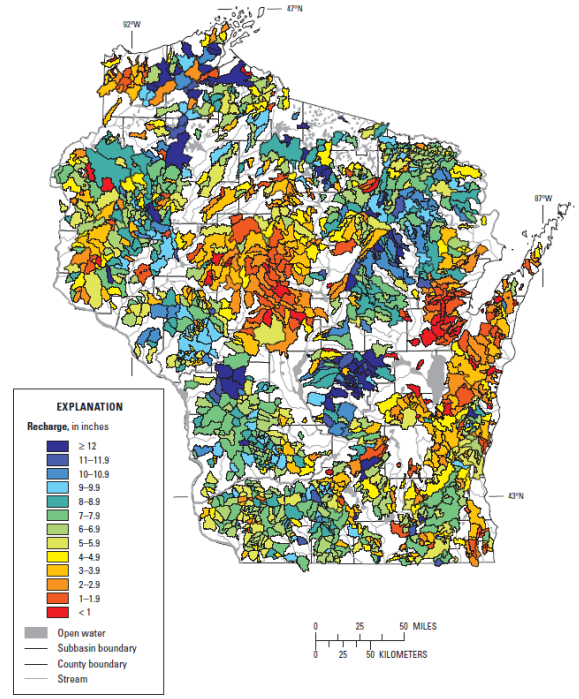

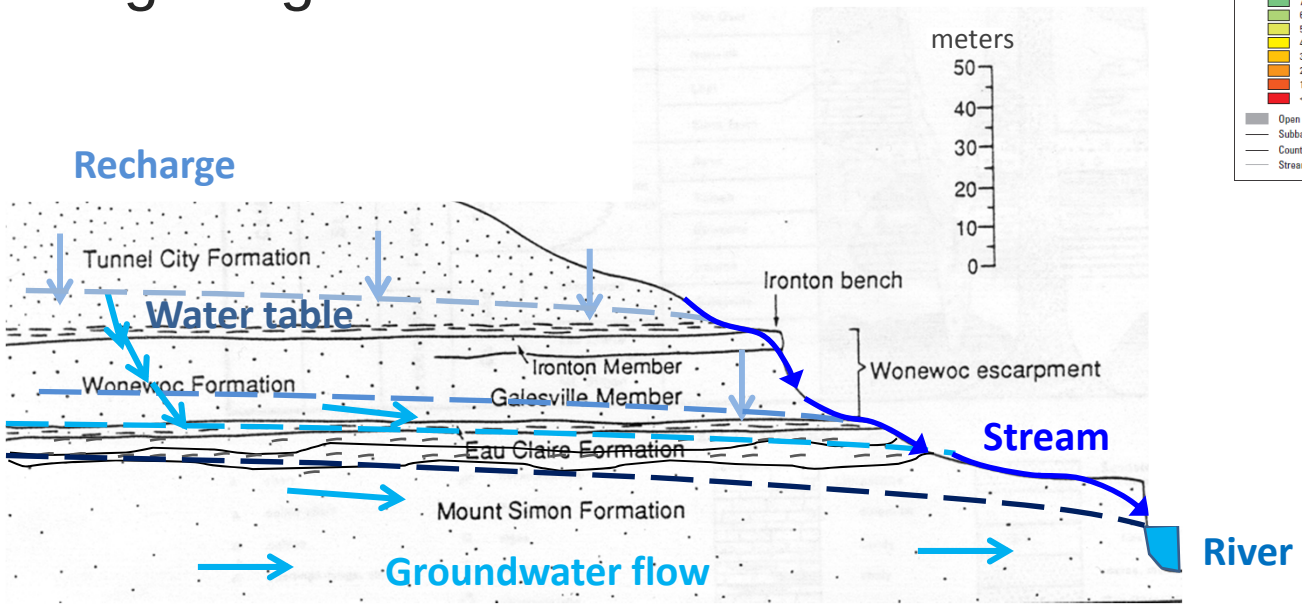

Recharge Varies Across Wisconsin

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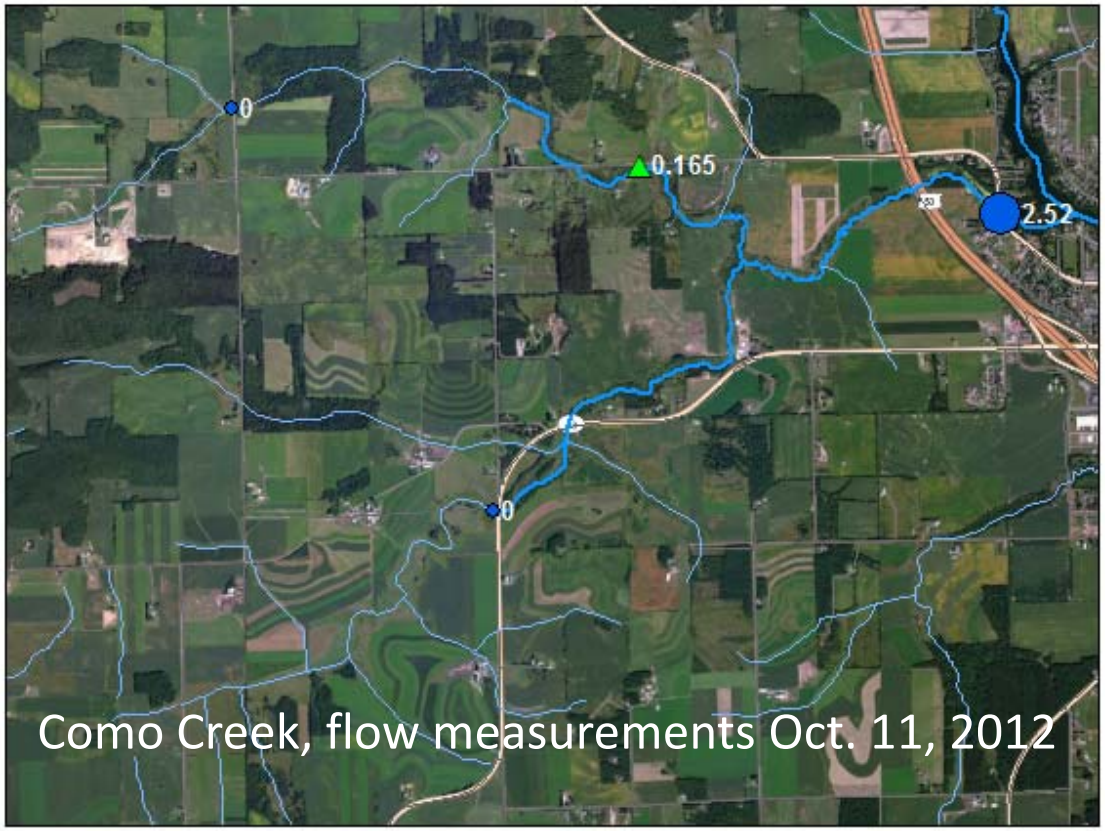
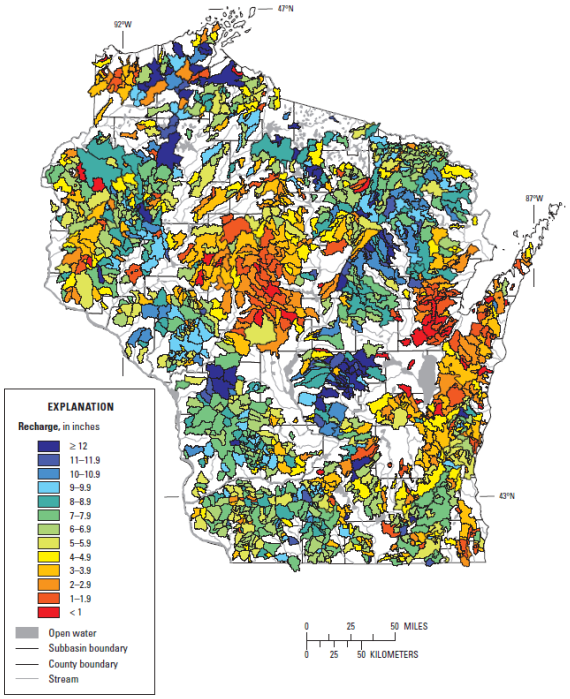
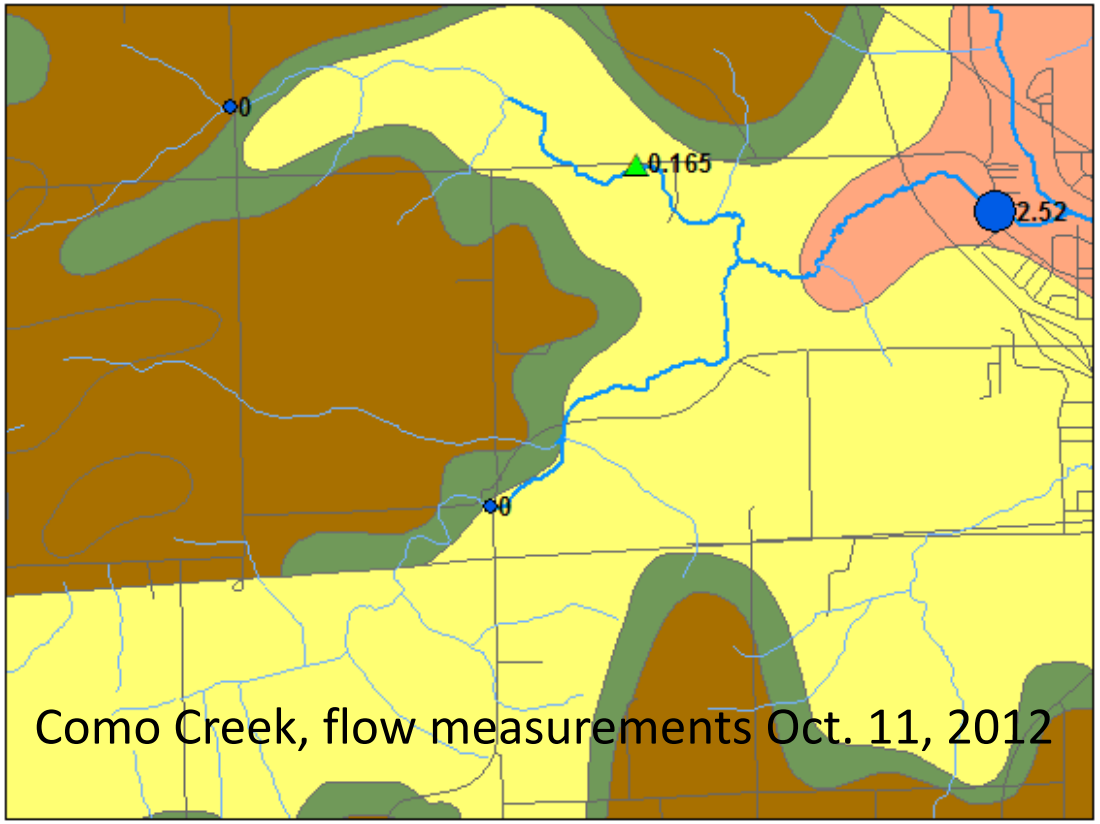


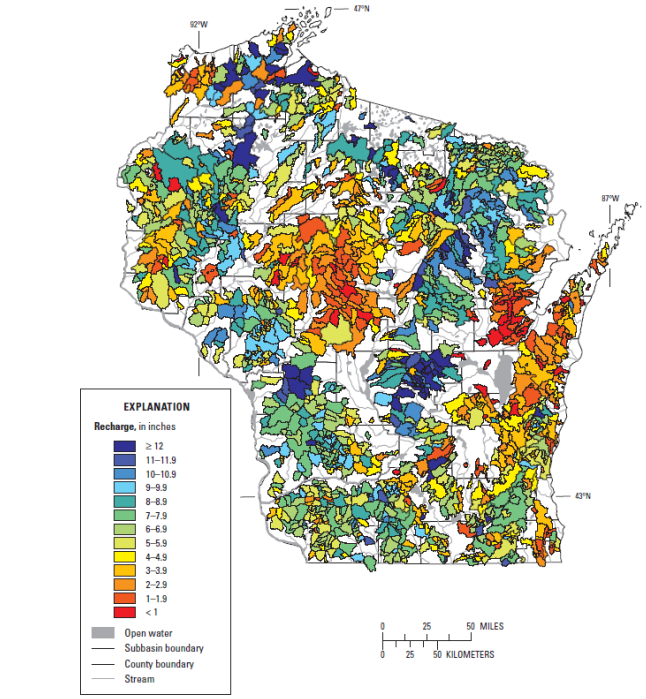


Tunnel City
Wonewoc
Eau Claire
Mount Simon

Recharge Varies Across Wisconsin

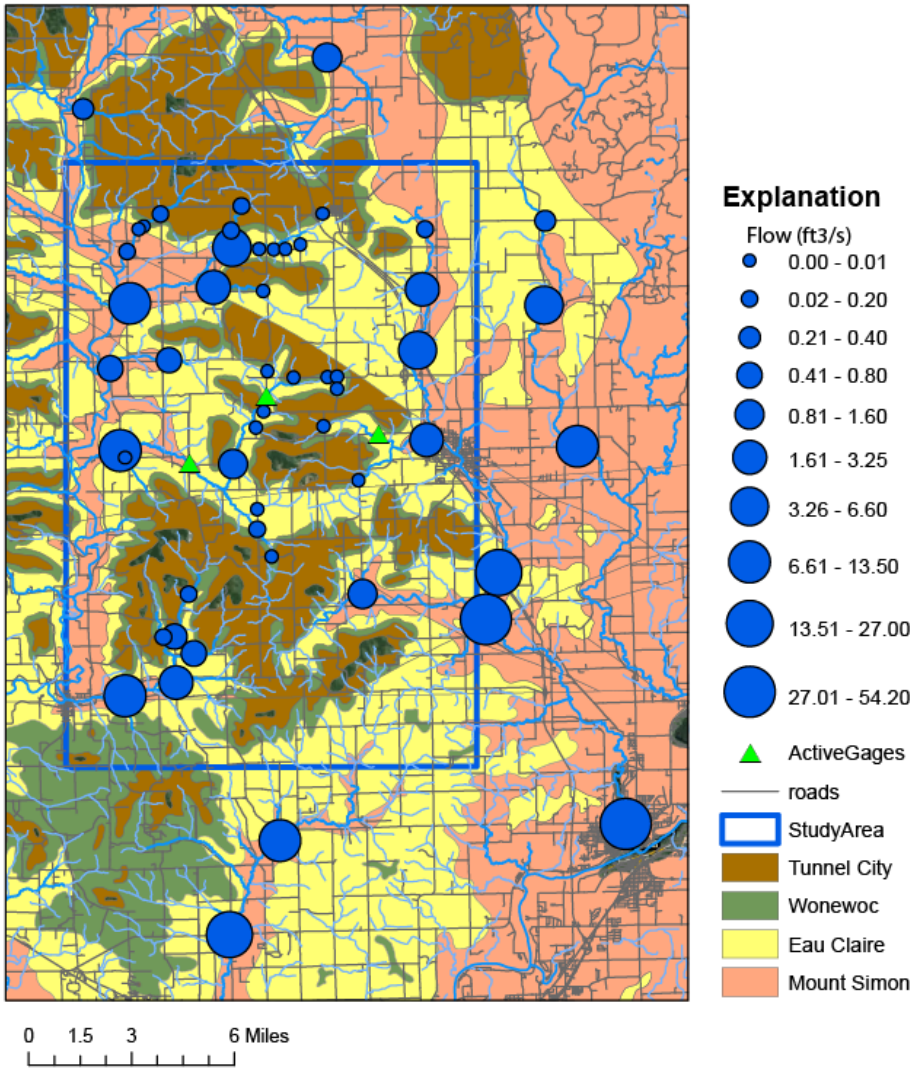
- Changes in baseflow *can* reflect changes in geology





