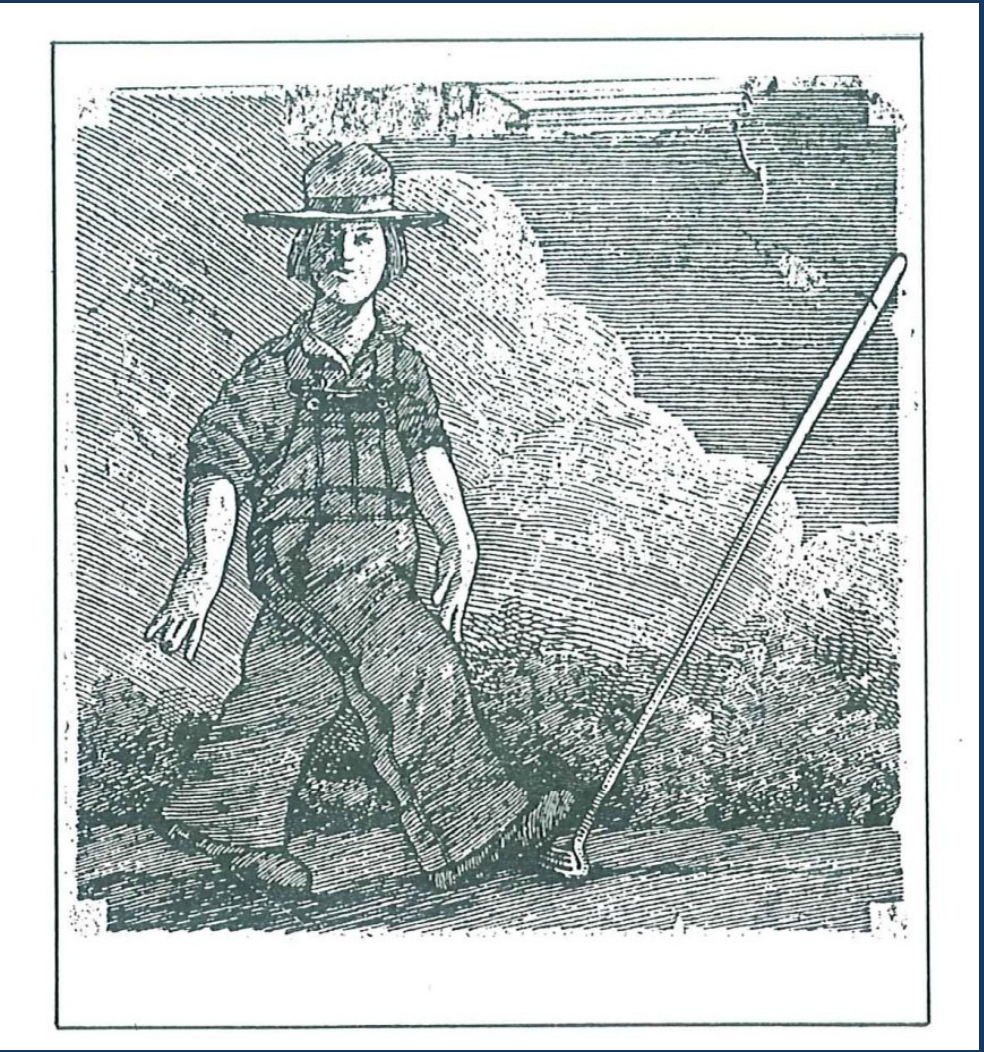
Overview of a Groundwater Study to Evaluate the Impacts of Non-Metallic Mining & Irrigated Agriculture in Western Chippewa County, Wisconsin

Midwest Groundwater Conference
Minneapolis, MN 10/1/12

Dan Masterpole
Dept. Director/Co. Conservationist

dmasterpole@co.chippewa.wi.us
www.co.chippewa.wi.us
LCFM/Non-Metallic Mines/Program Info.

Dept. of Land Conservation & Forest Management



Source: Common Sense, 1976, J. Prine

Structure of Presentation

- Overview of the issue
- Overview of hydrological study:
  - -Purpose
  - -Study approach/methods
- Overview of model approach:
  - -SWB (Soil Water Balance)
  - -MODFLOW
- Status of project & data collection
- Lessons learned
- Q & A

Regional Issue

Global demand for food, fiber, & energy have increased demands on the land & natural resource base in Midwest States:

- Increased acreage of irrigated agriculture
- New demand for “frac sand”

Public concerns expressed regarding impacts on:

