Groundwater Considerations for Gravel Mining at UMore Park: Background, Groundwater Modeling, and Monitoring

Minnesota Ground Water Association

Spring Conference

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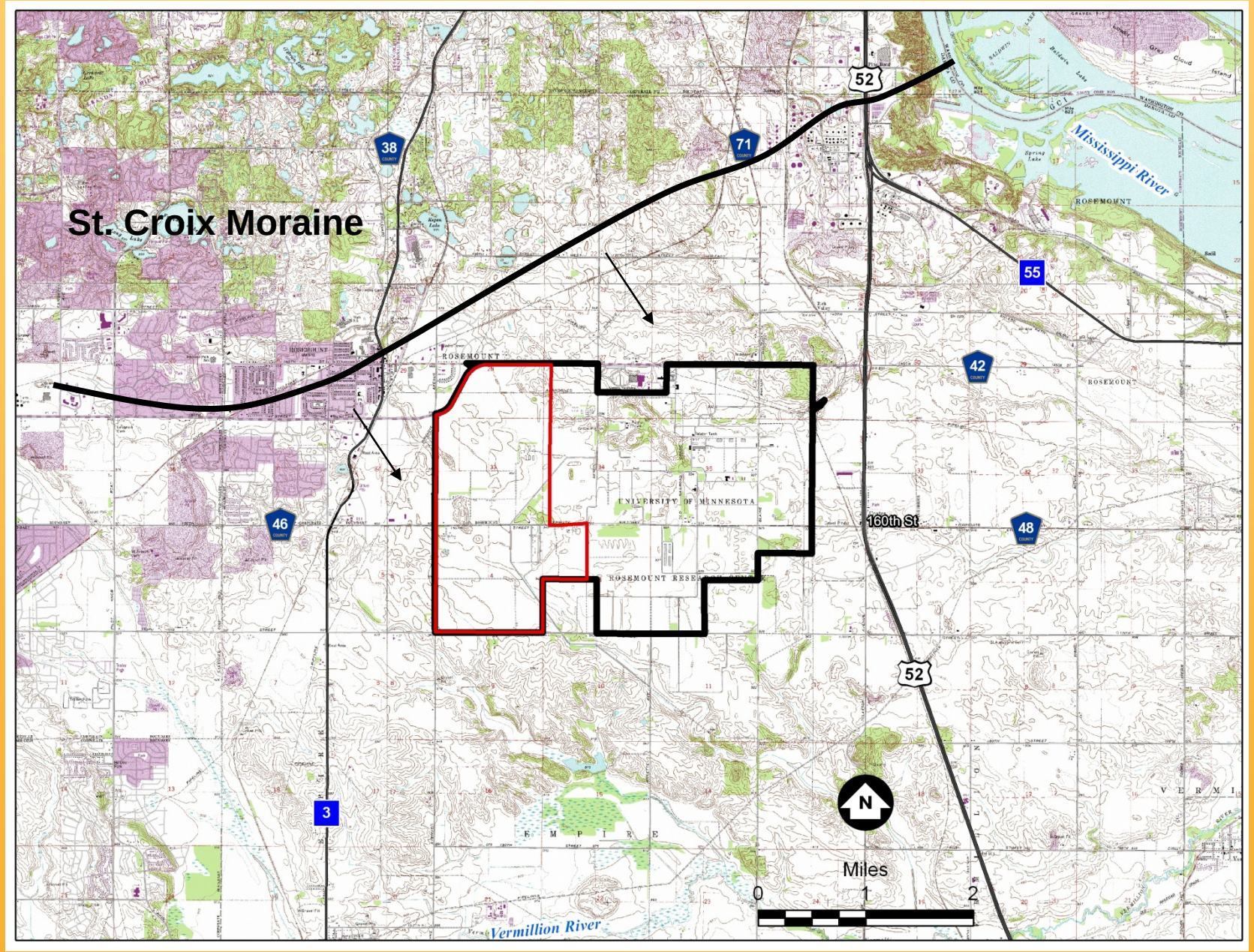
Jim Aiken, PG; Evan Christianson (Barr Engineering), and Cale Anger (University of Minnesota)

BARR

4700 West 77th Street, Minneapolis, MN Contact: jaiken@barr.com

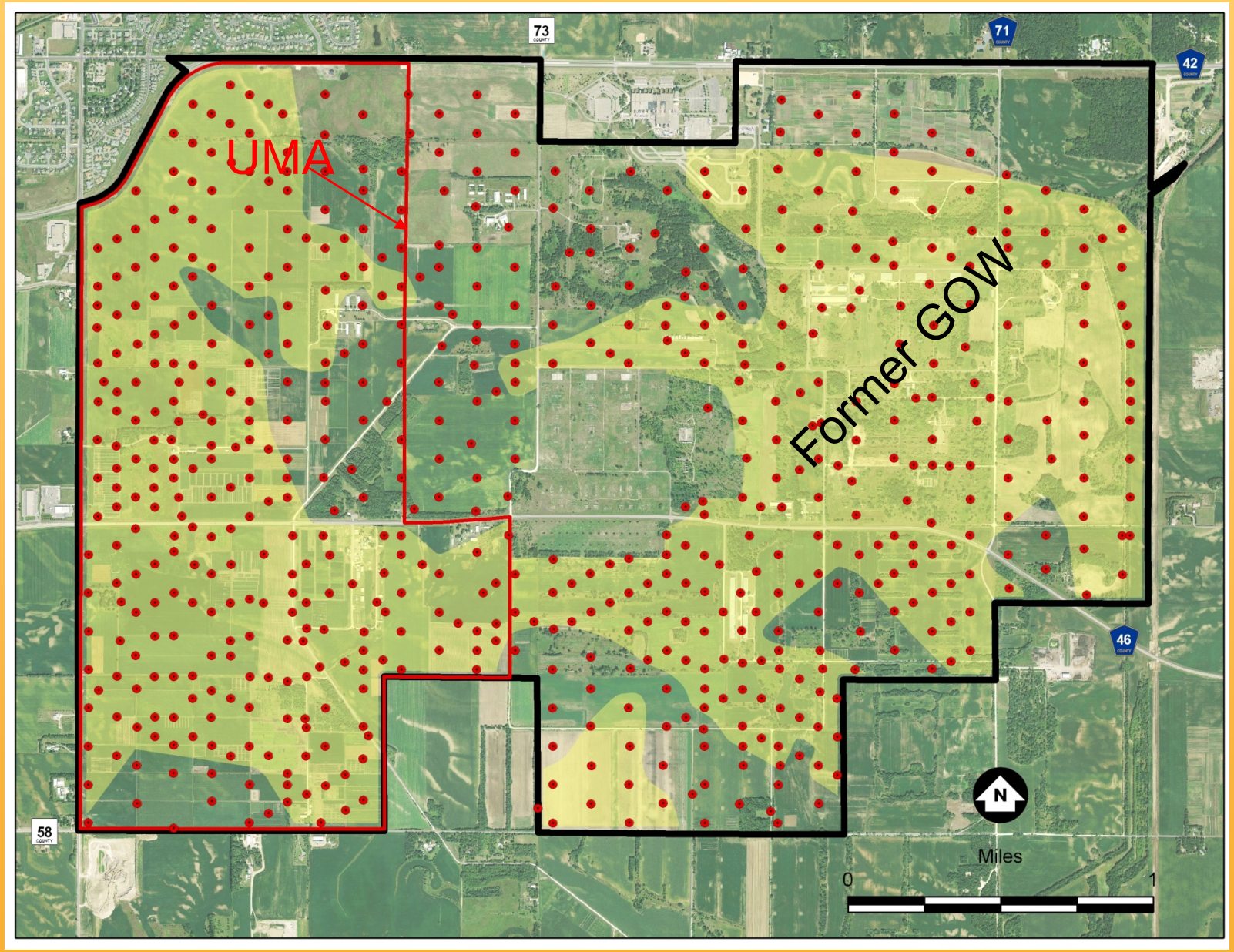
University of Minnesota's Outreach, Research, and Education Park

(aka the Rosemount Agricultural Experimental Station)


St. Croix Moraine
52
38
71
55
42
46
48
3
ROSEMOUNT
UNIVERSITY OF MINNESOTA
160th St
Mississippi River
Vermillion River
N
Miles
0
1
2

Resource Development

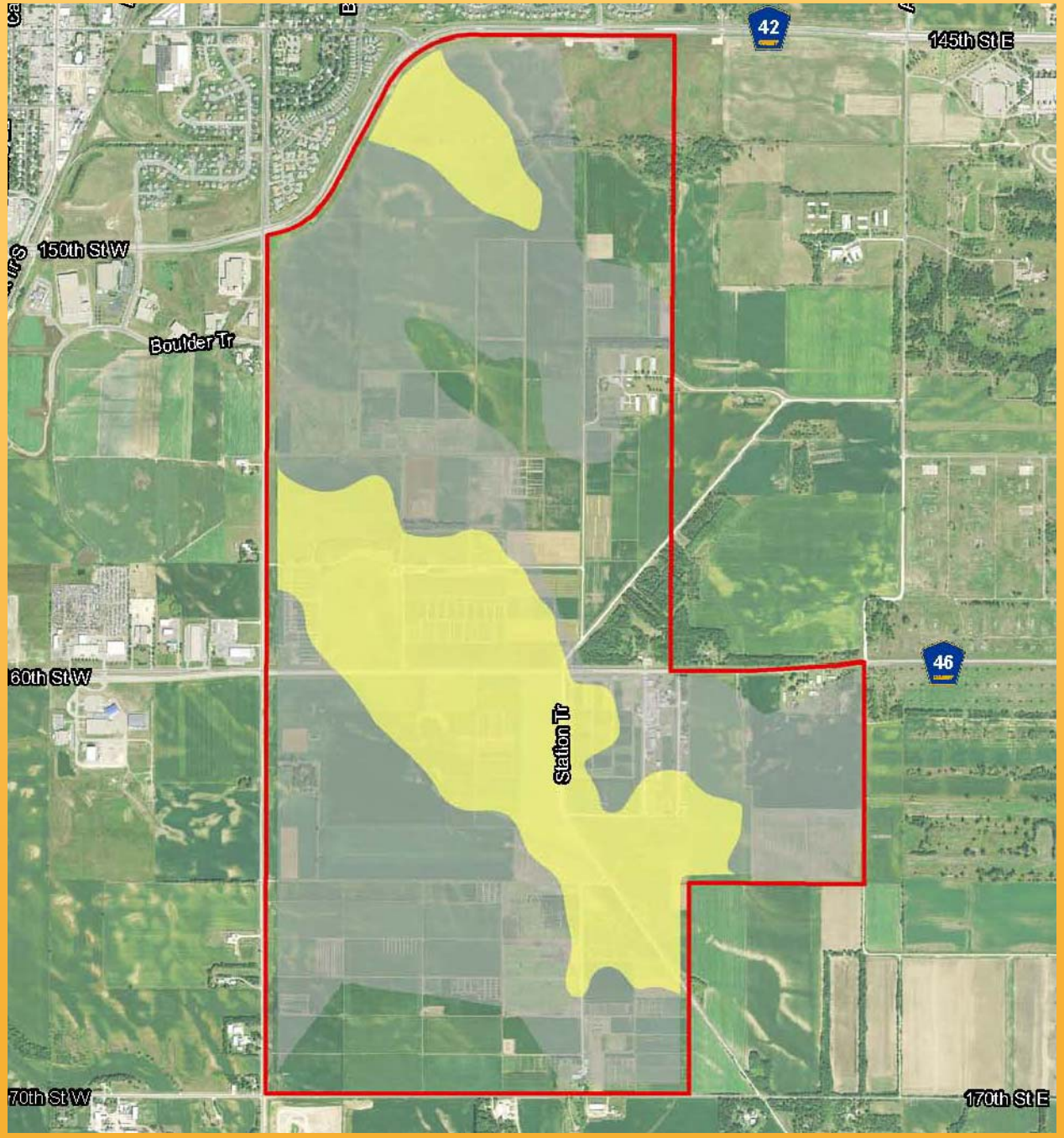
- University commissioned a gravel resource survey (ProSource, 2008)
- Conducted 600+ borings over 5,000 acres
- Found extensive gravel deposits up to 100+ feet thick
- Estimated 100 Million+ Tons of Gravel
- Identified the UMore Mining Area (UMA) for future resource development


UMA
Former GOW
73
71
42
46
58
N
Miles
0
1

Gopher Ordnance Works – WWII Gunpowder Plant

Smokeless gunpowder = Nitrocellulose, Dinitrotoluene, Diphenylanaline, and Dibutylpthalate

NOT a Munitions Works, NOT a High Explosives Plant



Project Description

- Phased Mining
- Surface Mining
- Open Water
- No Dewatering
- Gravel washing
- Production well

Key Issues for Mining EIS

- Effect of thermal transfer from mine lake
- Effect of mining on existing releases – both documented and presumed
- Drawdown effects on water resources
- Sustainable withdrawals related to mining
- Effects of mining and possible releases on drinking water aquifers
- Effects of mine pit lake on future groundwater flow/resource

DEIS and Related Investigations

- **DEIS for UMA Gravel Mining (2008…)**
- **Hydrogeologic Assessment (2008-09)**
  - **Site stratigraphy/Geologic Concept Model**
  - **Groundwater flow – direction, rate, etc.**
- **Groundwater Modeling (2009-2010)**
  - **Model Development**
  - **Predictive Simulations for DEIS**
- **Baseline Monitoring/Evaluation (Cale Anger – U of M)**
- **Environmental Investigations (2009…)**


TRAUT
HYDRO-TECH
SONIC
Drilling Division

Path Forward: Groundwater Modeling

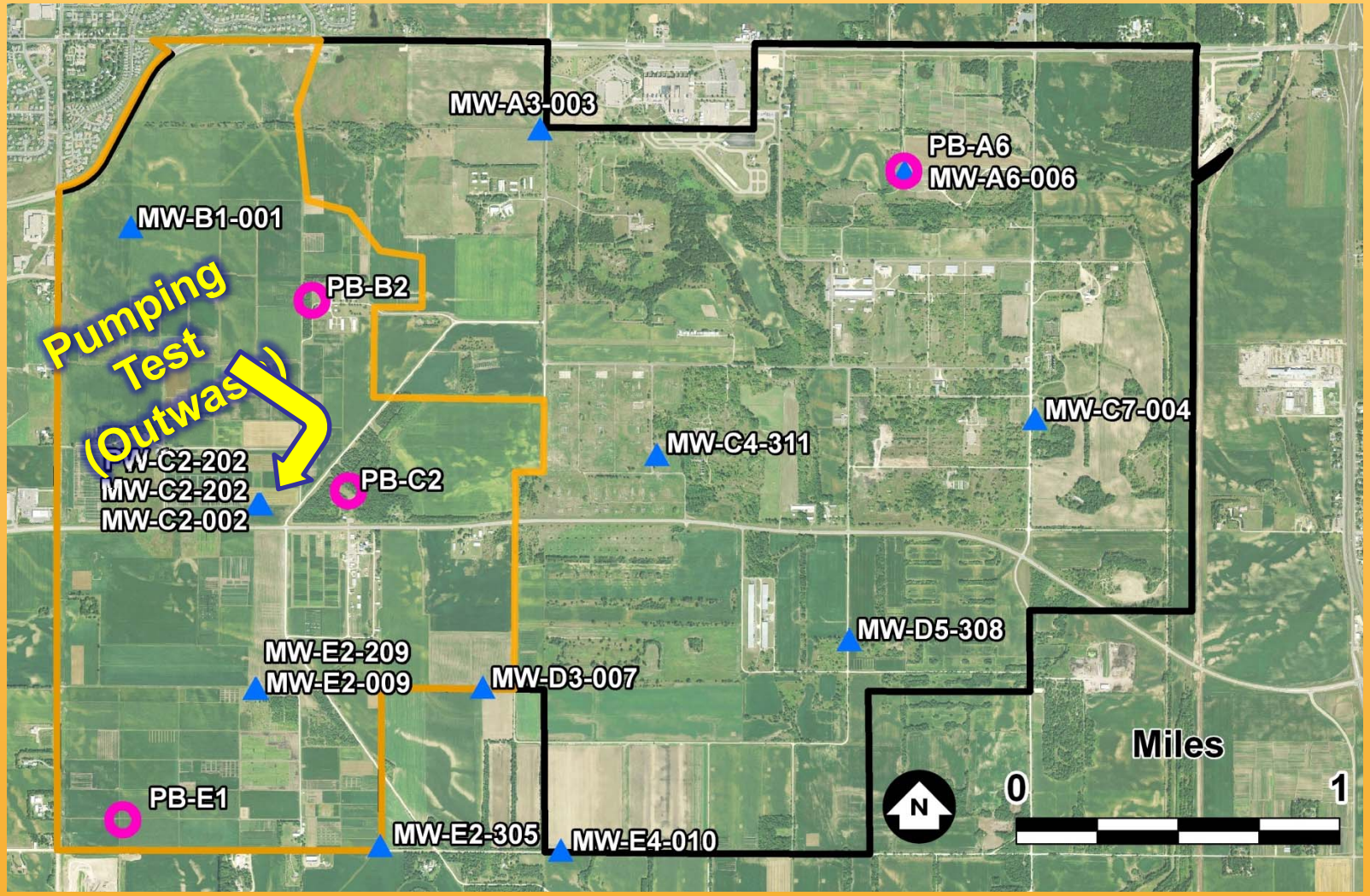
Overview

- Hydrogeologic assessment
- Development of groundwater flow model
- Using groundwater model to evaluate:
  - Effects of mining on groundwater
  - Simulation of future conditions
  - Using modeling results to help guide mine planning

