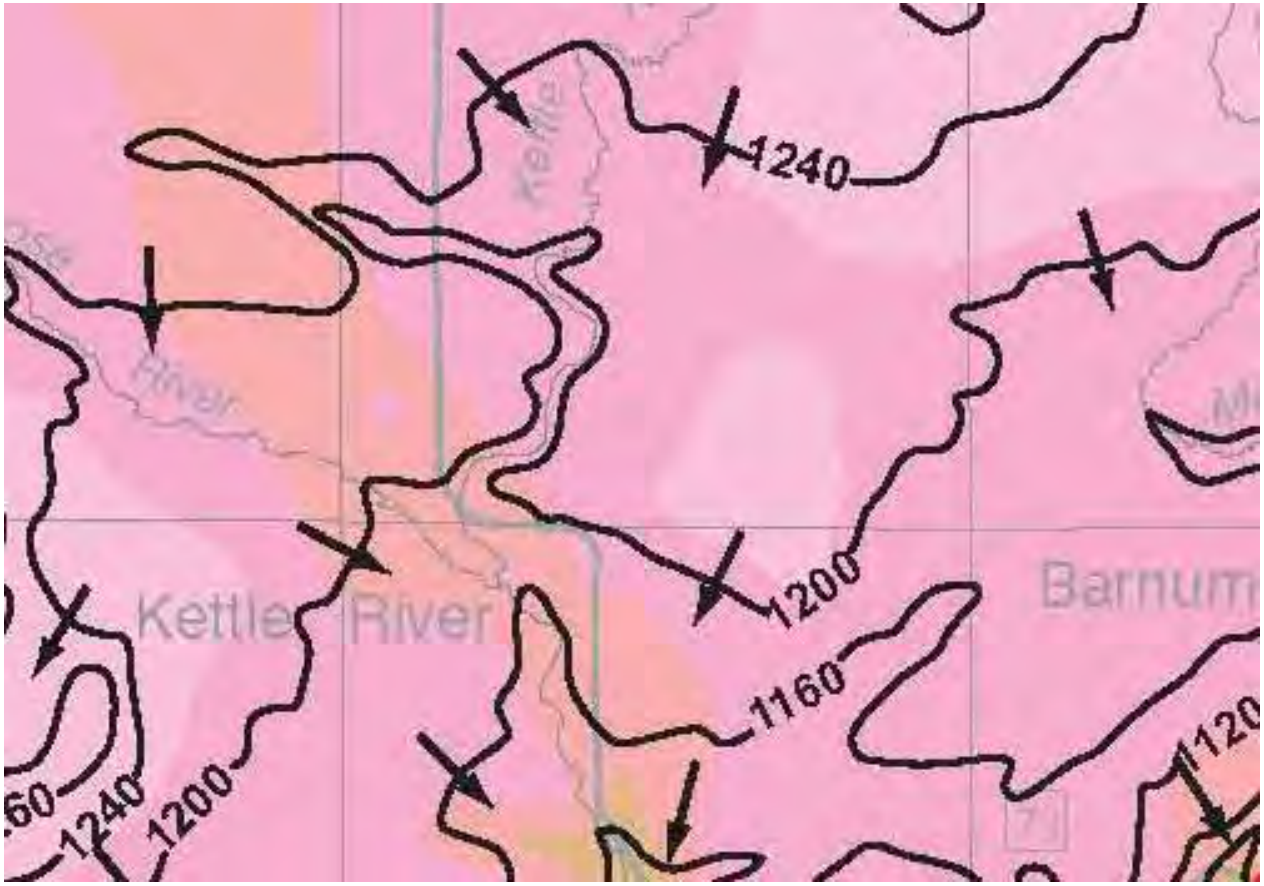
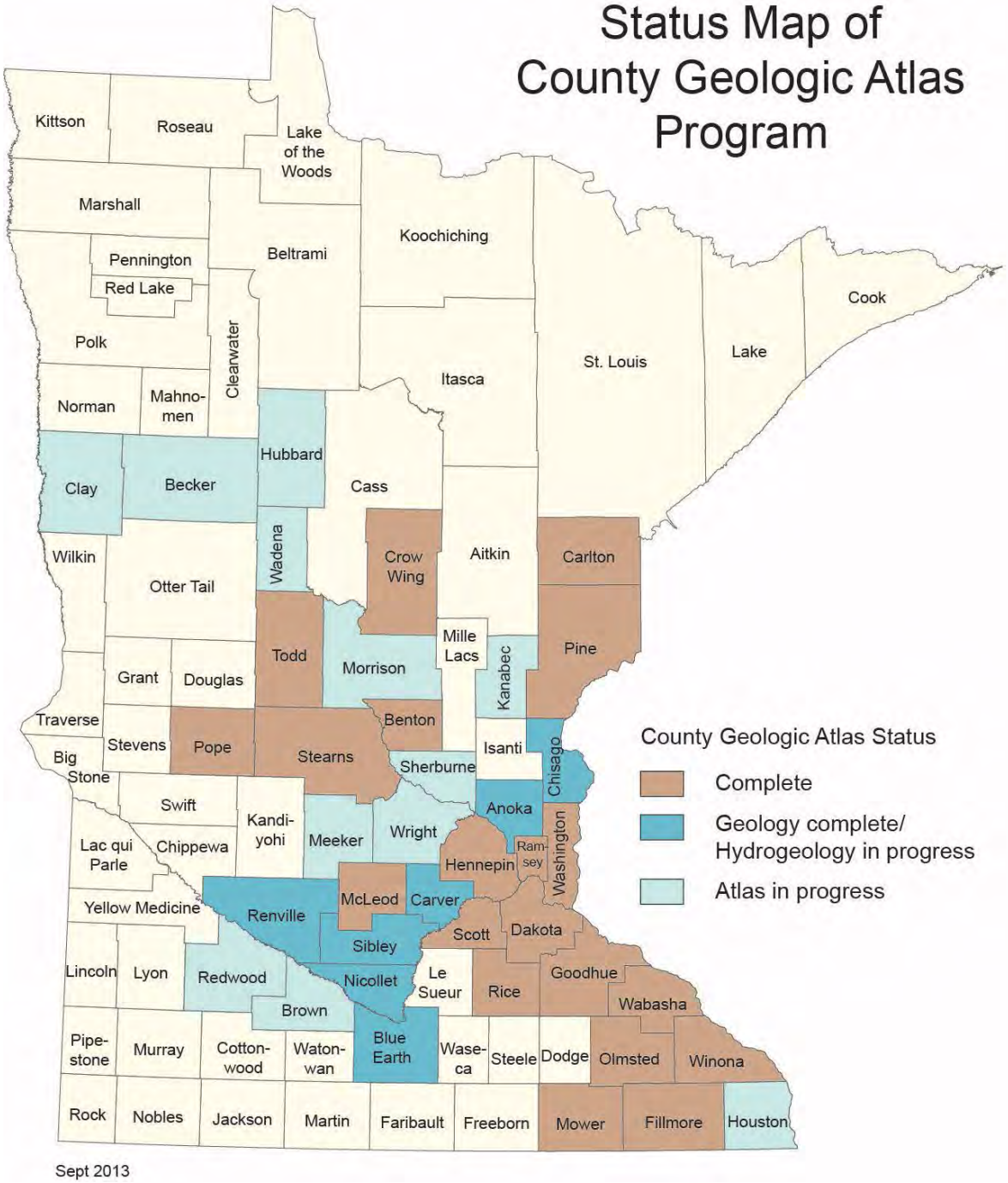
County Geologic Atlases



