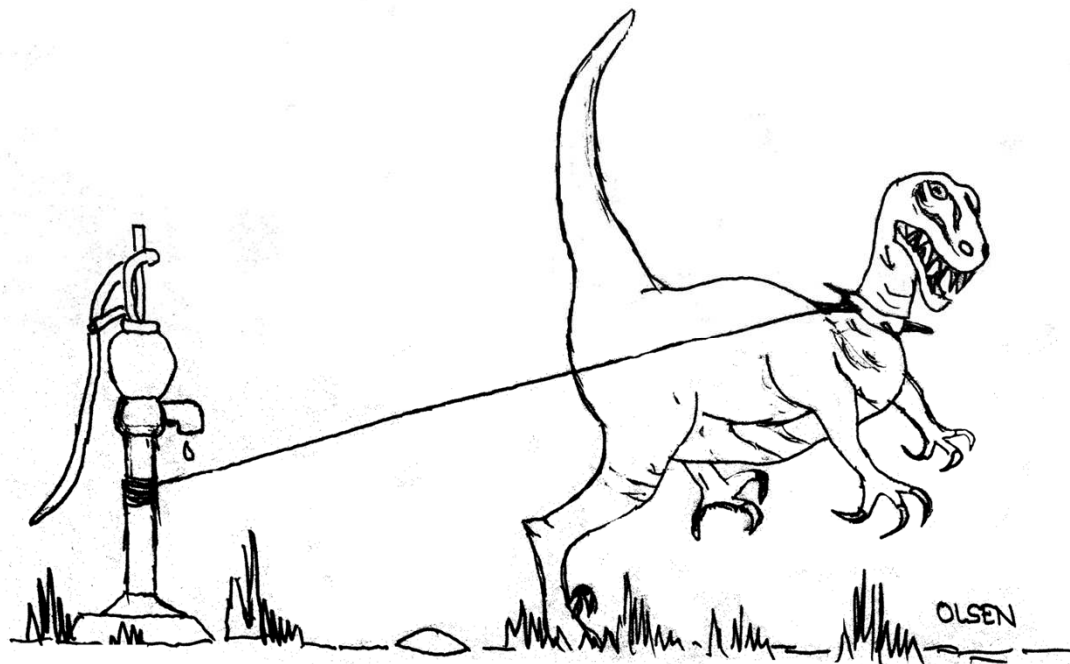




# Mapping the Transitional Boundary Between Wellhead Protection to Source Water Protection

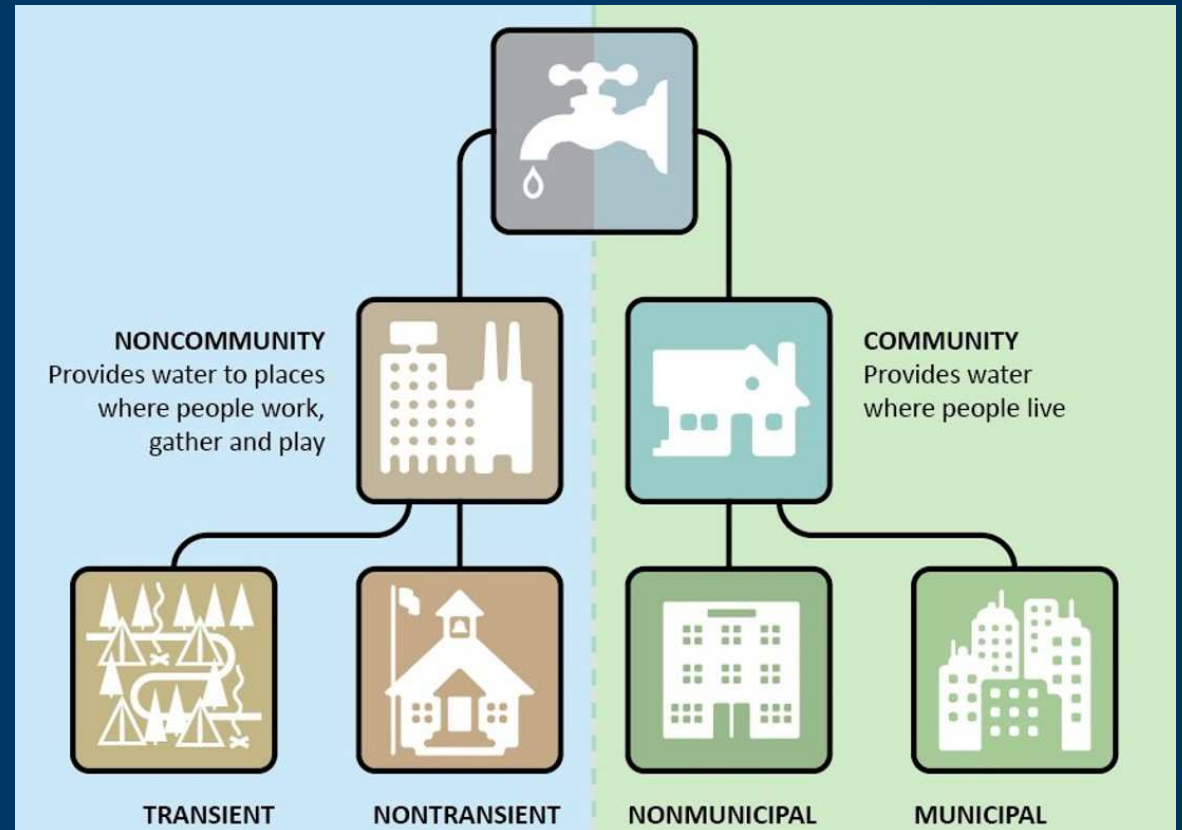
Steve Robertson | Bob Tipping | Bruce Olsen

