Applying Past Lessons Learned to Future Groundwater Problems

Kelton Barr, PG

Kelton Barr Consulting LLC

Over the past 30 years (some Minnesota highlights):

1970s – landfills replacing dumps
        MPCA starts investigating Riley Tar
        MDH well regulations started
        MN water priority law

1980s – Superfund investigations started
        LUST investigations started
        MGWA founded
        first county atlas by MGS

1990s – closed landfill program
        county well index program
        USGS metro model
        start of Metro Model (at MPCA)

2000s – Metro Model 2 (at Metro Council)
        LiDAR and other technologies

Fundamental Lessons Learned

Once contamination is in the groundwater it can take a long, long time to remove it

Contamination plumes migrate toward discharge points and areas (surface waters and wells)

Treating contaminated water to potable standards is very, very expensive.

Only by ongoing groundwater monitoring can we identify the problem and fix it

Example of Future Groundwater Problem:

- By 2040: one million more people in Twin Cities metro area
- most drinking water is from groundwater
- groundwater pumping can effect surface waters
- issues of groundwater depletion/no bedrock aquifers

Can we enhance the recharge to groundwater supplies for the Twin Cities' drinking water?
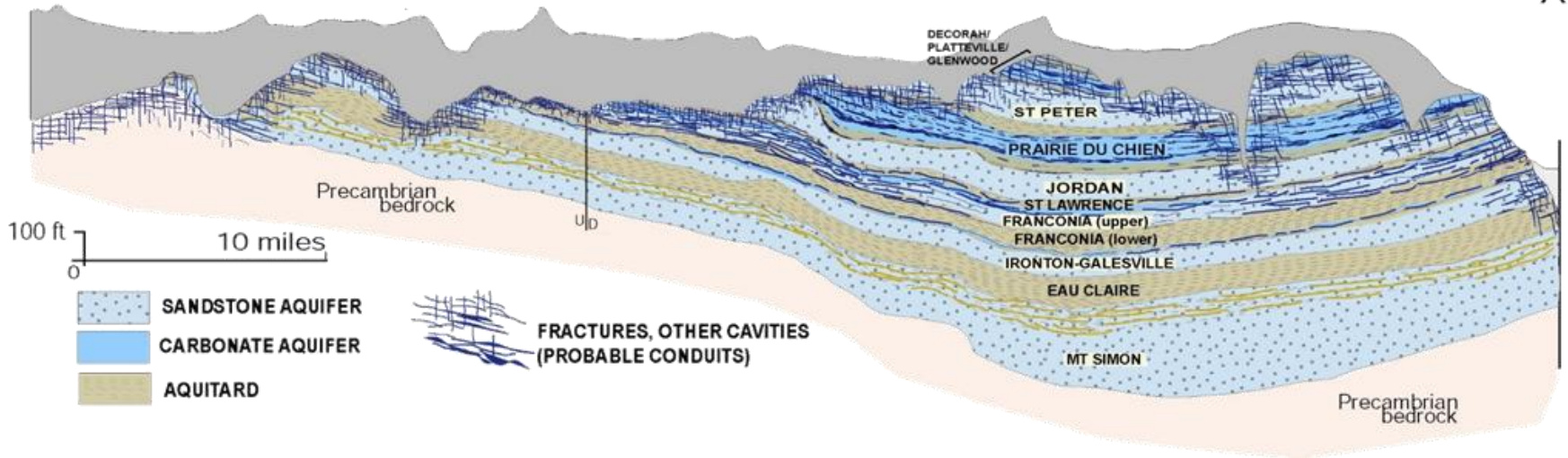
Twin Cities geology–

Layers of glacial tills and outwash, up to 300 feet thick

Sequence of Paleozoic sedimentary units of sandstones, shales, and carbonates

100 ft

10 miles

0

SANDSTONE AQUIFER

CARBONATE AQUIFER

AQUITARD

FRACTURES, OTHER CAVITIES
(PROBABLE CONDUITS)

DECORAH/
PLATTEVILLE/
GLENWOOD

ST PETER

PRAIRIE DU CHIEN

JORDAN
ST LAWRENCE
FRANCONIA (upper)
FRANCONIA (lower)
IRONTON-GALESVILLE
EAU CLAIRE

MT SIMON

Precambrian bedrock

Precambrian bedrock

Sherburne Isanti

A

Anoka

Wright

Ramsey

Washington

A'

Hennepin

Carver

Dakota

Scott

Ordovician

Cambrian

ENHANCED RECHARGE ANALYSIS

Goal

Identify areas potentially suitable for regional-scale enhanced recharge projects

Strategies

- Use existing datasets and public databases
- GIS-based analysis

Two Approaches

- Hydrogeological Criteria
- Expanded Criteria

ENHANCED RECHARGE ANALYSIS

Dataset	Source
Vertical Infiltration Rate - Top 5 feet	NRCS
Hydraulic Conductivity (Unconsolidated)	MGS
Depth to Water Table	MCES
Uppermost Bedrock	MGS

Criteria	Tier 1 (Good)	Tier 2 (Ok/not bad)	Tier 3 (No Good)
Vertical Infiltration Rate - Top 5 feet	> 5 in/hr	0.5 – 5 in/hr	< 0.5 in/hr
Hydraulic Conductivity (Unconsolidated)	>10 ft/day	≥1 ft/day	<1 ft/day
Depth to Water Table	>50 feet	≥15 feet	<15 feet
Uppermost Bedrock	Prairie du Chien and older	St. Peter and older	Galena, Decorah, Platteville, Glenwood

Enhanced Recharge Analysis

Average Vertical Infiltration Rate (ft/day)

- >5 in/hr (Tier 1)
- 0.5 – 5 in/hr (Tier 2)
- <0.5 in/hr (Tier 3)
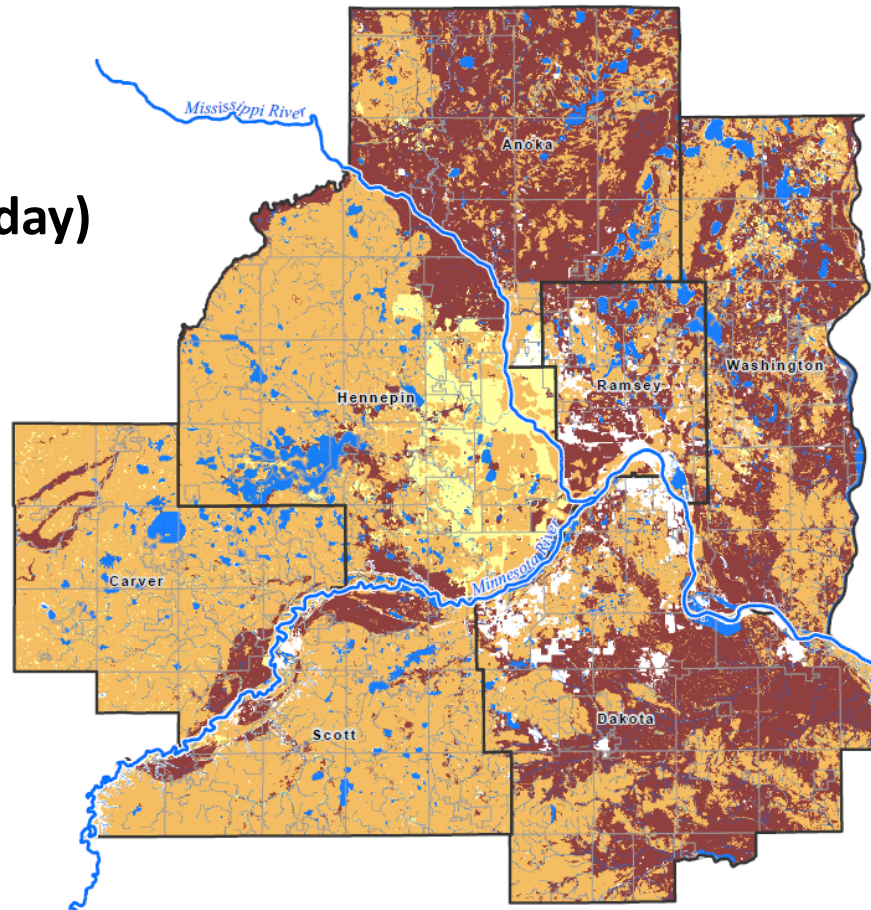
Enhanced Recharge Analysis