- Groundwater supplies
- Surface waters

A Review of the Basics

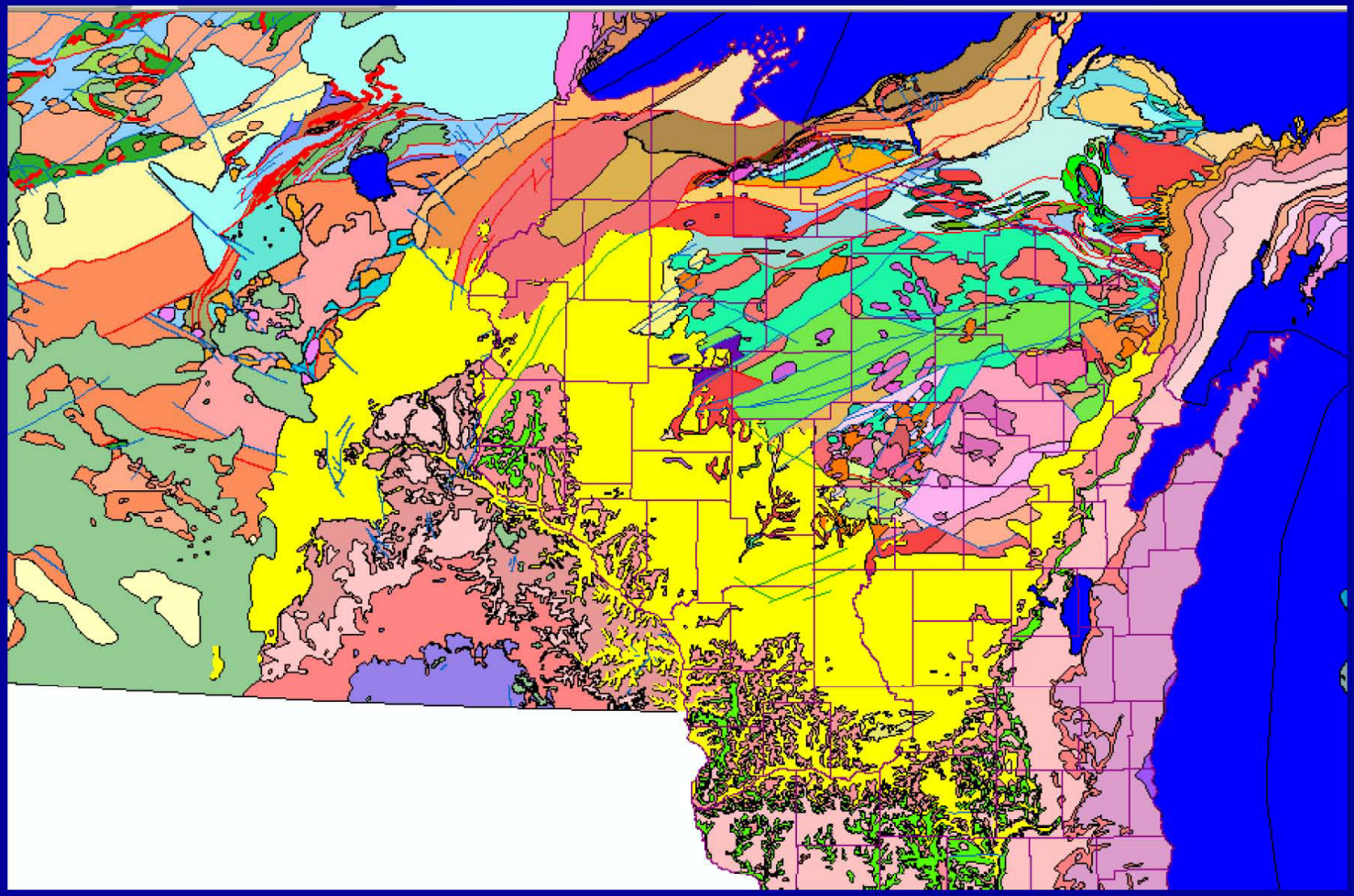
In some areas of MN & WI, sandstone formations occur at or near the surface

Sand from several of these formations has physical properties that allow it to be used in oil & gas well development

- St. Peter Formation
- Jordan Formation
- Wonewoc Formation

These formations can provide a stable supply of “frac sand”, that will be used to offset global energy demand

OUTCROP AREA OF THE CAMBRIAN SANDSTONES WISCONSIN AND MINNESOTA



Source: GOLD, IRON, COPPER, ZINC, AND SAND; WHAT'S DRIVING THE NEW INTEREST IN MINING AND MINERAL RESOURCES IN WISCONSIN Bruce A. Brown (WGNHS – UWEX)

BEDROCK SAND RESOURCES

Cambrian Wonewoc Fm.

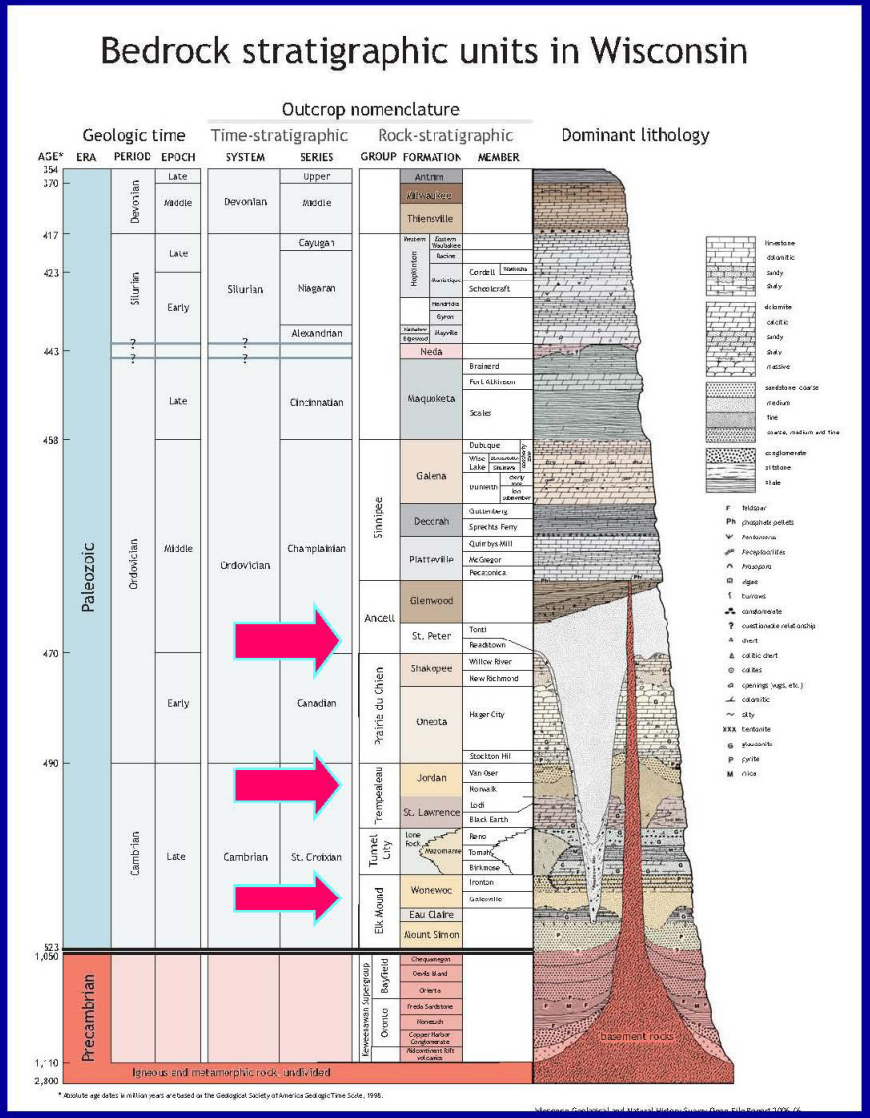
Important producer and potential resource in west, not exposed elsewhere.