Tunnel City
Wonewoc
Eau Claire
Mount Simon

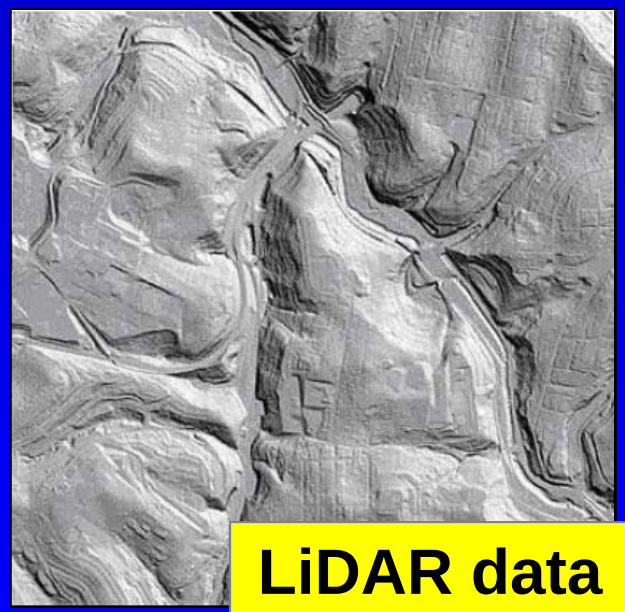
Synoptic Streamflow Measurements



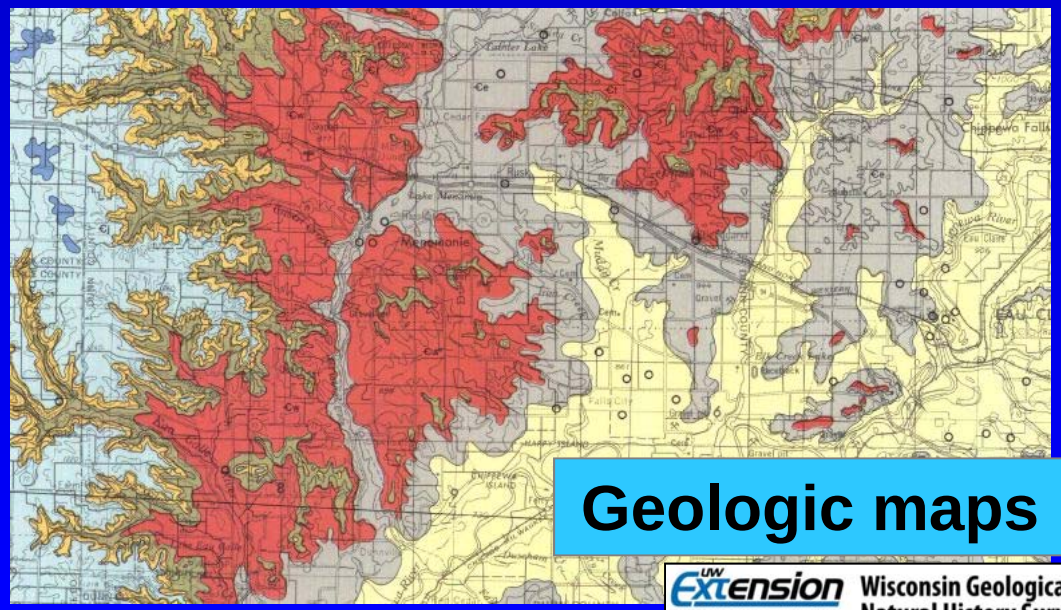
- High spatial resolution
- Adjust one-time measurements to "normal" using regression methods…

Progress to date - Maps / regional datasets

- DEM surface maps – *USGS (2003)*
- Surface water feature maps – *DNR (2003)*
- LiDAR data – *Chippewa County Land Information Office (2011)*
- Bedrock geology of Chippewa County – *WGNHS (1987-88)*
- Glacial geology of Chippewa/Barron Counties – *WGNHS (1985/2007)*
- National Land Cover dataset – *USGS (2006)*
- Hydric soils – *US Department of Agriculture (2011)*



LiDAR data



Geologic maps

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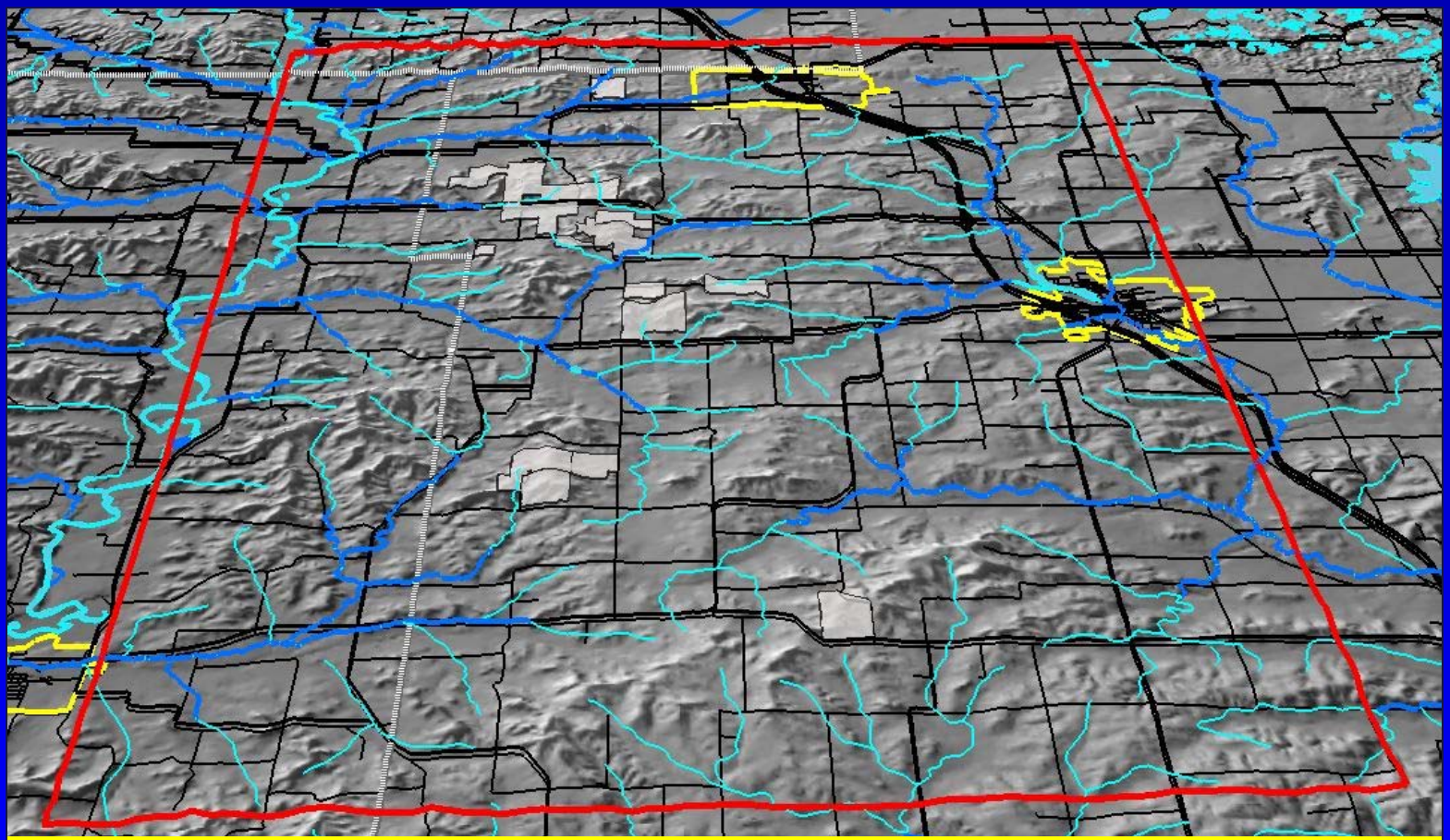
Technical Investigation – *data collection*

- DEM (**D**igital **E**levation **M**ap) *(USGS, 10-m resolution)*
- Surface water features *(DNR, 1:24,000 scale)*



Oblique view looking north over study area with shaded relief DEM

Technical Investigation – *data collection*

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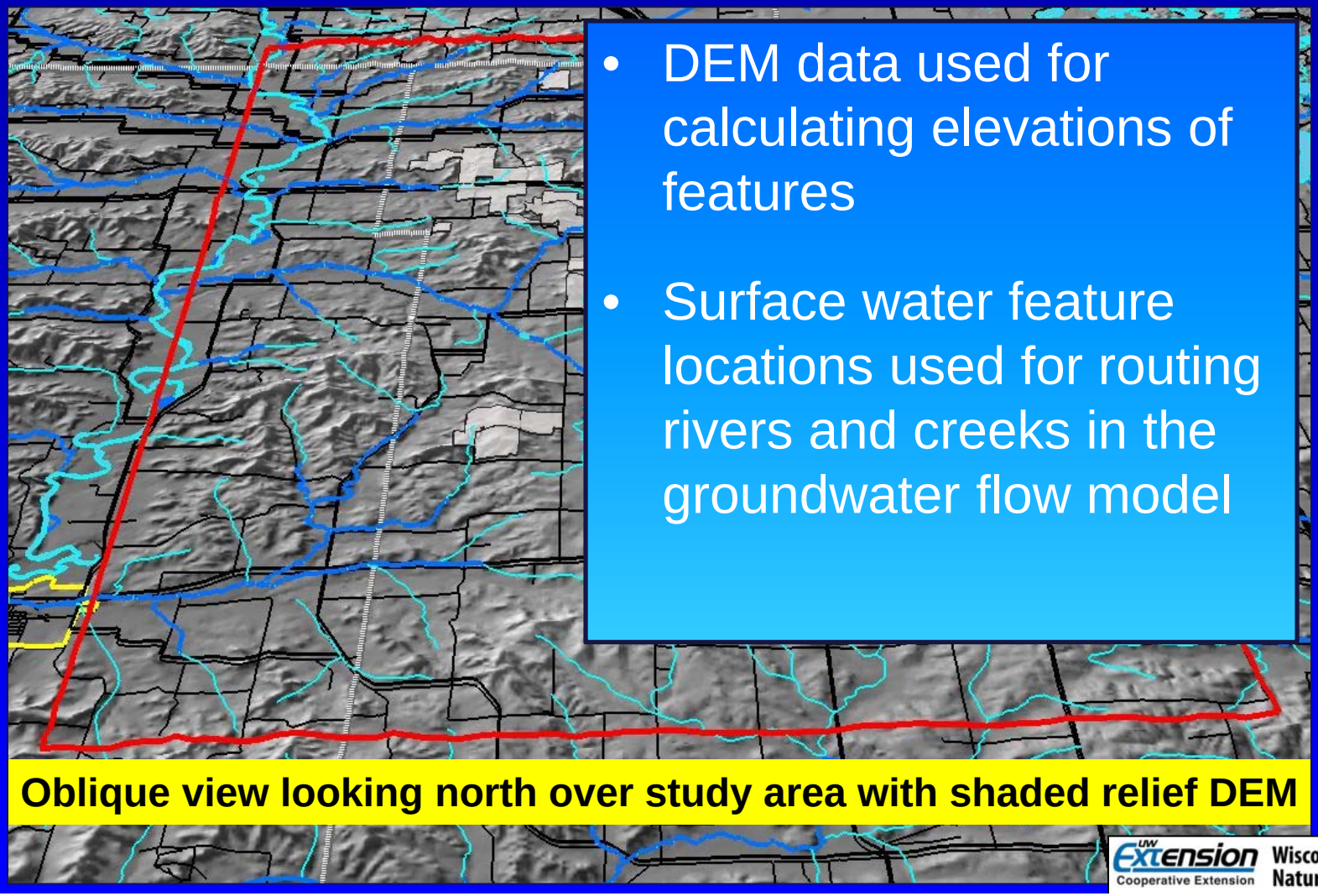
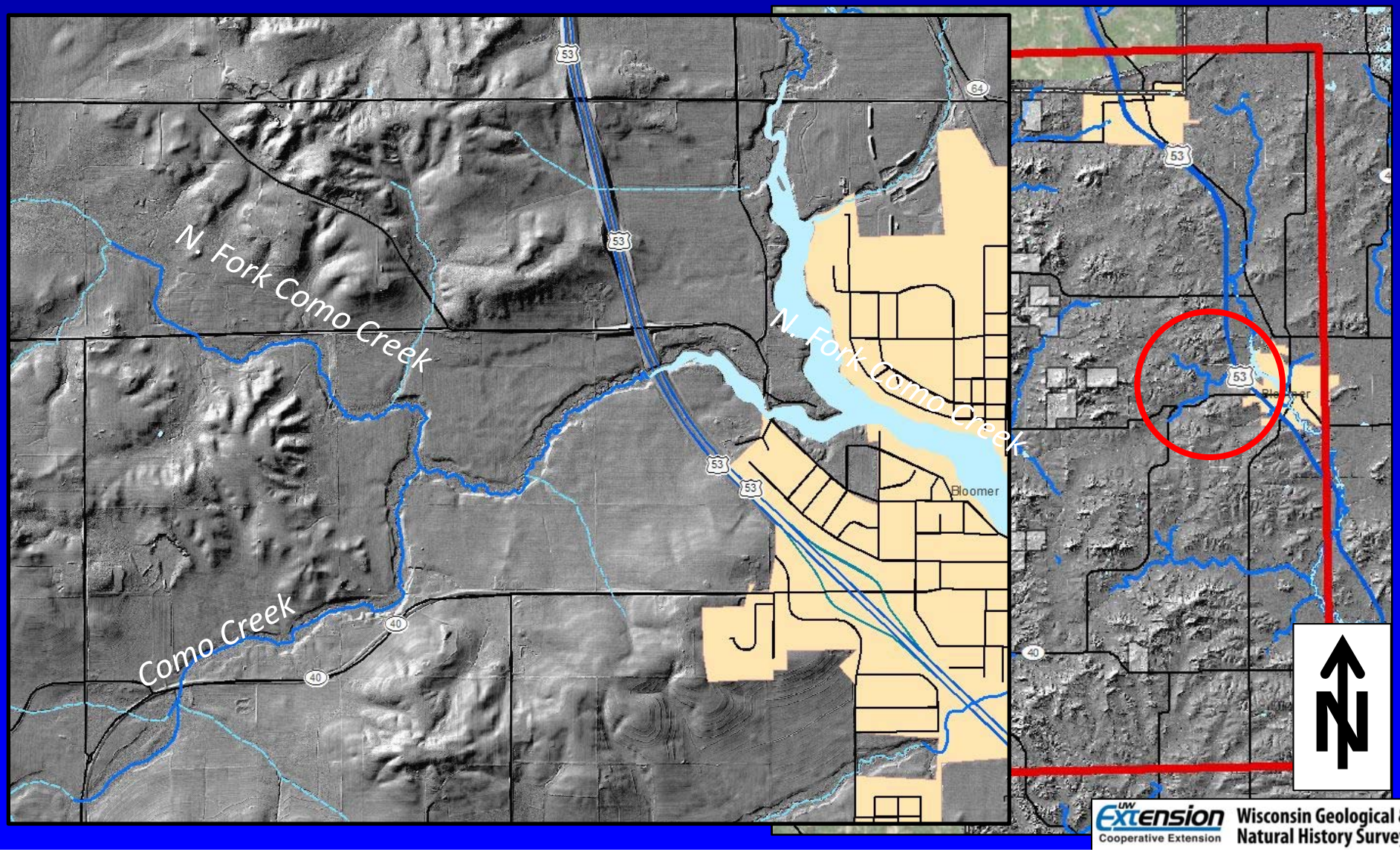


- DEM data used for calculating elevations of features
- Surface water feature locations used for routing rivers and creeks in the groundwater flow model

Oblique view looking north over study area with shaded relief DEM

Technical Investigation – *data collection*

- LiDAR (**Li**ght **D**etection **A**nd **R**anging)



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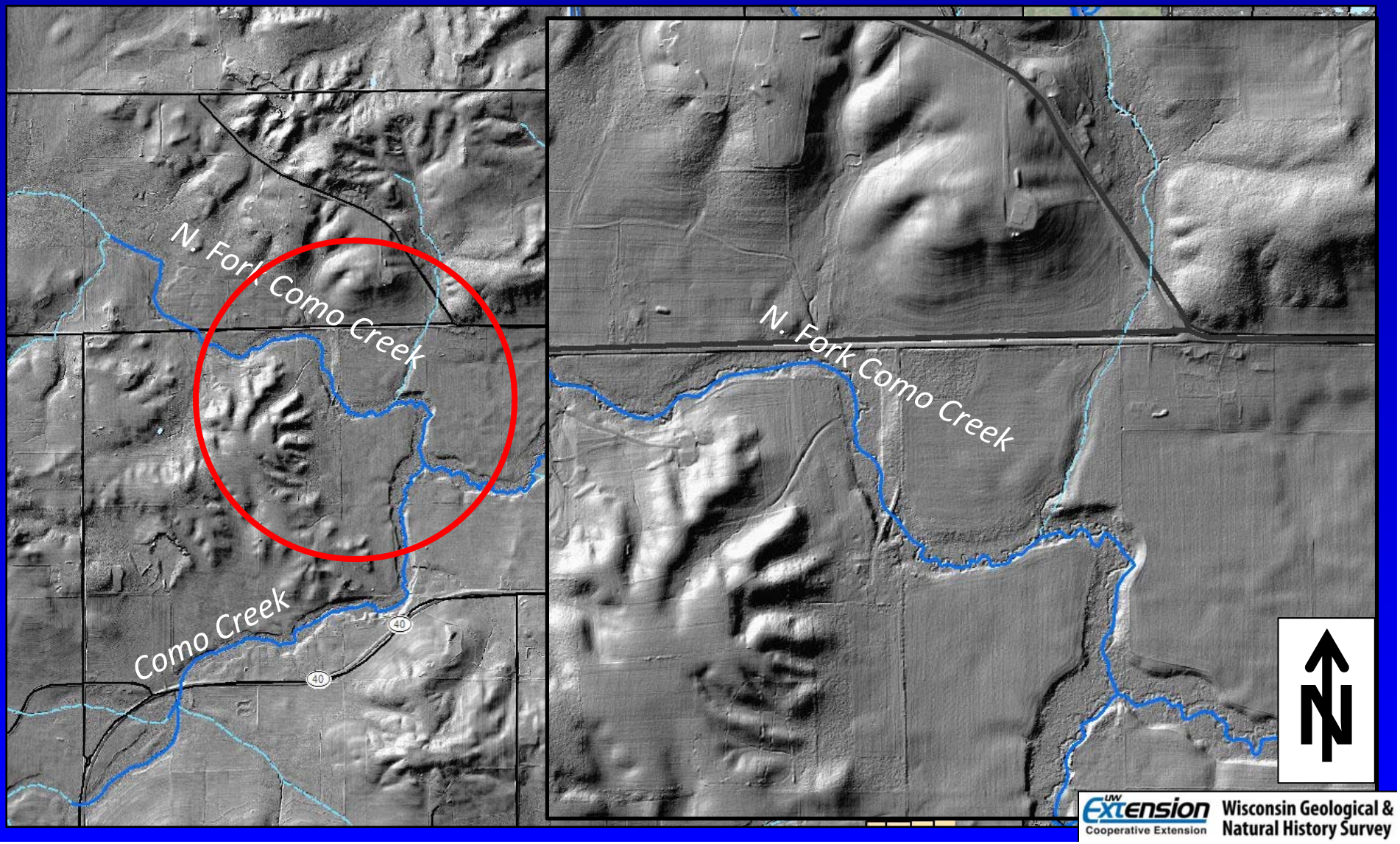
Technical Investigation – *data collection*