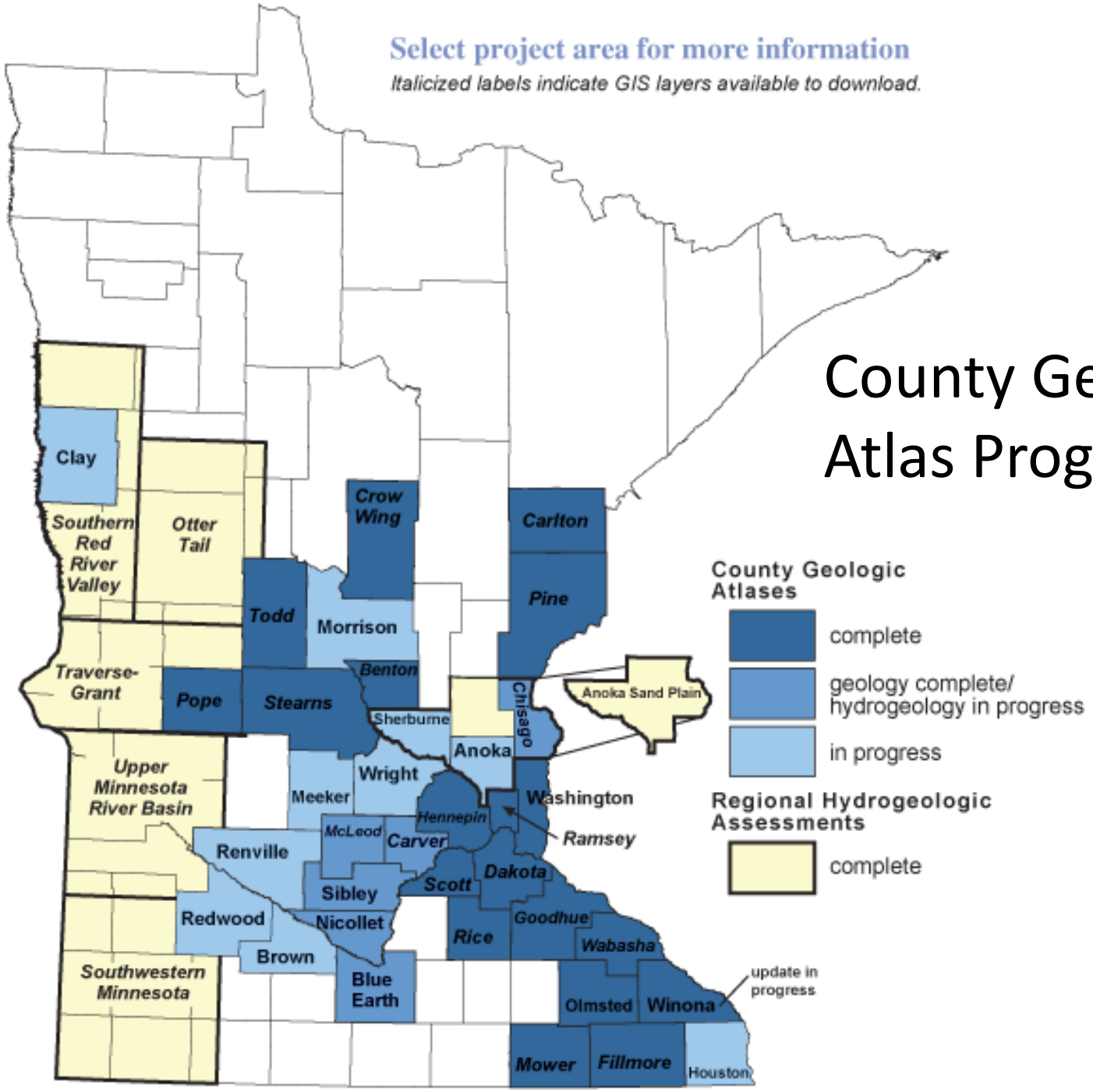
Applications and Uses

Jim Berg, Hydrogeologist Minnesota Department of Natural Resources
Ecological and Water Resources, St. Paul, Minnesota