Cambrian Jordan Fm.

Extensive potential in west, currently important source of fracsand from underground mines. Poor exposure in east.

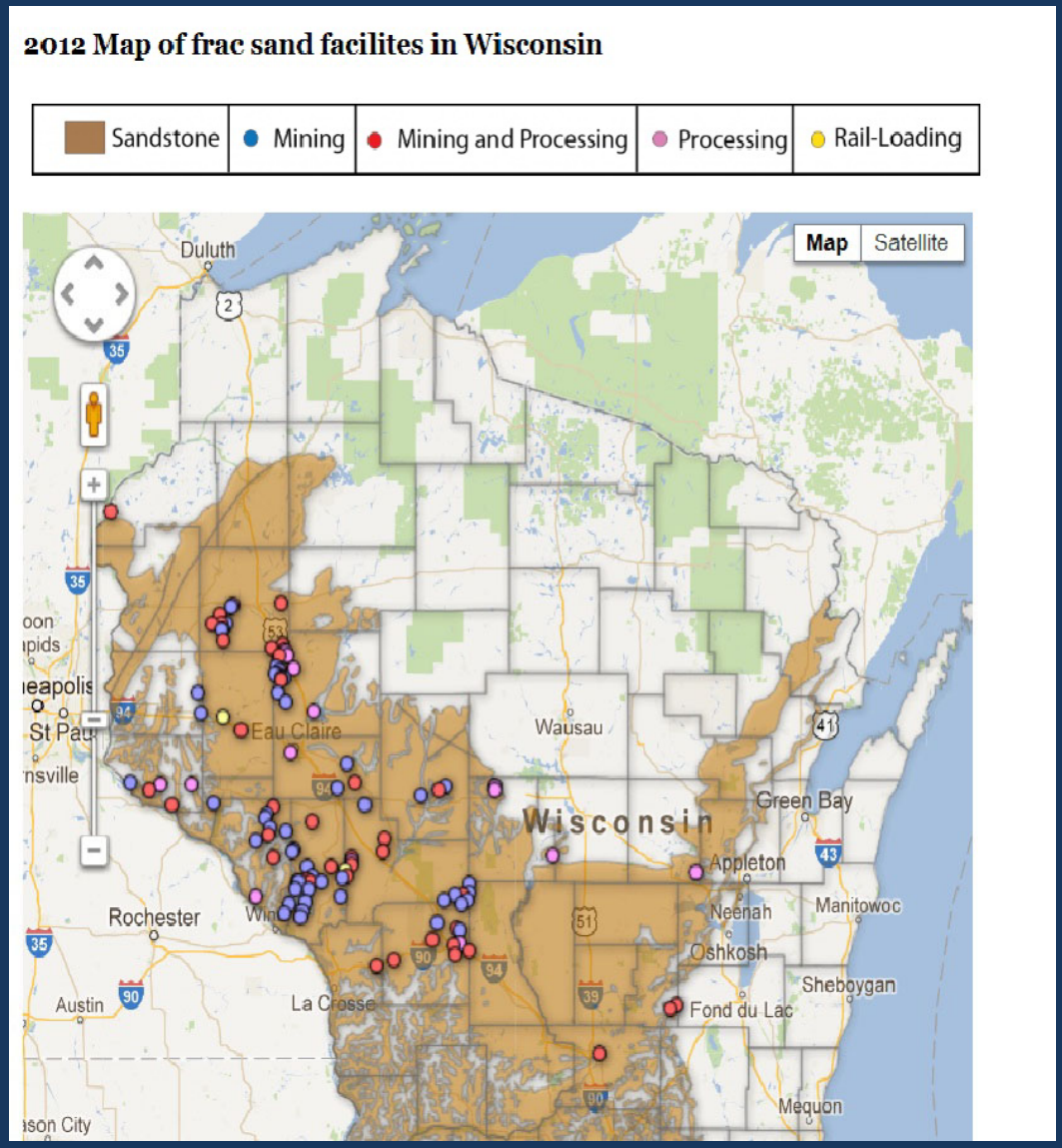
Ordovician St. Peter Fm.

Long production history and good potential in south and east. Channels can make prospecting a challenge in the northeast.