Hydraulic Conductivity (ft/day) – first 60 feet
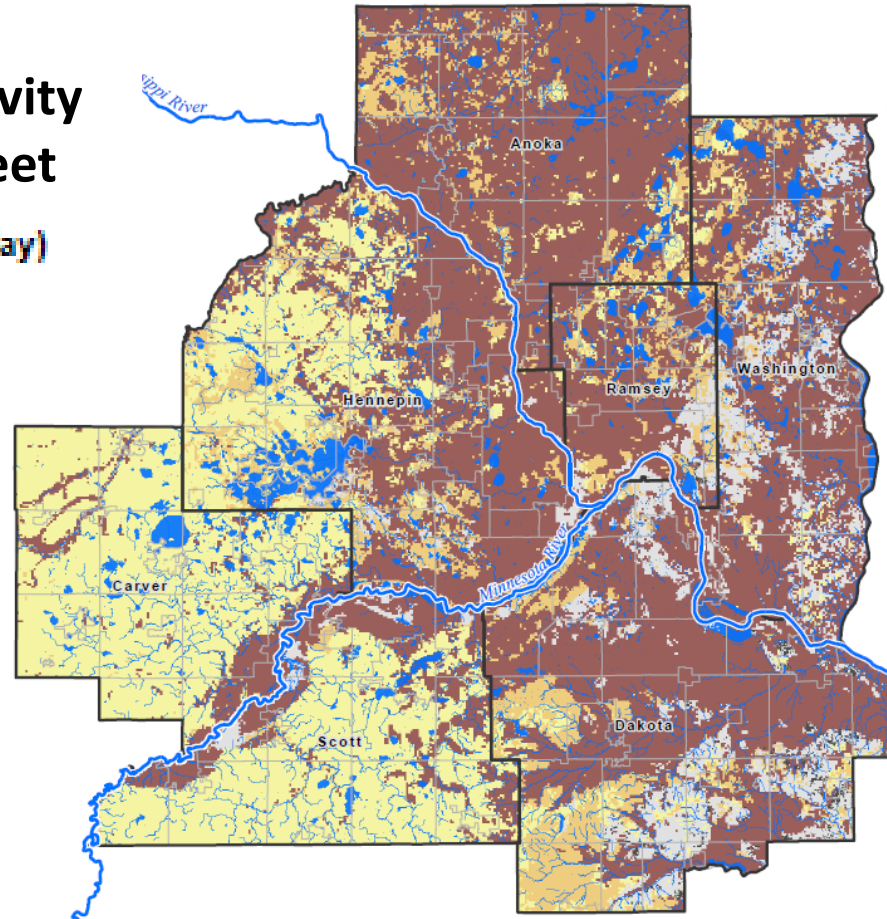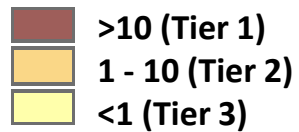
Enhanced Recharge Analysis
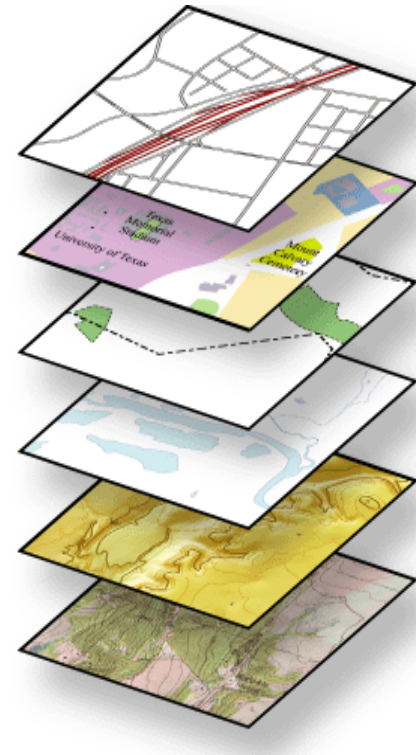
Hydraulic Conductivity (ft/day) – entire overburden

▉	>10 (Tier 1)
▉	1 - 10 (Tier 2)
▉	<1 (Tier 3)
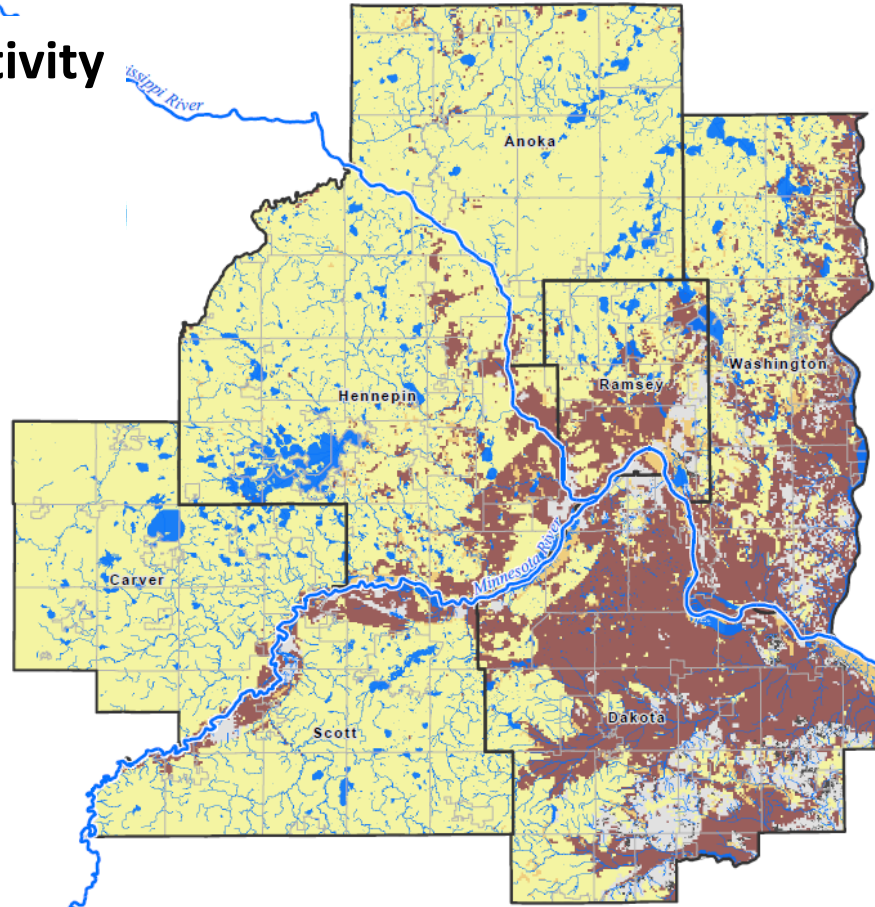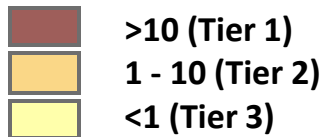
Enhanced Recharge Analysis