# Prehistoric Wellhead Protection 1986-2008



# Types of Public Water Supply Systems

- **Community**
  - 25 or more people at their primary residence *or* had at least 15 service connections
- **Nontransient Noncommunity**
  - 25 or more non-residents for at least 6 months/year
- **Transient Noncommunity**
  - 25 or more people daily for 60 days/year



# Wellhead Protection Enabling Legislation



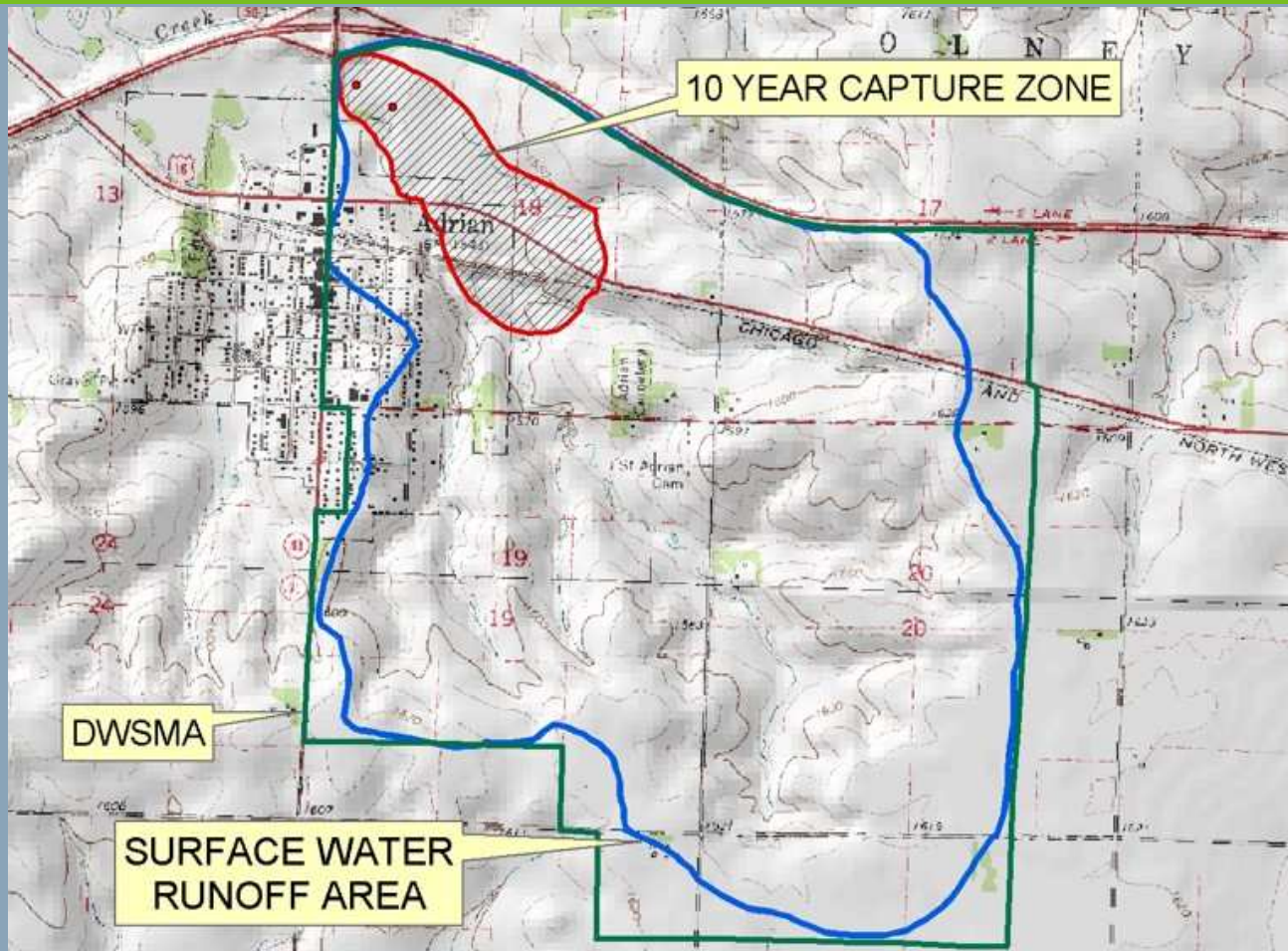
- 1986 Safe Drinking Water Act amended CFR 420 Sec 300h-7A
- 1989 Minnesota Ground Water Act Laws 1989, Ch. 326
- 1996 Safe Drinking Water Act Amended PL 104-182