Status Map of County Geologic Atlas Program

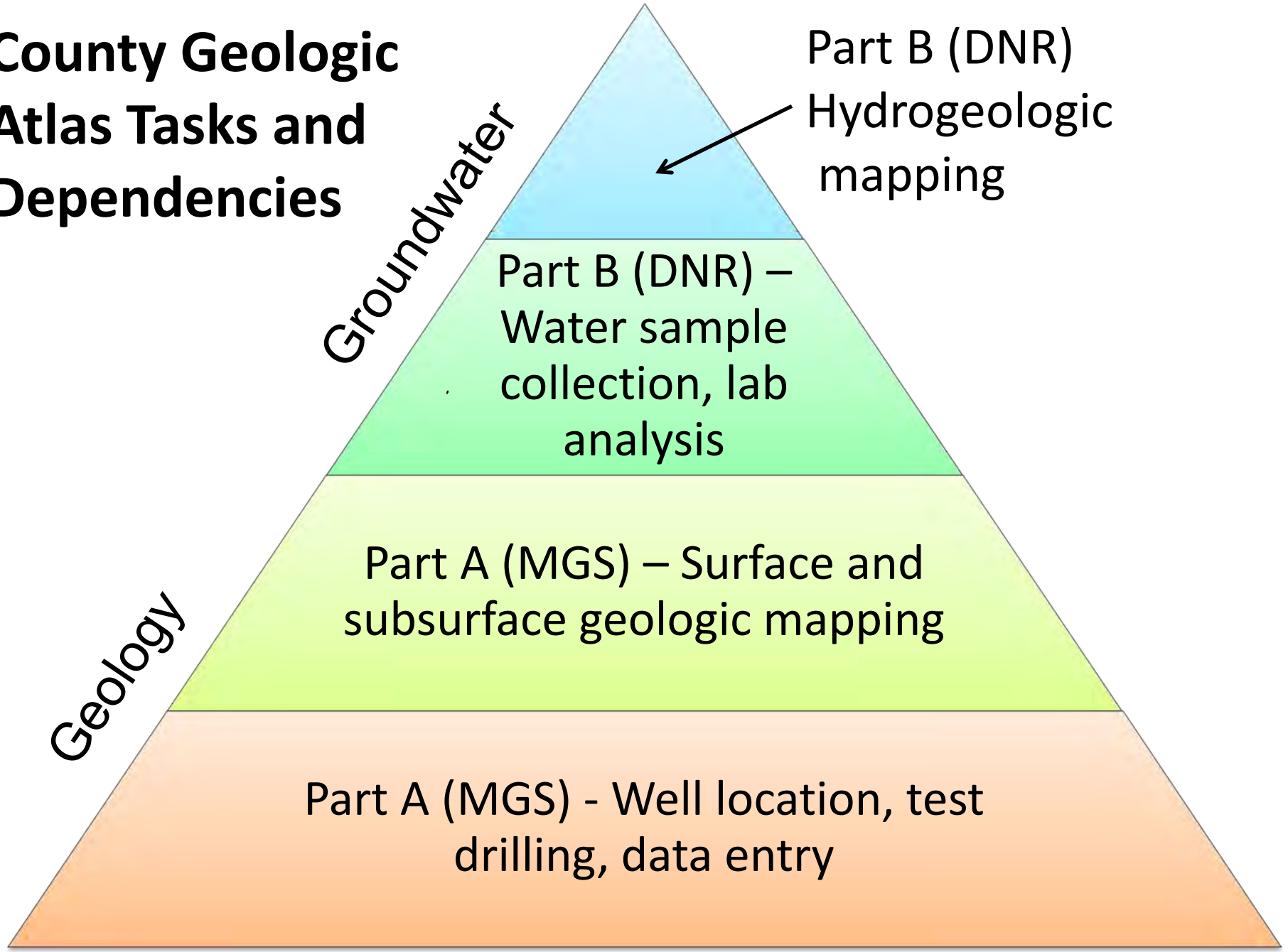


Sept 2013

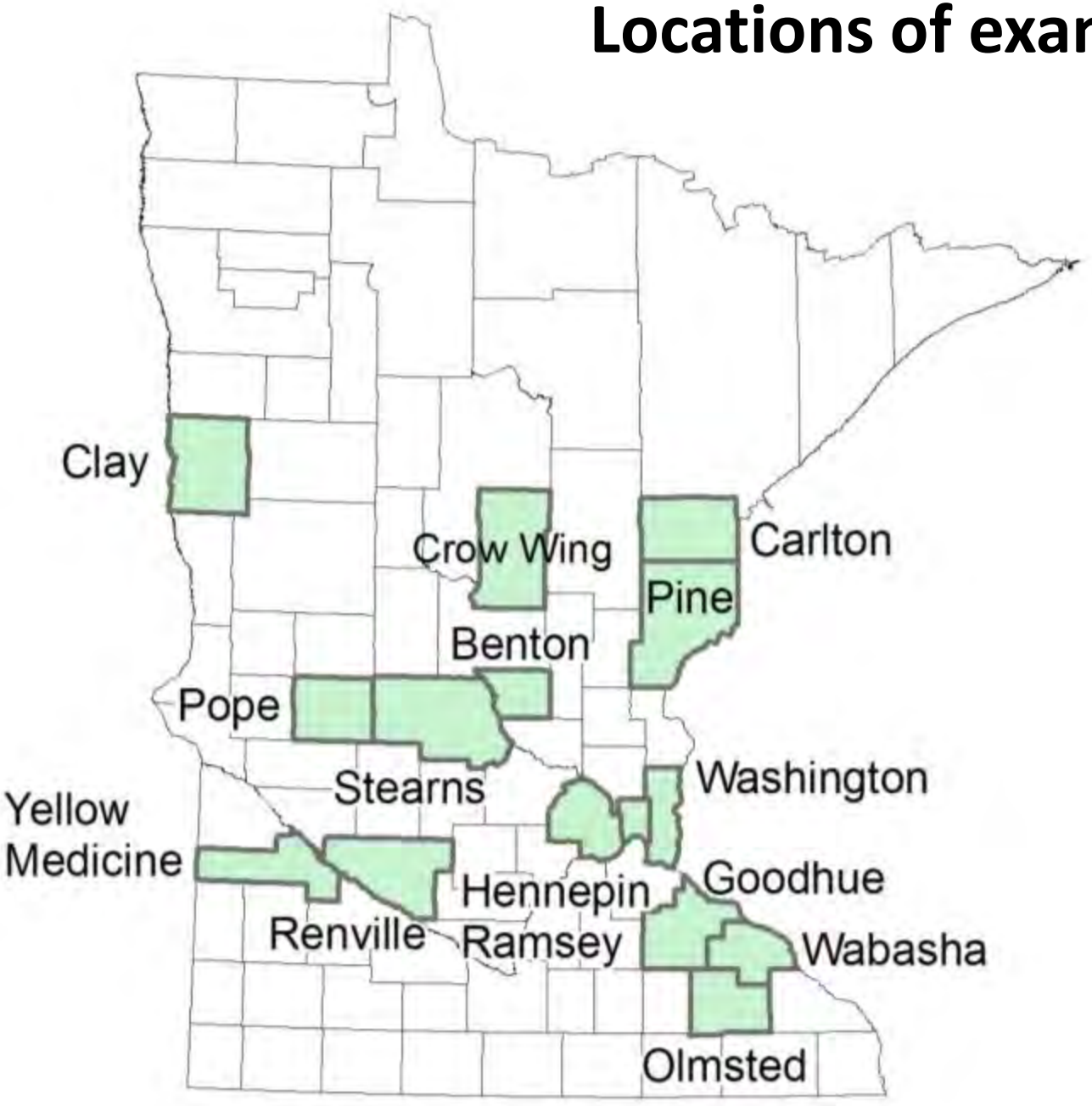