Depth to Water Table (ft)

- ⬛ >50 (Tier 1)
- ⬛ 15 - 50 (Tier 2)
- ⬛ <15 (Tier 3)
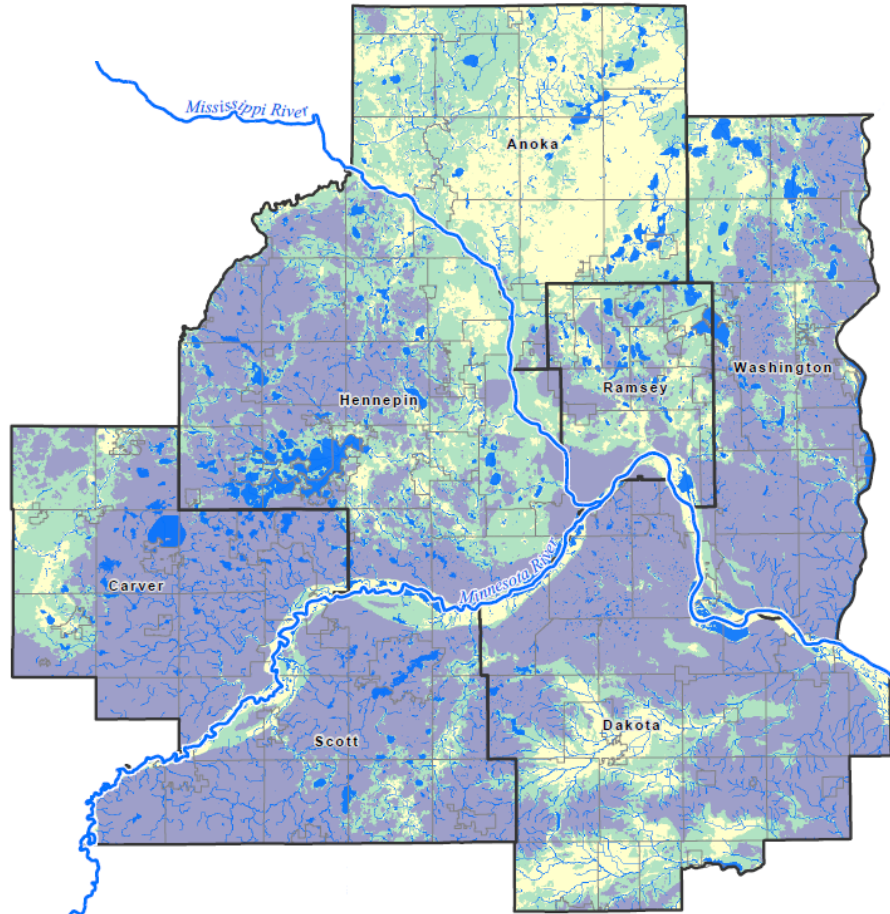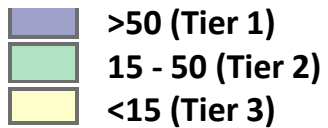
Overlay all Datasets...Get Results

- ## Tier 1 Areas:
    - areas where all Tier 1 criteria are met

- ## Tier 2 Areas:
    - areas where one or more Tier 1 criteria are not met, and all Tier 2 criteria are met