- LiDAR (**Li**ght **D**etection **A**nd **R**anging)



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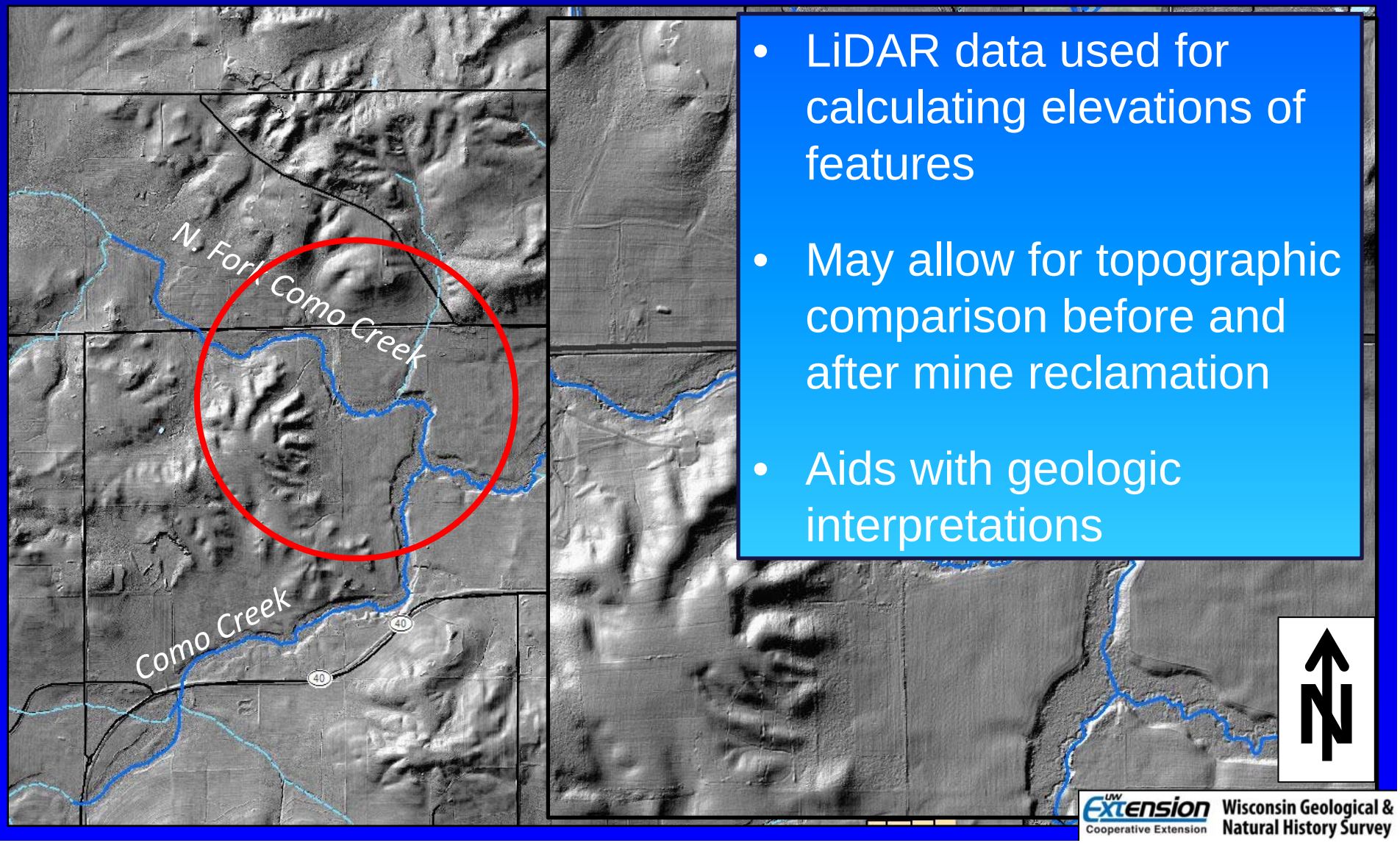
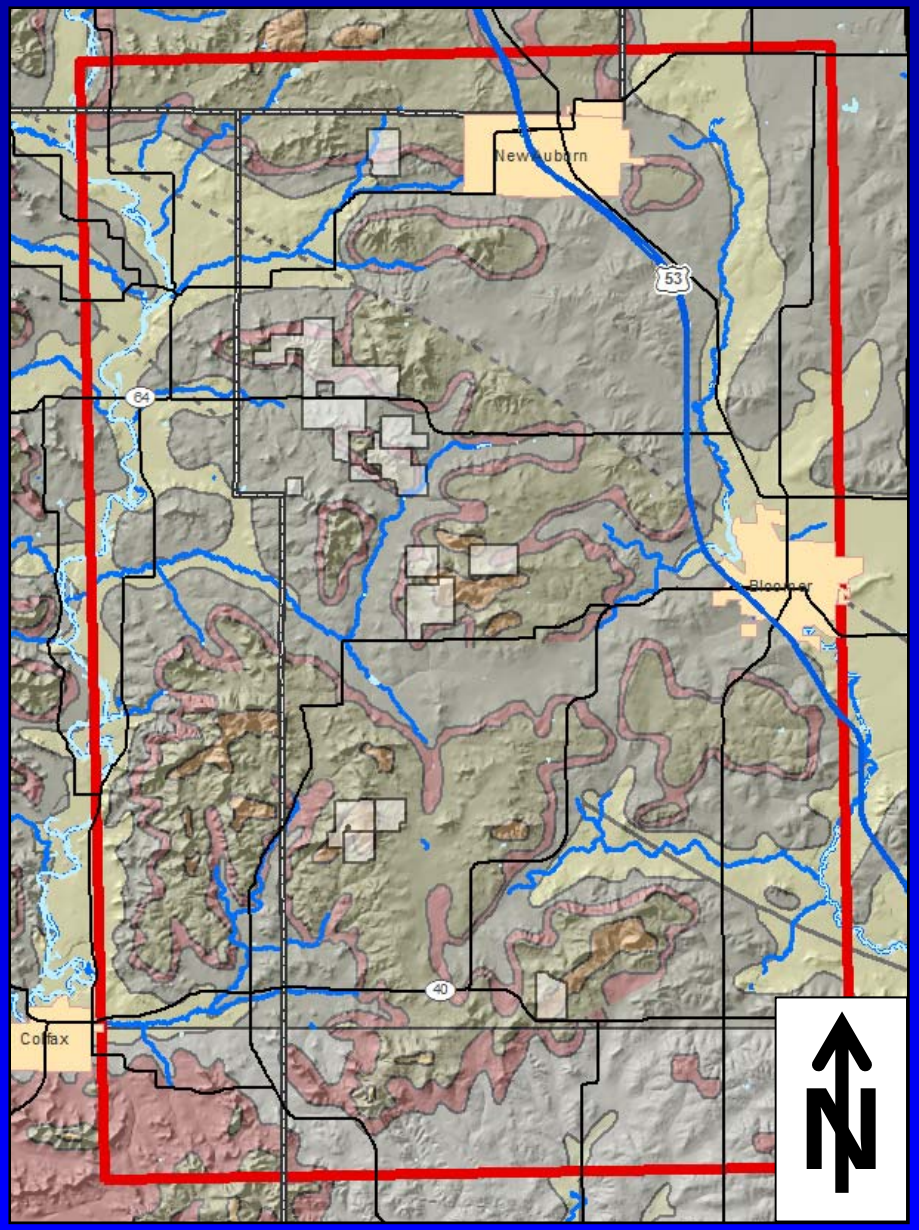
Technical Investigation – *data collection*

- LiDAR (**Li**ght **D**etection **A**nd **R**anging)



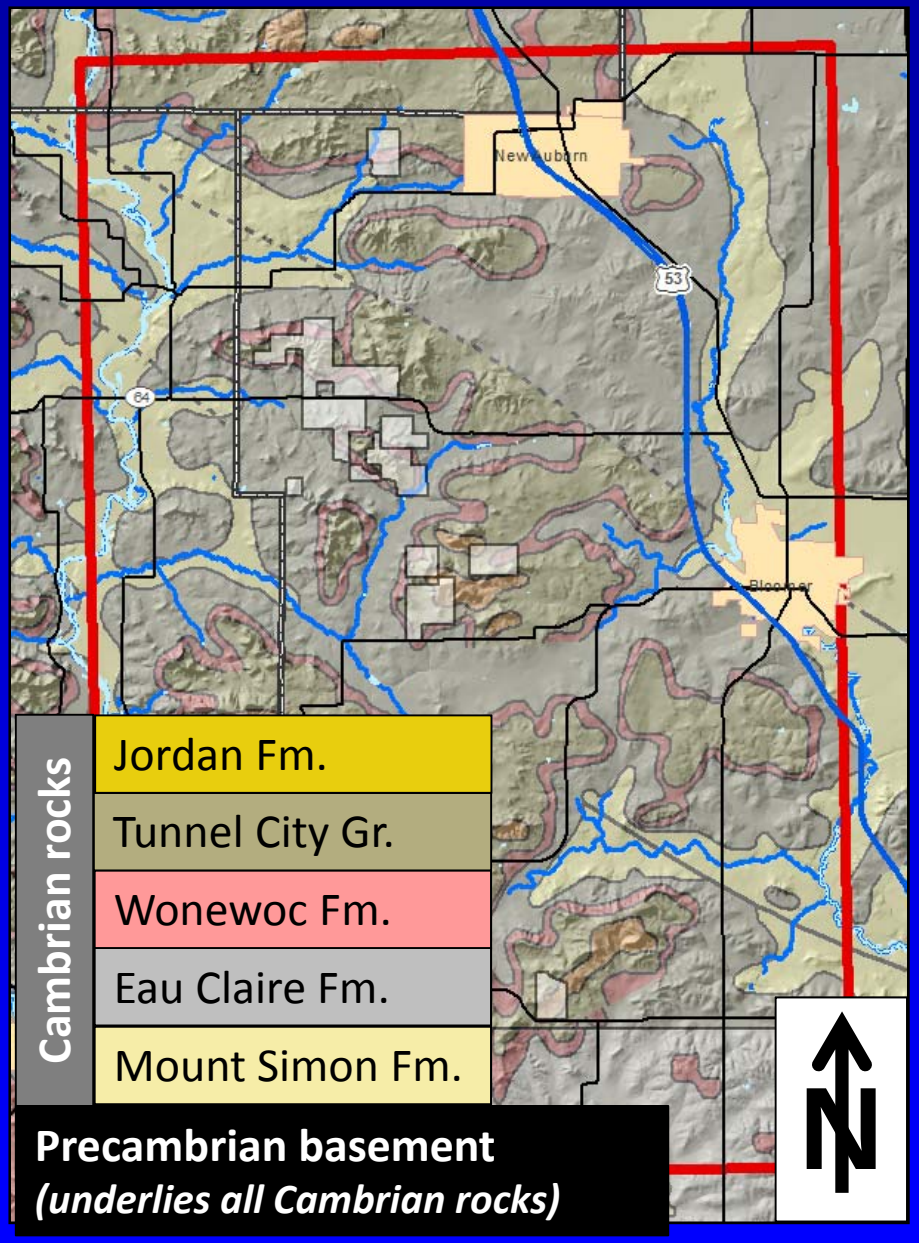
- LiDAR data used for calculating elevations of features
- May allow for topographic comparison before and after mine reclamation
- Aids with geologic interpretations

Progress to date - Maps / regional datasets



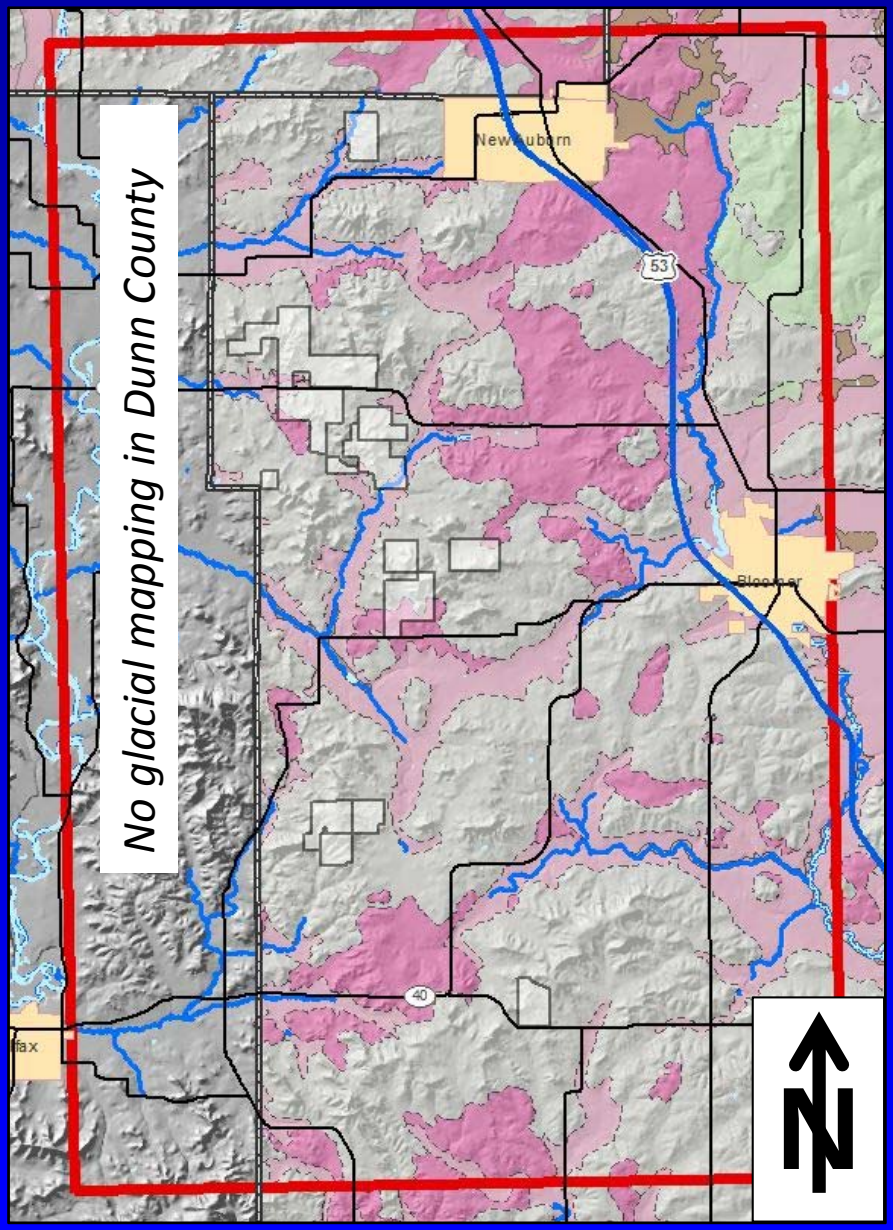
- **Bedrock geology** *(WGNHS)*
  - Northwest WI (1987)
  - West Central WI (1988)
  - 1:250,000 scale

Progress to date - Maps / regional datasets



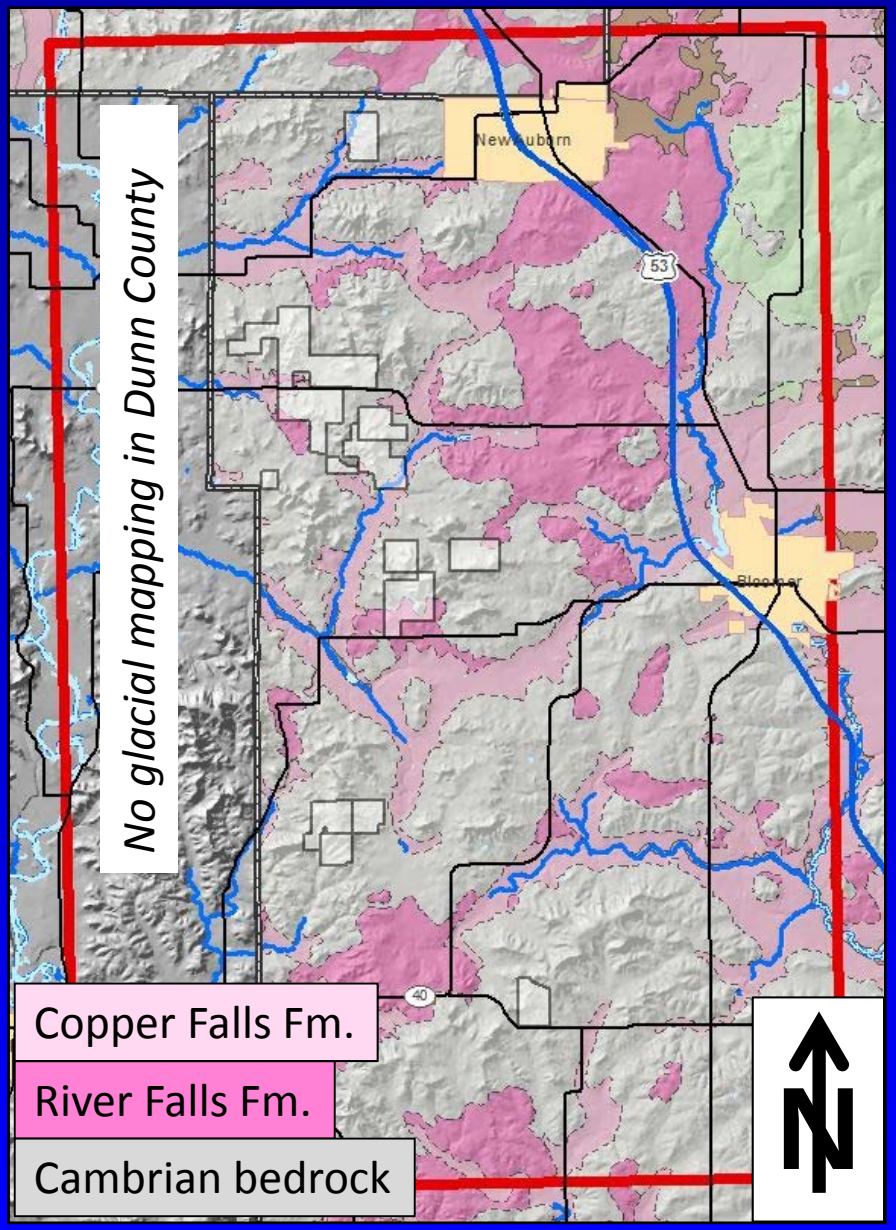
- **Bedrock geology** *(WGNHS)*
  - Northwest WI (1987)
  - West Central WI (1988)
  - 1:250,000 scale
- Good framework but relatively small scale mapping
- We will improve by using:
  - More detailed geologic data
    - Geologic logs
    - Geophysical logs
    - Rock cores
    - Outcrop descriptions
  - High resolution elevation data to calculate extent of each fm.