# 1989-1997

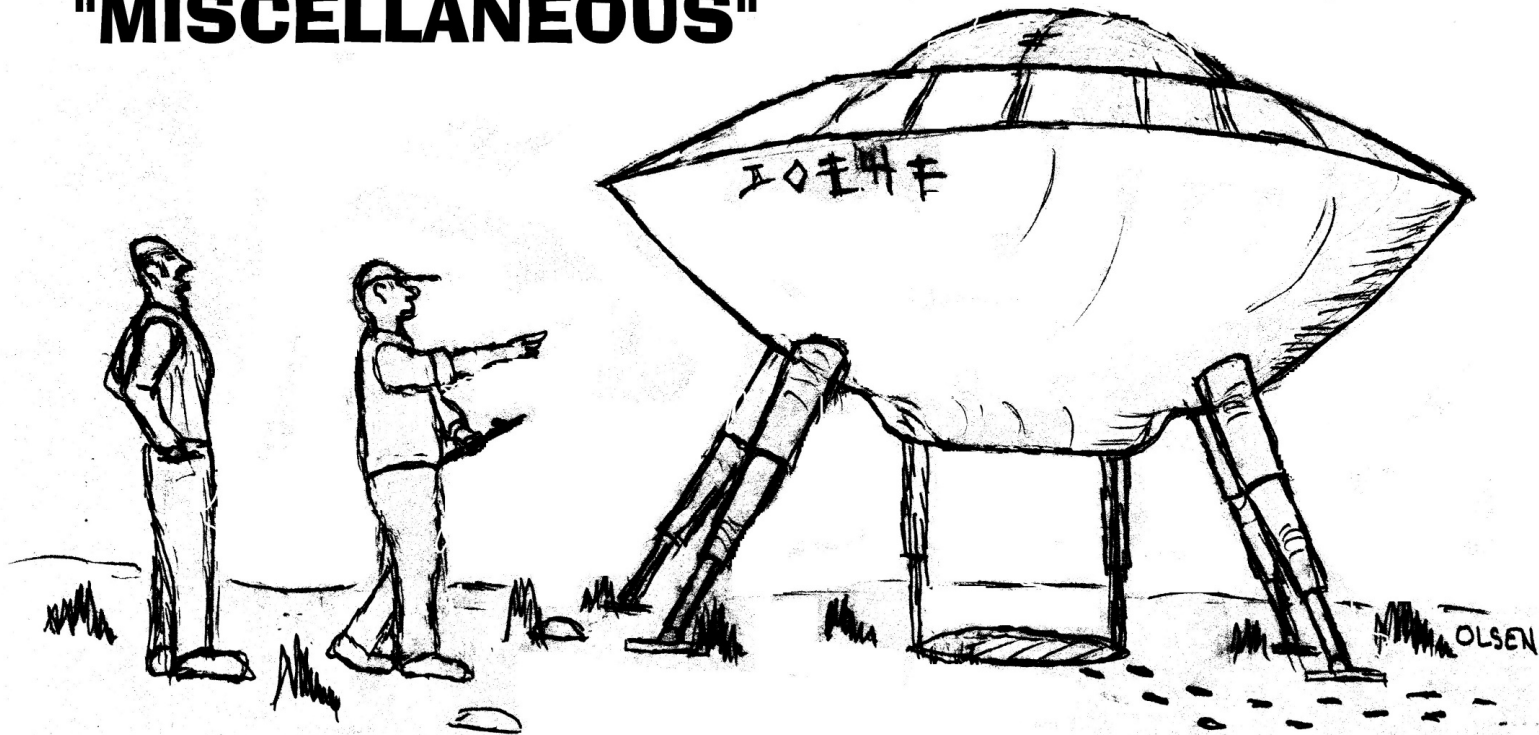
- WHP Program Submittal to EPA – 1996
- WHP Rule Promulgated – 1997
- Developed WHP planning to support rule
- Developed capabilities to support WHP



# WHPA/DWSMA Delineation



# LIST IT AS "MISCELLANEOUS"



## Contaminant Source Inventory



TOO MUCH CARRY  
OVER NITROGEN  
HUH, JACK?