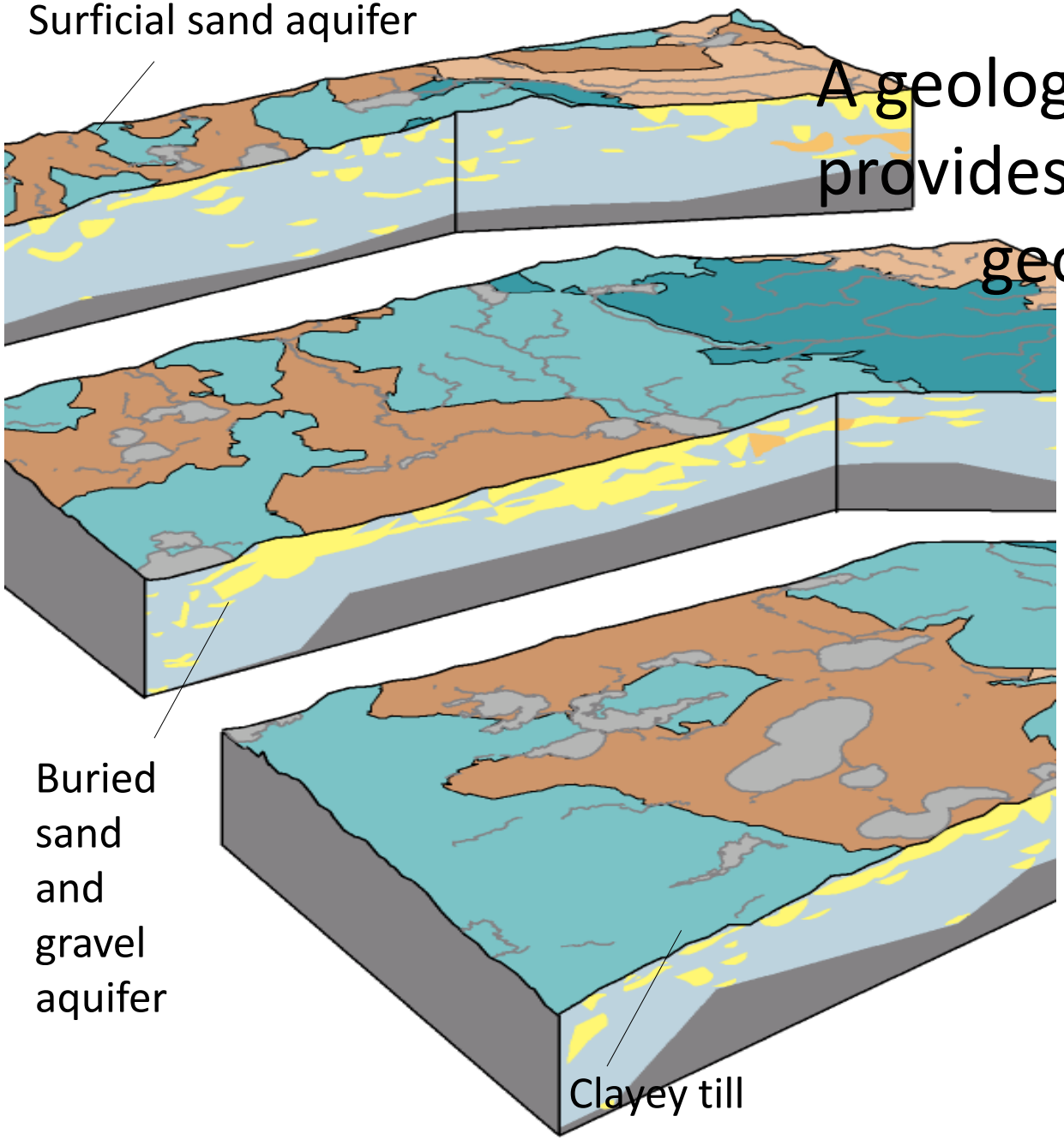
County Geologic Atlas Progress 2013

County Geologic Atlas Tasks and Dependencies