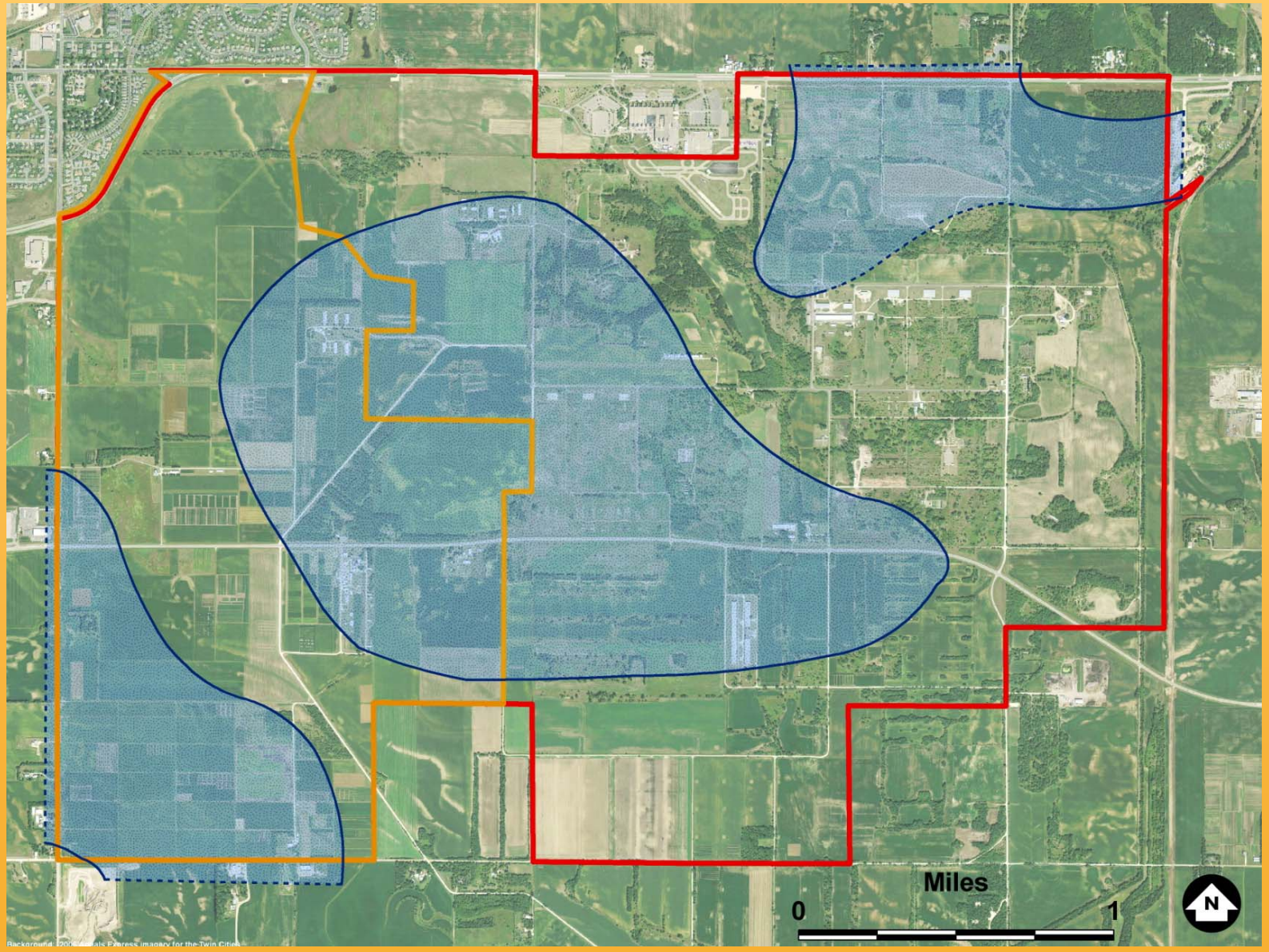
Hydrogeologic Assessment

- 13 Monitoring wells installed
- 1 Pumping Well
- 4 Additional Pilot borings
- Refine geology
- Aquifer Testing
- Develop conceptual model