## Managing Potential Contamination Sources



## Source Water Assessments

- Required by 1996 SDWA amendment
- Deadline for completion – May 2003
- Included surface and groundwater-based PWS
- Funding provided through SDWA grants to states
- MDH provides assessments online



# Transition from the WHP Era to Source Water Protection



- External drivers
  - 2008 Legacy Amendment
  - 2013 State Government Roundtable
  - Drinking water issues in the public consciousness
    - 2014 Toledo – Lake Erie HAB
    - 2015 Flint – Lead
    - 2019 – Minnesota Groundwater Protection Rule

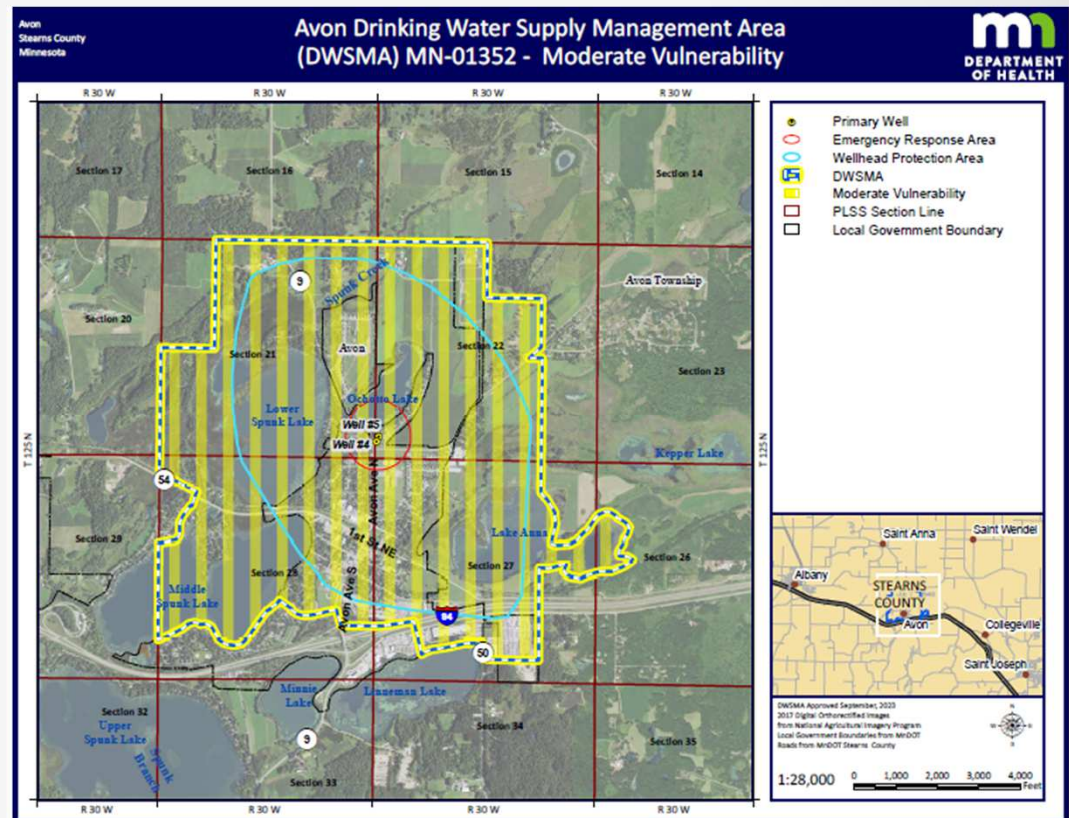
# Transition from the WHP Era to Source Water Protection



- Program reactions
  - More staff – increased output
  - Grants to systems
  - Addressing surface water sources
  - Increased coordination with Federal, State, and local partners
  - Groundwater restoration and protection strategies

# SWP – Ongoing Technical Challenges

- Redefining approaches for simulating groundwater flow
  - Analytic to numerical
  - GUIs to Jupyter notebooks and python scripts
  - Qualitative to quantitative uncertainty
- Expanding means by which we assess vulnerability



# Assessing Vulnerability

- Limitations of traditional approaches

- Decreasing signal strength of atmospheric tritium
- Pathogen occurrence in non-vulnerable settings

- Adaptations

- Ultra-low tritium analysis
- Anthropogenic contamination (e.g., CECs)
- Indicators as surrogates
- Understanding implications of mixing