Progress to date - Maps / regional datasets



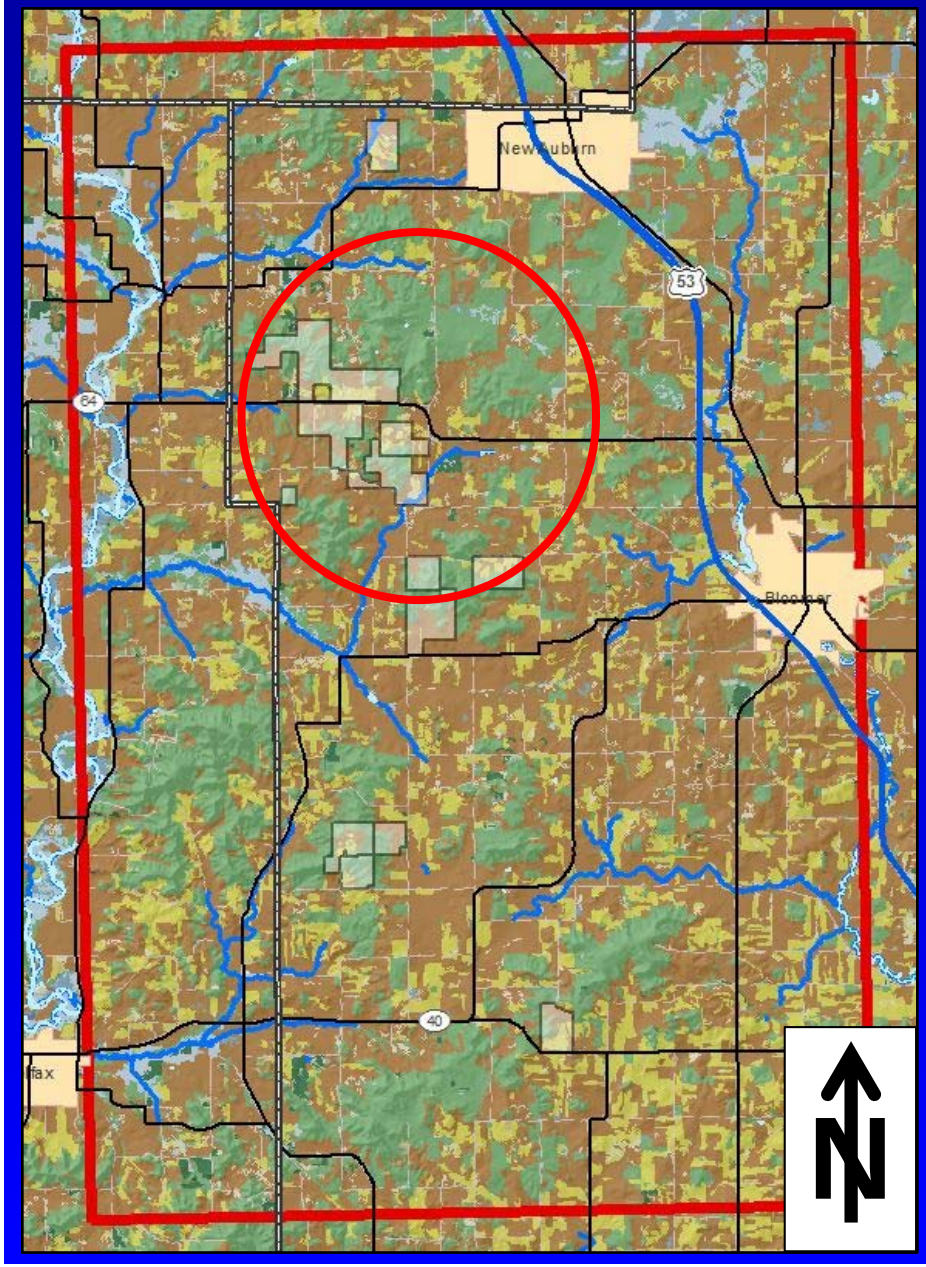
- **Glacial geology** *(WGNHS)*
  - Chippewa County (2007)
  - Barron County (1986)
  - 1:100,000 scale

Progress to date - Maps / regional datasets



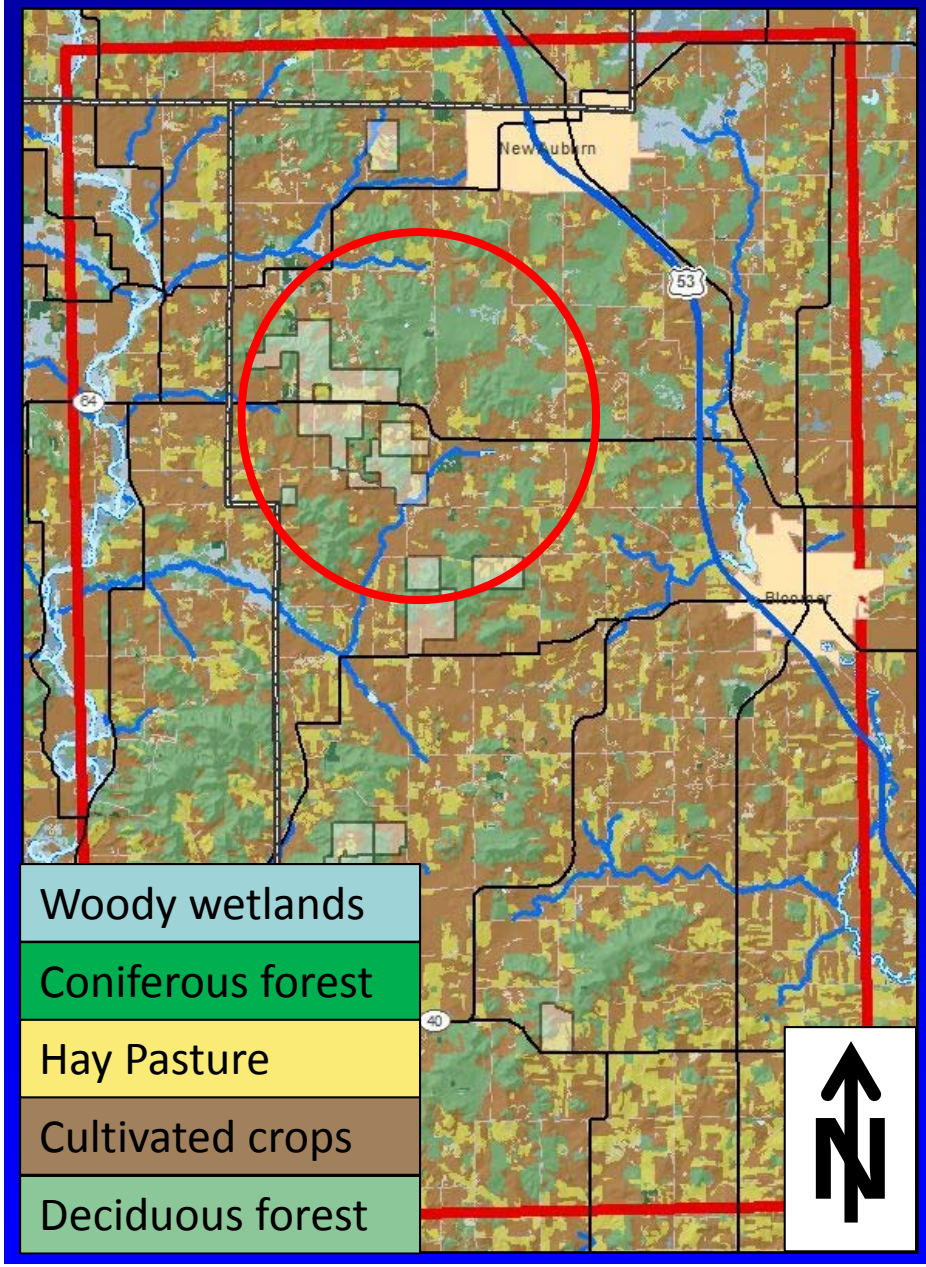
- **Glacial geology** *(WGNHS)*
  - Chippewa County (2007)
  - Barron County (1986)
  - 1:100,000 scale
- River Falls Fm.
  - Pre-Wisconsin glaciation
  - Meltwater stream deposits
- Copper Falls Fm.
  - Wisconsin glaciation
  - Meltwater stream deposits
- River falls Fm. may increase runoff (reduced infiltration)
- Good data for model building

Progress to date - Maps / regional datasets



- **Land cover dataset** (*USGS*)
  - Statewide (2006)
  - 30 m resolution

Progress to date - Maps / regional datasets



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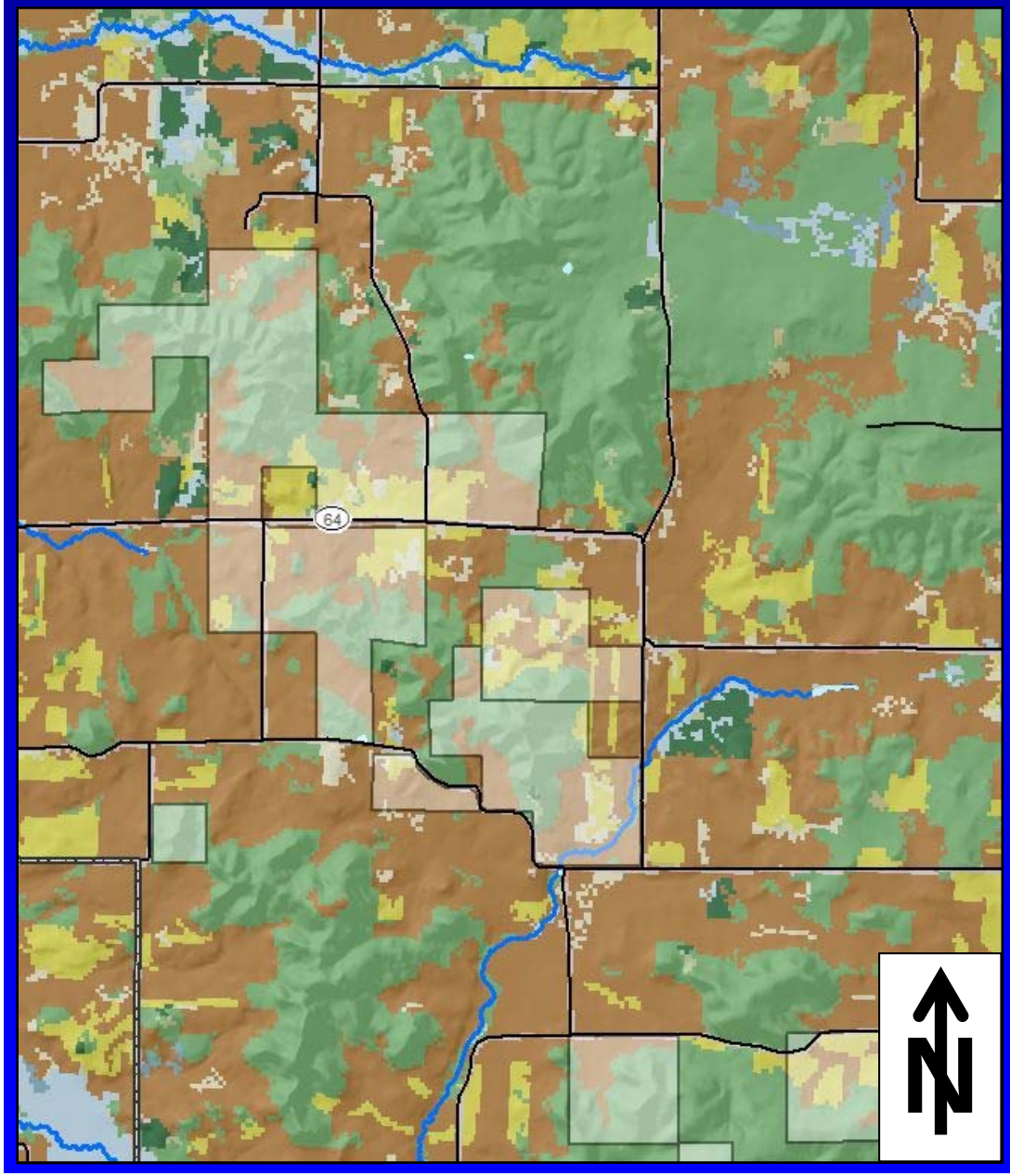
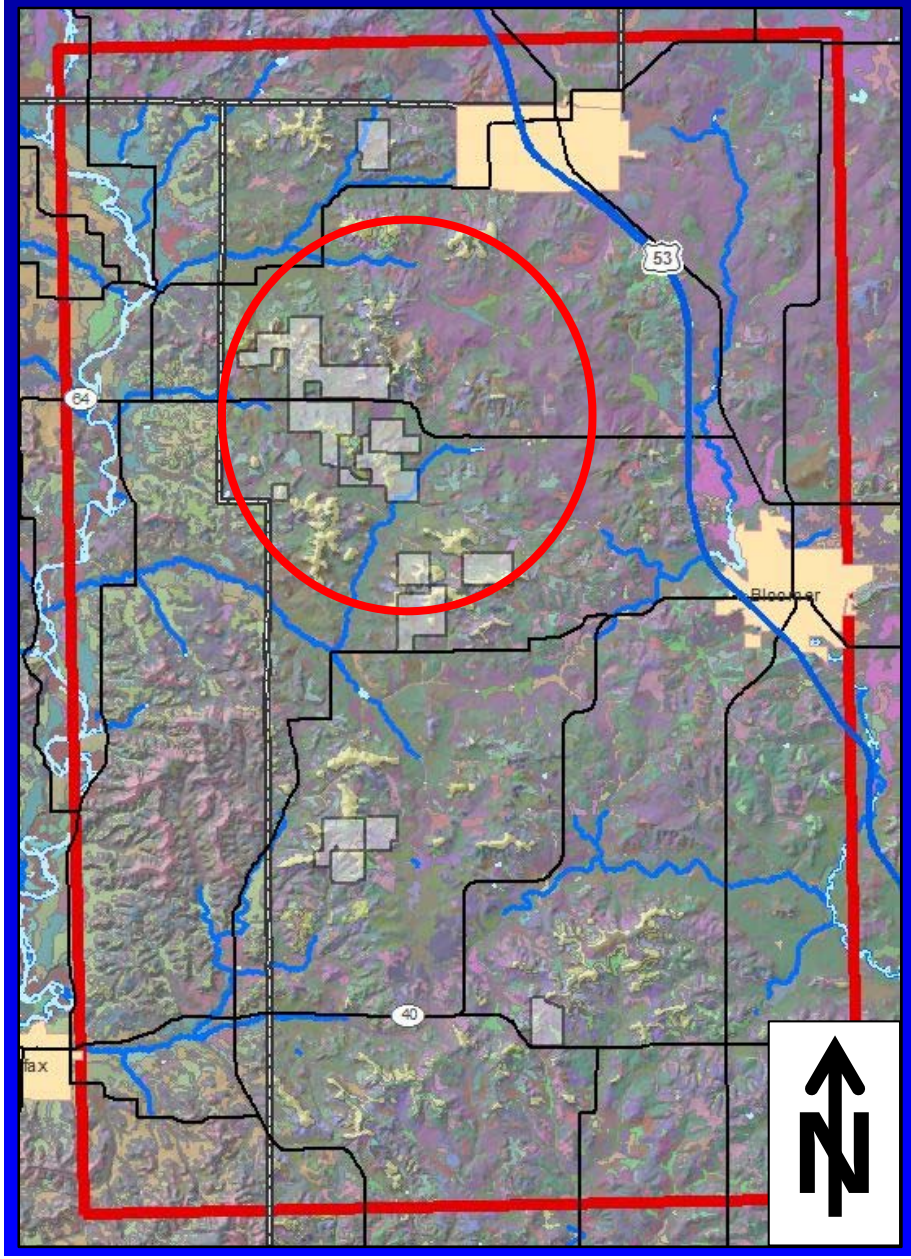
Progress to date - Maps / regional datasets