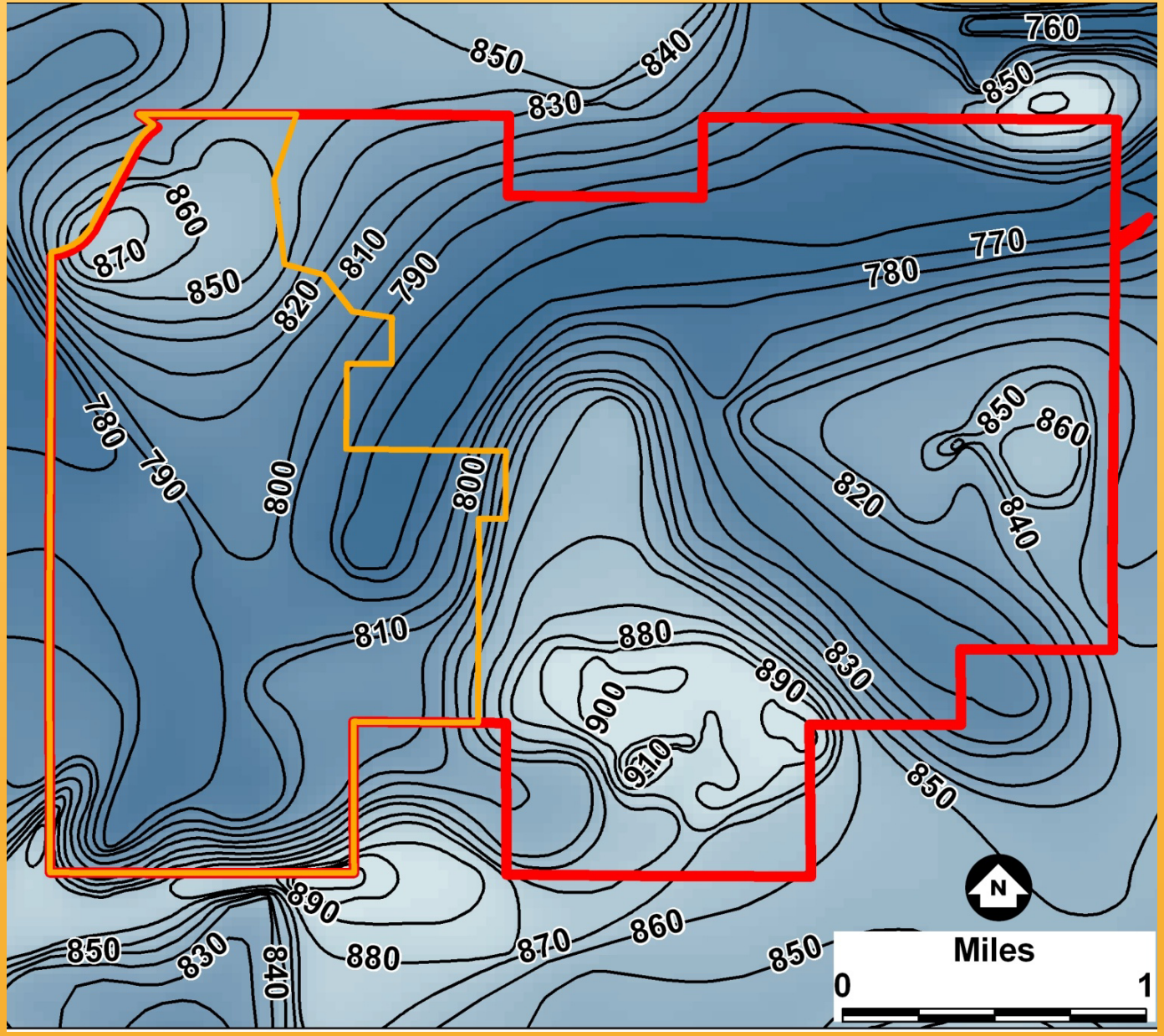
Pilot Borings and Monitoring Wells



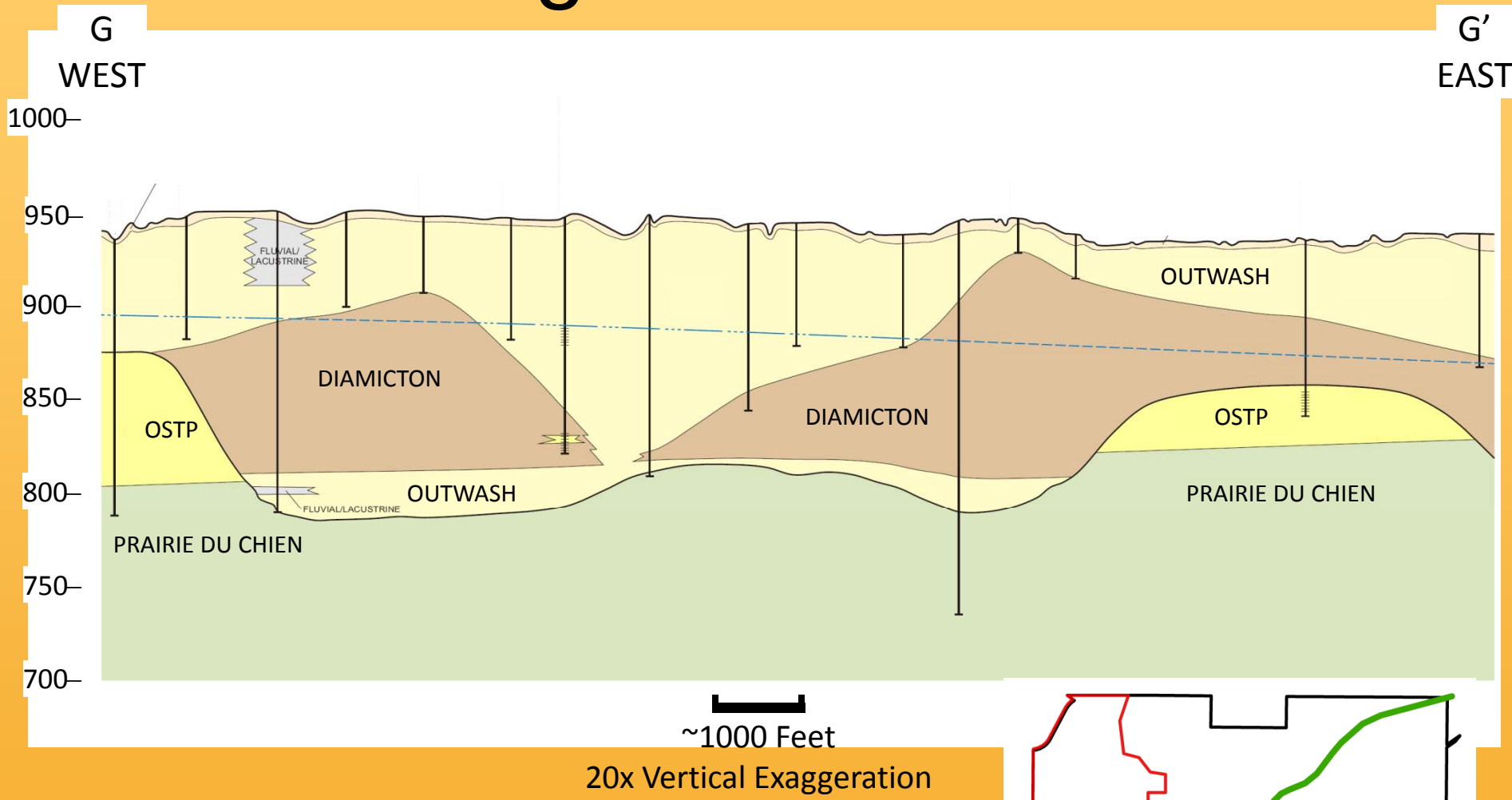
Till Extent



Bedrock Topography

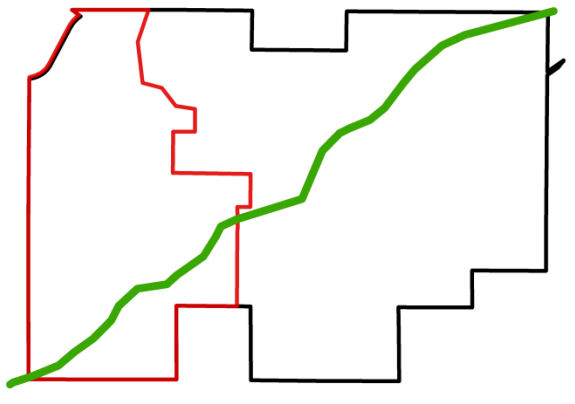


Geologic Cross Section

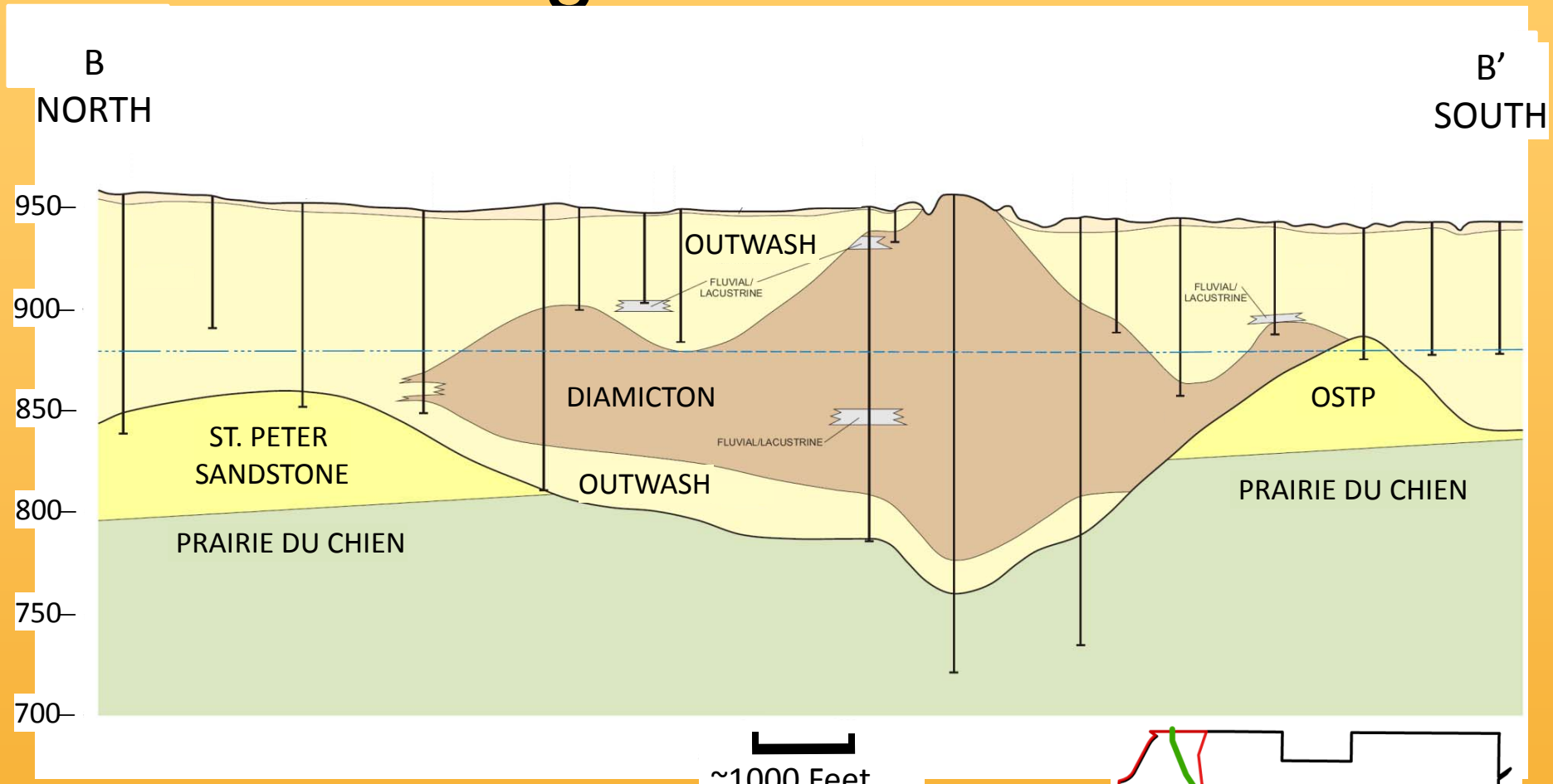


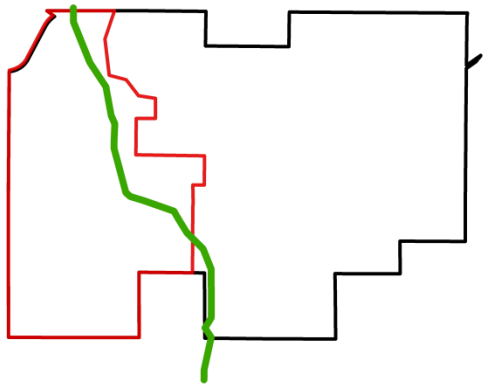
~1000 Feet

20x Vertical Exaggeration

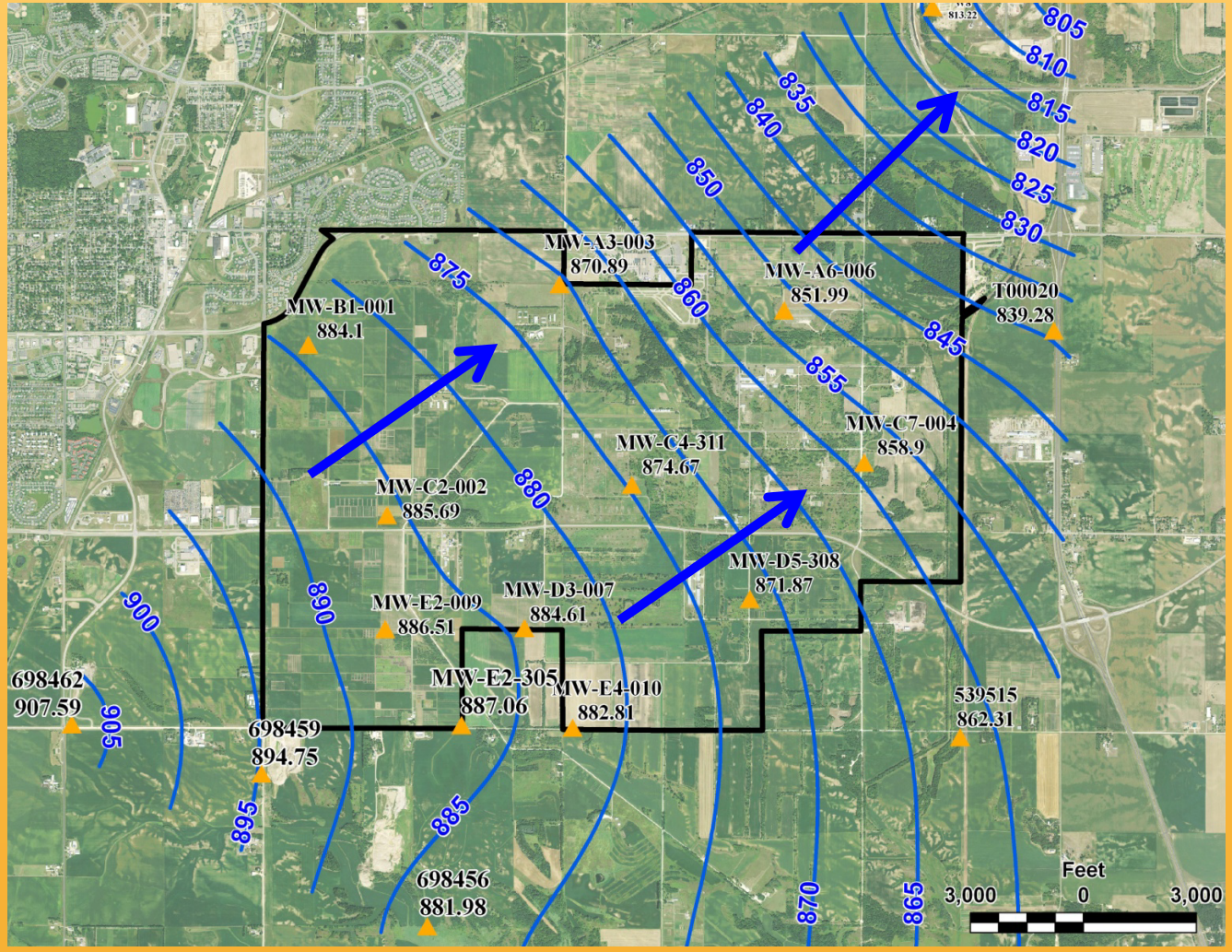


Geologic Cross Section



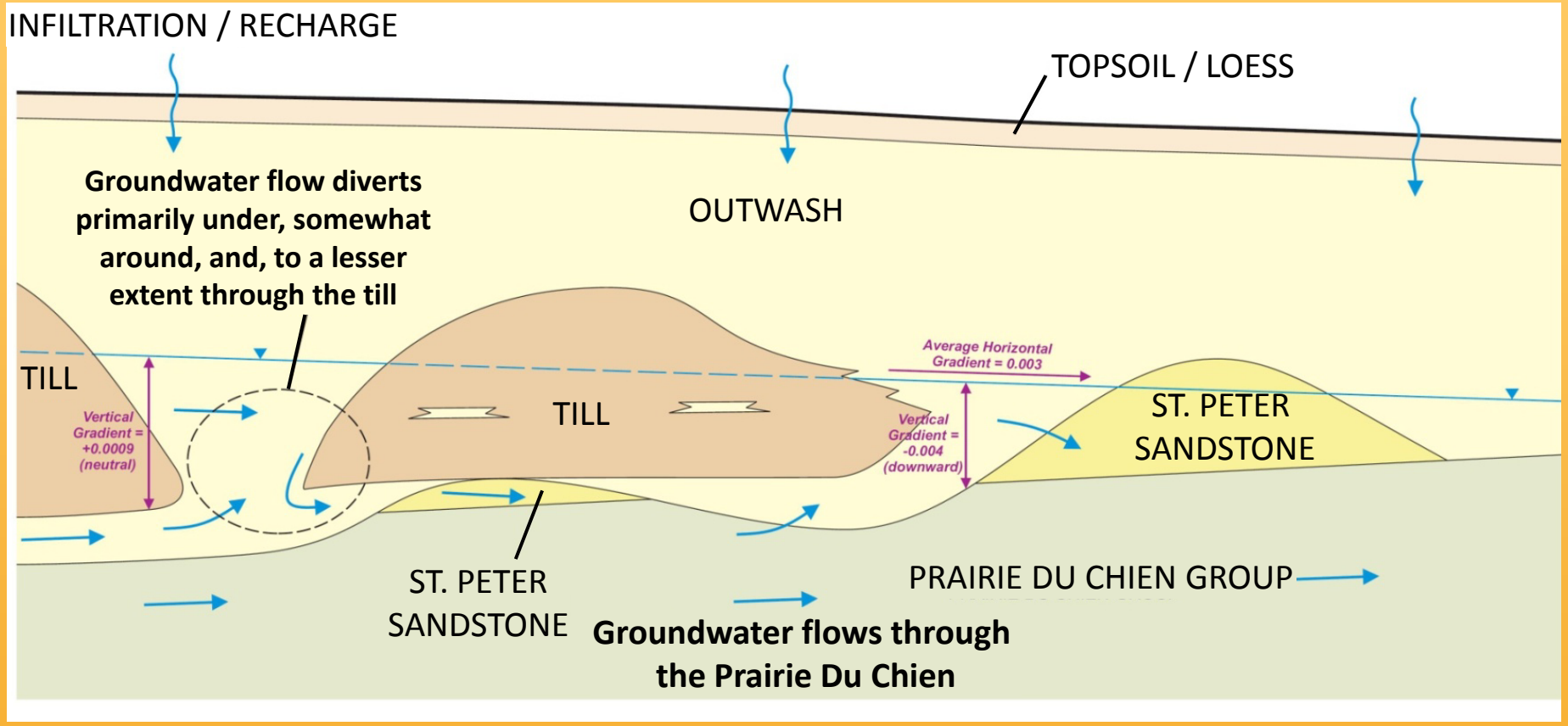


Conceptual Model



- Groundwater flow to the northeast toward Mississippi River

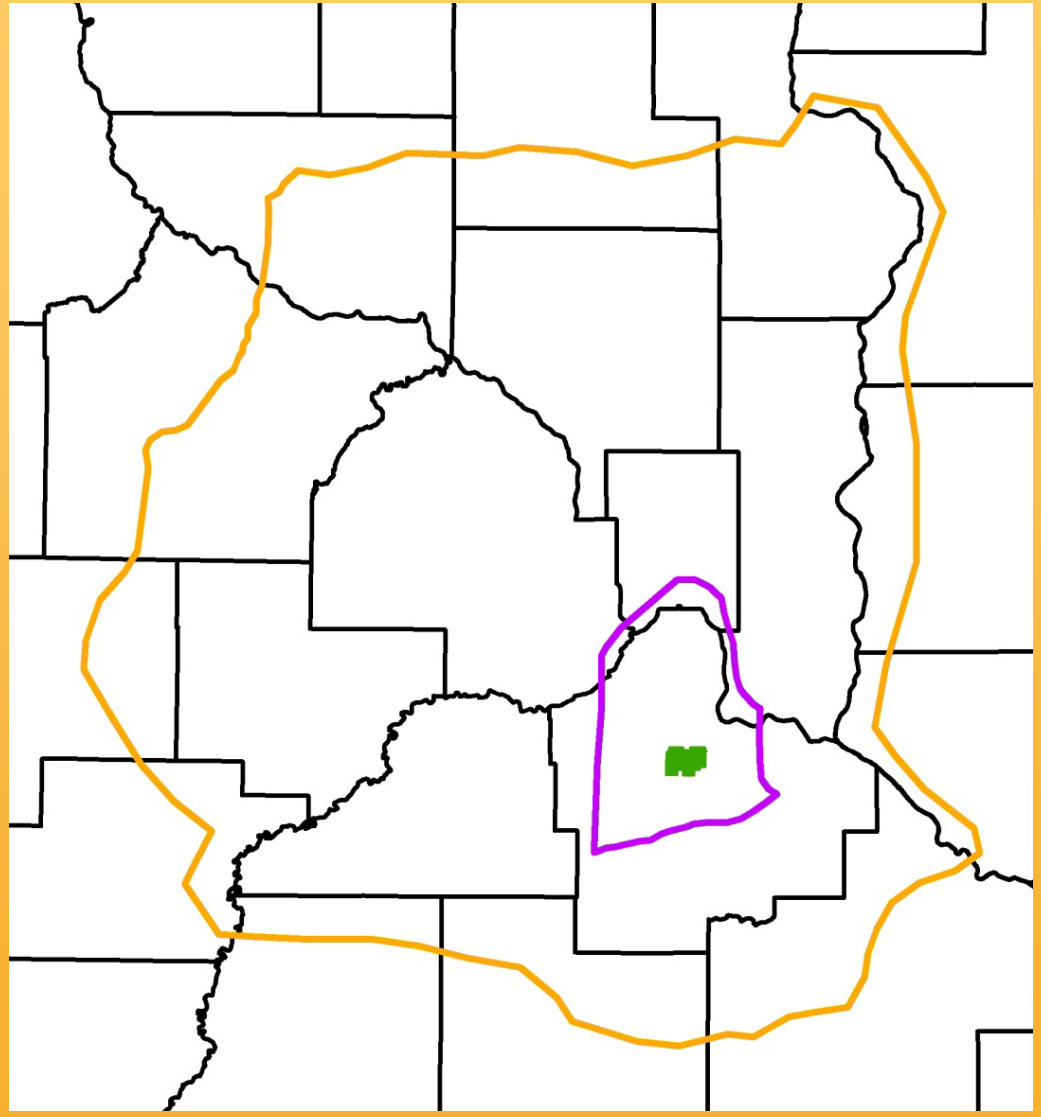
Conceptual Model



Groundwater Flow Model

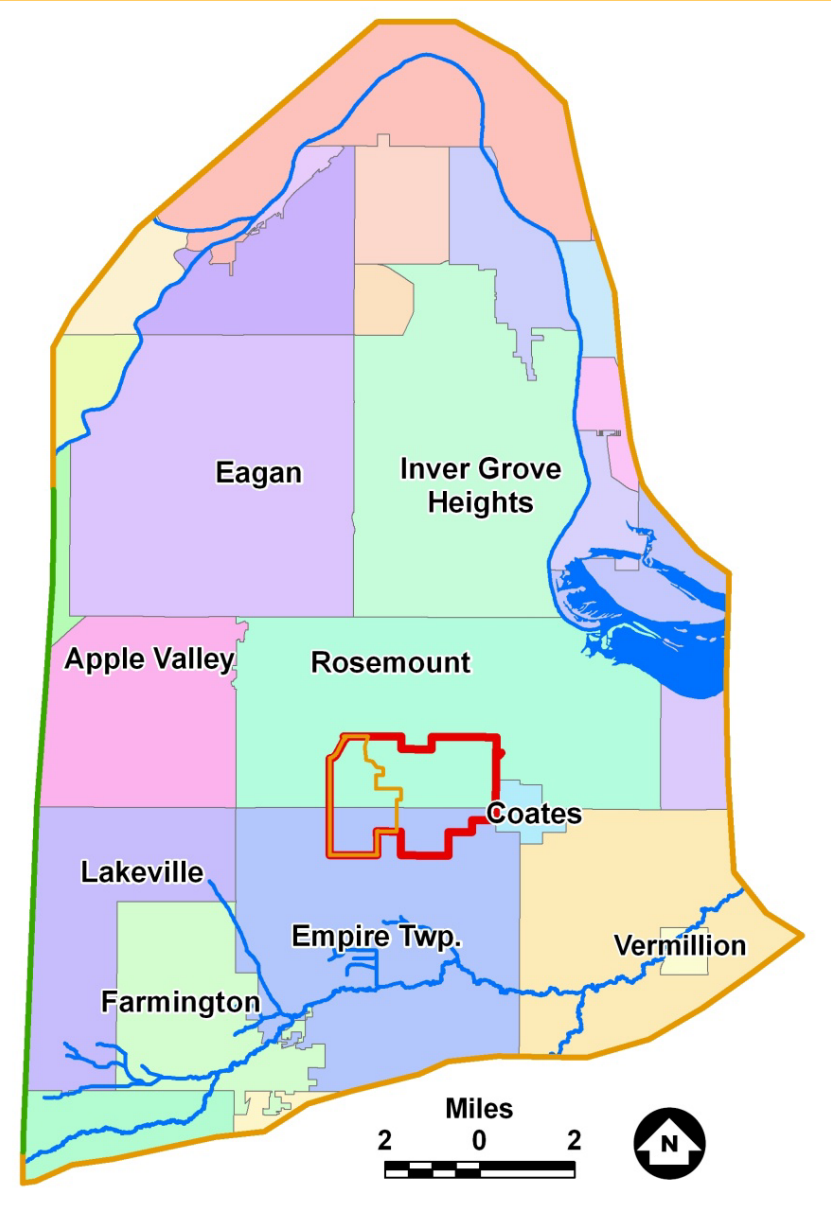
- Purpose
  - Test conceptual model of groundwater flow
  - Test hypotheses regarding potential impacts
  - Evaluate possible mitigation solutions