# SWP – Ongoing Program Challenges

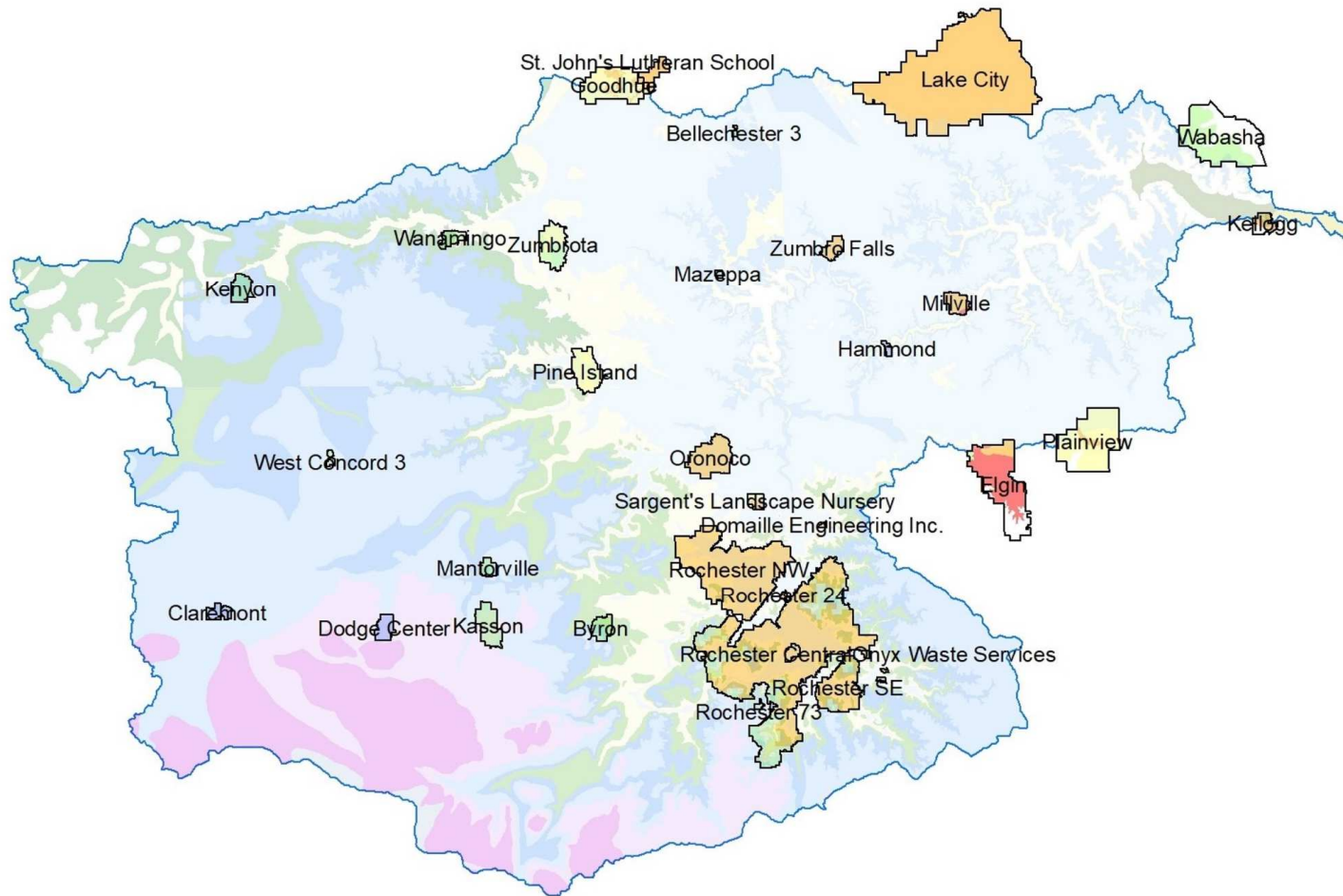


- Data management
- Promoting outcomes not just outputs
- Addressing needs of small systems
- Empowering and motivating public water systems
  - Landowners, too

# Transition to SWP – Emerging Issues

- Limitations of DWSMA scale
- Coordination with partners
- CECs
- Climate change
- Lead, infrastructure, treatment