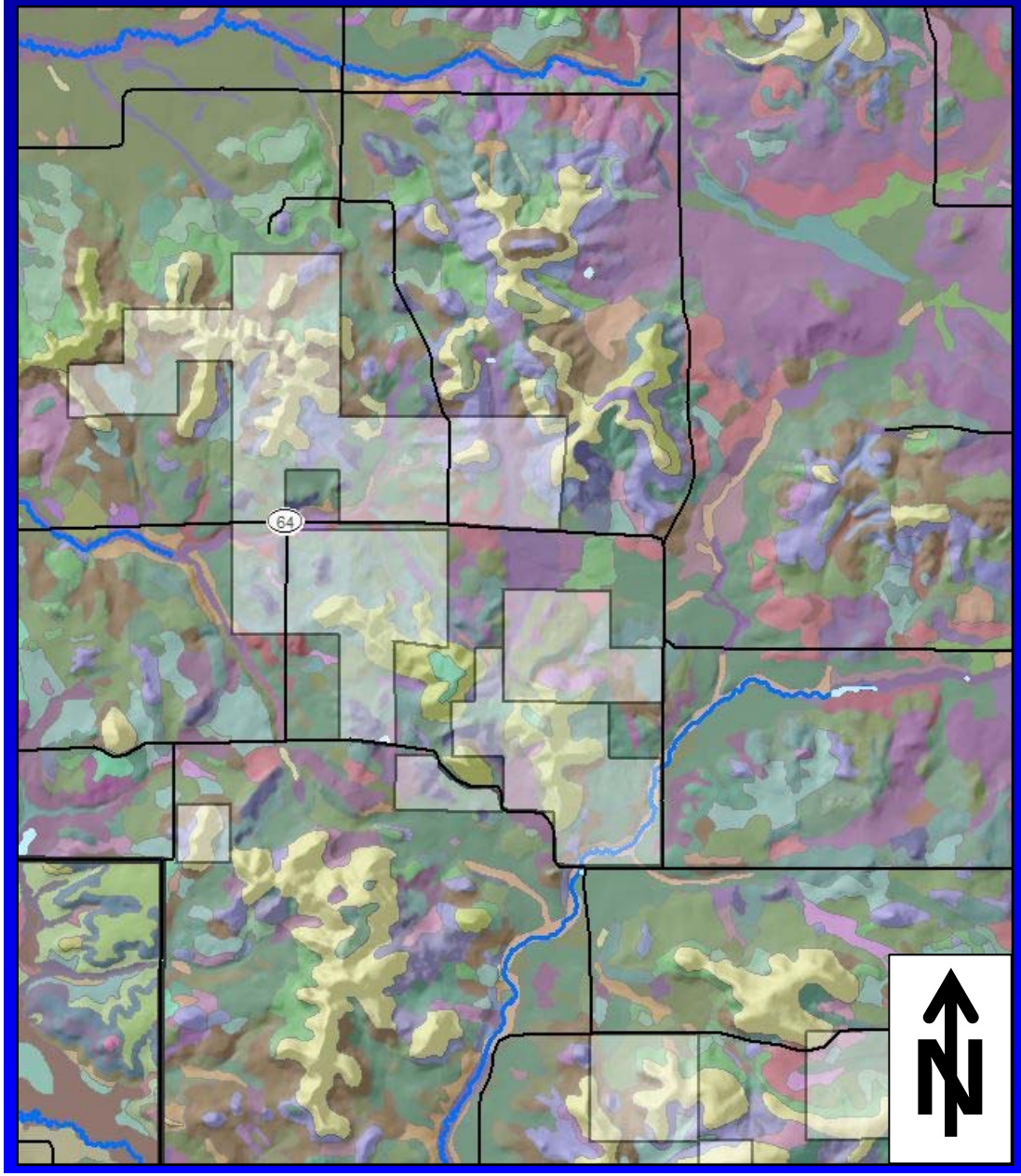
- **Land cover dataset** (*USGS*)
  - Statewide (2006)
  - 30 m resolution
- Used in Soil-water-balance (SWB) modeling
  - Represents pre-mine land use
- Could be modified to fit future scenarios
  - Peak mine operations
  - Post-mine reclamation

Progress to date - Maps / regional datasets



- **Soils dataset** *(USDA)*
  - Statewide (2011)

Progress to date - Maps / regional datasets

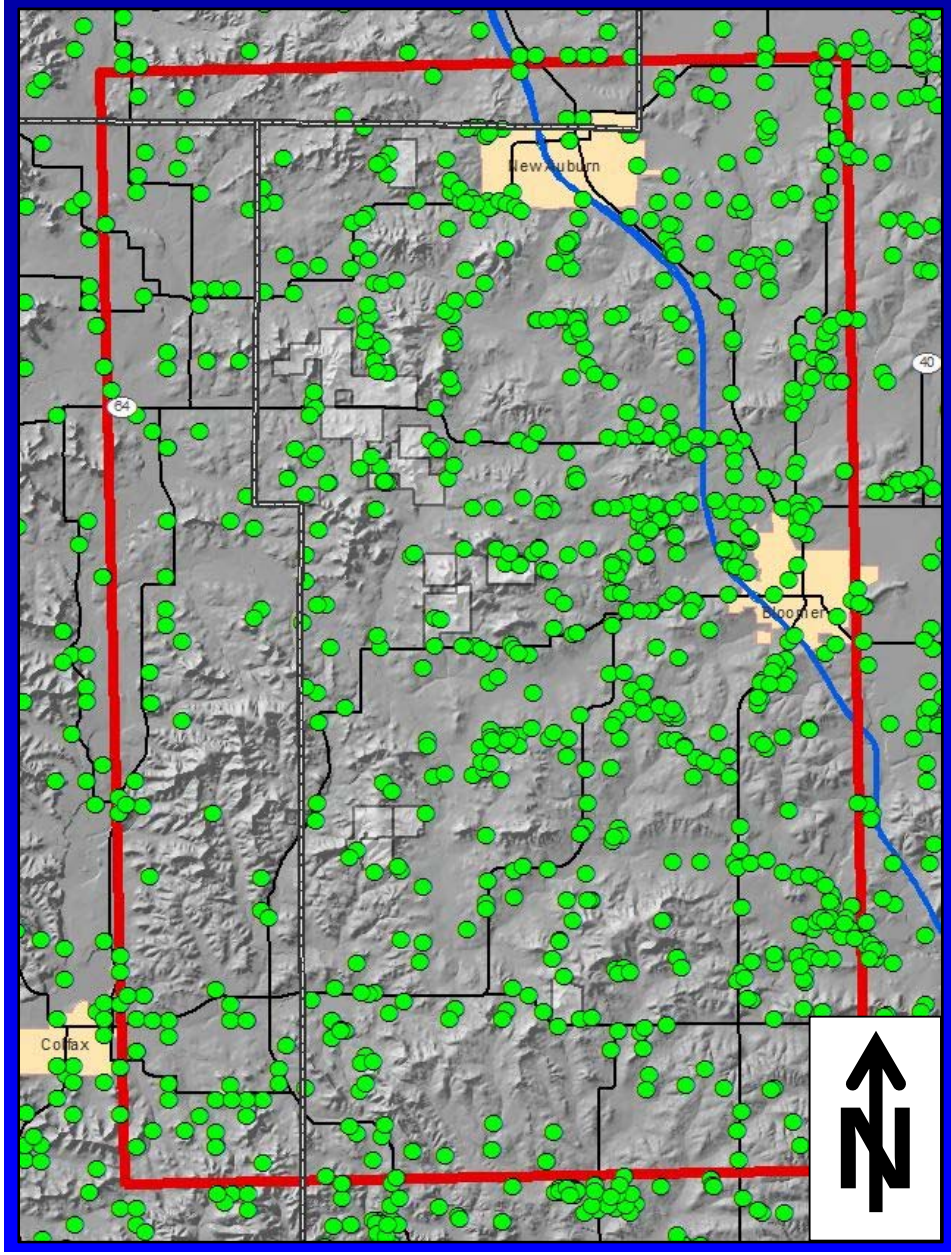


- **Soils dataset** *(USDA)*
  - Statewide (2011)
- Used in Soil-water-balance (SWB) modeling
  - Based on soil survey data
  - Represents pre-mine soil type
- Could be modified to fit future scenarios

Progress to date - (hydro)geologic data

- **Well construction reports** *(DNR)*
- Drillers descriptions of cuttings in the field

Progress to date - (hydro)geologic data

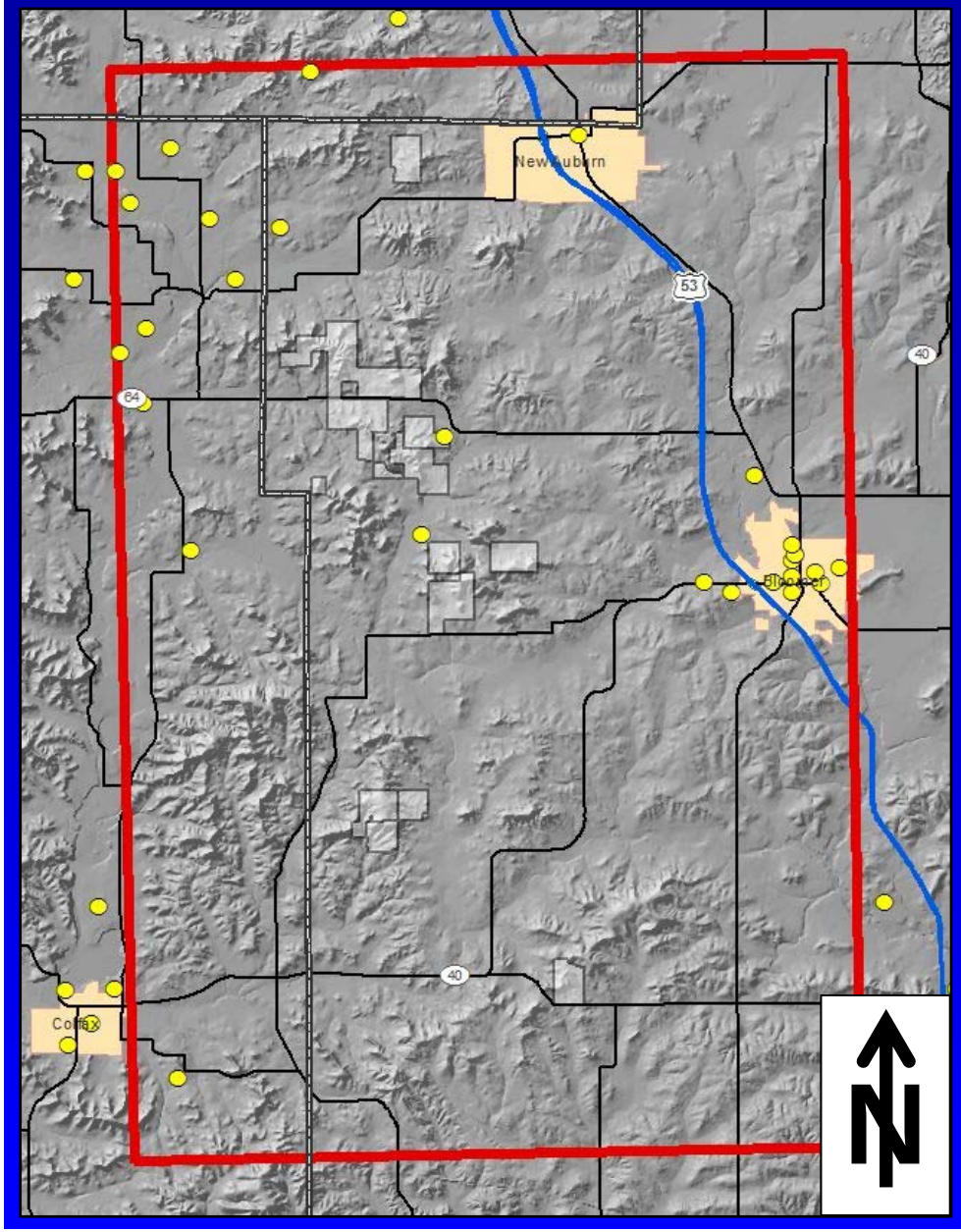


- **Well construction reports** *(DNR)*
- Drillers descriptions of cuttings in the field
- (Hydro)geologic data
  - Locations of wells
  - Rock descriptions with depth
  - Specific capacity (hydraulic property of aquifer units)
  - Water levels (for calibration)
- Many data points but relatively low quality

Progress to date - (hydro)geologic data

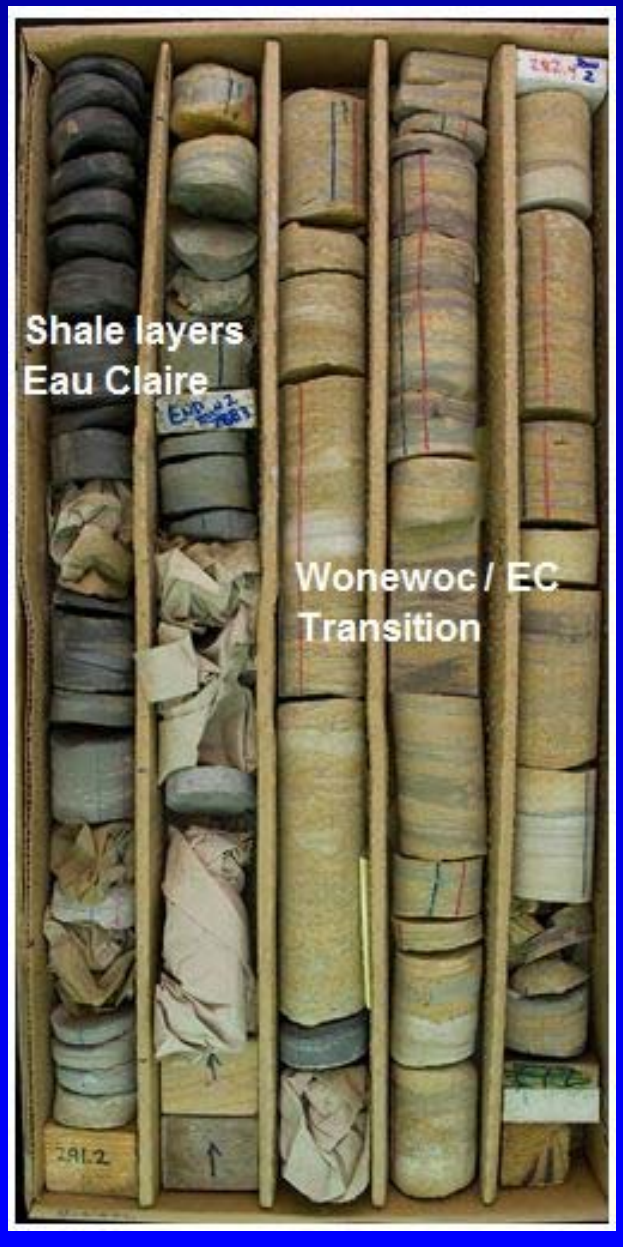
- **Geologic logs** *(WGNHS)*
- Cuttings from municipal supply or other high-capacity wells
- Evaluated by WGNHS geologists in the laboratory