Model Domain



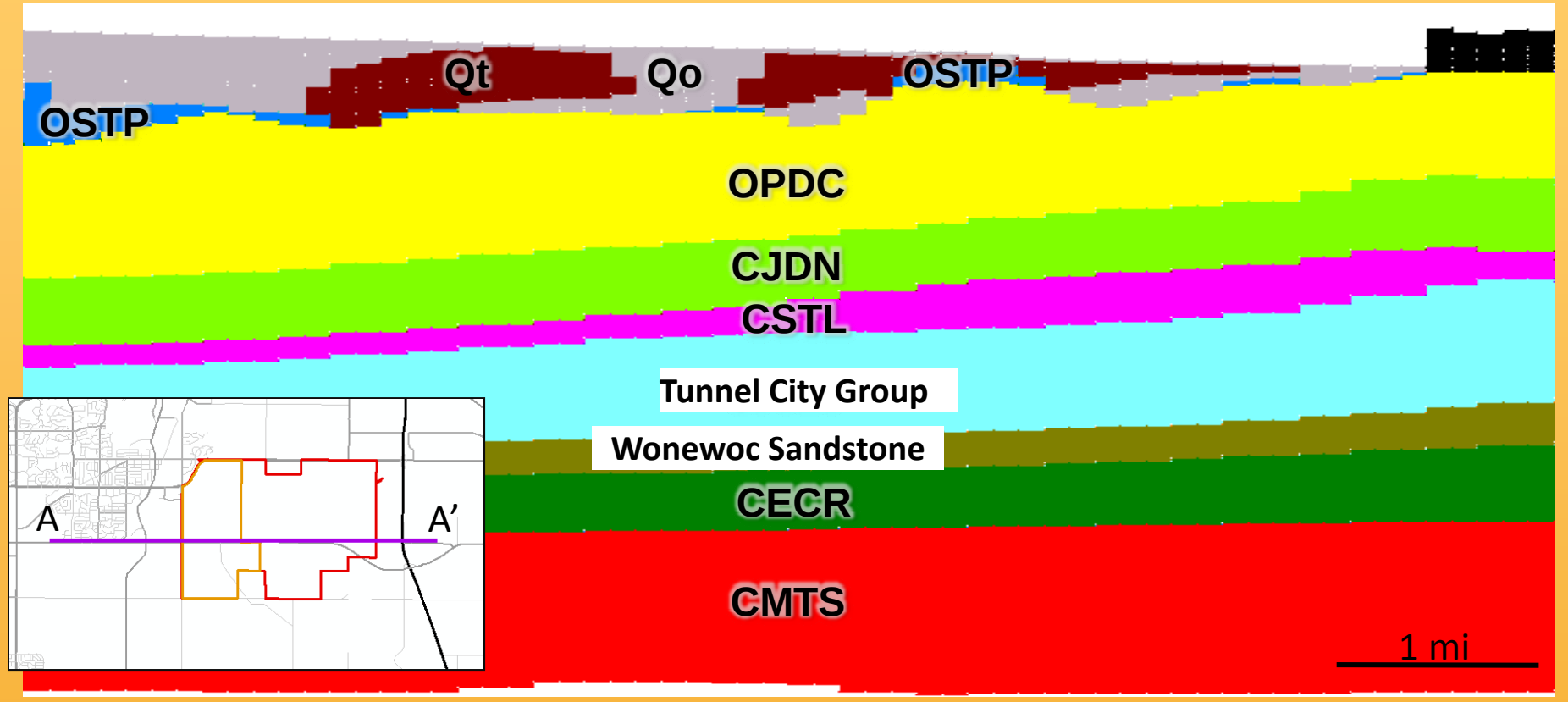
- TMR of Metro Model 2

Model Domain



- Metro Model 2 used to help define boundary conditions
- Two additional layers added to better simulate flow in the Quaternary sediments

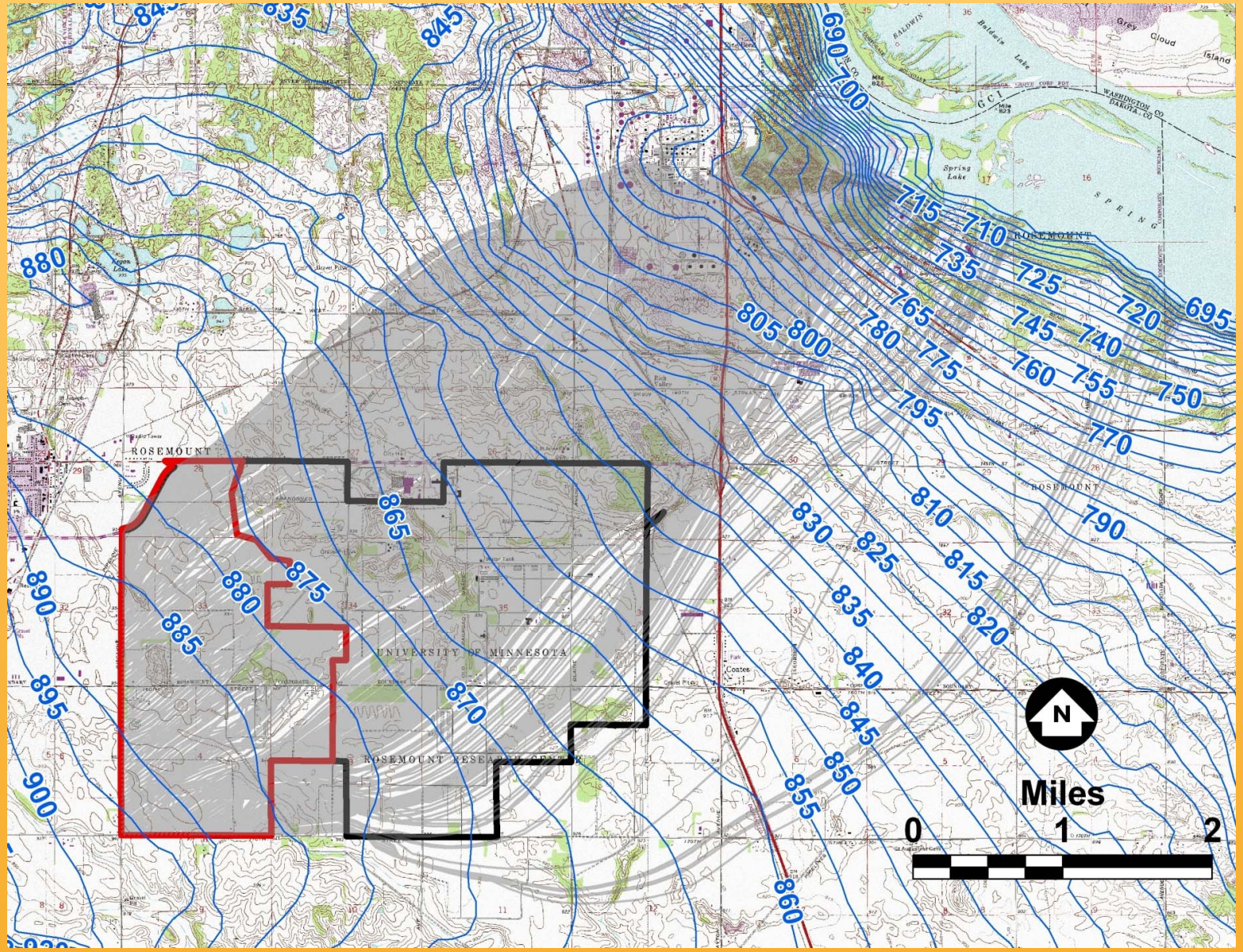
Model Cross Section



Vertical exaggeration = ~18x

- Till (Qt)
- Outwash / Quaternary Undifferentiated (Qo)
- St Peter Sandstone (OSTP)
- Prairie du Chien Group (OPDC)
- Jordan Sandstone (CJDN)
- St. Lawrence Formation (CSTL)
- **Tunnel City Group**
- **Wonewoc Sandstone**
- Eau Claire Formation (CECR)
- Mt. Simon Sandstone (CMTS)

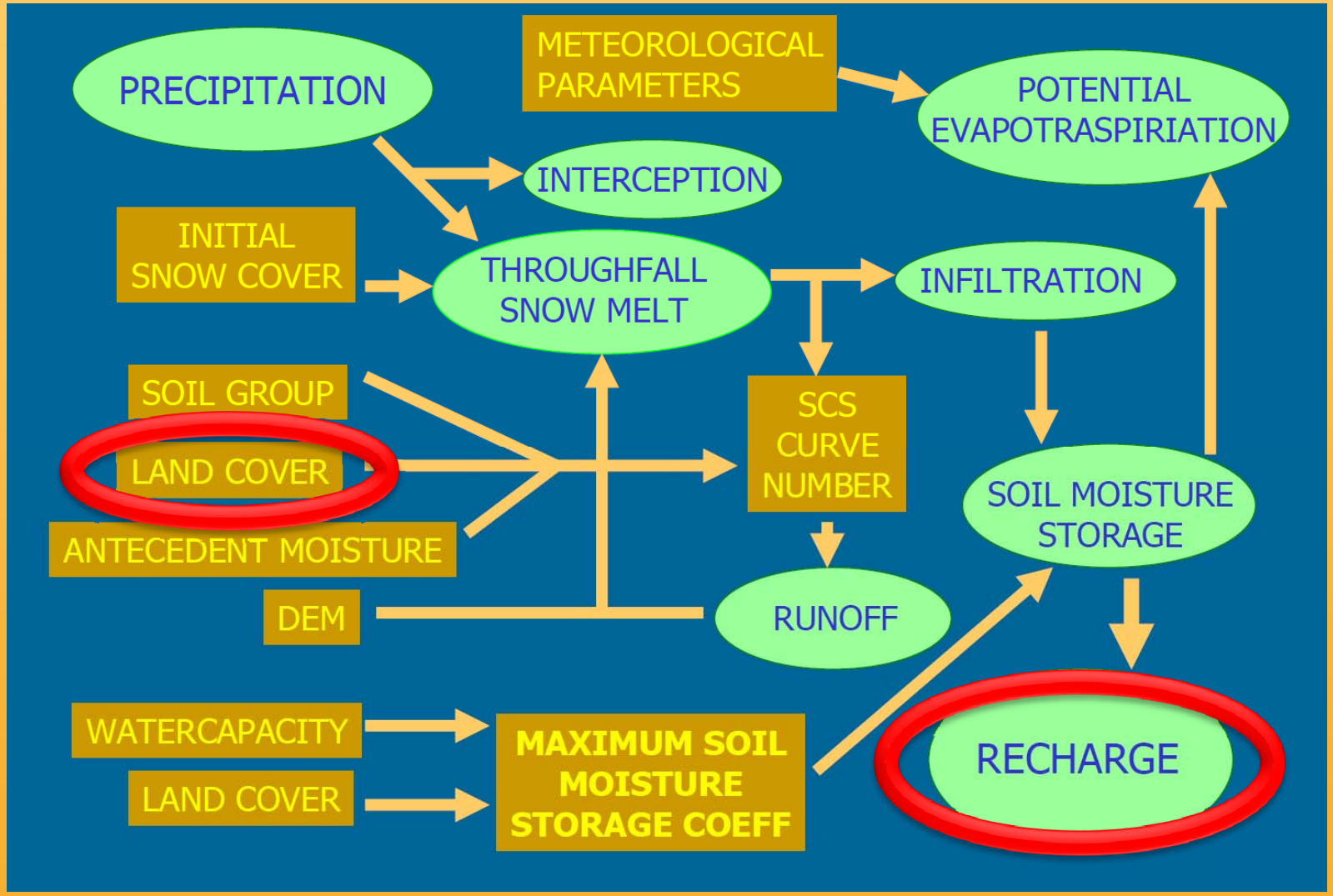
Groundwater Flow From UMA



Predictive Simulations

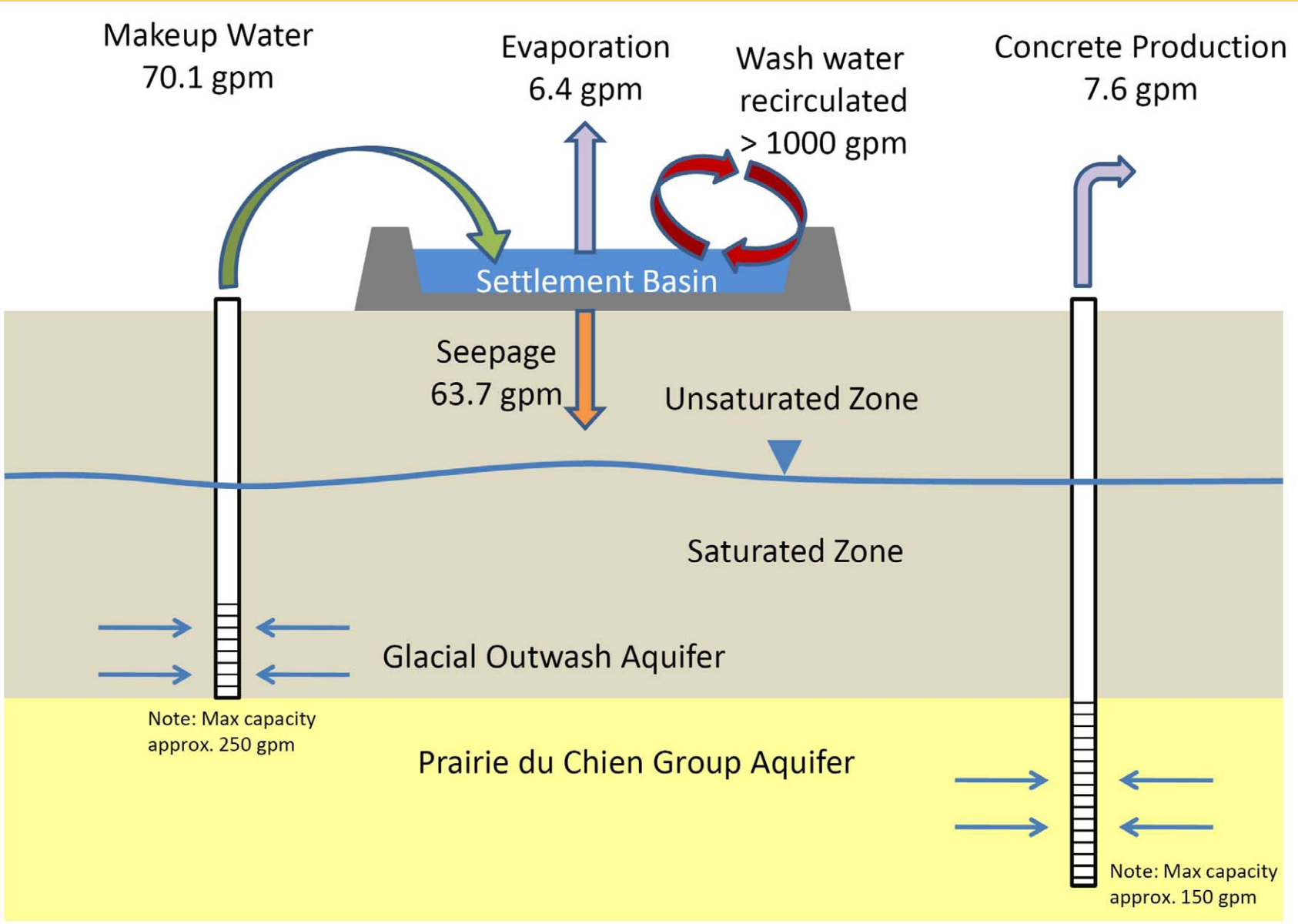
- Sustainable pumping
- Effect of mining related impacts on future groundwater resources
- Future municipal demand and future DWSMA