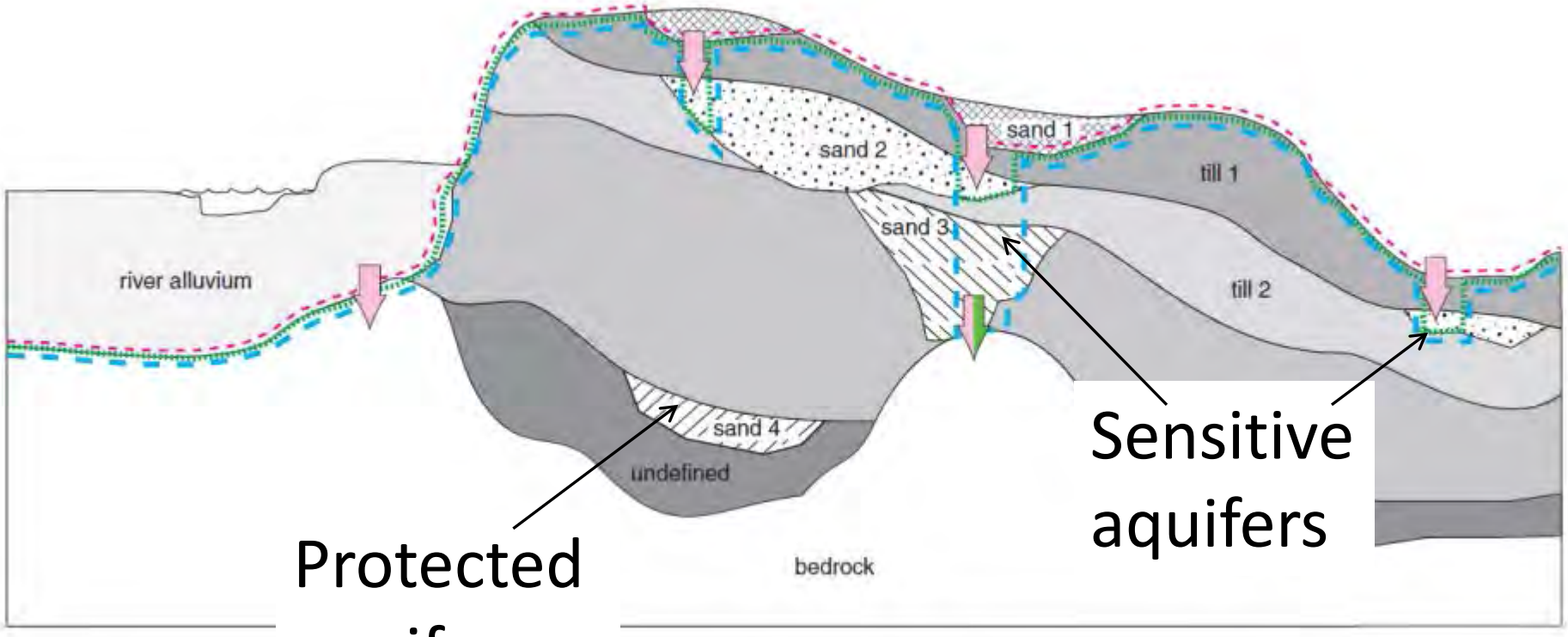
Locations of examples





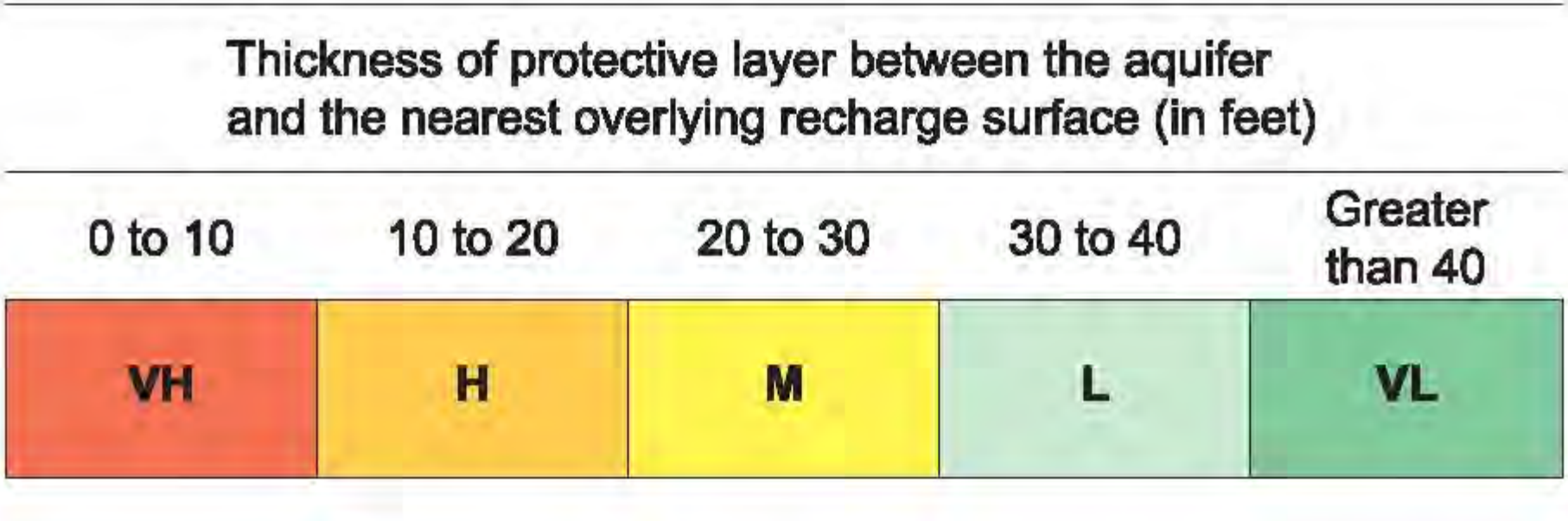
A geologic atlas provides comprehensive geologic and hydrogeologic mapping and associated databases suitable for managing water and mineral resources.