- ## Tier 3 Areas:
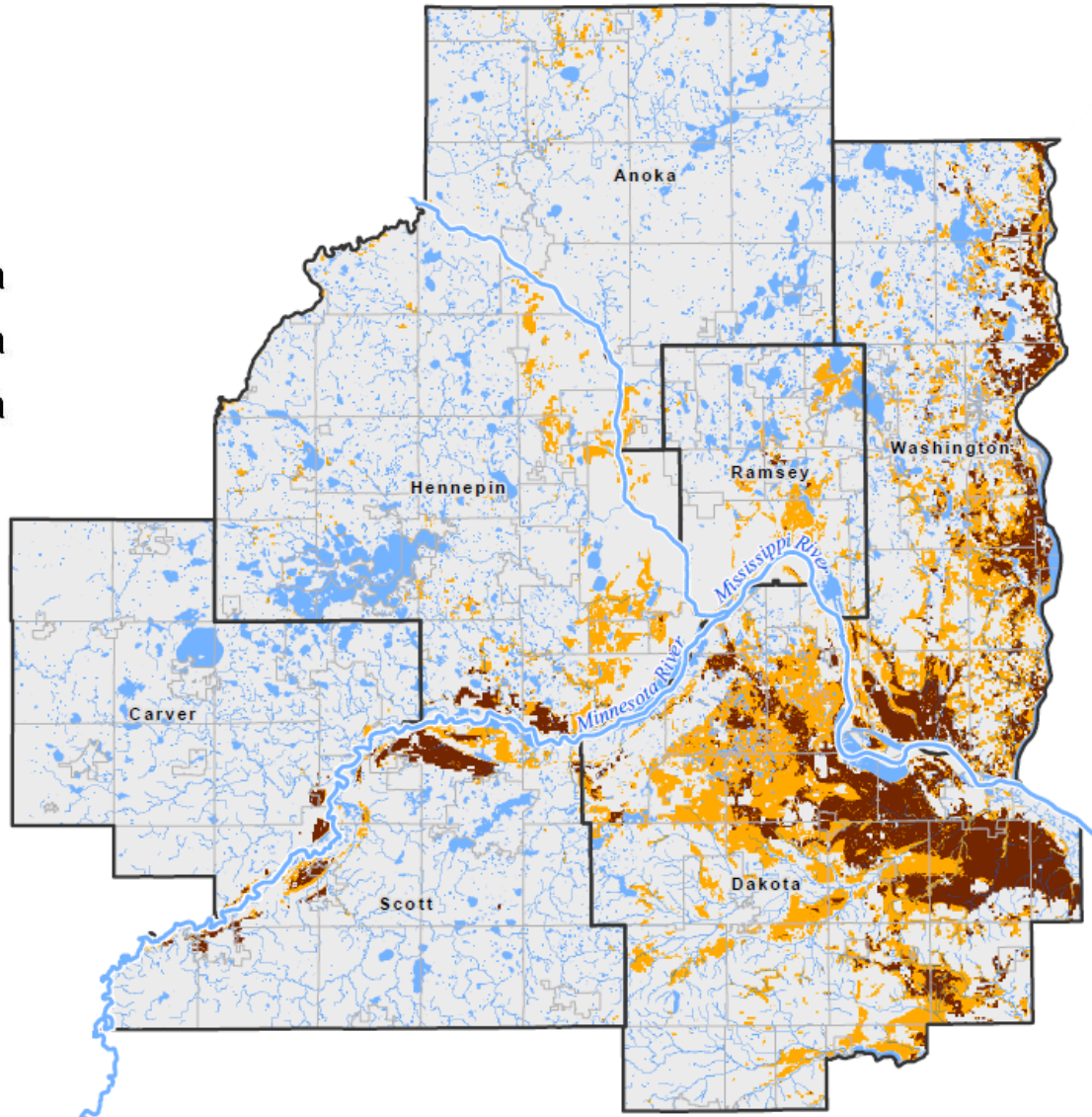   - the leftovers

Enhanced Recharge to ALL Aquifers
Hydrogeological Criteria Only

Legend:
- Tier 1 Area
- Tier 2 Area
- Tier 3 Area
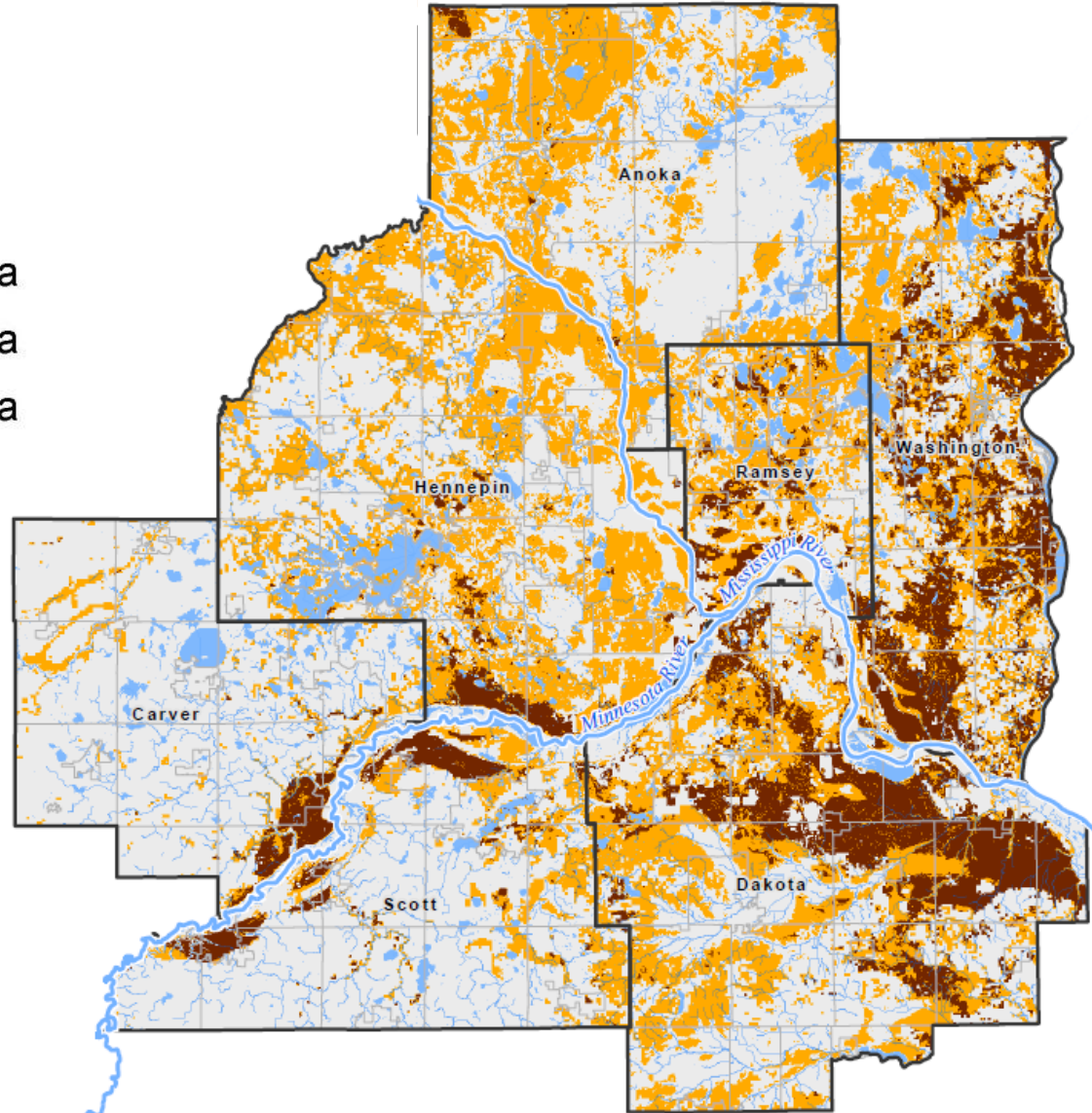
Enhanced Recharge to BEDROCK Aquifers -- Hydrogeological Criteria Only