Surface **W**ater **B**alance (SWB) Model

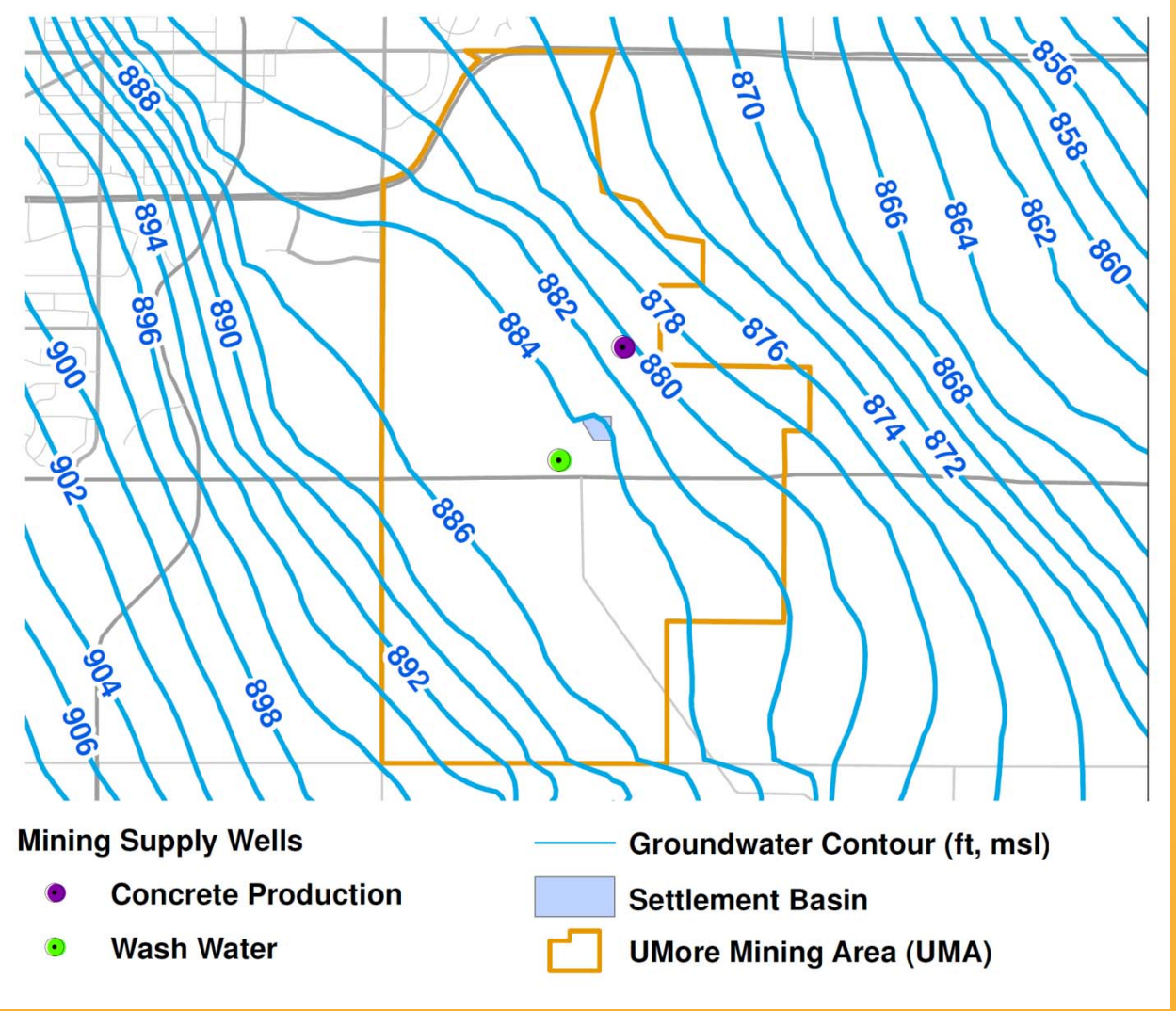


Adapted from Dripps and Bradbury, 2007

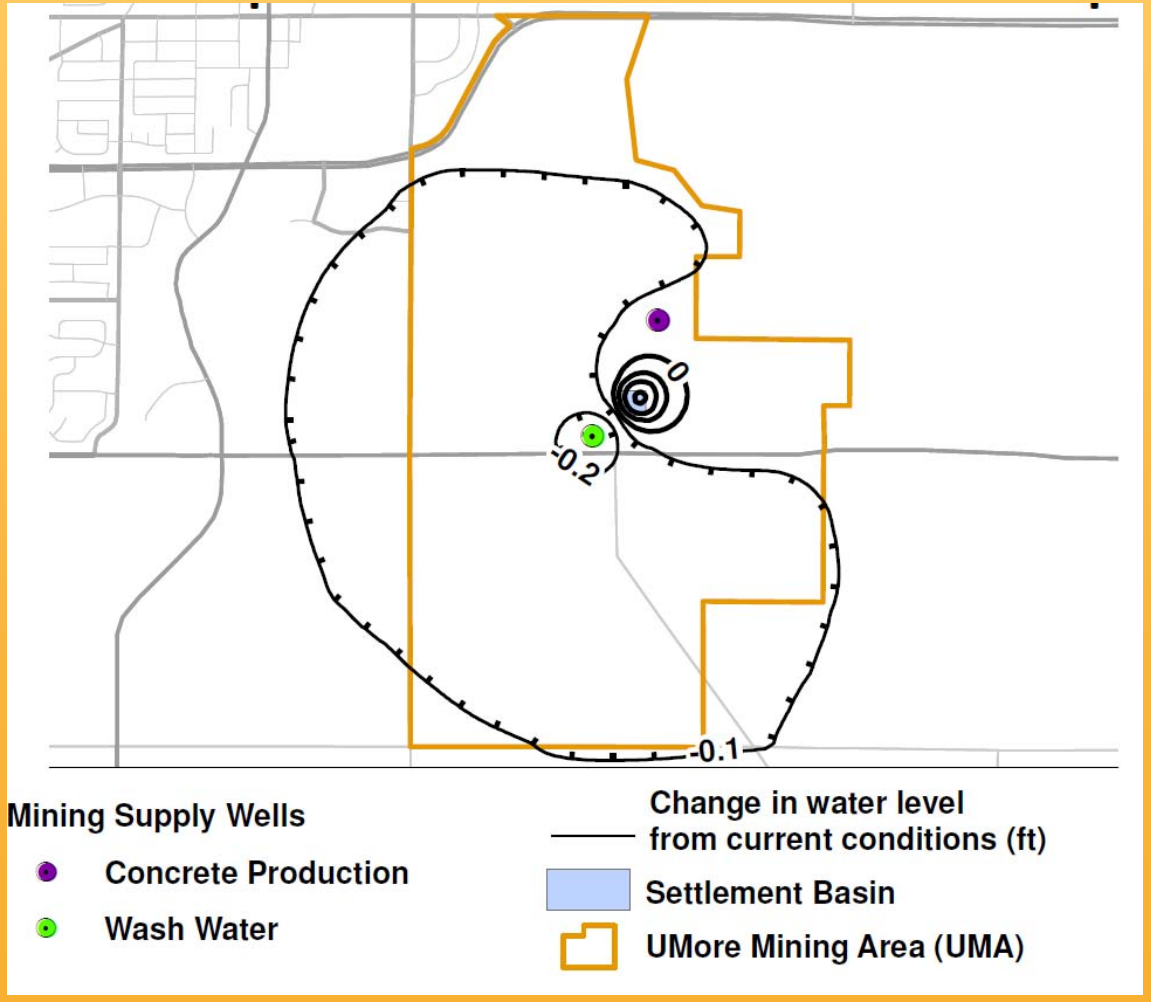
Conceptual Water Use



Groundwater flow during mine development prior to formation of pit-lake

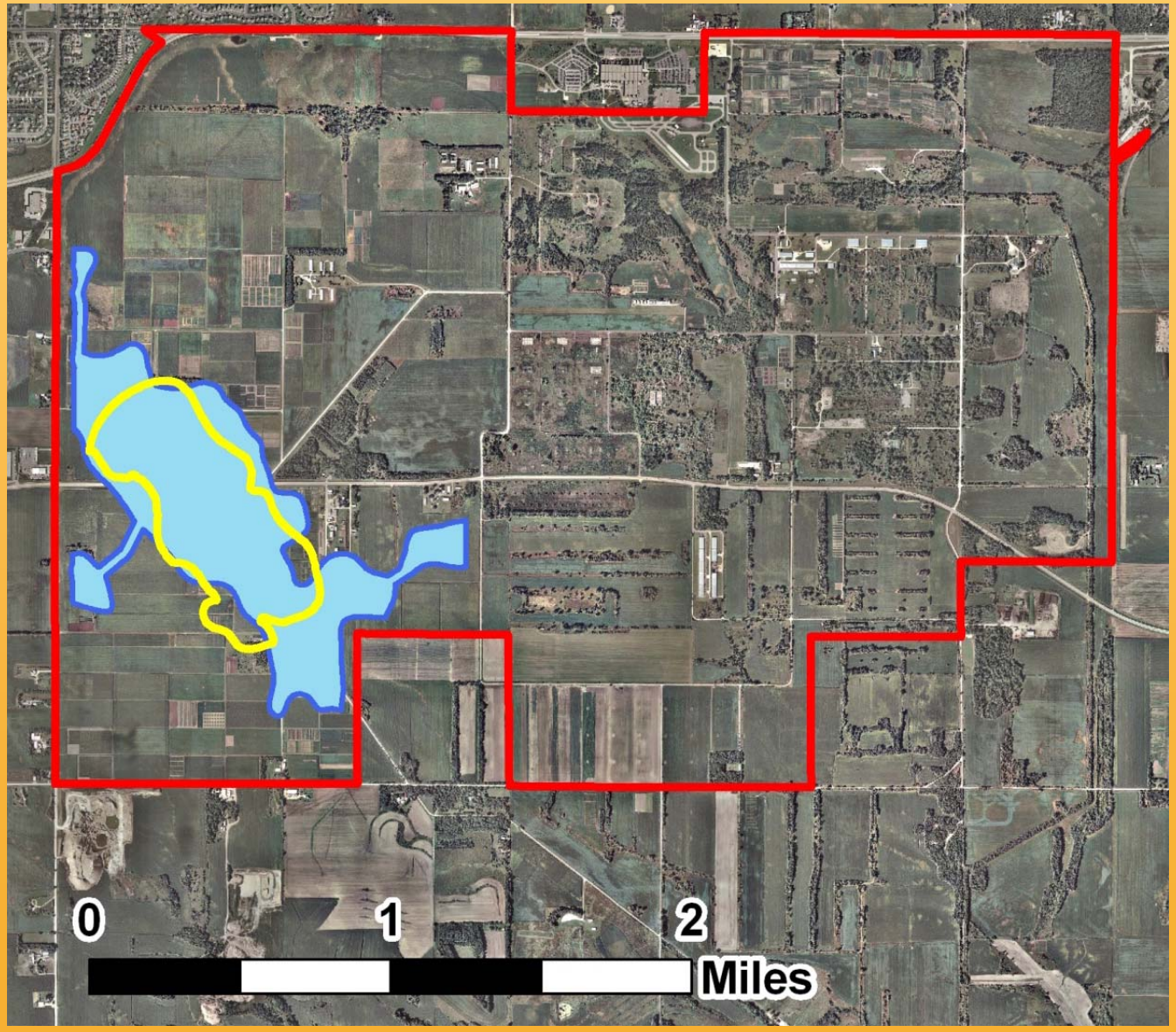


Change from current conditions during mine development prior to formation of pit-lake

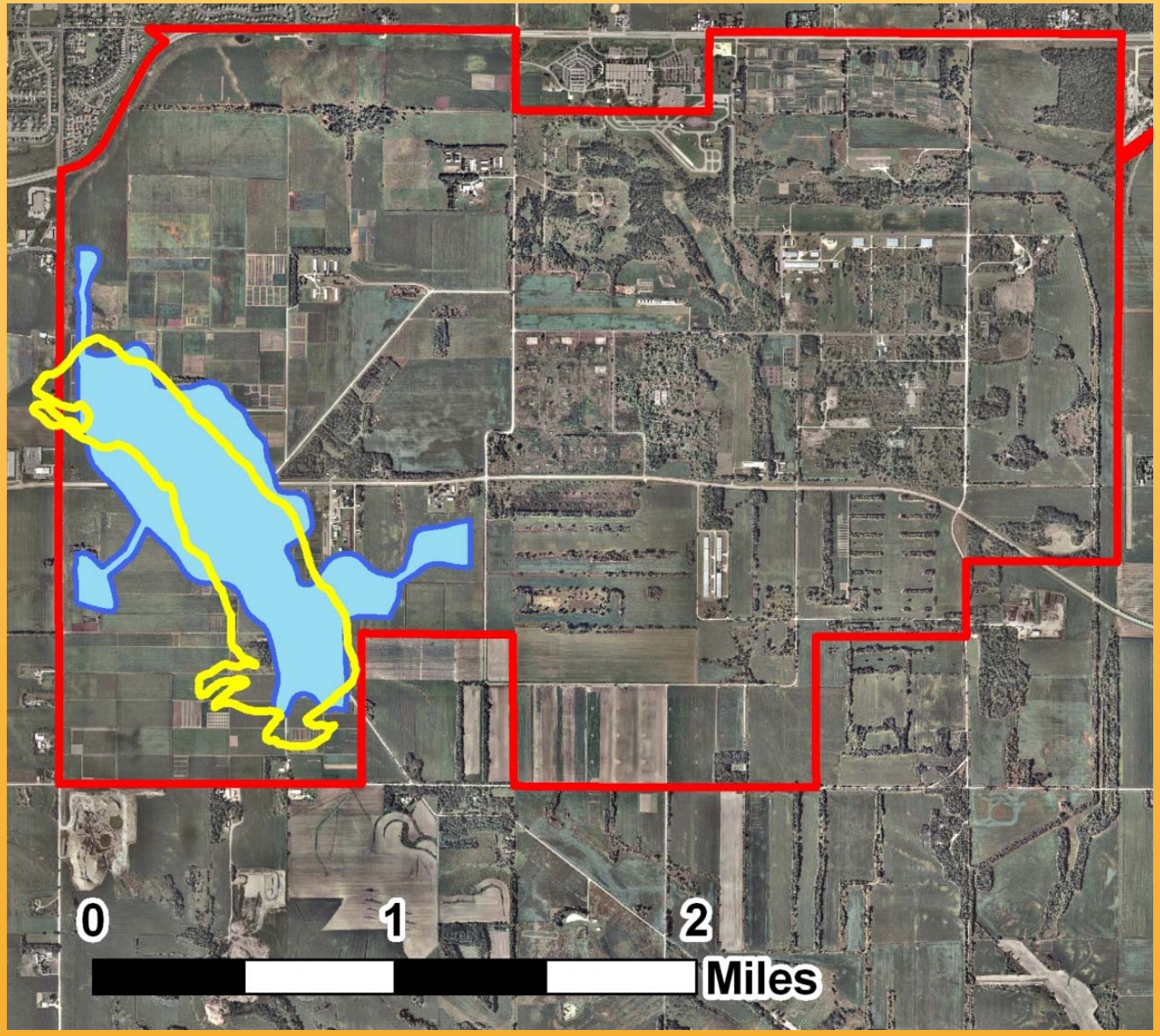


- Drawdown of ~ 0.1 feet near boundary
- Slight increase in water level near settlement basin