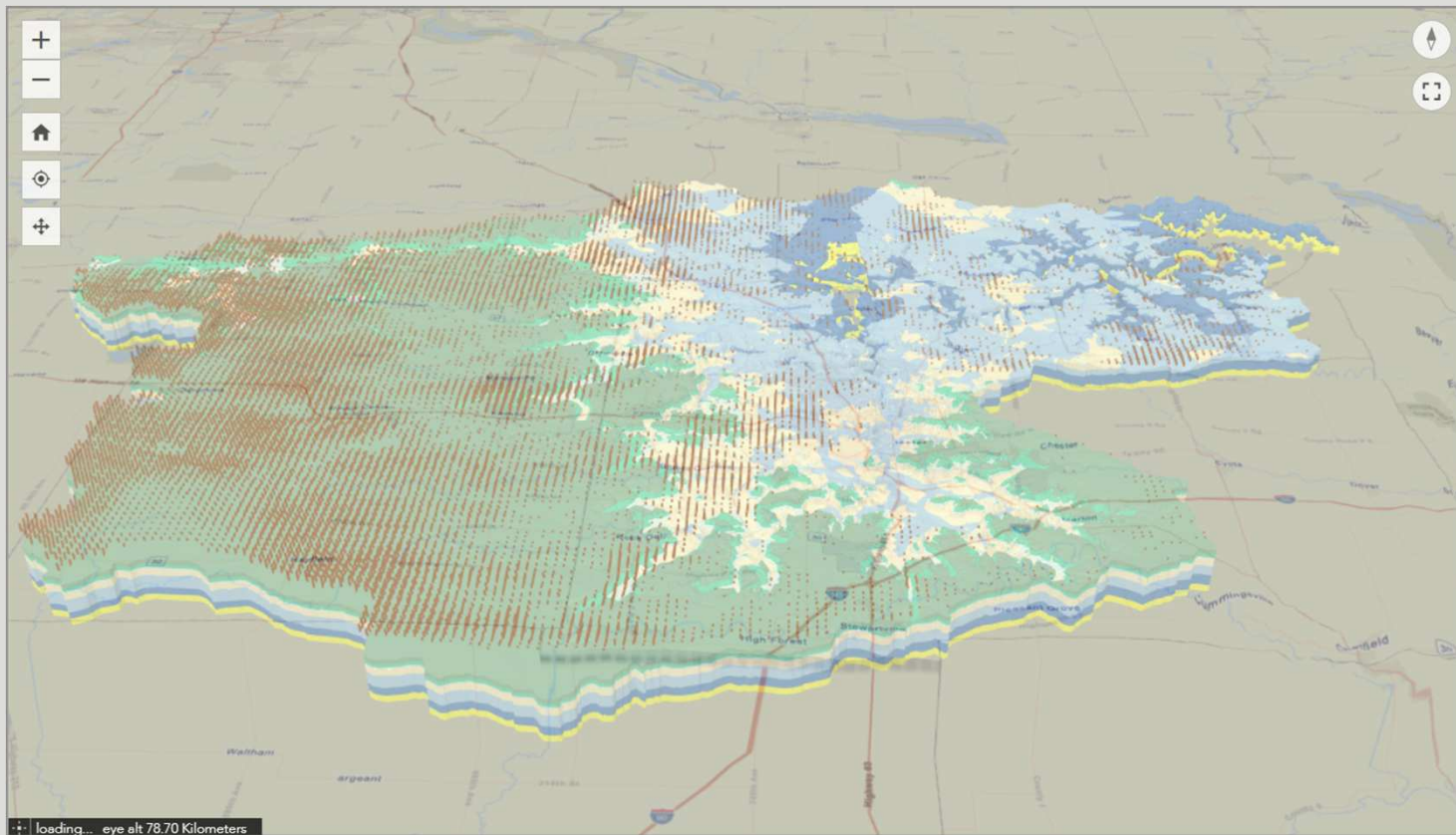


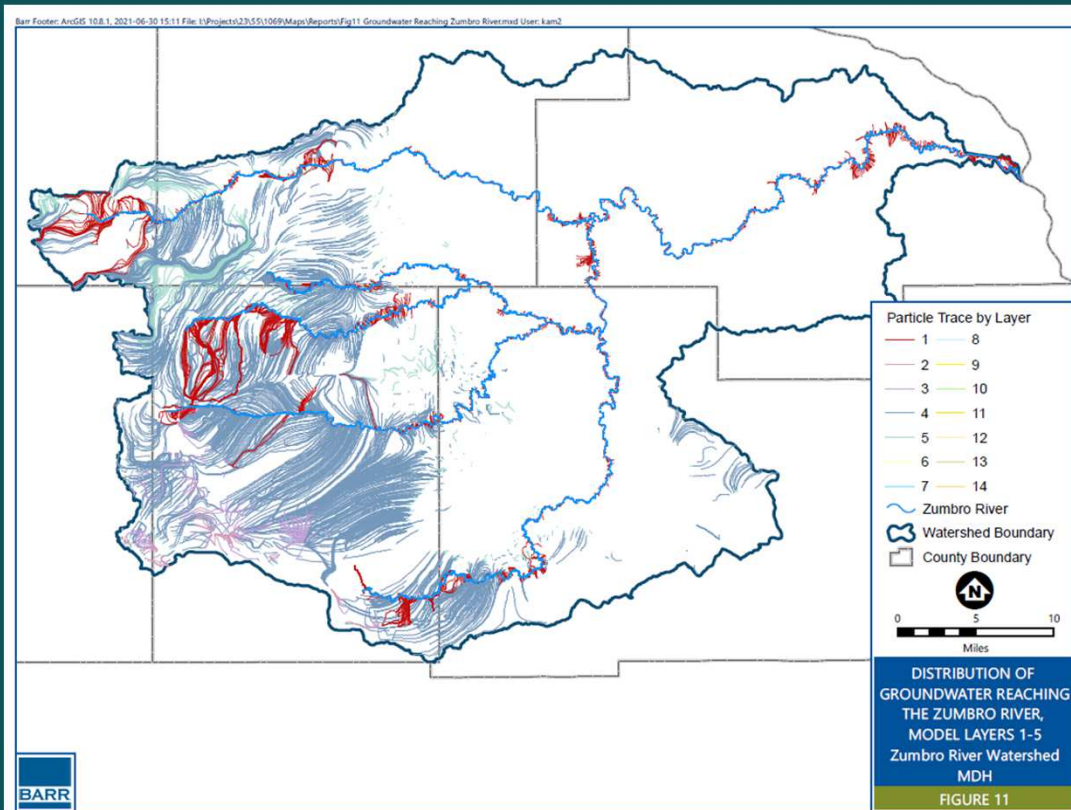


Drinking Water Quality in Areas Between DWSMAs not Currently Assessed