EXPANDED CRITERIA

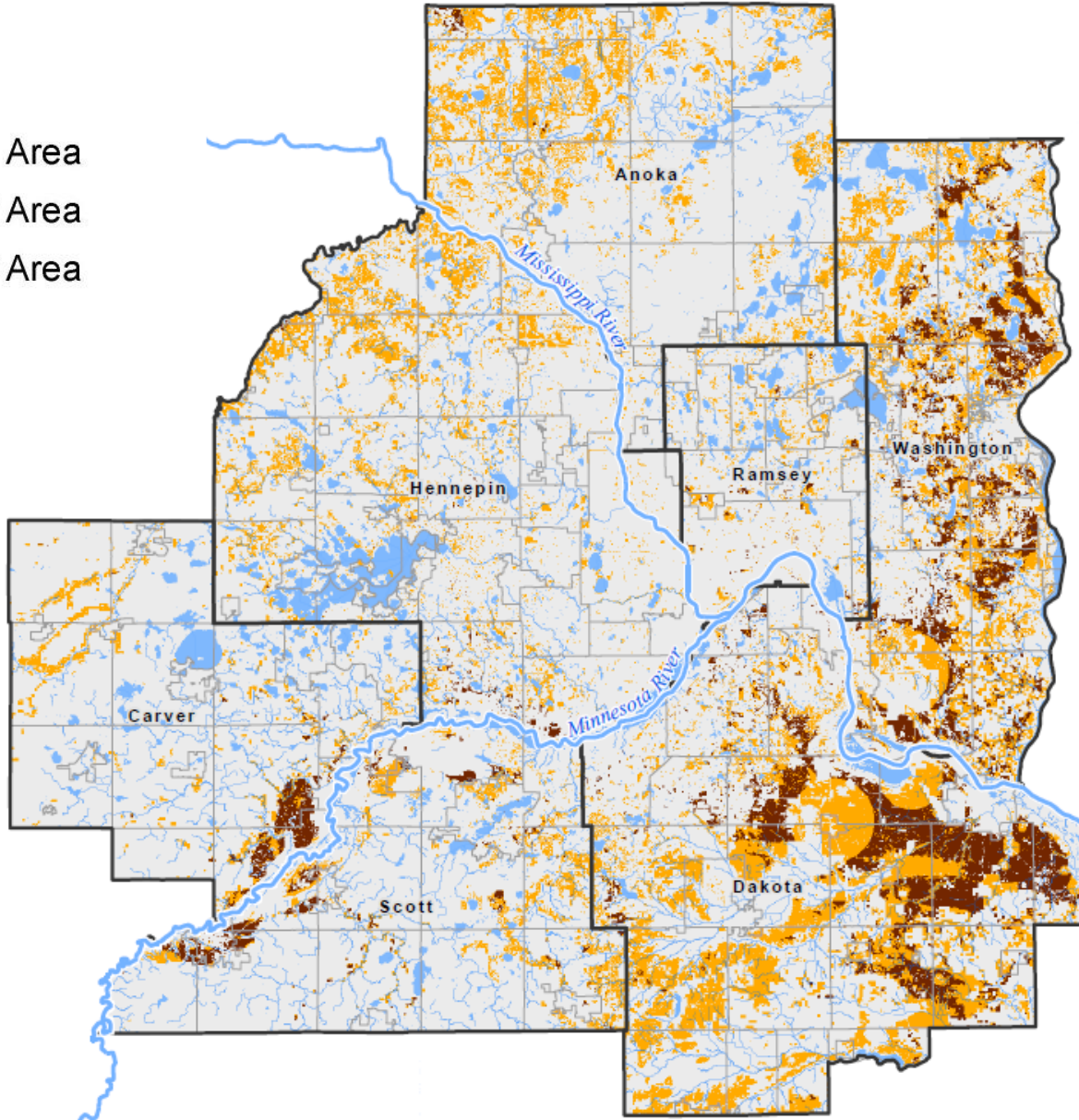| Criteria	Tier 1	Tier 2	Tier 3
Current Land Use	• Agricultural • Parks • Undeveloped areas	• Agricultural • Parks • Undeveloped areas	All other land use types
Natural Resource Areas	**Not within:** Sensitive/ protected areas	**Not within:** Sensitive/protected areas, not including T&E Species areas	**Within:** Sensitive/ protected areas

EXPANDED CRITERIA (cont'd.)

Criteria	Tier 1	Tier 2	Tier 3
High or Very High Vulnerability DWSMA **and** <100 ft to Prairie du Chien	Not within	Not within	Within

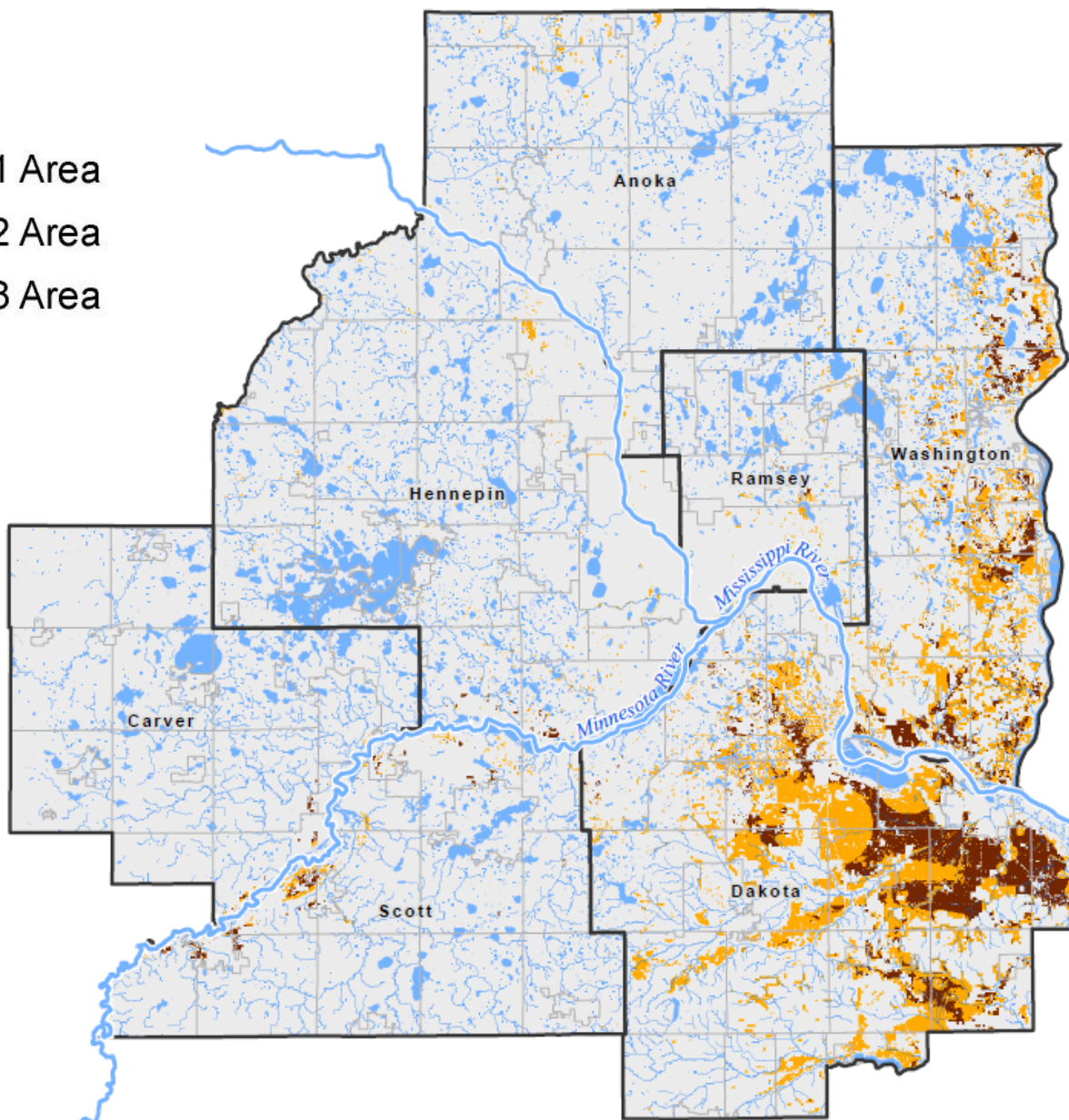**Location of Contamination Sites and Plumes**

Enhanced Recharge to ALL Aquifers -- ALL Criteria

Enhanced Recharge to BEDROCK Aquifers -- ALL Criteria

And now, some movies from Bill Olsen

Weighted Median of nitrate samples, 25 feet below water table.