Progress to date - (hydro)geologic data



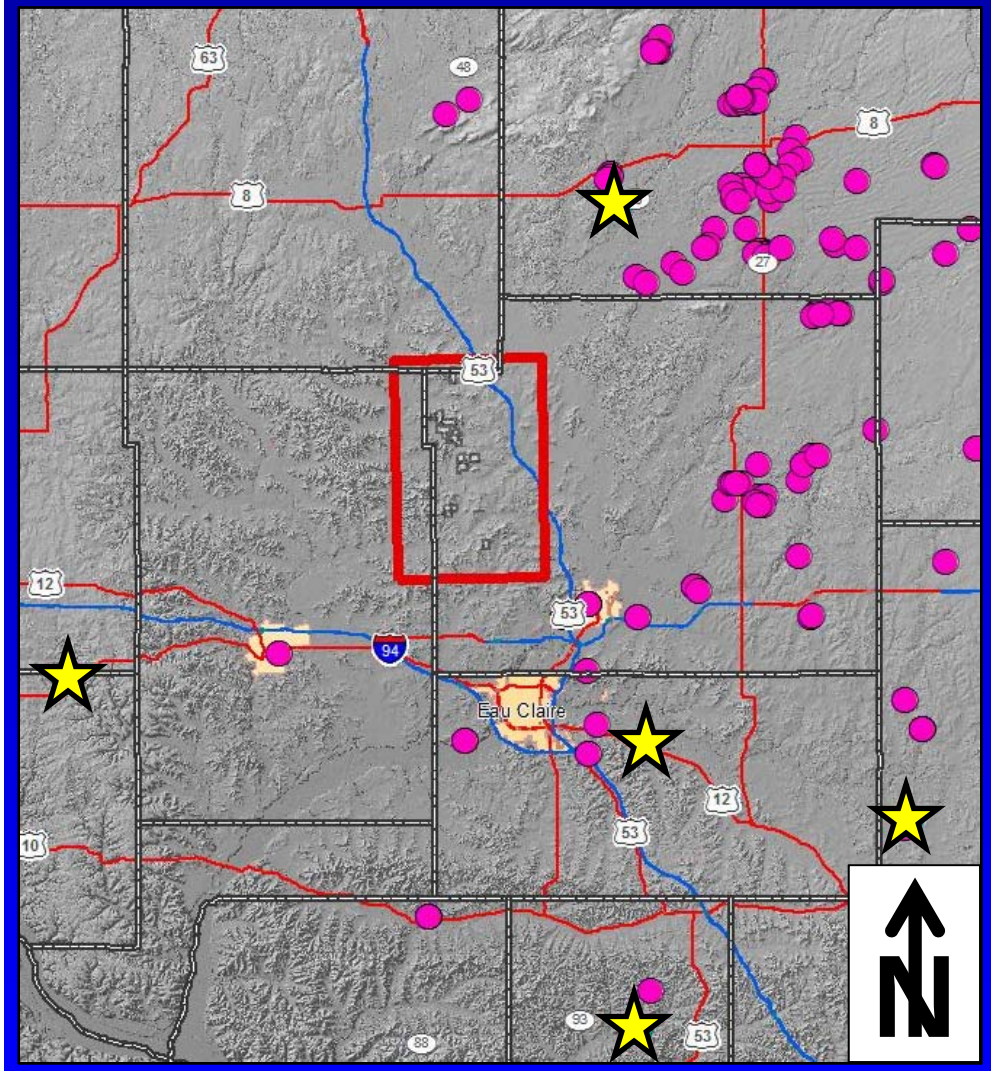
- **Geologic logs** *(WGNHS)*
- Cuttings from municipal supply or other high-capacity wells
- Evaluated by WGNHS geologists in the laboratory
- (Hydro)geologic data
  - Rock descriptions with depth
  - Stratigraphic interpretations
  - Aquifer / aquitard locations
- Fewer data points but relatively high quality

Progress to date - (hydro)geologic data



- **Rock cores**
- Commonly collected for mineral exploration

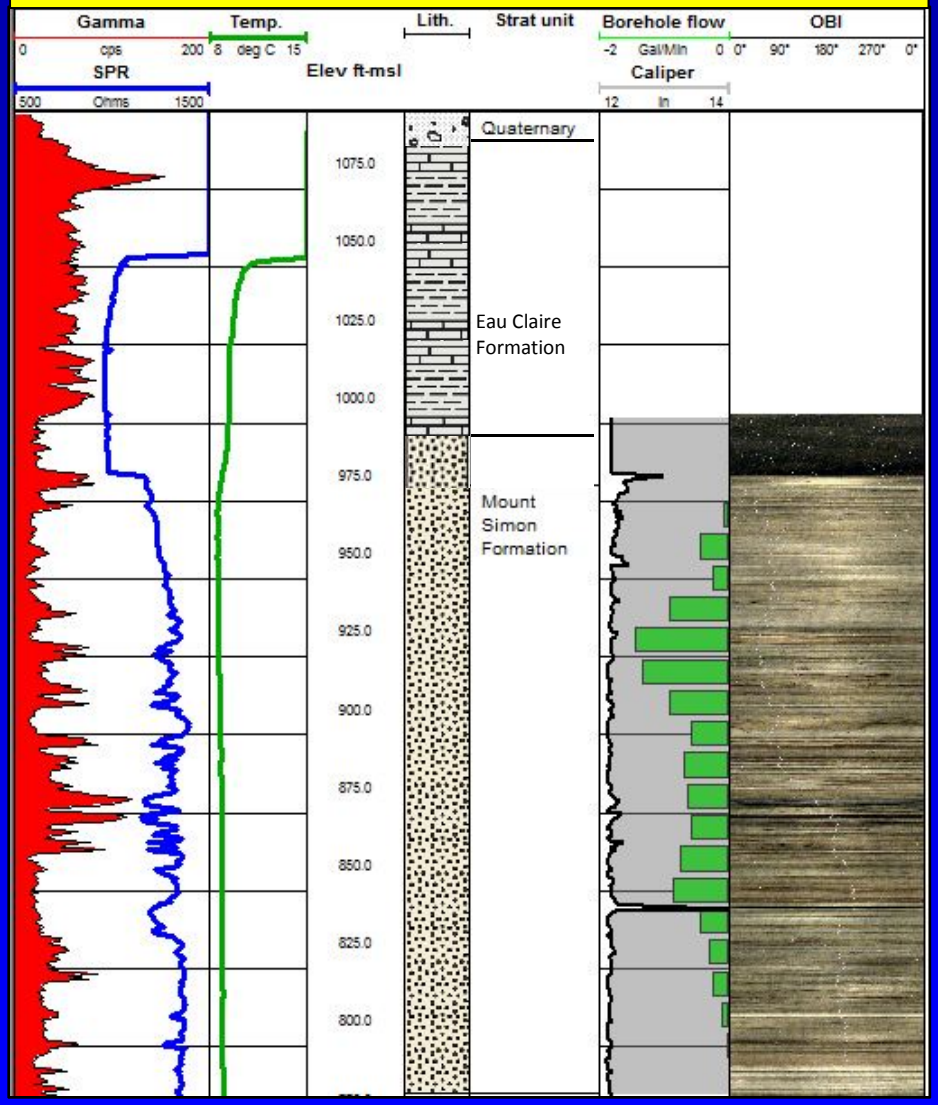
Progress to date - (hydro)geologic data



- **Rock cores**
- Commonly collected for mineral exploration
- (Hydro)geologic data
  - Rock descriptions with depth
  - Stratigraphic interpretations
  - Aquifer / aquitard locations
- All relevant cores are located outside study area
- We'd like to collect/view core within the study area!

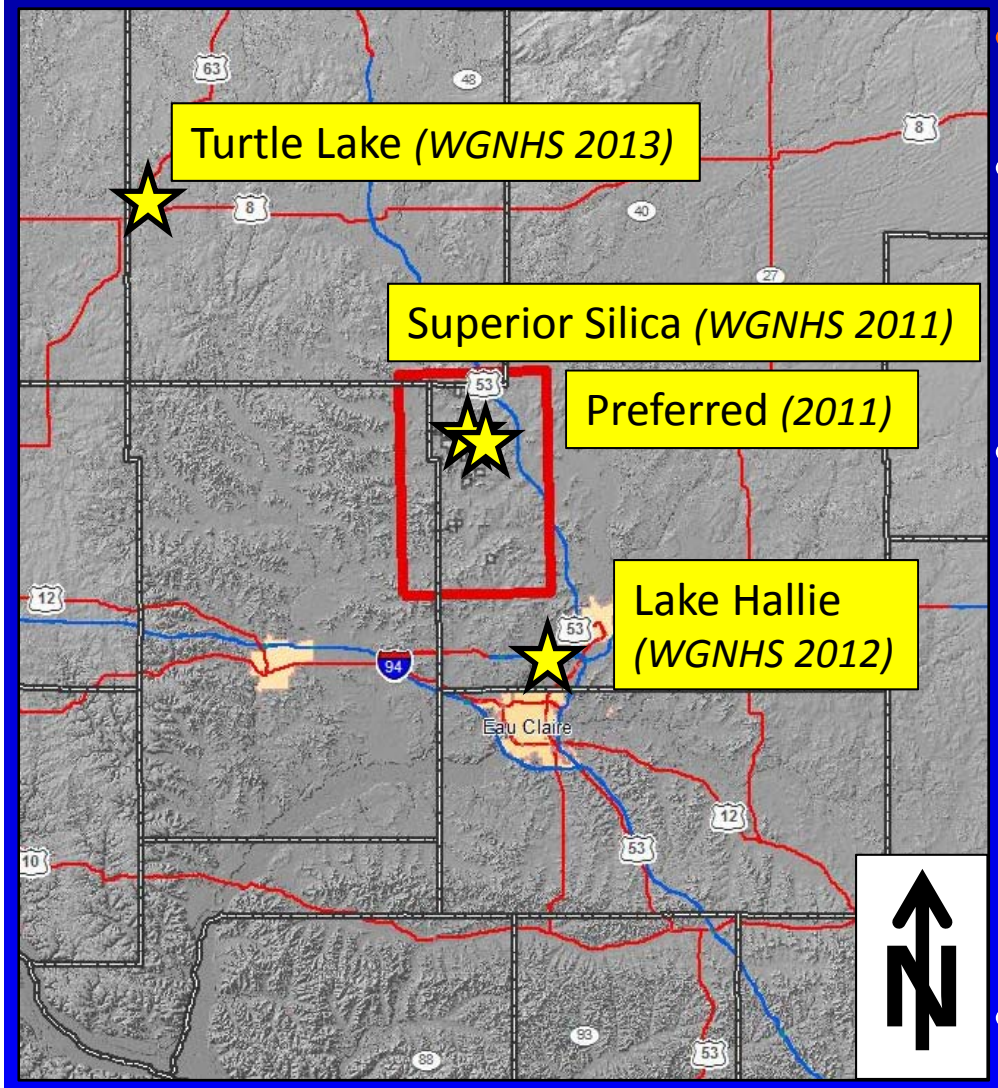
Progress to date - (hydro)geologic data

Superior Silica Sands (WGNHS 2011)



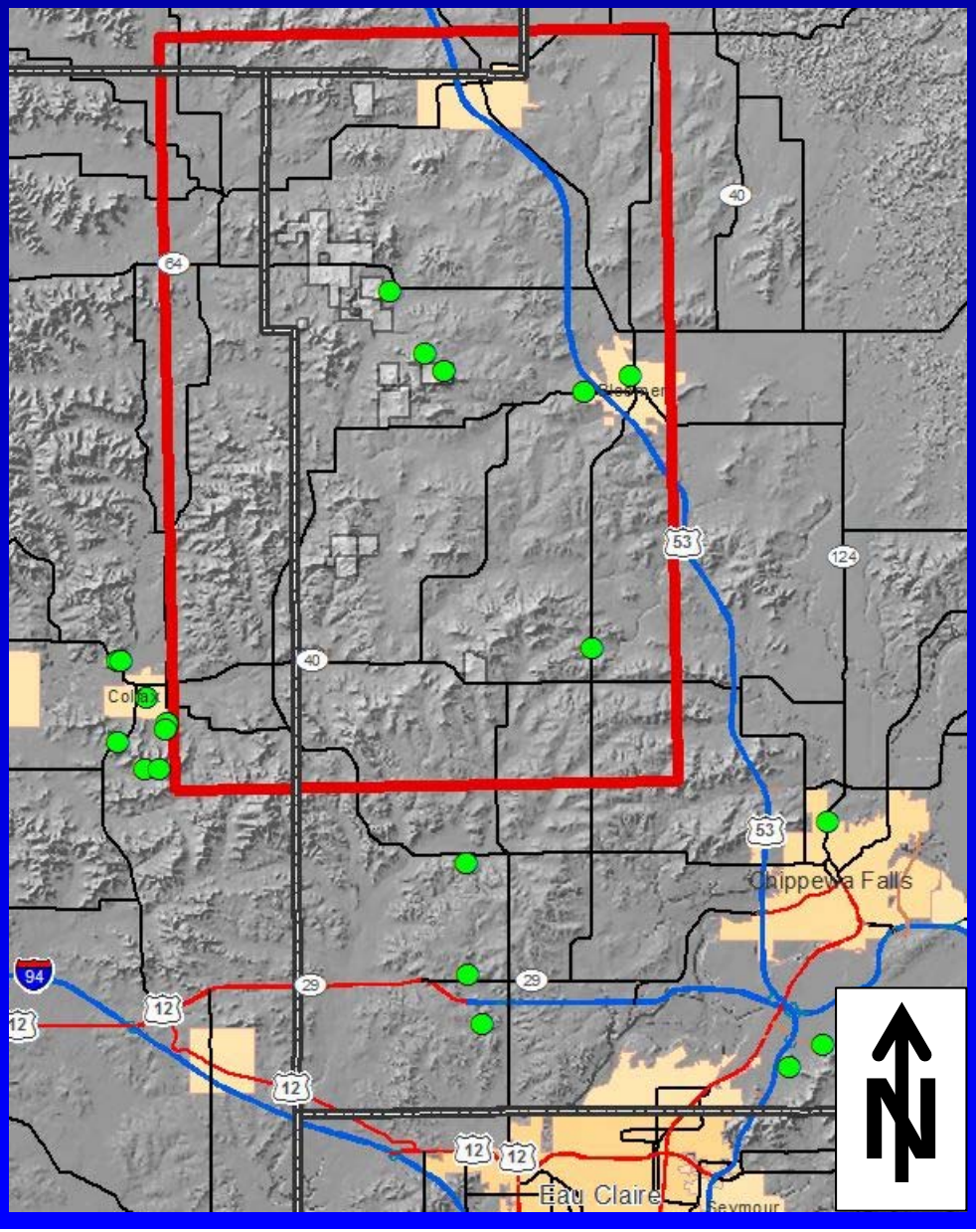
- **Geophysical logs**
- Collected by WGNHS and other well exploration companies

Progress to date - (hydro)geologic data



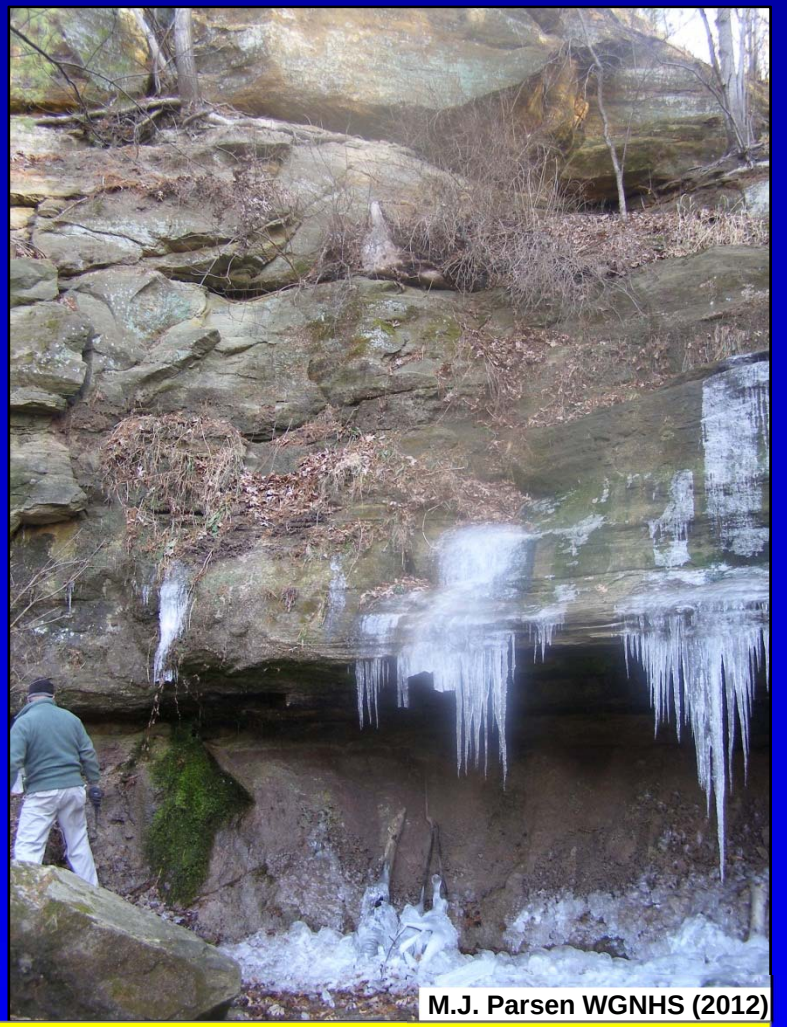
- **Geophysical logs**
- Collected by WGNHS and other well exploration companies
- (Hydro)geologic data
  - Rock and fluid properties with depth
  - Stratigraphic interpretations
  - Aquifer / aquitard locations
  - Groundwater flow properties (Borehole flow, packer tests)
- We'd like to collect/view more GP logs in the study area!

Progress to date - (hydro)geologic data



- **Field outcrops**
- Documented in field guides or readily visible outcrops
- (Hydro)geologic data
  - Stratigraphic interpretations
  - Aquifer / aquitard locations
- Help to build and confirm regional interpretations

Progress to date - (hydro)geologic data



Irvine Park in Chippewa Falls

Contact: Precambrian Granite and Mount Simon Fm. (Cambrian)

Progress to date - (hydro)geologic data

M.J. Parsen WGNHS (2012)

M.J. Parsen WGNHS (2012)

Tilden Outcrop CTH F south of Bloomer

Contact: Eau Claire Fm. and Mount Simon Fm.

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Progress to date - (hydro)geologic data

M.J. Parsen WGNHS (2013)

M.J. Parsen WGNHS (2013)

South of Colfax above Hwy 40

Contact: Tunnel City Gr. and Wonewoc Fm.

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Progress to date - (hydro)geologic data

Superior Silica Sands Mine, Hwy 64 at DD

Contact: Tunnel City Gr. and Wonewoc Fm.