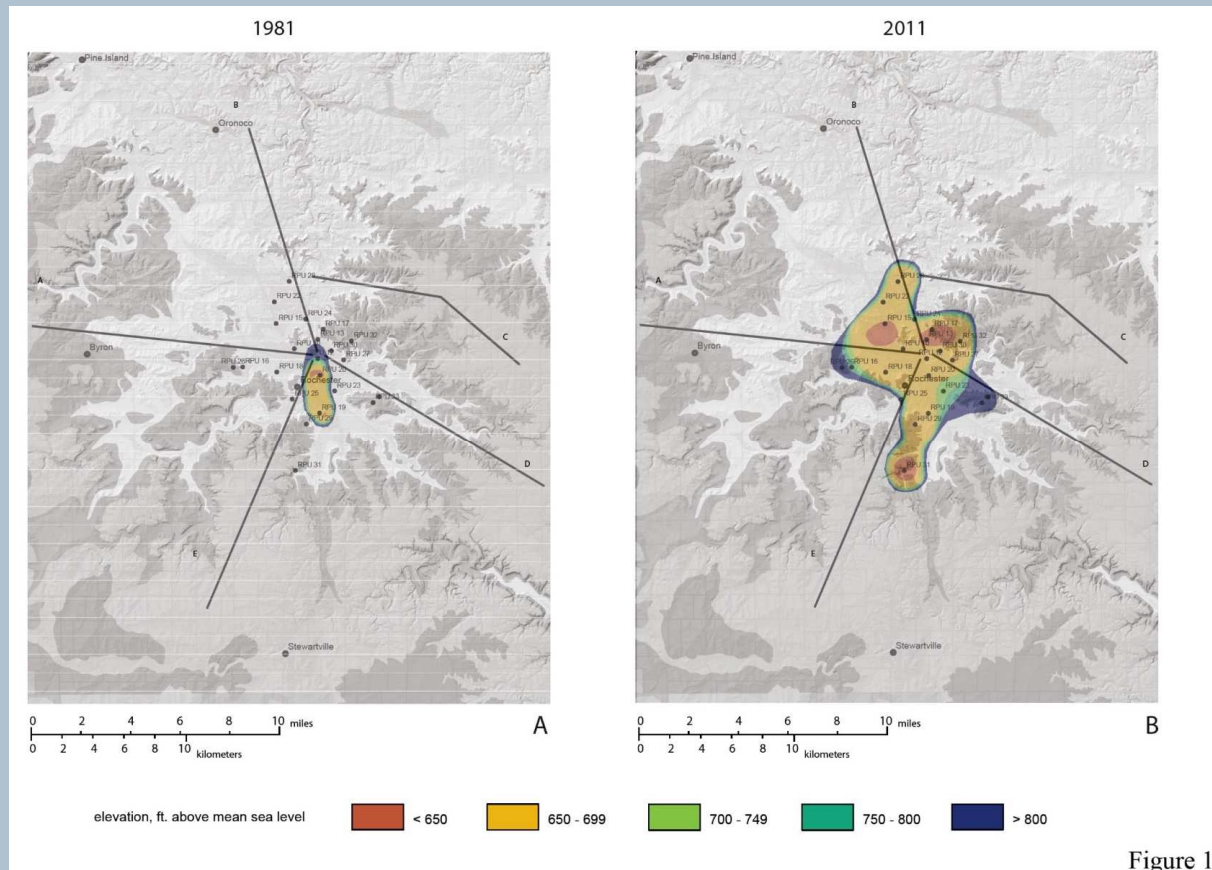
# 3-Dimensional Geologic Model of Unconsolidated and Bedrock Aquitards Helps Explain Watershed-Scale Differences in Drinking Water Quality