1980.00

Legend

Nitrate (ppm)

- 50
- 40
- 30
- 20
- 15
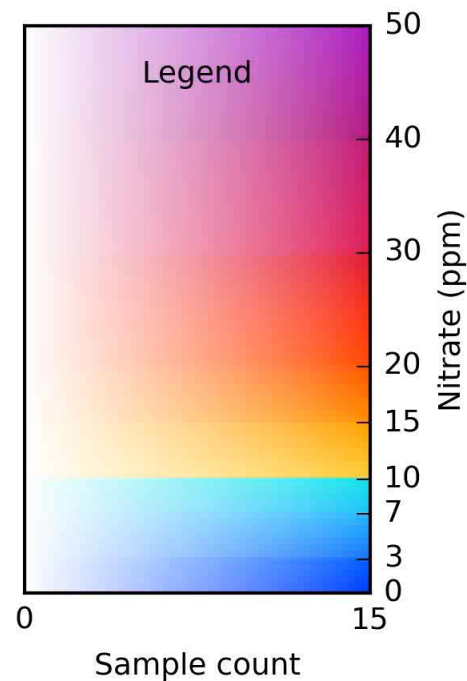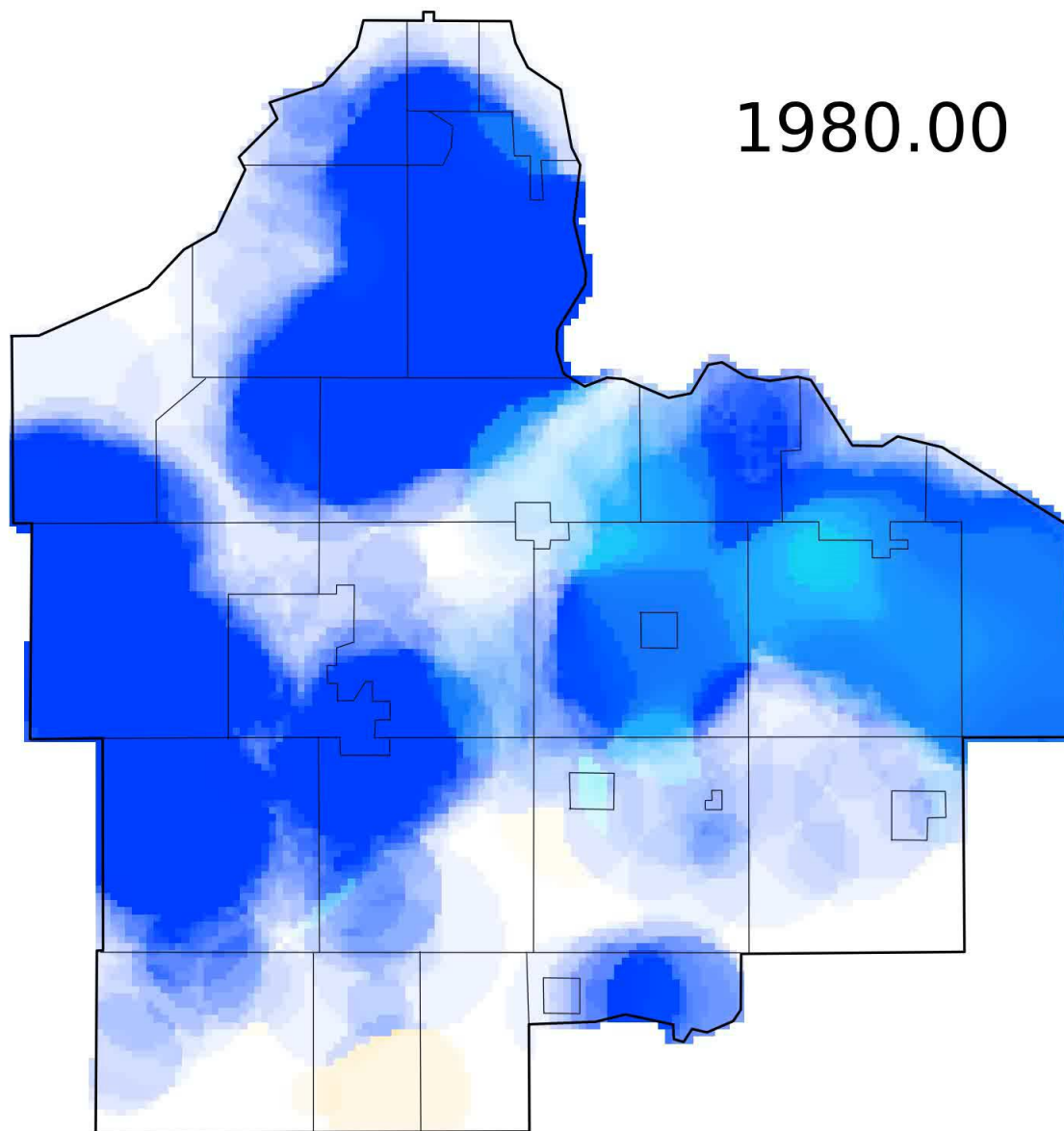- 10
- 7
- 3
- 0

Sample count

0   15

Image Resolution
Horizontal: 15,000 feet
Vertical: 80 feet
Time span: 15 years

Dakota
C O U N T Y

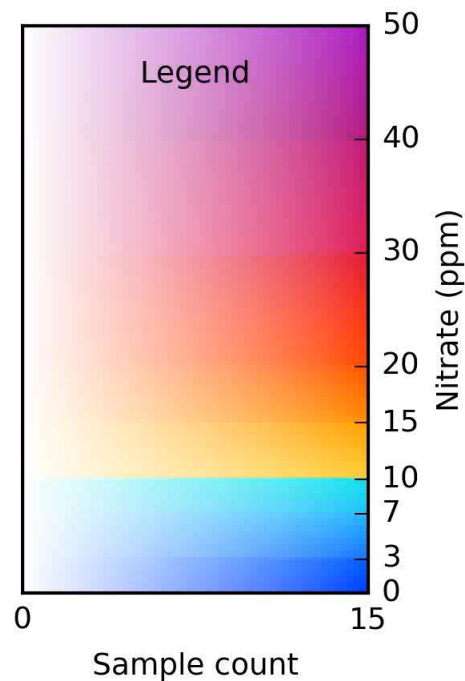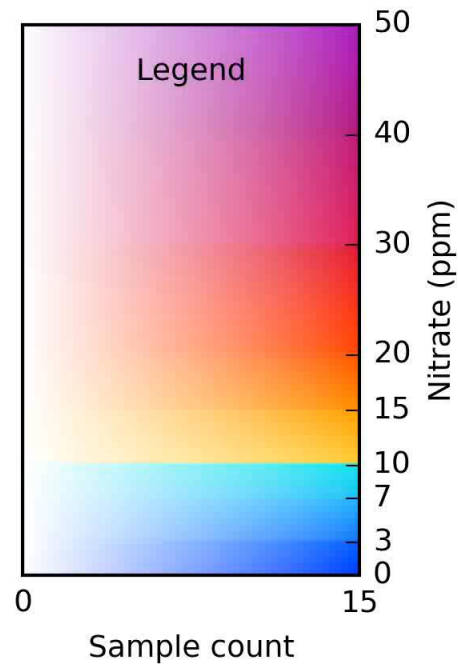# Weighted Median of nitrate samples, 100 feet below water table.

