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

Chippewa County Board Presentation
1/8/13

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LCFM/Non-Metallic Mines/Program Info.
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
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
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
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)
Silica-rich sandstone

Mines & proposed mines

Silica sand-rich layers

Source: Amended from Dr. Tony Runkel, MN Geological Survey, (University of MN); Silica Sand Mining in the Central Midcontinent, MGWA Fall 2012 Conference, Minneapolis, MN (10/1/12),
2012 Map of frac sand facilities in Wisconsin

Source: WisconsinWatch.org (7/22/12)
Sand Mines in Chippewa County

Nonmetallic Mines in Bedrock
Permits & Permit Applications in Chippewa County

Legend:
- Roads
- Railroads
- Cities & Villages
- Town Boundaries
- County Boundary
- Permitted Mine Parcels
- Application Received
- Dry Processing Plant

Date: 9/27/2012
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 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 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?
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
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
<table>
<thead>
<tr>
<th>Mining interests</th>
<th>Agencies</th>
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</thead>
<tbody>
<tr>
<td>• Superior Silica Sands</td>
<td>• USGS</td>
</tr>
<tr>
<td>• Preferred Sands</td>
<td>• WGNHS/UWEX</td>
</tr>
<tr>
<td>• Chippewa Sands</td>
<td>• DNR</td>
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<td>• EOG Resources</td>
<td>• LCFM</td>
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<td>• Taylor Creek Transit</td>
<td></td>
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<td>• Others (as mines open)</td>
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<thead>
<tr>
<th>Irrigated Ag. Interests</th>
<th>Env. &amp; Public Interests</th>
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</thead>
<tbody>
<tr>
<td>• WI Farmer’s Union</td>
<td>• Trout Unlimited</td>
</tr>
<tr>
<td>• (2) producers</td>
<td>• (1) citizen rep.</td>
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</tbody>
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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

- WGNHS $40,725
- USGS $155,700
- Chippewa Co. $100,000
- Industry $150,000
- Grants & Other $179,500
- Total $625,925
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
## Data Commitments by Stakeholders

### Table 1

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

<table>
<thead>
<tr>
<th>Cooperating Parties</th>
<th>Baseline Resource Characterization</th>
<th>Resource Response &amp; Monitoring</th>
<th>Baseflow</th>
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<tr>
<td></td>
<td>Geology</td>
<td>Groundwater</td>
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<td>PPT/ET Weather Station</td>
<td>High Cap. Drill Logs</td>
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<td>Borehole Analysis</td>
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<td></td>
<td>Monitor Well Network &amp; Elev. Map</td>
<td>Deep/Shallow Nest</td>
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<tr>
<td>Superior Silica Sands</td>
<td>✓</td>
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**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.*
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
Figure 1 - Preliminary Model Area
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
SWB model (Soil Water Balance)

• Used with MODFLOW to:
  - Estimate recharge to the groundwater system
  - Evaluate impacts from changes to topography, soils, & land cover
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)
   • 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?)
5. Transferability (2017)

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

• Develop logical “rules of thumb” to support qualitative assessments of hydrologic response to changes in groundwater pumping.
Stream Gauging and groundwater monitoring networking installed

Study design completed & service contracts signed

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

[Images of groundwater monitoring equipment and graphs showing groundwater elevation data from Bloomer Mine, MW-104 and MW-201, from Oct. 21 to Dec. 28, 2011.]
Data Collections - Case Studies – Water Mngt. – Wash Process
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
Questions/Suggestions?

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