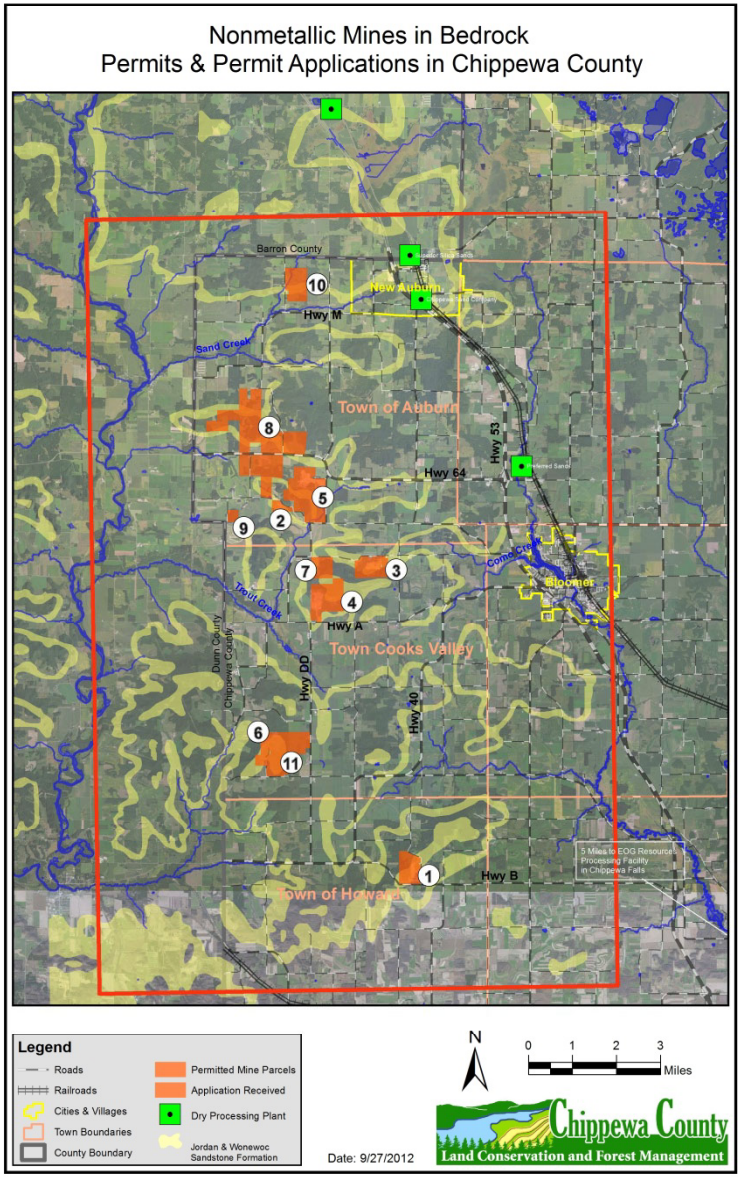
Source: GOLD, IRON, COPPER, ZINC, AND SAND; WHAT'S DRIVING THE NEW INTEREST IN MINING AND MINERAL RESOURCES IN WISCONSIN Bruce A. Brown (WGNHS – UWEX)

WI Industrial Sand (7/22/2012)



Source: WisconsinWatch.org (7/22/12)

Sand Mines in Chippewa County



Wisconsin County Role in Non-Metallic Mine Permitting

Role of County (if no zoning):

- Receive & review non-metallic mine reclamation permit applications & plans
- Facilitate public participation via public notice & hearing process
- Develop reclamation permit conditions & issue permits if state reclamation standards can be met
- Administer ongoing reclamation program & assure permit compliance

Public Concerns

Public hearing concerns:

- Location of industrial sand mines/processing facilities in proximity to headwater streams & domestic wells

- Cumulative impacts of multiple mines/processing facilities (high density)

Public Concerns

Public hearing concerns:

"What will be the short and long-term affects on groundwater levels and stream base flow" caused by:

- Changes in topography & recharge?
- Additional groundwater use?

Local Response to Concern

1. Form a “Coalition of the Willing”, comprised of project stakeholders:

    - Mining interests
    - Ag. Interests
    - Agencies
    - Conservation orgs.

2. Collaborate to share info. & resources (staff hrs., skills sets, $)

3. Contract independent agencies to do a science-based hydrologic study

    - USGS
    - WGNHS

Why Collaborate?

Benefits to participants:

•Provides all parties with the best available information to support informed decision making by:

-General public
-Facility operators
-Regulatory agencies
-Local units of government

Purpose of Study

1. Develop soil water balance & groundwater flow models to evaluate the impacts of current and future water use & topography on the hydrologic system

2. Disseminate the study results to project stakeholders & public

3. Transfer the results to similar geologic & hydrologic settings

Project Stakeholders & Participants

Mining interests

- Superior Silica Sands
- Preferred Sands
- Chippewa Sands
- EOG Resources
- Taylor Creek Transit
- Others (as mines open)

Agencies

- USGS
- WGNHS/UWEX
- DNR
- LCFM

Irrigated Ag. Interests

- WI Farmer's Union
- (2) producers

Env. & Public Interests

- Trout Unlimited
- (1) citizen rep.