By creating three dimensional maps of aquifers and aquitards we can map the locations of sensitive aquifers and begin to understand groundwater–surface water connections.



Sensitivity of groundwater systems to pollution

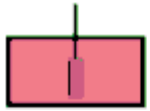
Rating matrix



Hours to months	Weeks to years	Years to decades	Decades to century	> Century

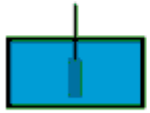
Estimated vertical travel time to top of aquifer

Tritium



Recent—Water entered the ground since 1953 (10 or more tritium units).

Mixed—Water is a mixture of recent and vintage waters
(0.8 to less than 10 tritium units).

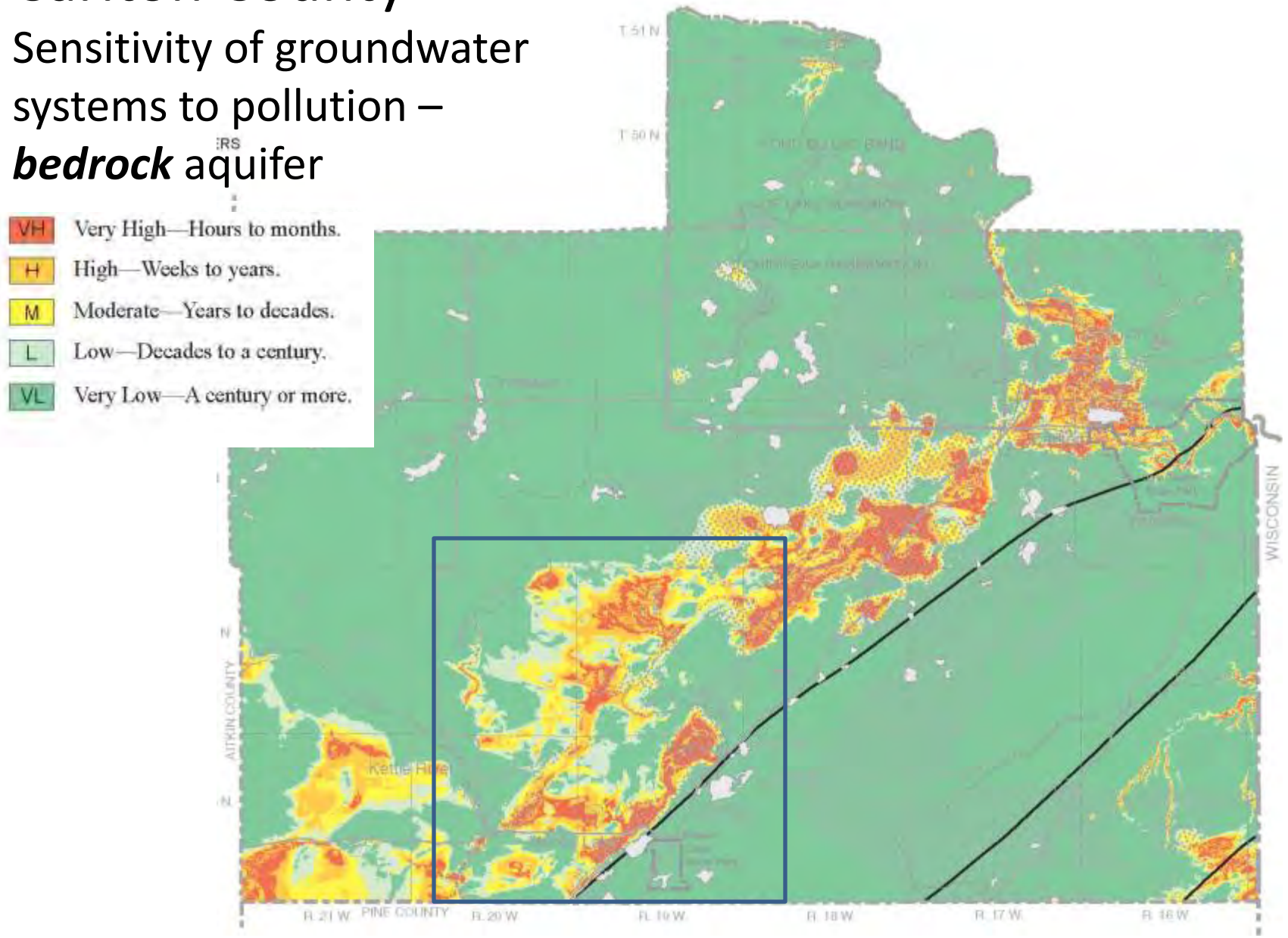


Vintage—Water entered the ground before 1953 (less than 0.8 tritium units).