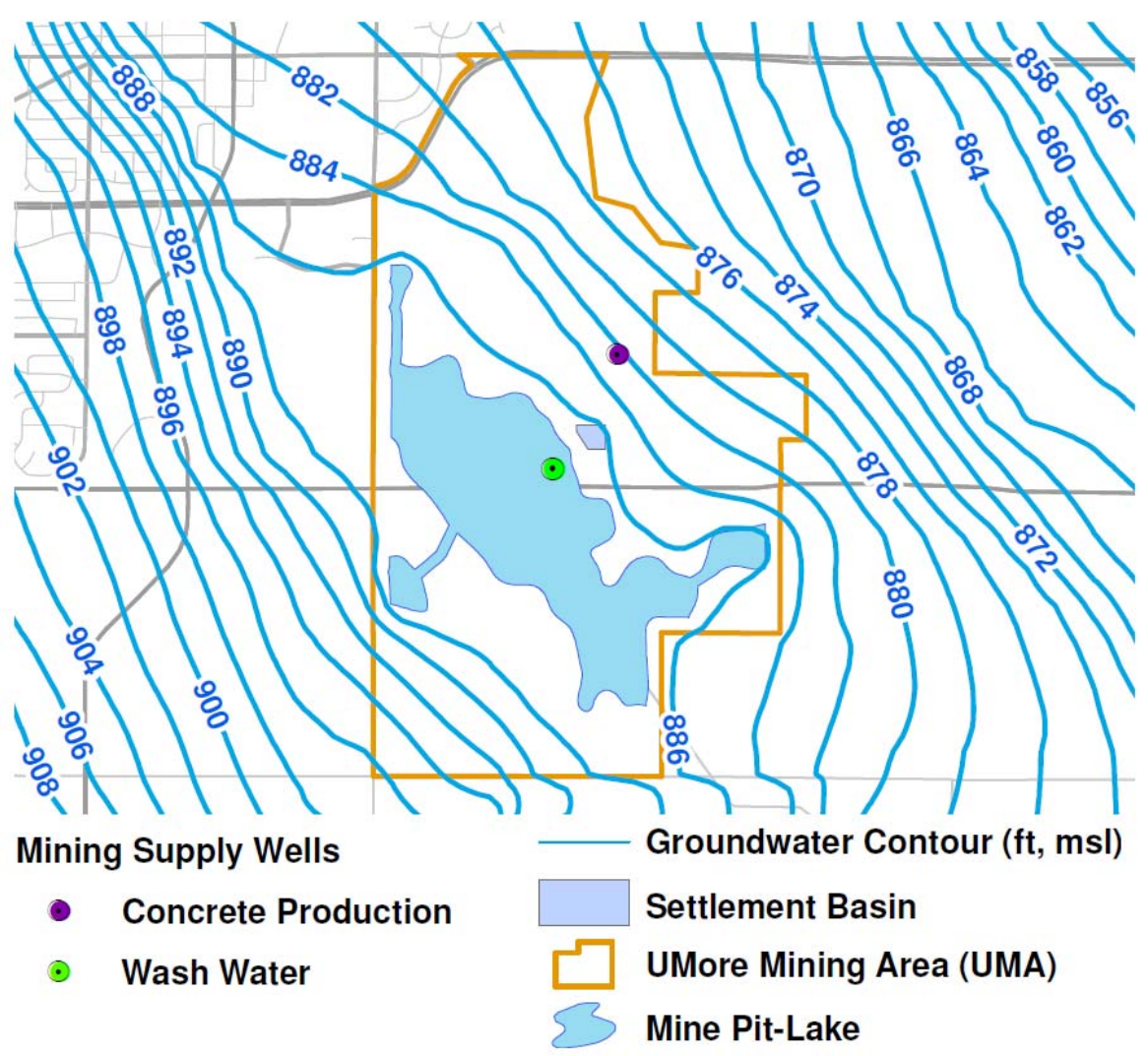
Pit-Lake Compared to Lake Nokomis



Pit-Lake Compared to Lake Elmo

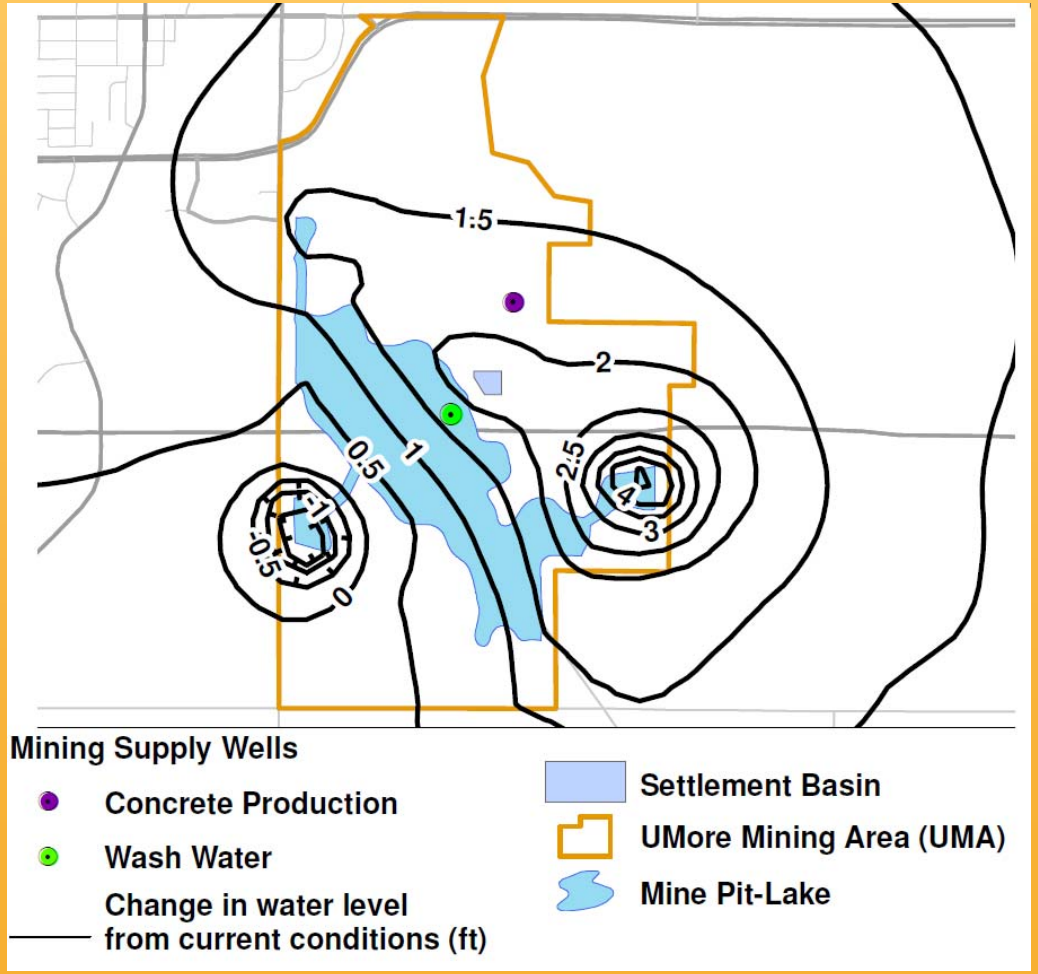


Groundwater flow during mine development after formation of pit-lake



- Flow still to the northeast to Mississippi R.
- Slight divergence of flow near shore of pit-lake

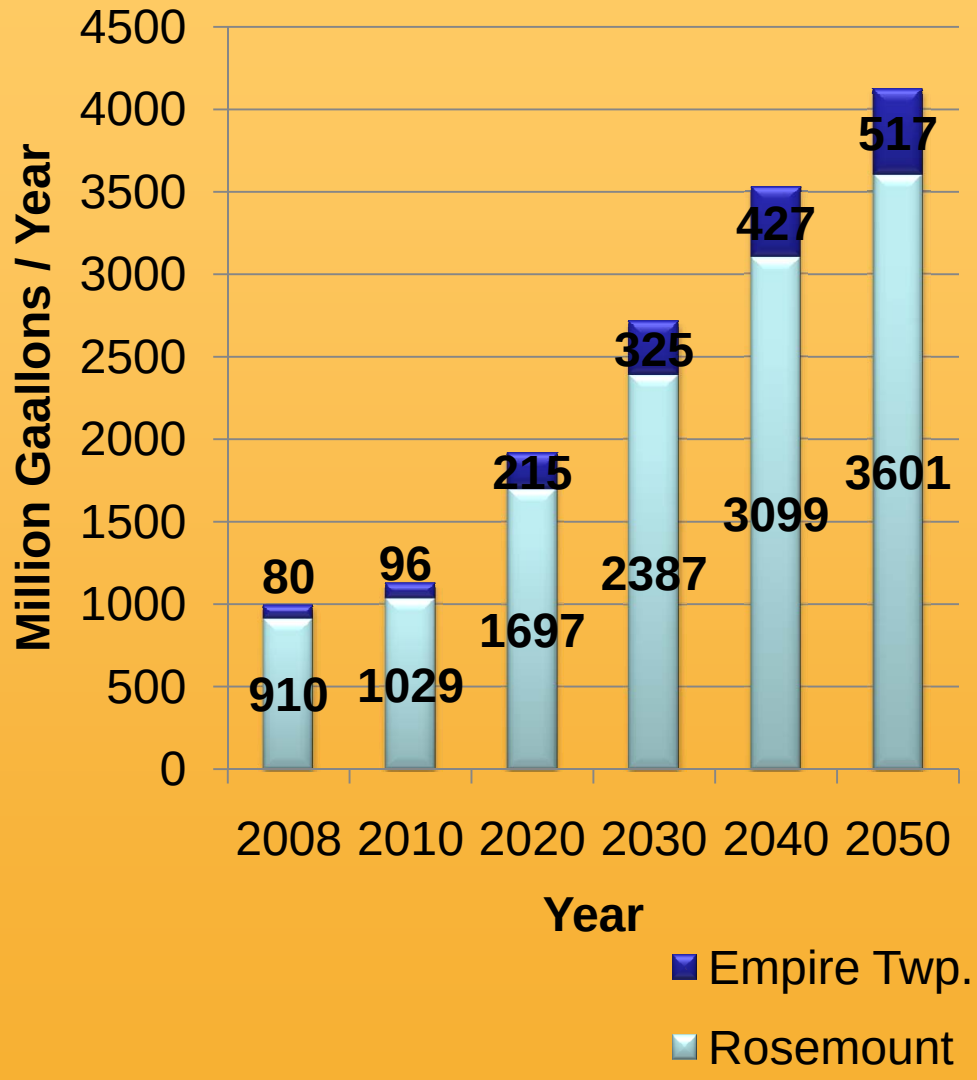
Change from current conditions during mine development after formation of pit-lake



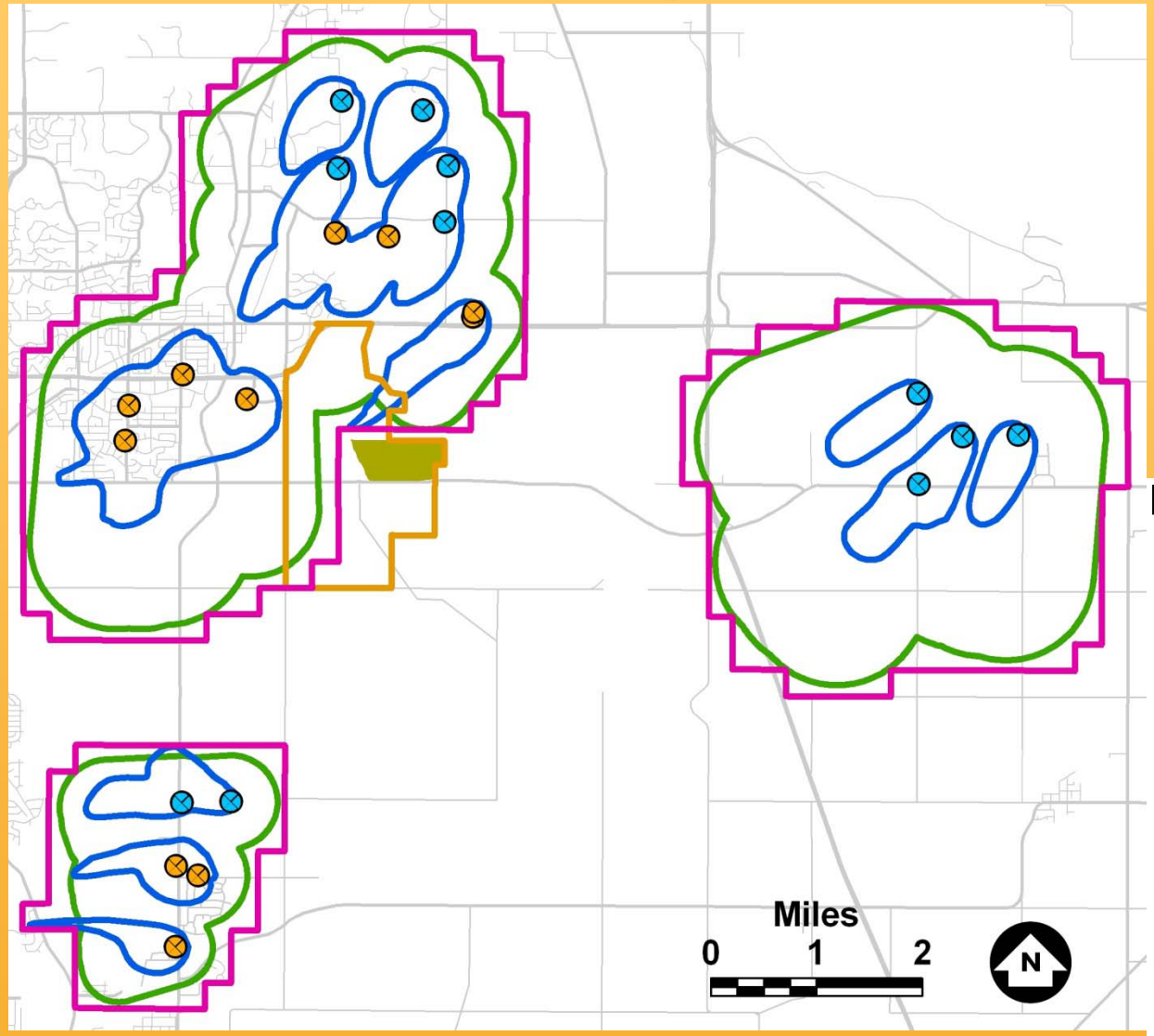
- Reduce hydraulic gradient in footprint of lake to near zero
- Decrease in water levels up-gradient
- Increase in water levels downgradient
- Overall, increase in groundwater levels

Increase in municipal demand

- Rosemount
  - 2008 = 910 million gallons
  - 2050 = 3.6 billion (estimated, Metropolitan Council)
- Empire Township
  - 2008 = 80 million gallons
  - 2050 = 517 million gallons (estimated)



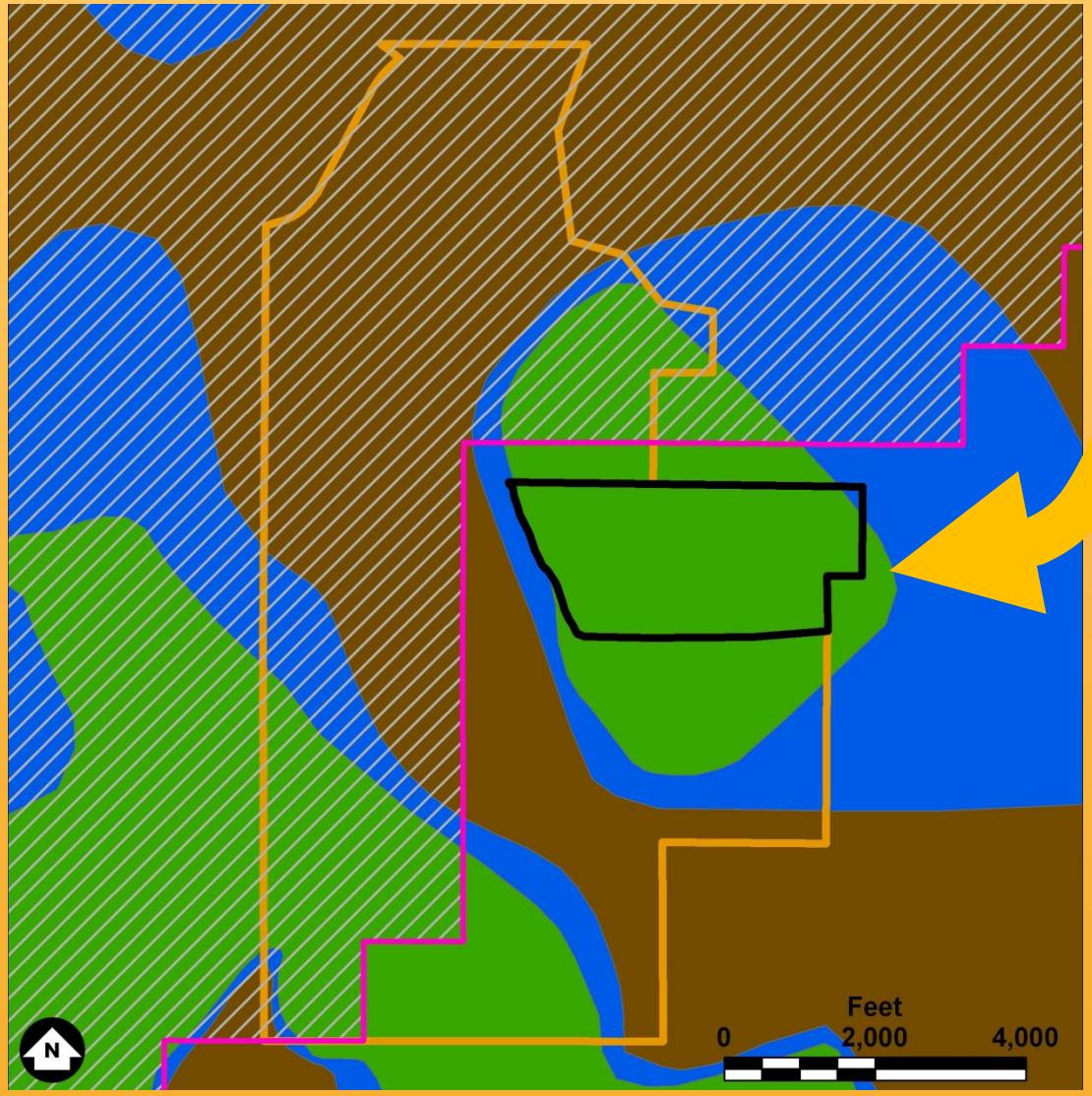
Capture Zones



Muncipial Supply Wells

- Existing Well
- Future Well
- Estimated Future DWSMA
- UMore Mining Area (UMA)
- Estimated Future Porous Media Capture Zone
- Estimated Future Fracture Flow Capture Zone

Future DWSMA and Aquifer Vulnerability



- Aggregate Plant and Ancillary Facilities set outside future DWSMA and in low vulnerability area

Aquifer Vulnerability

- High
- Moderate
- Low
- Estimated Future DWSMA
- Aggregate Plant and Ancillary Facilities

GROUNDWATER MONITORING AT UMORE PARK

BASELINE DATA ASSESSMENT AND GROUNDWATER EVALUATION

University of Minnesota Outreach, Research, and Educational Park (UMore Park)

Cale T. Anger

E. Calvin Alexander Jr.

Department of Geology and Geophysics

University of Minnesota – Twin Cities

Overview

1. Review of Project Goals and Objectives
2. Groundwater Assessment Update
3. Sustainable Groundwater at UMore Park

Project Goals and Objectives

- Groundwater Assessment

1. *Historical Groundwater Trends*

   - Compilation of groundwater data from previous site investigations.
   - Determine historical flow patterns.