1980.00

Legend

Nitrate (ppm)

50
40
30
20
15
10
7
3
0

0   Sample count   15

Image Resolution
Horizontal: 15,000 feet
Vertical: 80 feet
Time span: 15 years

Dakota
C O U N T Y

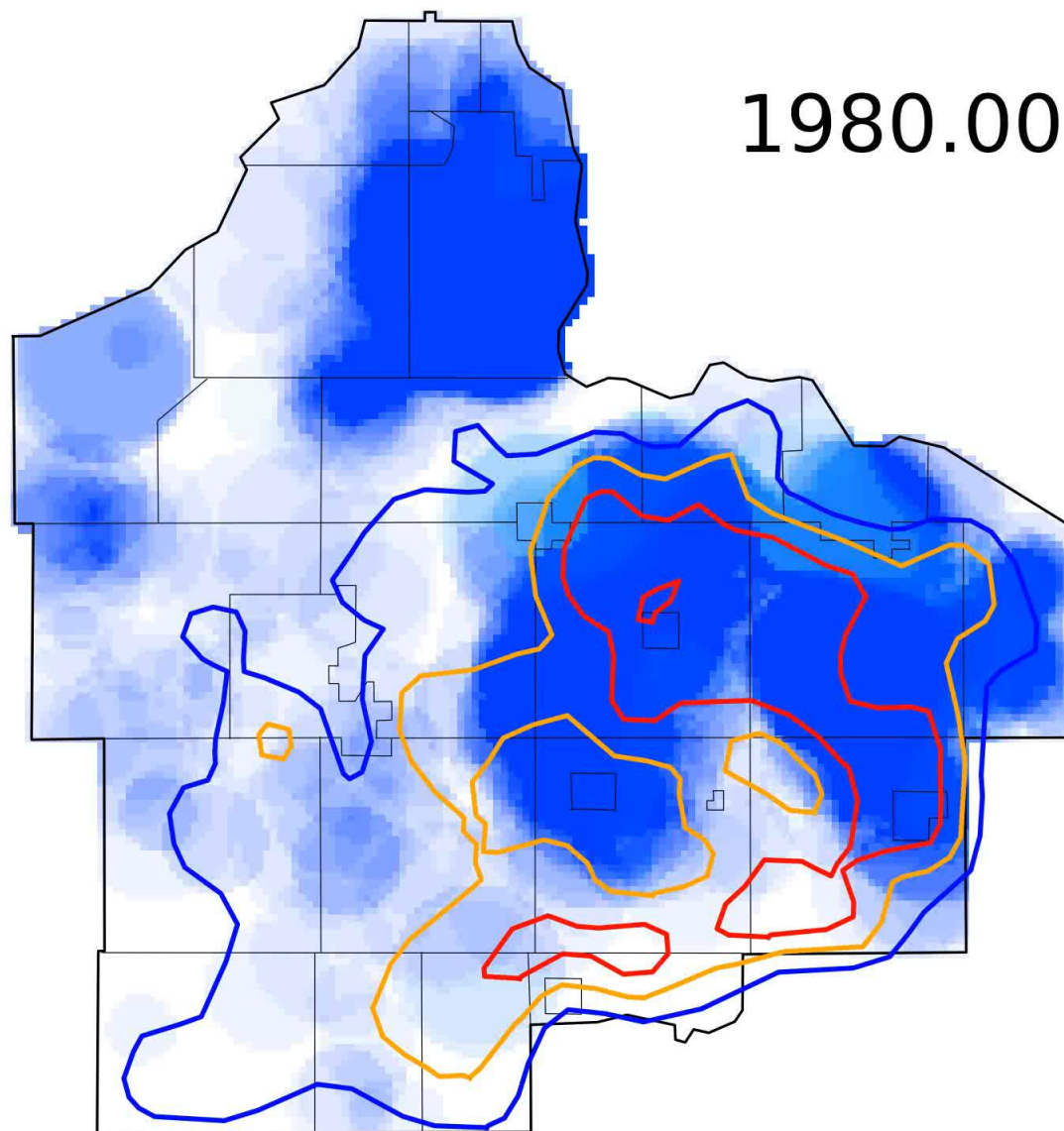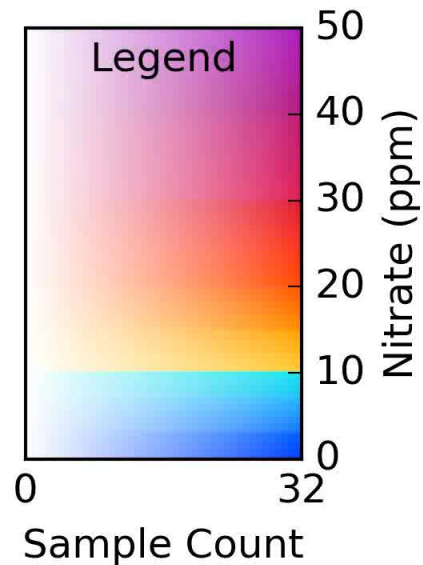Weighted Median of nitrate samples, 200 feet below water table.

1980.00

Legend

Nitrate (ppm)

50
40
30
20
15
10
7
3
0

0   Sample count   15

Image Resolution
Horizontal: 15,000 feet
Vertical: 80 feet
Time span: 15 years

Dakota
C O U N T Y

Weighted median of nitrate samples, in vertical section.