Geologic & Scientific Support

USGS

Surface Water Monitoring
R. Waschbusch

Groundwater Modeling
M. Fienen
P. Juckem

WGNHS

M. Parsen
M. Gotkowitz

WDNR

Reg. Water Res. Team
Reg. Fisheries Team

Timeframe & Costs

Five (5) year project

- 7/1/2011 – 12/31/2016

Range
$500,000 - $600,000

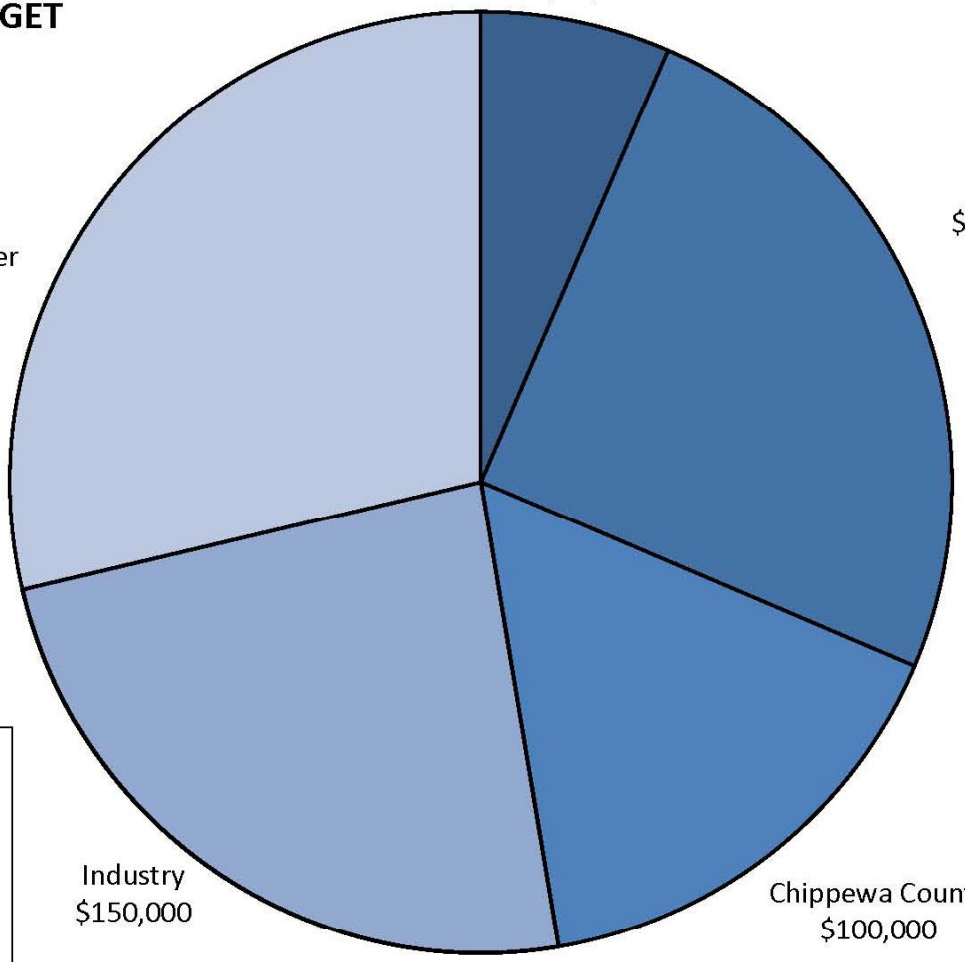
Variables

- # of gauging stations, well monitoring networks
- # of cooperating parties
- Amount of data and $ contributed by cooperating parties

Proposed Cost Distribution

REVENUE SOURCES
GROUNDWATER STUDY BUDGET

Figure 2



WGNHS	$ 40,725
USGS	$155,700
Chippewa Co.	$100,000
Industry	$150,000
Grants	$179,500
Total	**$625,925**

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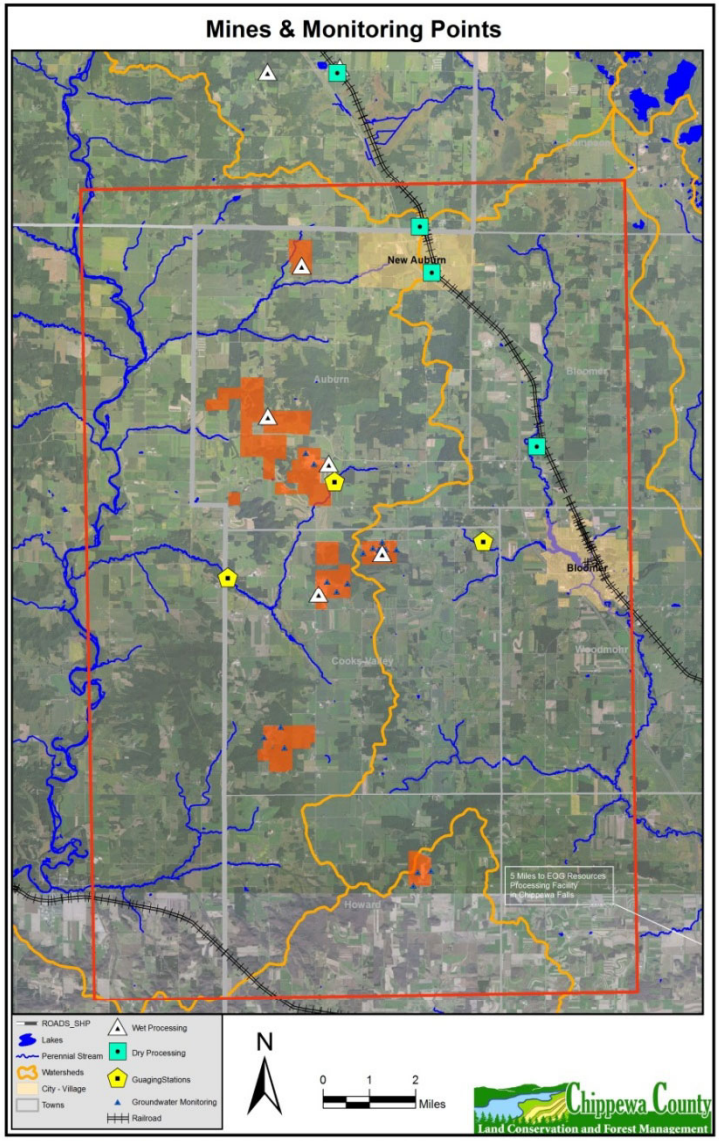
Data Commitments by Stakeholders

1. Stream gauges (3 sites – 3 yrs) to record baseflow discharge
2. Drill logs & onsite boreholes to characterize sandstone strata
3. Monitoring well networks to record groundwater elevations, fluctuations, & flow gradients
4. High-cap well pumping records & pump test to characterize groundwater use, yield, & response
5. Site specific measurements & case studies

- Water budgets
- Storm pond infiltration
- Weather station (ET)
- Groundwater chemistry

Mines & Monitoring Points



Data Commitments by Stakeholders

Table 1

LCFM 9/24/12

TENTATIVE COMMITMENTS TOWARD DATA SHARING TO CHARACTERIZE RESOURCE CONDITIONS AND DEVELOP A PREDICTIVE GROUNDWATER MODEL TO EVALUATE THE EFFECTS OF WATER WITHDRAWS ASSOCIATED WITH THE WONEWOC, EAU CLAIRE, AND MT. SIMON SANDSTONE FORMATIONS

Cooperating Parties	Baseline Resource Characterization					Resource Response & Monitoring					
	Geology			Groundwater		Groundwater				Baseflow	
	PPT/ET Weather Station	High Cap. Drill Logs	Borehole Analysis	Monitor Well Network & Elv. Map	Deep/Shallow Nest	Pump Test	Monitoring (Vol.)	Monitoring (Chemistry)	Modeling +(3)	Monitoring (Vol.)	Monitoring (Biology)
Superior Silica Sands		✓	✓	✓	✓		✓	✓	✓	✓	
Preferred Sands		✓	✓	✓	✓	✓	✓+(1)	✓+(2)	✓	✓	
Chippewa Sands		✓		✓			✓		✓	✓	
EOG Resources	?			✓			✓	✓+(2)			
Taylor Creek Transit				✓			✓				
Western WI Sand Co.											
A & M Mikl Sands		✓	✓	✓							
Trout Unlimited									✓	?	?
WI Farmer's Union									✓		
WGNHS									✓		
USGS									✓	✓	
DNR									✓	✓	✓
Chippewa County									✓		

Explanatory Notes:

(1.) Groundwater Monitoring (Vol.) includes commitment to place continuous data loggers on wells in the monitoring well network.