2. *Current Field and Modeling Data*

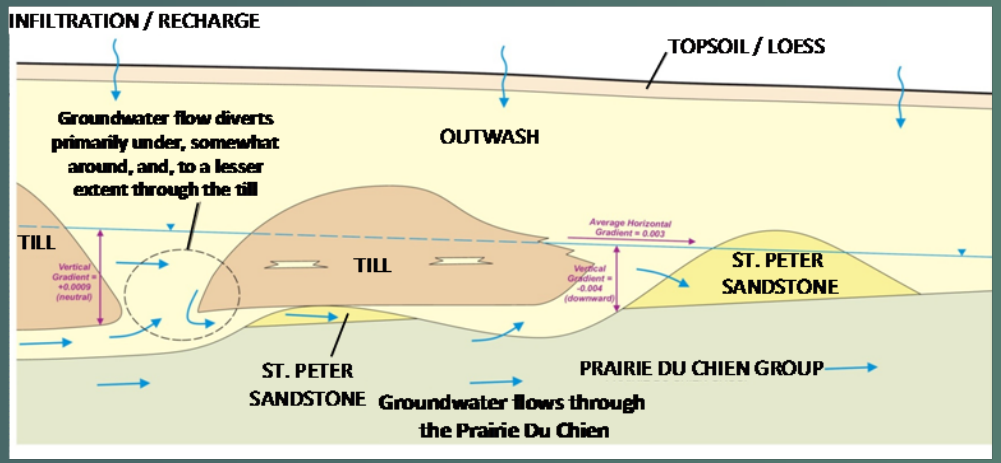
   - Constrain modern groundwater elevation, temperature, and geochemistry through point and time-series groundwater monitoring at UMore Park.
   - Couple large datasets and groundwater models to define pre-aggregate mining groundwater characteristics.

Project Goals and Objectives

- Sustainable Groundwater at UMore Park

1. *Continued Monitoring of Basic Groundwater Characteristics*
   - *inexpensive*
   - *multipurpose*

2. *Hydrologic and Recharge Modeling*
   - *future assessment and calibration of models developed for the EIS*

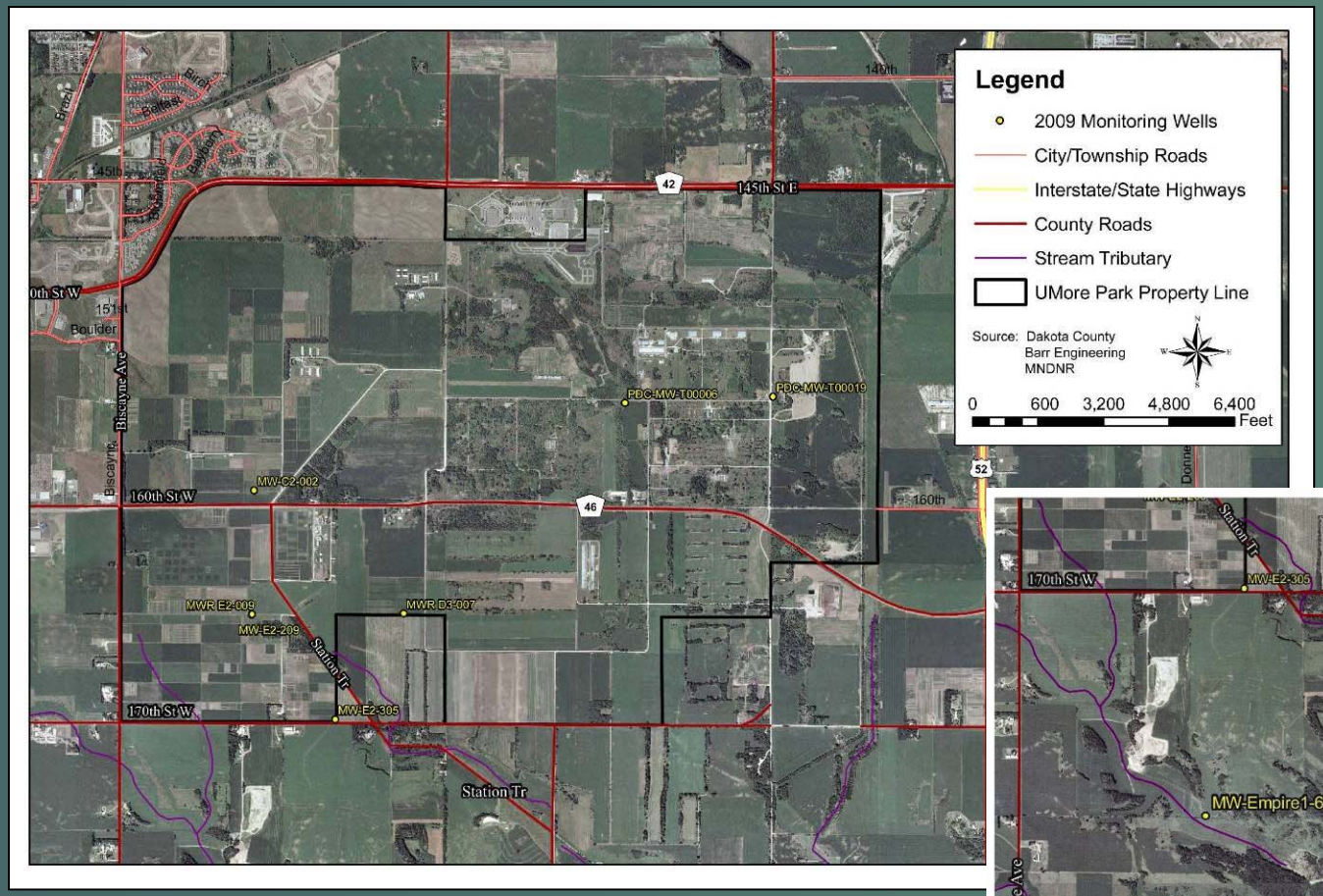


Groundwater Monitoring & Analysis

- Monitoring Locations & Data Collection
  1. Monitoring Wells
- Regional Groundwater Flow
  1. Temporal and Spatial Groundwater Variability
- Physical Groundwater Characteristics
  1. Temperature
  2. Specific Conductivity
  3. Geochemistry