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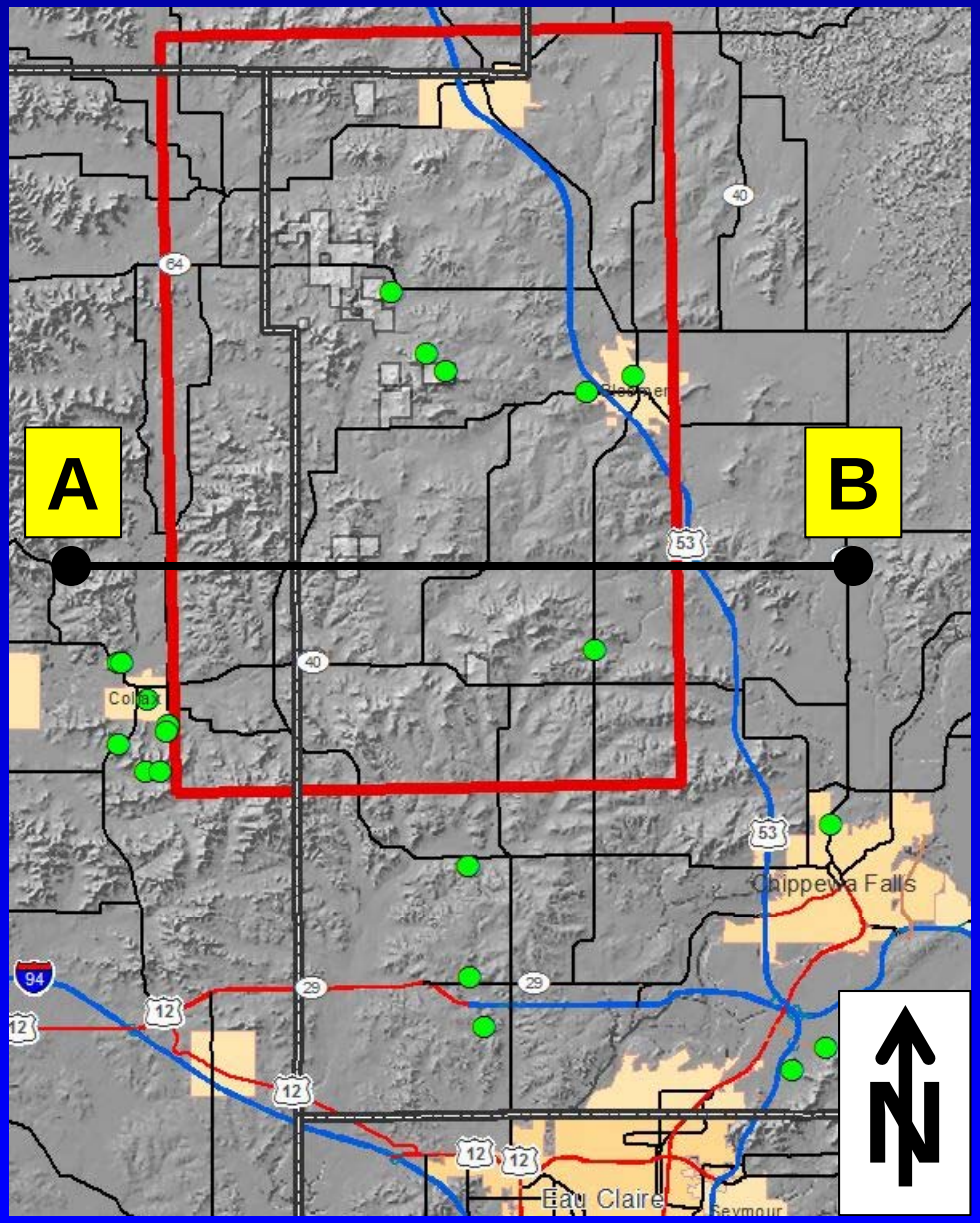
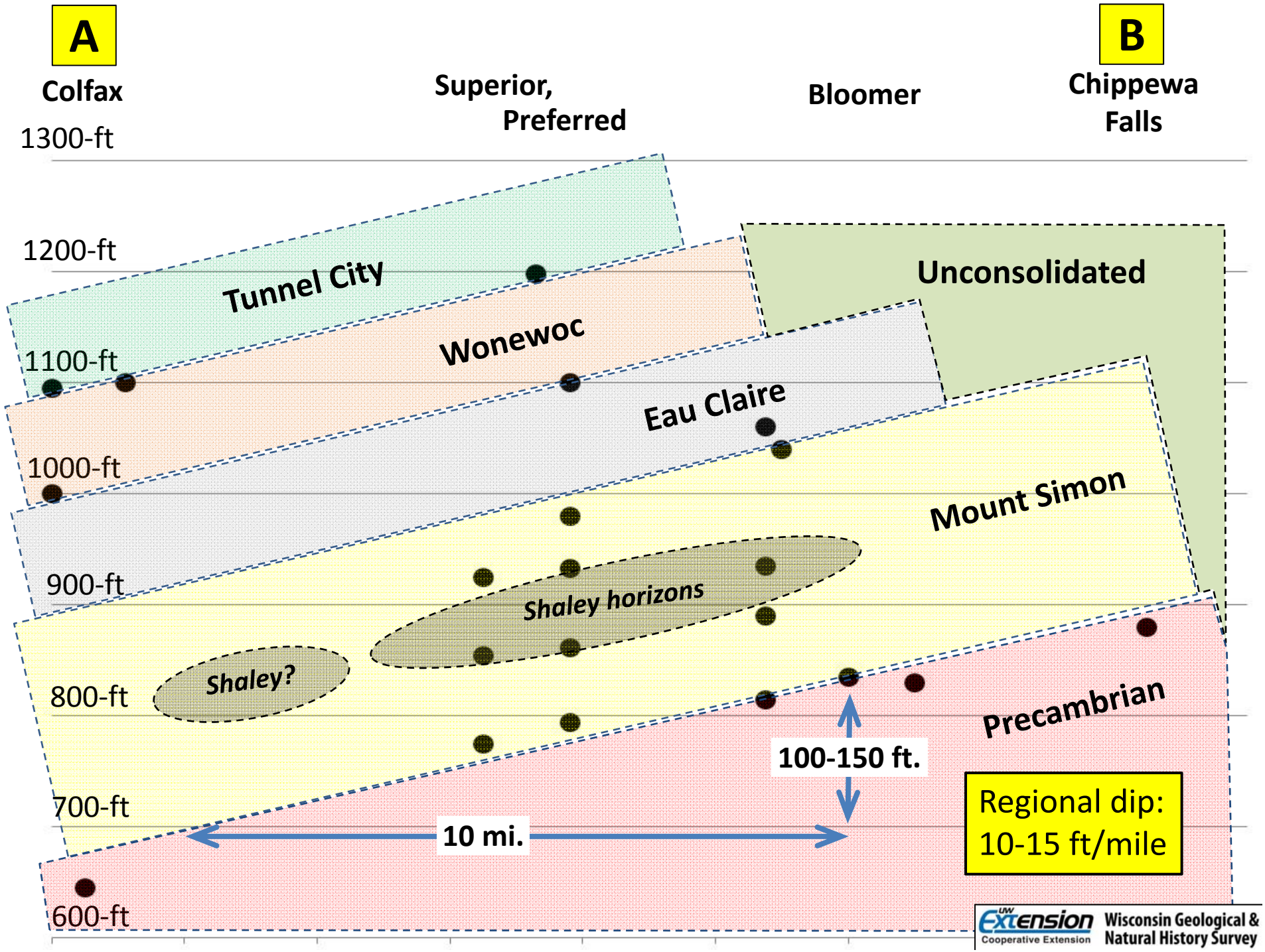
Progress to date – Prelim. interpretations



- Using geologic logs, Geophysical logs, and outcrops…
- General dip and location of bedrock units
- Presence of aquifer and aquitard units


A
B
Colfax
Superior, Preferred
Bloomer
Chippewa Falls
1300-ft
1200-ft
1100-ft
1000-ft
900-ft
800-ft
700-ft
600-ft
Tunnel City
Wonewoc
Eau Claire
Mount Simon
Unconsolidated
Shaley horizons
Shaley?
Precambrian
100-150 ft.
10 mi.
Regional dip: 10-15 ft/mile
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Progress to date – Data collection

- Mine specific data collected by Chippewa Co. LCFM

What's next...

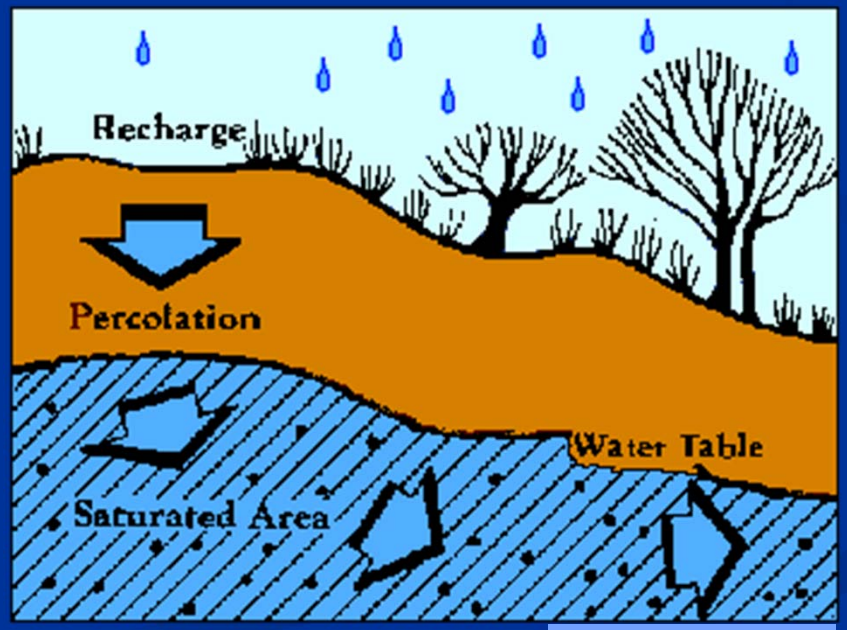
- Soil-water-balance modeling (recharge)

Recharge from Soil-Water Balance (SWB)

- Recharge = Precipitation - Evapotranspiration - Soil Storage – Runoff

These different terms can be related to GIS layers.

- Evapotranspiration depends on soils and land cover.
- Soil storage from the soil type.
- Runoff depends on hillslope and soils.



D. Feinstein USGS

Courtesy of D.J. Hart
WGNHS

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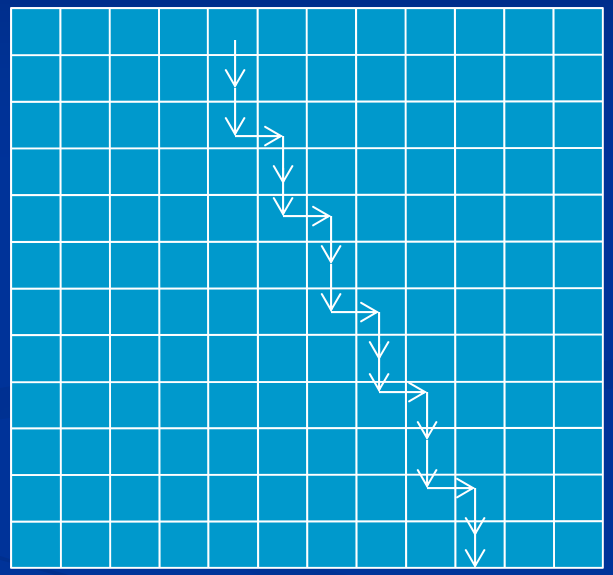
Mechanics of SWB Model

- GIS layers are gridded
- Soil-Water Balance equation applied to cell.
- Excess water (runoff) moved to next down gradient cell and SWB equation applied again.
- Repeat until all runoff is moved to surface water or out of model.

Recharge = Precipitation
- Evapotranspiration - Soil Storage – Runoff



An example from East Central WI RPC (ECWRPC)…

Courtesy of D.J. Hart
WGNHS

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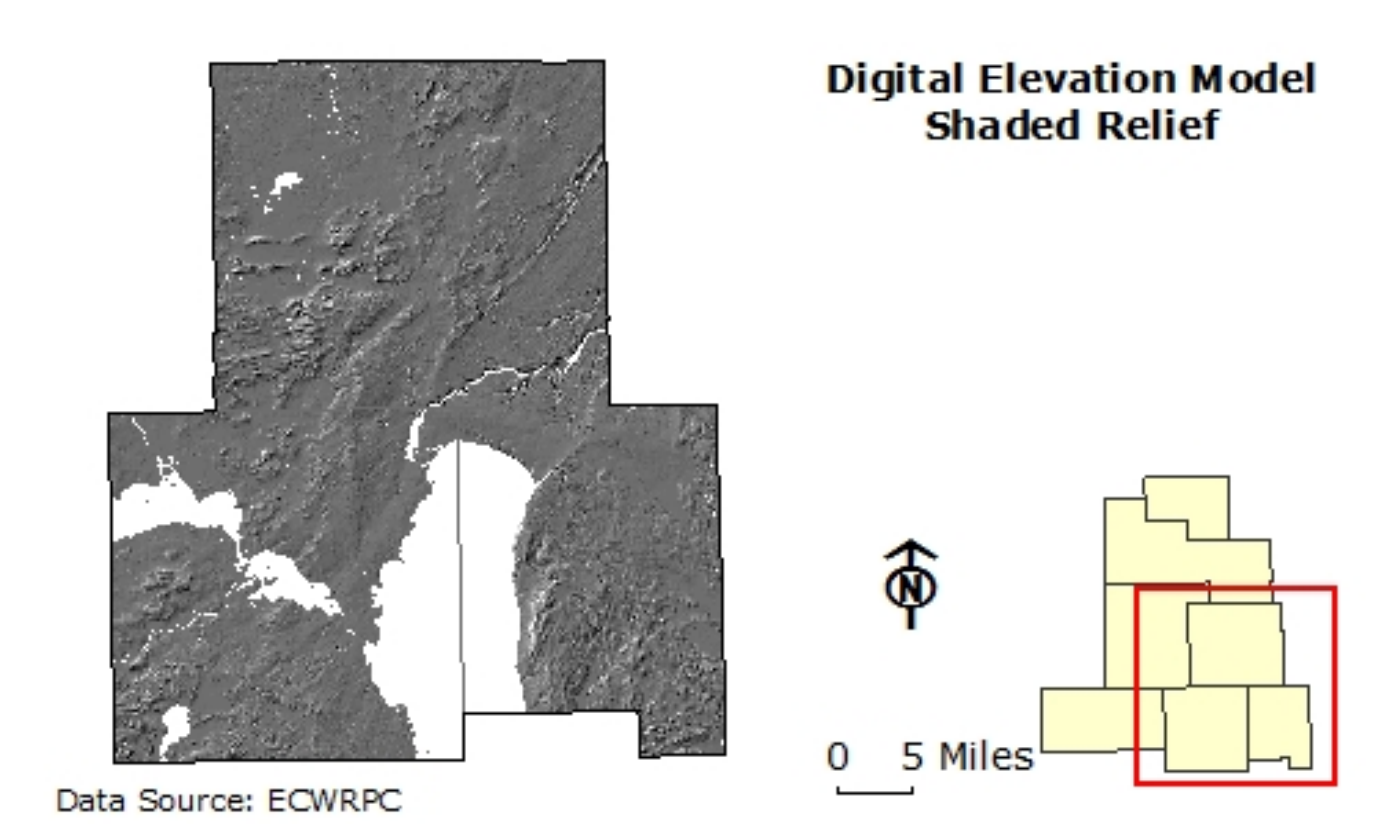
GIS Layers
Digital Elevation Model (DEM)



Controls runoff amount and direction

Courtesy of D.J. Hart
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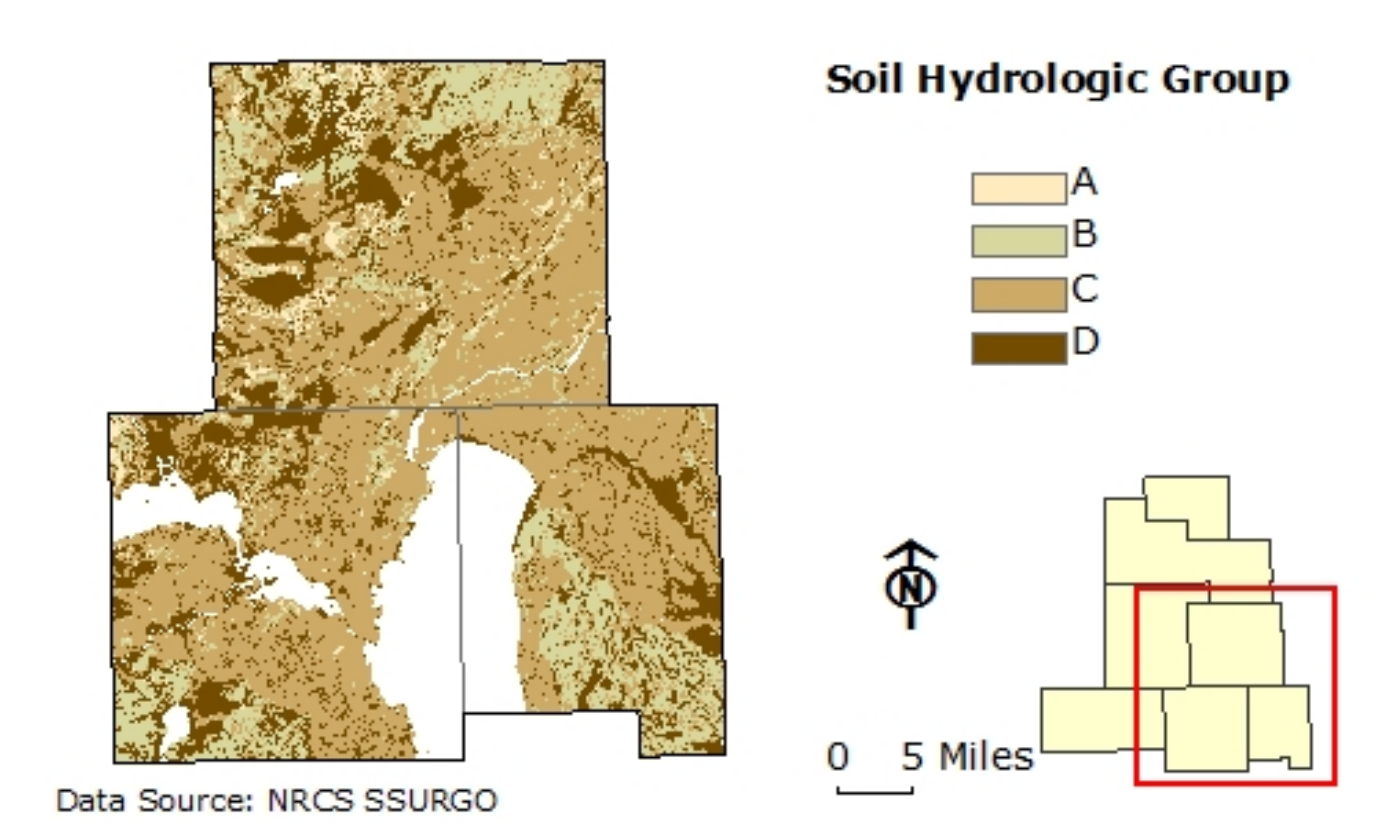
GIS Layers
Soil Hydrologic Group