(2.) Groundwater Monitoring (Chemistry) includes commitment to sample monitor wells located on the mine site and select domestic wells located adjacent the mine site.

(3.) Initial interest in participating in model design.

Project Management

There are two study components (conducted in parallel):

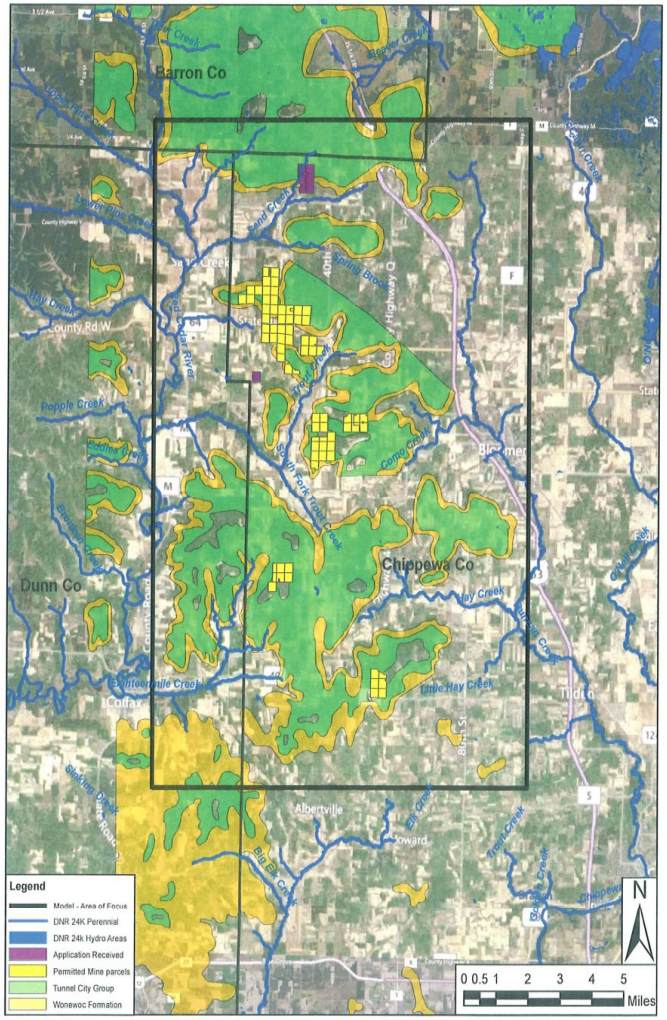
1. A technical investigation & modeling component

2. A public outreach & reporting component

-Specific tasks & products are scheduled under each component to coincide with model development

Model Area

Figure 1 - Preliminary Model Area



Technical Investigation & Modeling

MODFLOW model (3D/steady state conditions)

- Used to characterize the hydrologic system & evaluate changes resulting from groundwater withdrawal

- Used for scenario testing & predictions:

  -Changes in hydrologic conditions (i.e. drought/wet cycle)

  -Changes in water use
    - New wells
    - Alt. pumping rates and duration
    - Water conservation BMP's

Technical Investigation & Modeling

SWB model (Soil Water Balance)

•Used with MODFLOW to:

-Estimate recharge to the groundwater system

-Evaluate impacts from changes to topography, soils, & land cover

Technical Investigation & Modeling

1. Data collection & interpretation (2012-2013)

    •Collect available hydrologic/geologic data for model development

2. Soil Water Balance (SWB) modeling (2014)

    •Build model & evaluate recharge under select scenarios

        -Current (pre-mining)
        -Future (post-mining)

Technical Investigation & Modeling (Continued)

3. Groundwater modeling & calibration (2013-2015)

   •Build MODFLOW model & calibrate to steady state condition/pre-mining landscape

4. Scenario testing (2016)

   •Apply combined models (SWB/MODFLOW) to evaluate impacts of changes in pumping rates & recharge under select scenarios

   - Peak mine expansion & irrigation (~2030?)
   - Post-mine reclamation (~2050?)

Technical Investigation & Modeling (Continued)

5. Transferability (2017)

- Apply model to evaluate generalized system response to areas outside the model boundary with comparable with geologic/hydrologic setting

- Develop logical “rules of thumb” to support qualitative assessments of hydrologic response to changes in groundwater pumping

Project Status

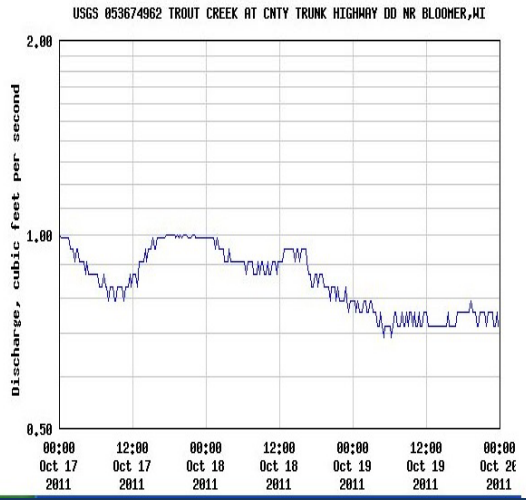
- [x] Stream Gauging and groundwater monitoring networking installed
- [x] Study design completed & service contracts signed
- [x] Stakeholder group formed & data sharing commitments made
- [ ] Data collection/Compilation (Q4; 2012)
- [ ] Modeling/Public outreach (2013)