Monitoring Locations & Data Collection

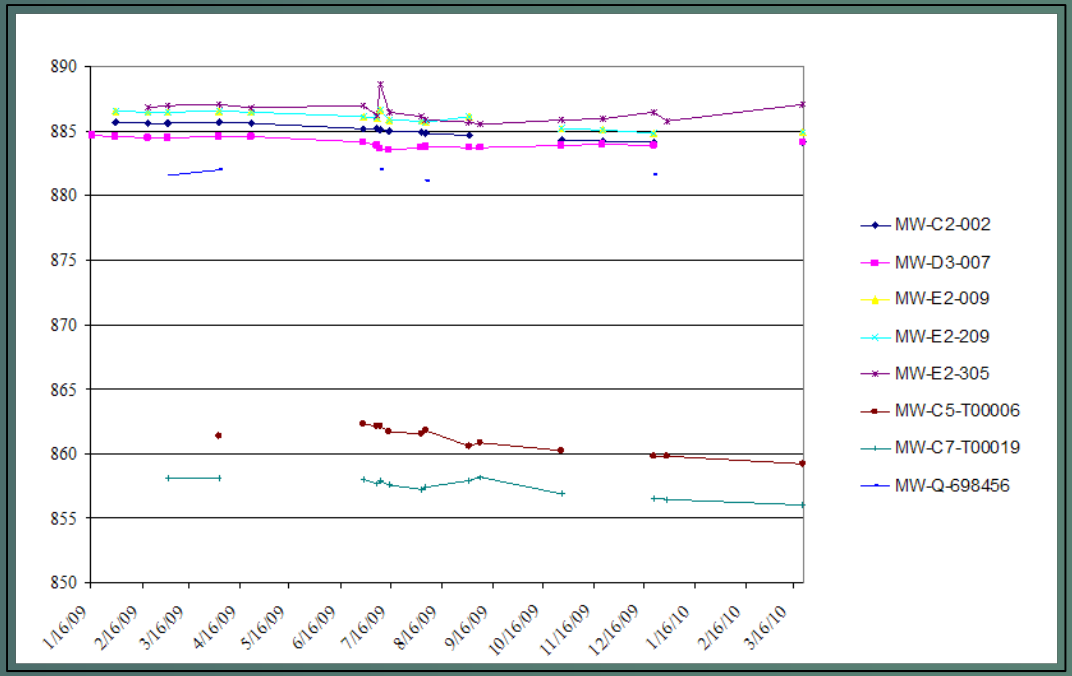
- Monitoring Wells – On and Off Site



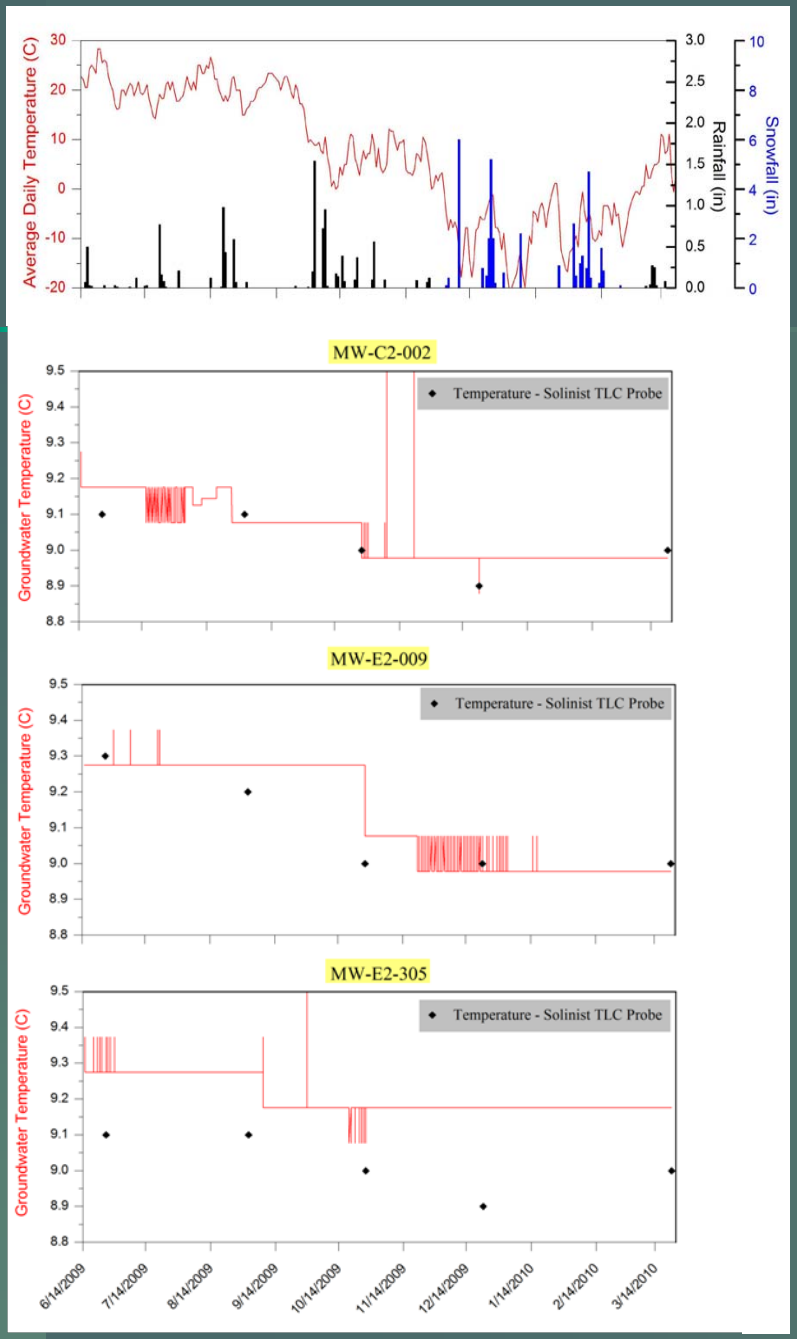
Regional Groundwater Flow

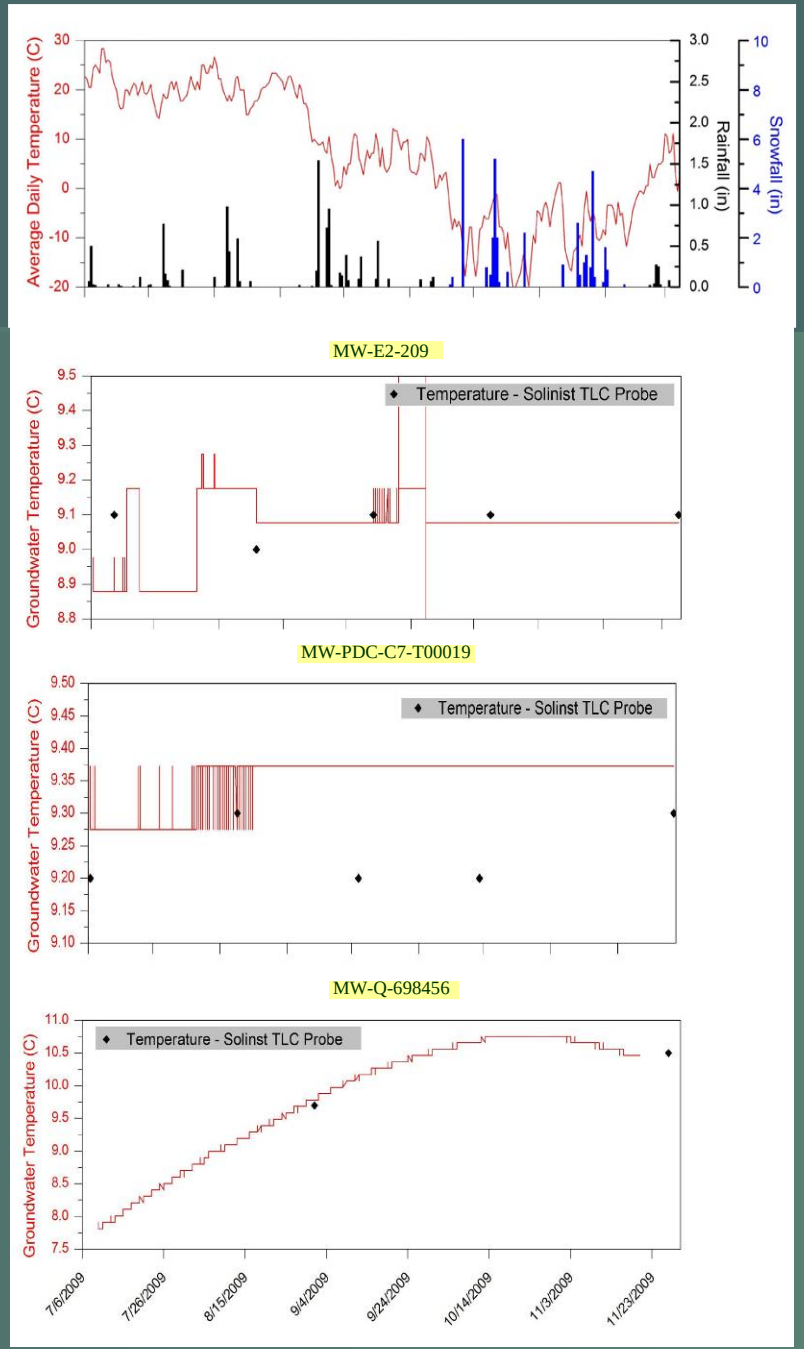
- Groundwater Variability

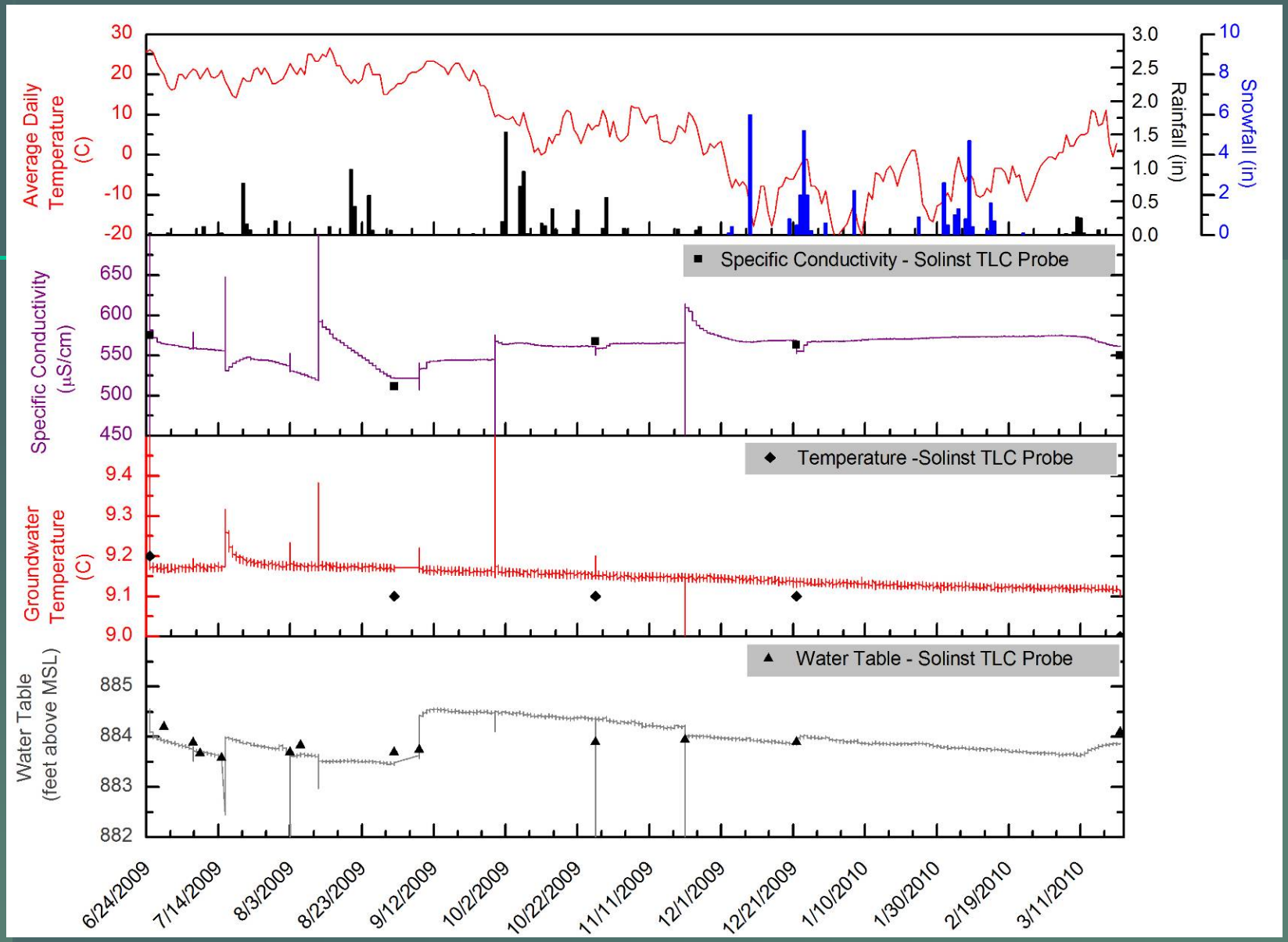
- Spatially, groundwater elevations range from 857 ft MSL to 887 ft MSL at the designated monitoring wells.
- Temporally, groundwater elevations vary between 0.1 and 1.1 ft during the sampling period. MW-PDC-C5-T00006 is an exception, with a 4.21 ft change.
- Possible recharge response in shallow aquifer in late March



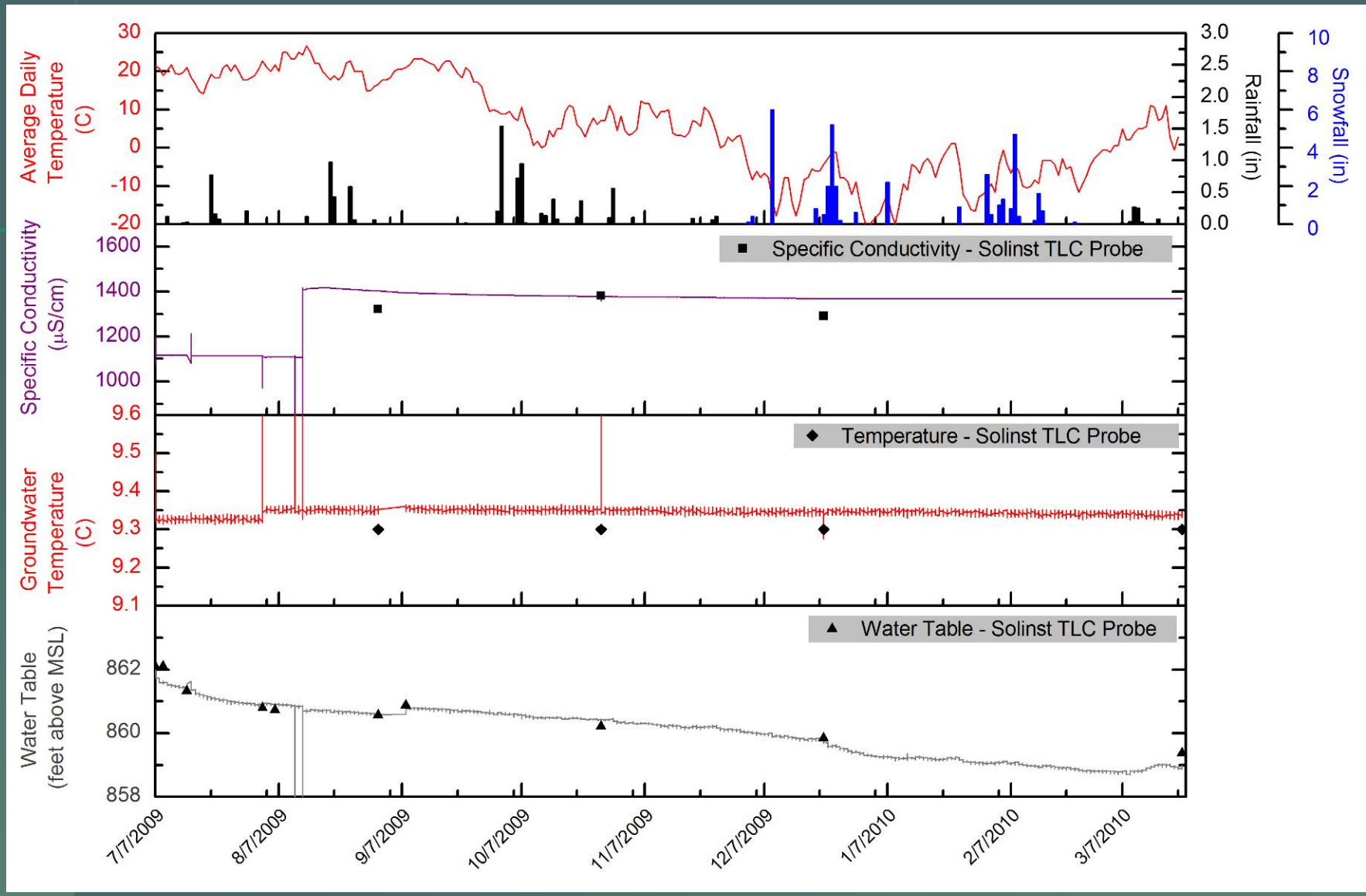
Monitoring Well Groundwater Elevations
UMore Park Hydrogeologic Monitoring and Assessment
Dakota County, MN


Average Daily Temperature (C)
Rainfall (in)
Snowfall (in)
MW-C2-002
Temperature - Solinist TLC Probe
Groundwater Temperature (C)
MW-E2-009
Temperature - Solinist TLC Probe
Groundwater Temperature (C)
MW-E2-305
Temperature - Solinist TLC Probe
Groundwater Temperature (C)
6/14/2009
7/14/2009
8/14/2009
9/14/2009
10/14/2009
11/14/2009
12/14/2009
1/14/2010
2/14/2010
3/14/2010


Average Daily Temperature (C)
Rainfall (in)
Snowfall (in)
MW-E2-209
Temperature - Solinist TLC Probe
Groundwater Temperature (C)
MW-PDC-C7-T00019
Temperature - Solinst TLC Probe
Groundwater Temperature (C)
MW-Q-698456
Temperature - Solinst TLC Probe
Groundwater Temperature (C)
7/6/2009
7/26/2009
8/15/2009
9/4/2009
9/24/2009
10/14/2009
11/3/2009
11/23/2009



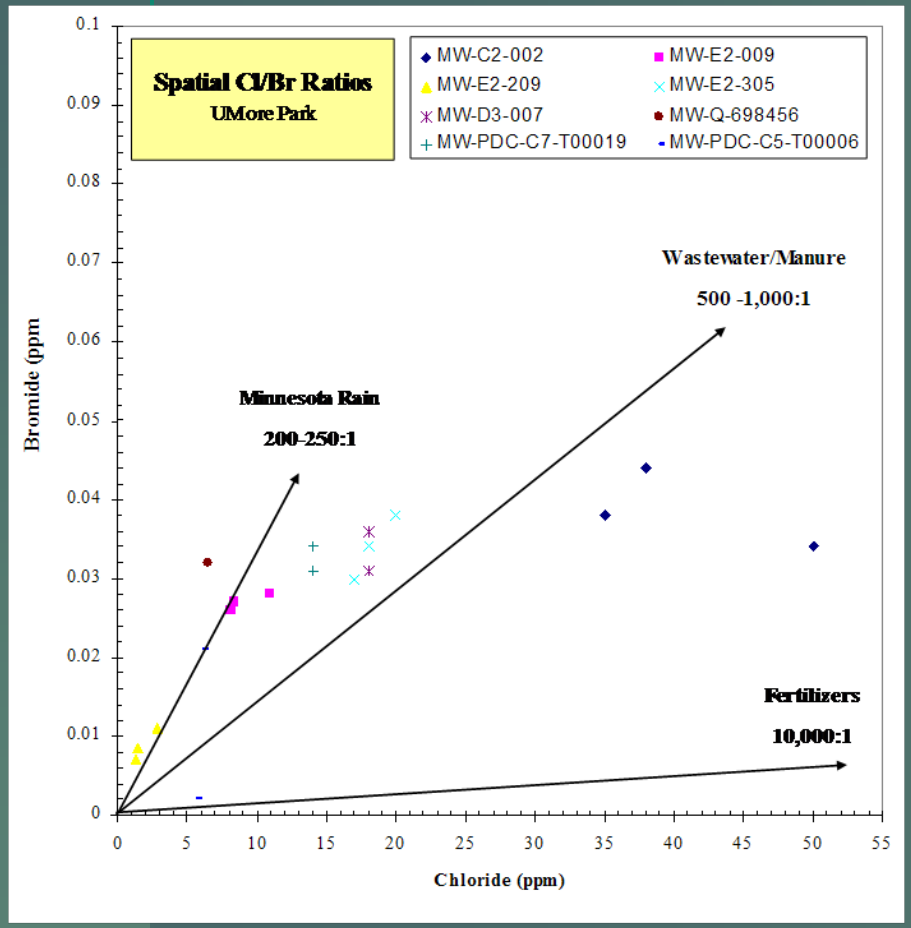
MW-D3-007
Unique Well ID: 769490

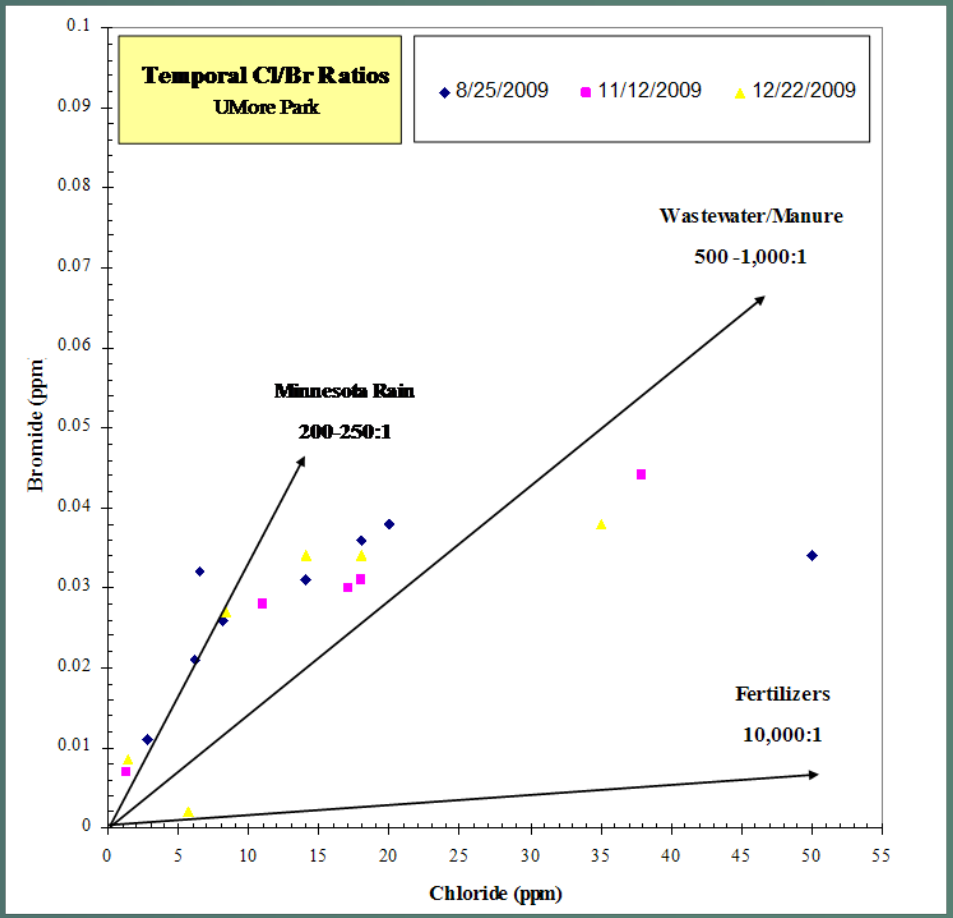


MW- PDC – C5 -T00006
Unique Well ID: NA

Groundwater Geochemistry

Environmental Chloride/Bromide Ratios	
Seawater	300:1
Minnesota Rain	200-250:1
Manure	500-1,000:1
Wastewater	1,000-2,000:1
KCl fertilizer	10,000:1
Road/Water Softner Salt	>20,000:1





Sustainable Groundwater at UMore Park

- The Role of Future Monitoring at UMore Park
  - Assessing physical and chemical groundwater variability *during* and *after* aggregate extraction.
  - Monitoring the effects of mine lakes on aquifer recharge.
  - Assessing the impacts of increased municipal demand and future development near the property.
  - Creation of a comprehensive monitoring database

Project Summary

Understanding background groundwater characteristics and forecasting future hydrologic changes are integral parts of effectively managing the aquifers at UMore Park.

This analysis assesses the following:

1. Defining baseline physical and chemical groundwater variability in the Q and PDC aquifers.
2. Surveying future monitoring and modeling needs for the property, focusing on impacts from aggregate extraction and regional development
3. Creation of a comprehensive monitoring database

   Agricultural Use -> Aggregate Mining -> Regional Development

Comments or Questions?