1980.00

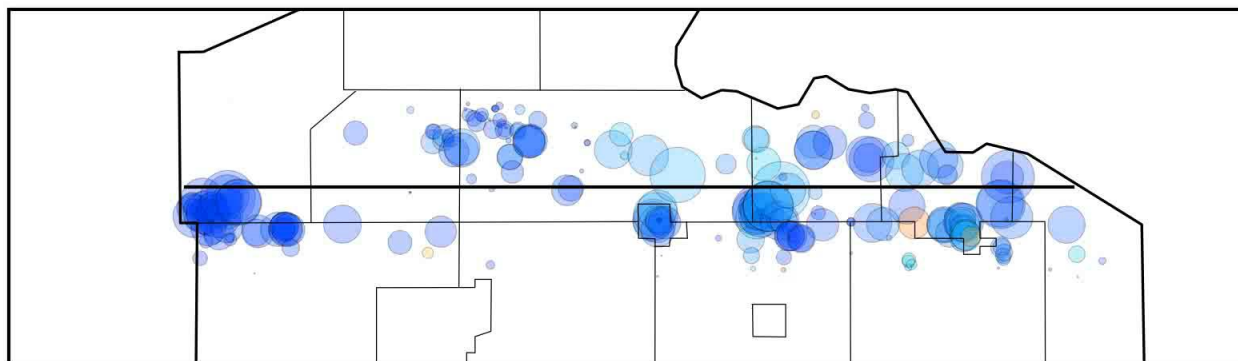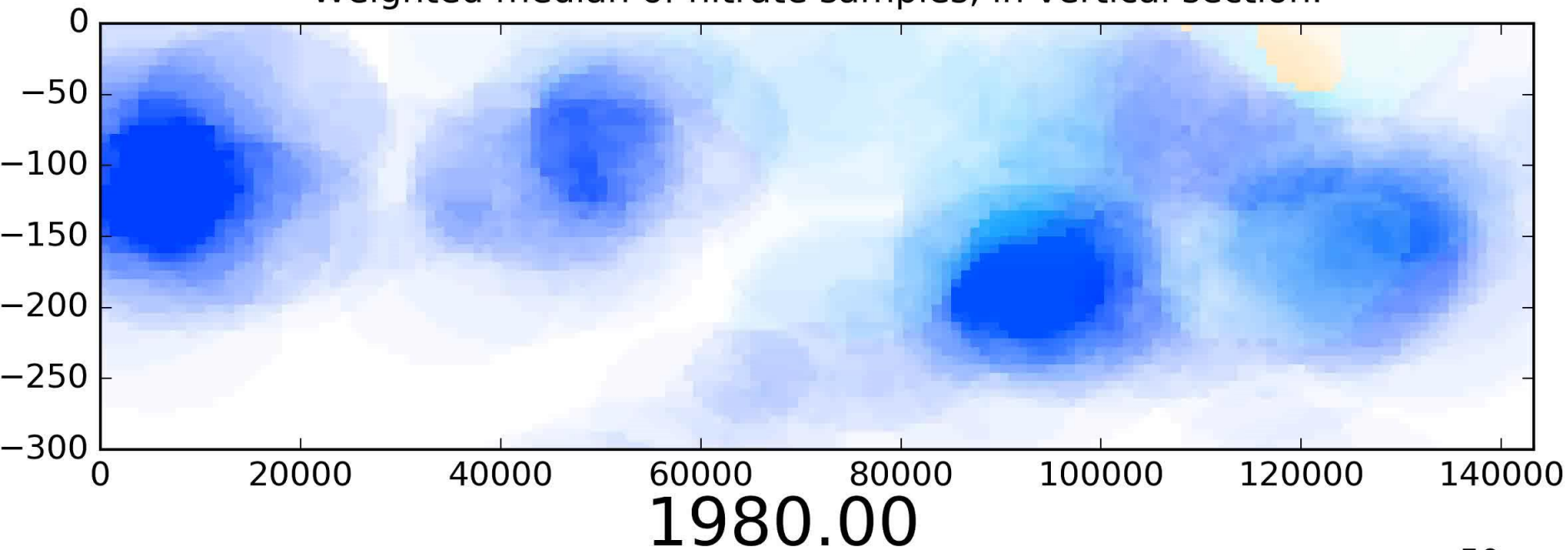Legend
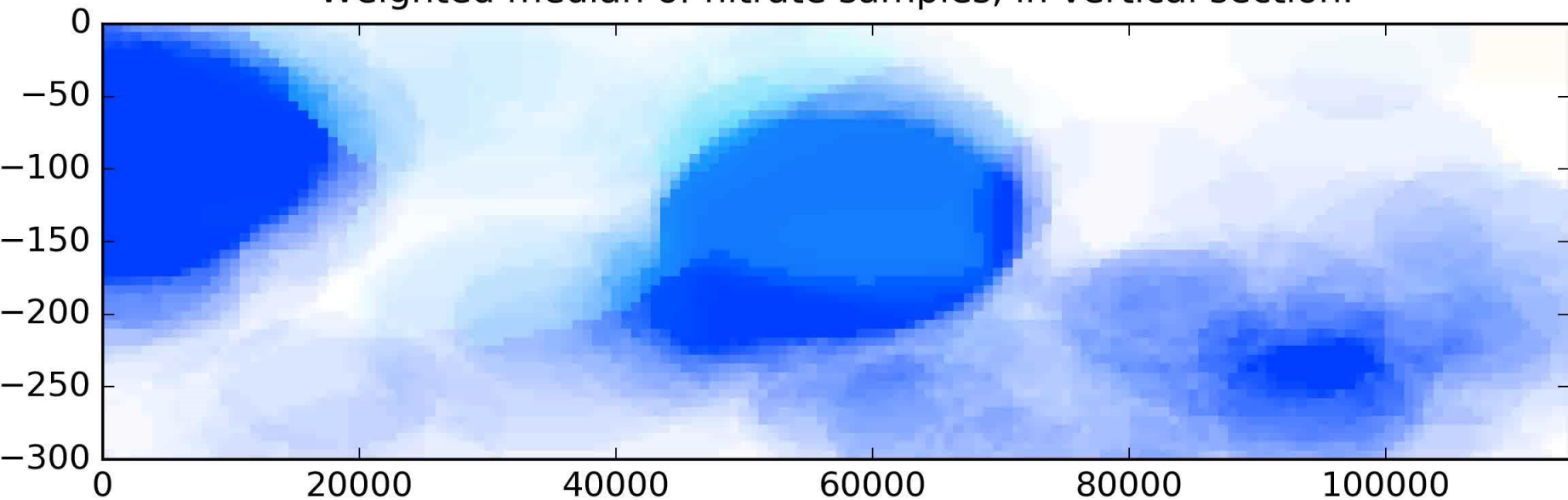
Nitrate (ppm)

Sample Count

Image Resolution: Horizontal: 15,000 feet, Vertical: 80 feet, Time span: 15 years

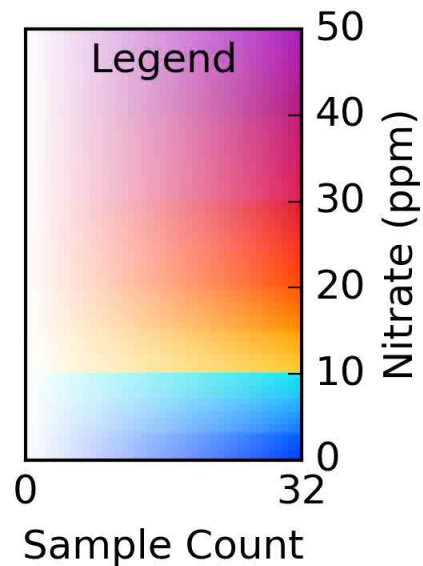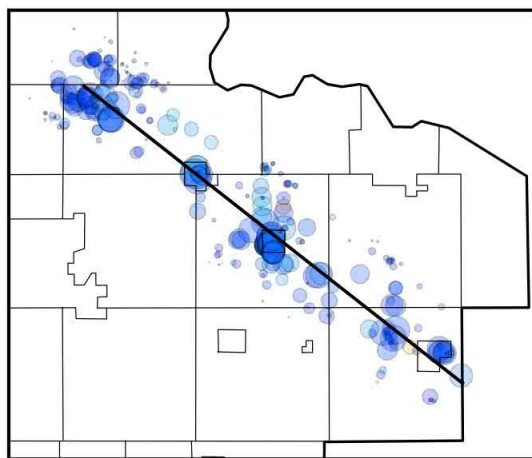# Weighted median of nitrate samples, in vertical section.

1980.00

Image Resolution: Horizontal: 15,000 feet, Vertical: 80 feet, Time span: 15 years

Legend

Nitrate (ppm)

Sample Count

Can we apply the lessons we've learned to our future problems?

- Once contamination is in the groundwater it can take a long, long time to remove it

- Contamination plumes migrate toward discharge points and areas (surface waters and wells)

- Treating contaminated water to potable standards is very, very expensive.

- Only by ongoing groundwater monitoring can we identify the problem and fix it

Questions?

keltondlbarr@gmail.com

https://metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning/Studies-Projects-Workgroups-(1)/Ongoing-Studies-Projects/Regional-Feasibility-Assessments.aspx