Lighter colors show more infiltration and less runoff;
Darker colors show less infiltration and more runoff

Courtesy of D.J. Hart
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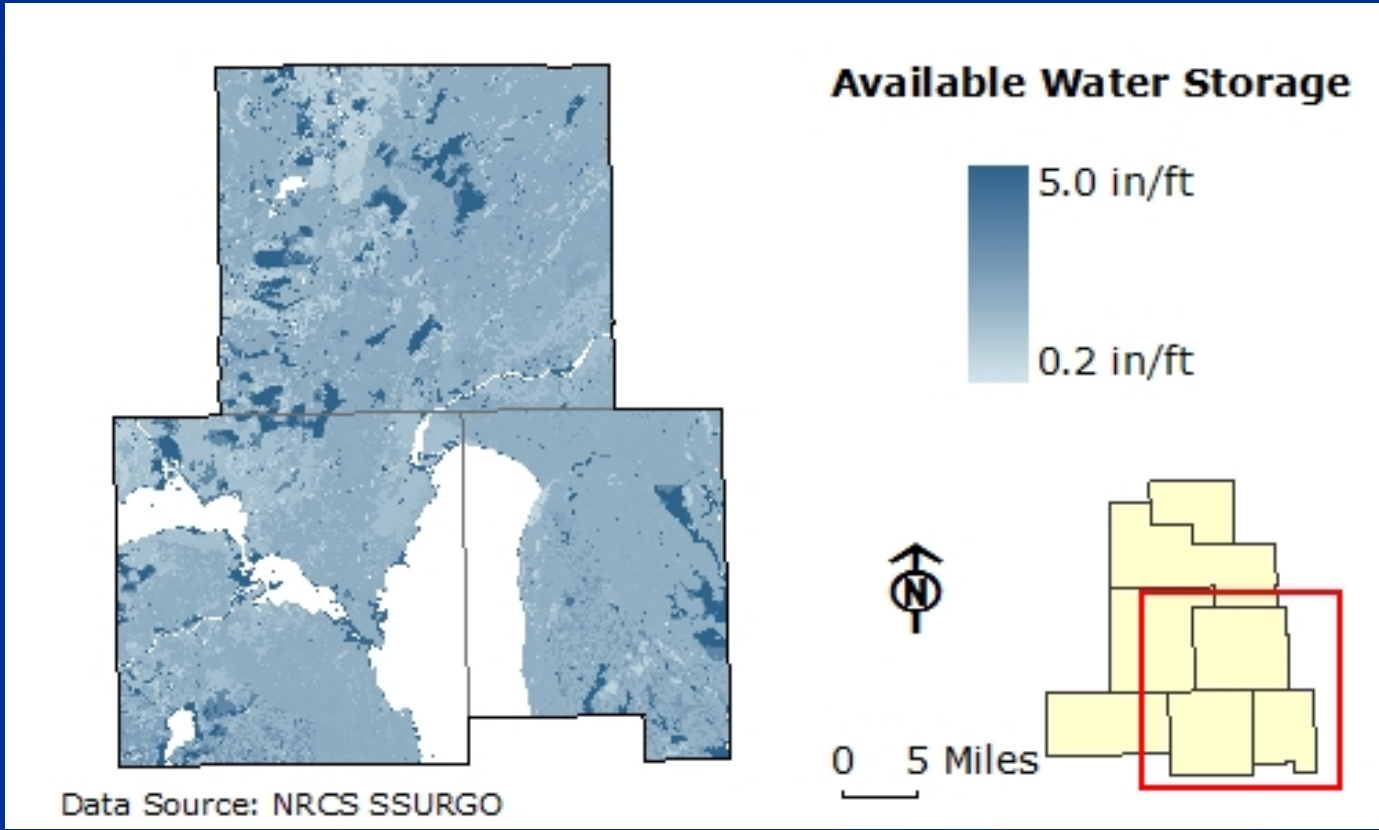
GIS Layers
Soil Available Water Storage

How much water can the soil hold before recharge occurs?



Darker colors indicate higher soil water storage capacity; Lighter indicate lower soil water storage capacity.

Courtesy of D.J. Hart
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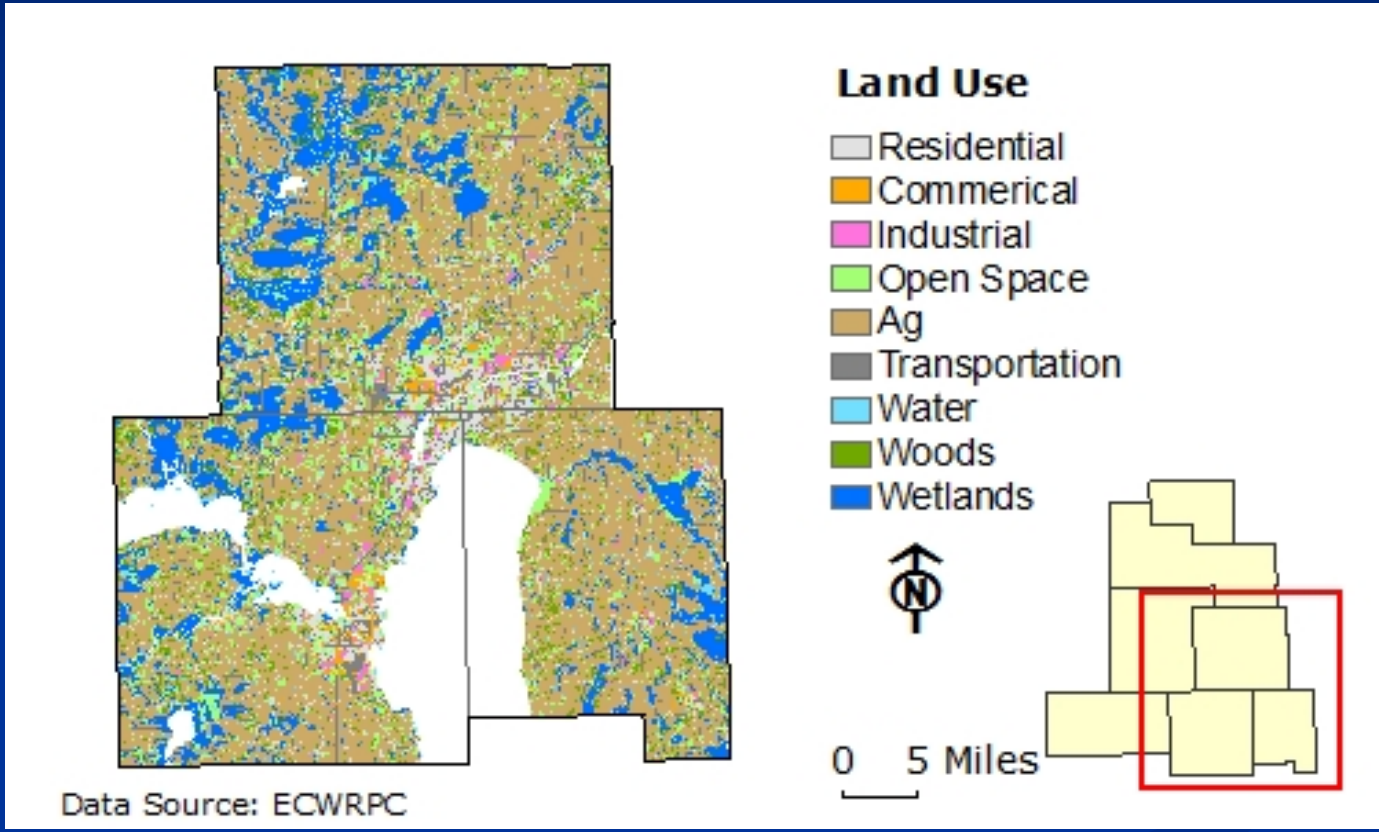
GIS Layers
Land Use



Controls evapotranspiration and runoff

Courtesy of D.J. Hart
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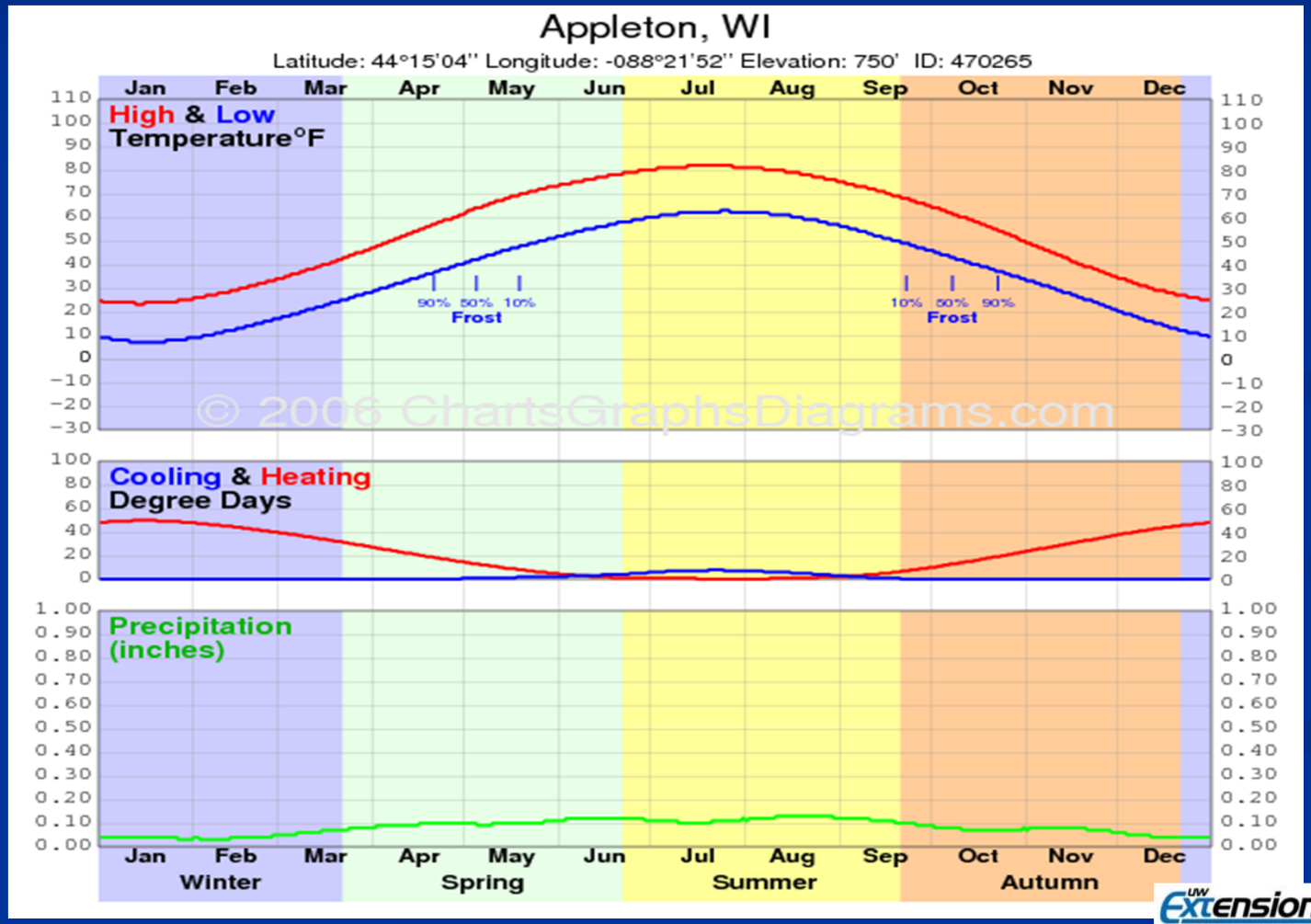
Climate

Precipitation – Snow, Rain, etc.

Temperature – Evapotranspitation

Runoff – Frozen ground (can use daily temperature or algorithm to determine)



Courtesy of D.J Hart WGNHS

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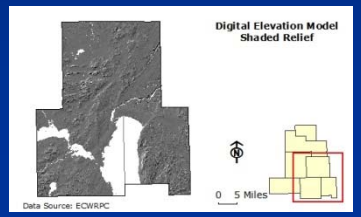
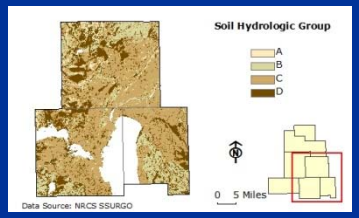
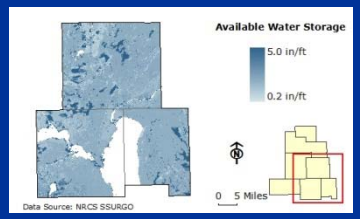
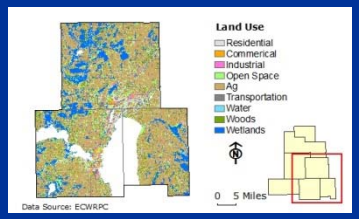
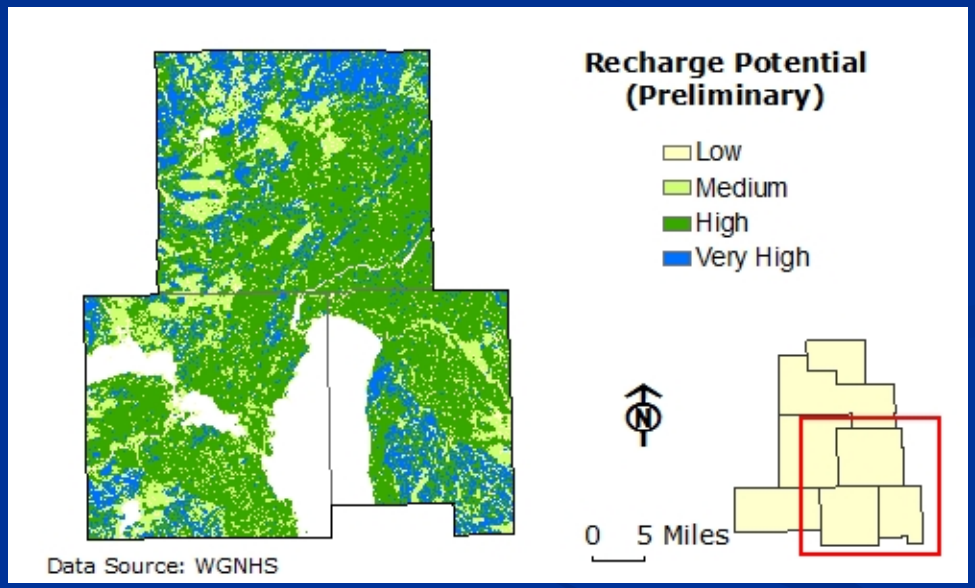
SWB Estimated Recharge











Courtesy of D.J. Hart
WGNHS

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What's next...

- Soil-water-balance modeling (recharge)
- Continue data collection, processing, and interpretation
  - GP logs, geologic logs, and rock core (WGNHS to collect directly)
  - Pump test data, water levels (Chippewa Co. LCFM to collect)
- WGNHS visiting several mine sites this week
- Seeking cooperation to obtain geologic logs, geophysical logs, rock cores (e.g., donated core, photos) from mining companies

Upcoming meetings and deliverables

- **Public meeting tonight at the Bloomer Middle School**
  - **5:00 – 7:00pm Outreach workstations**
  - **7:00 – 9:00 pm Public meeting**
- Next meetings (2014 annual update)
  - Stakeholders meeting – Q1 2014
  - General public meeting – Q1 2014
- Deliverables
  - Interim report – Q4 2014 (data collection and SWB modeling results)
  - Final report – Q3 2017 (final model, scenarios, transferability results)

Chippewa County Groundwater Study

2nd Stakeholders Group Meeting

Stakeholders Group Meeting
Chippewa Falls, WI
02/26/2013

USGS science for a changing world

Chippewa County Land Conservation and Forest Management "Stewardship for Sustainability"

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