Data Collection - Stream Gauges

Chippewa County Department of Land Conservation and Forest Management

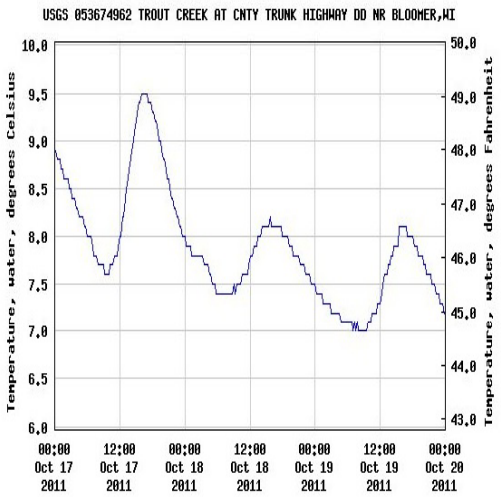
Discharge, cubic feet per second

Most recent instantaneous value: 1.0 03-23-2012 11:45 CDT



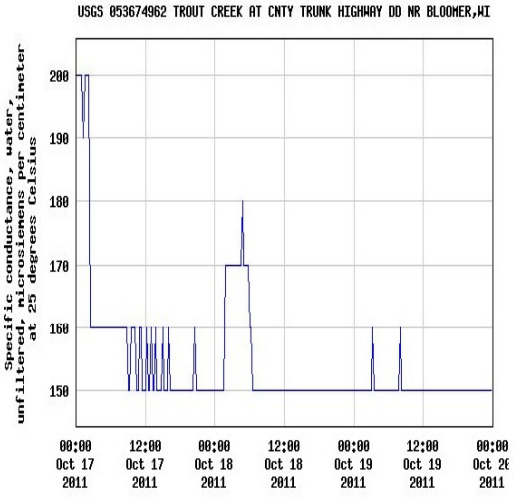
Temperature, water, degrees Celsius

Most recent instantaneous value: 11.6 03-23-2012 11:45 CDT



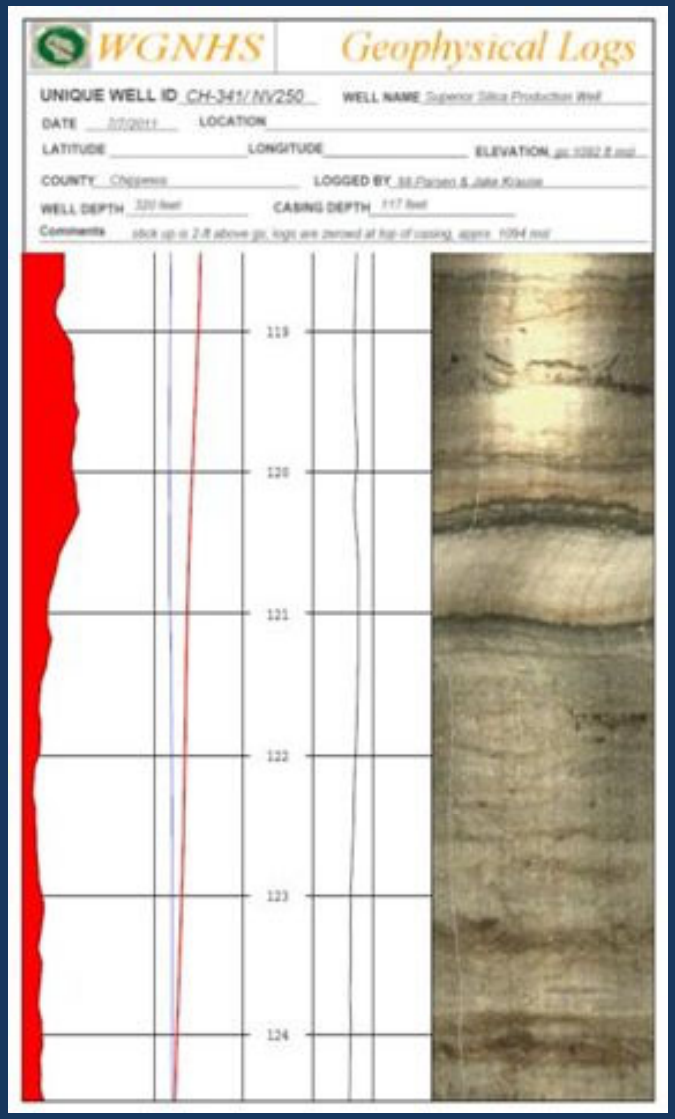
Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius

Most recent instantaneous value: 117 03-23-2012 11:45 CDT

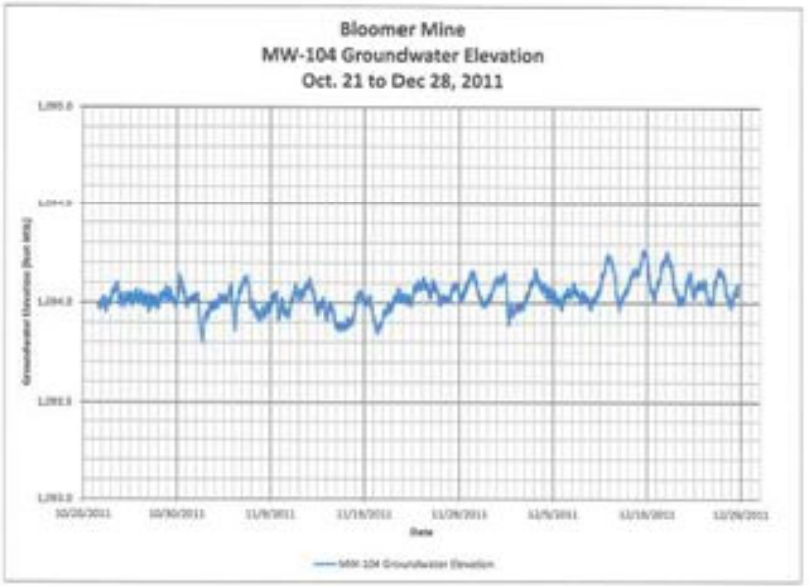


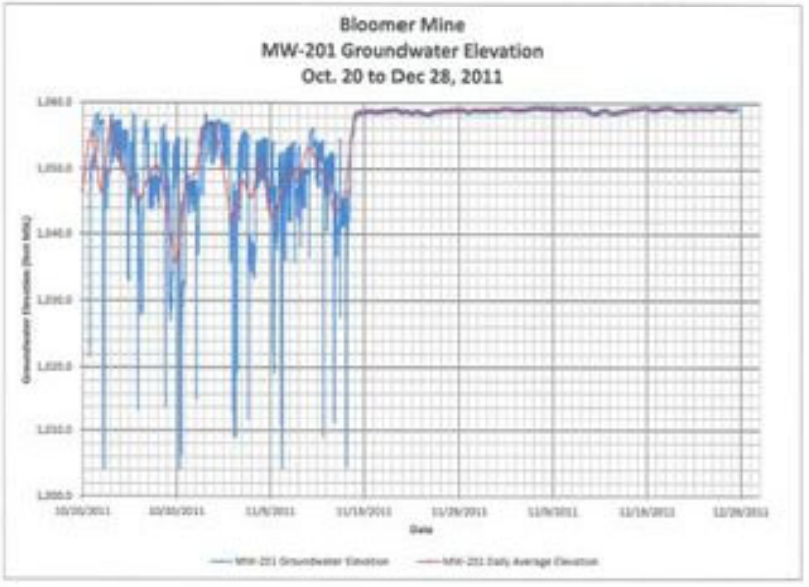
Data Collection - Onsite Borehole Logging

Data Collection - Geophysical Borehole Analysis

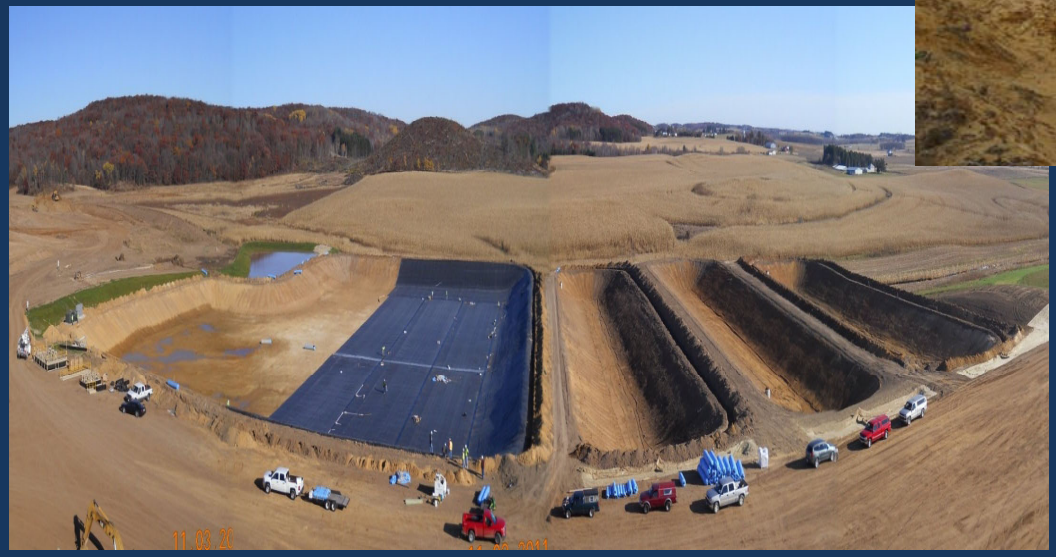


Data Collection - Groundwater Elevation Monitoring





Data Collections - Case Studies – Water Mngt. – Wash Process



Data Collection - Case Studies – Water Mngt. - Infiltration

Conclusion

Lessons Learned

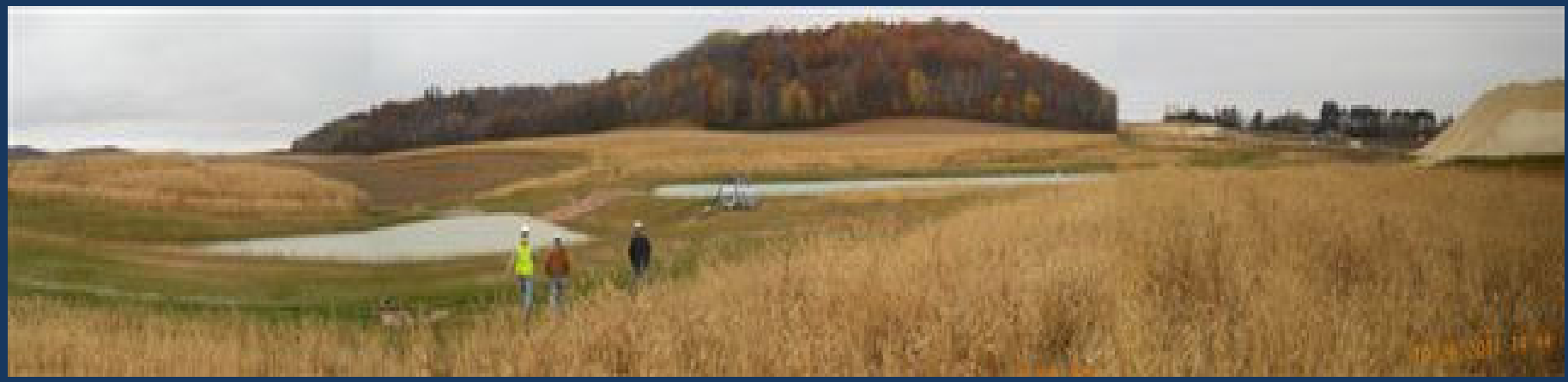
•Public is concerned about the quality of the environment & will participate in the permitting process

•Top tier mining companies have made commitments to address local water mngt. concerns via environmental monitoring & use of Best Management Practices (BMP's)

•Local/State/Fed. agencies have been responsive & have initiated research to address the groundwater mngt. concerns (Results to follow)

•Think globally/Act locally

Conclusion



Questions/Suggestions?

Full study proposal available at www.chippewa.wi.us, LCFM/Non-Metallic Mines/Program Info.