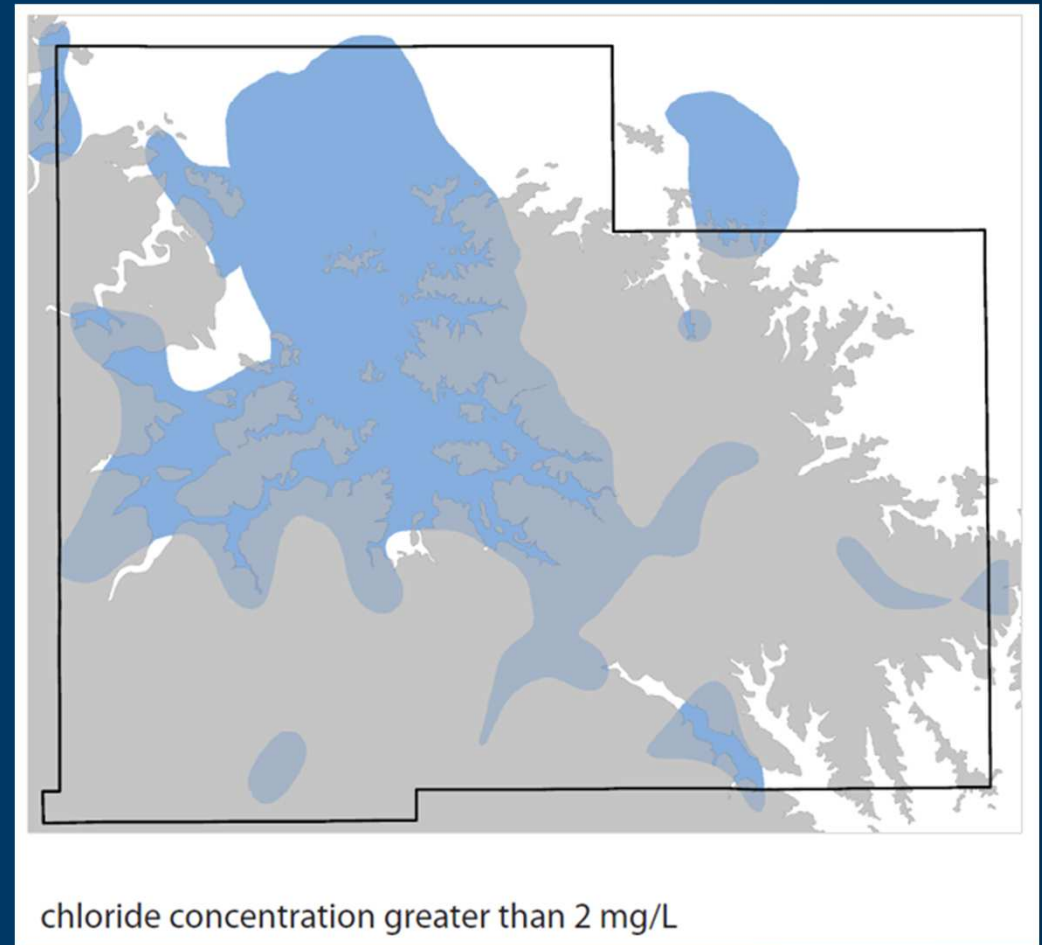


Uppermost Aquifers  
Have Hydrologic  
Boundaries that Most  
Closely Correspond to  
Watershed Boundaries

# Impact of Vertical Hydraulic Gradient on Distribution of Recent Waters Over Time



# Presence of Recent Waters Underneath Decorah Shale Indicative of Lateral Flow and Leakage through Confining Units



# Conclusions

- Transition from Wellhead Protection to Source water protection
  - WHP and SWP have in common
    - Goal of protecting drinking water sources
    - MDH role is similar
  - Drinking Water Ambient Monitoring Program (DWAMP)
    - Contaminants of Emerging Concern – watershed-scale monitoring of uppermost vulnerable aquifers
    - Not all groundwater, but provides sentinel monitoring of most recent recharge
  - Groundwater Restoration and Protection Strategies (GRAPS)
  - For groundwater, recognition of aquifer(s) as the drinking water source in addition to the public supply well

# Thank You!

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