Well not sampled for tritium.

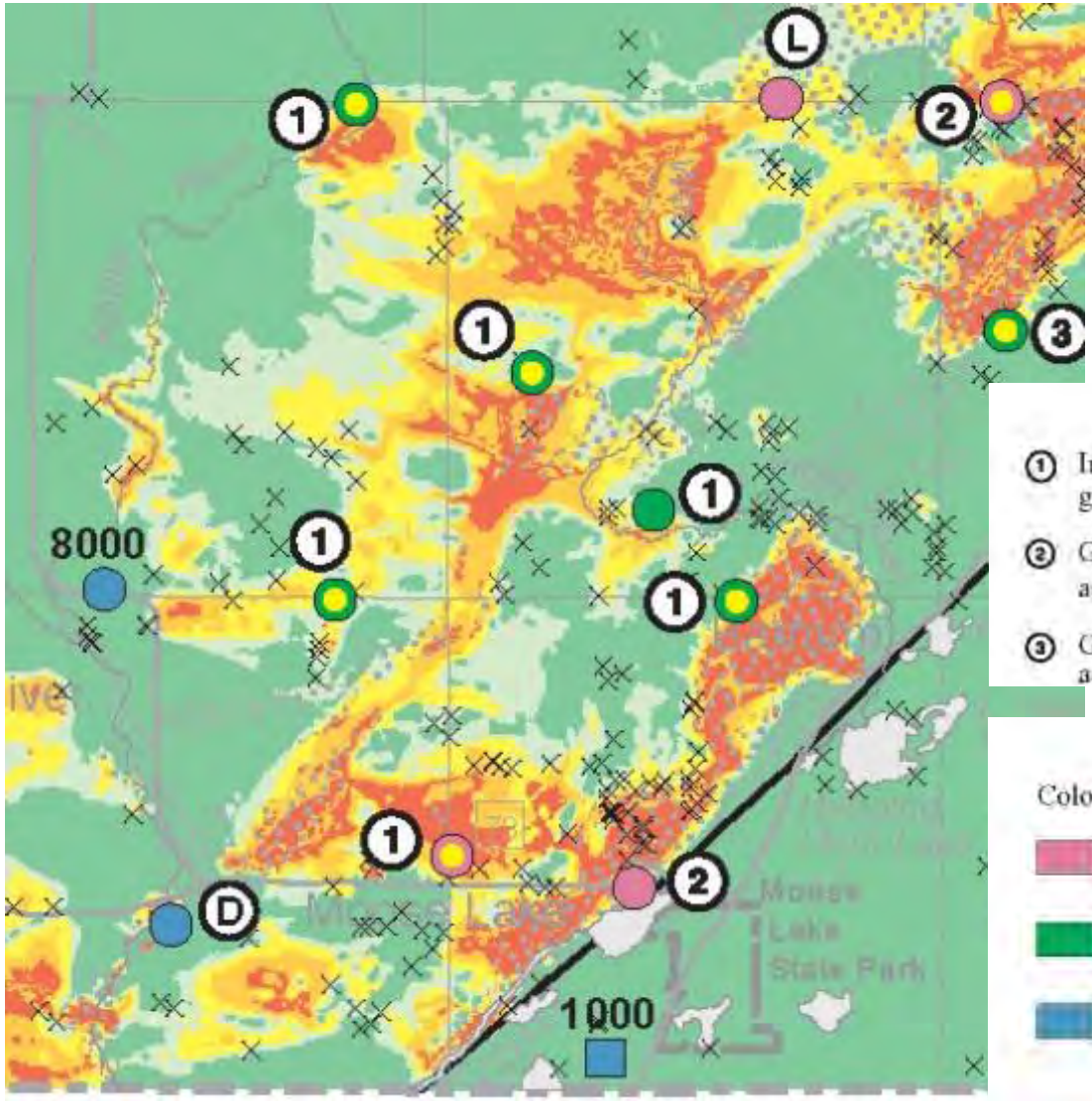
Carlton County

Sensitivity of groundwater systems to pollution – ***bedrock*** aquifer



Carlton County

Sensitivity of groundwater systems to pollution – ***bedrock*** aquifer



Groundwater conditions

① Infiltration through a thin layer of overlying, fine-grained material to an underlying aquifer.

② Groundwater recharge from overlying surficial aquifer to buried aquifer.

③ Groundwater leakage from an overlying buried aquifer to an underlying buried aquifer.

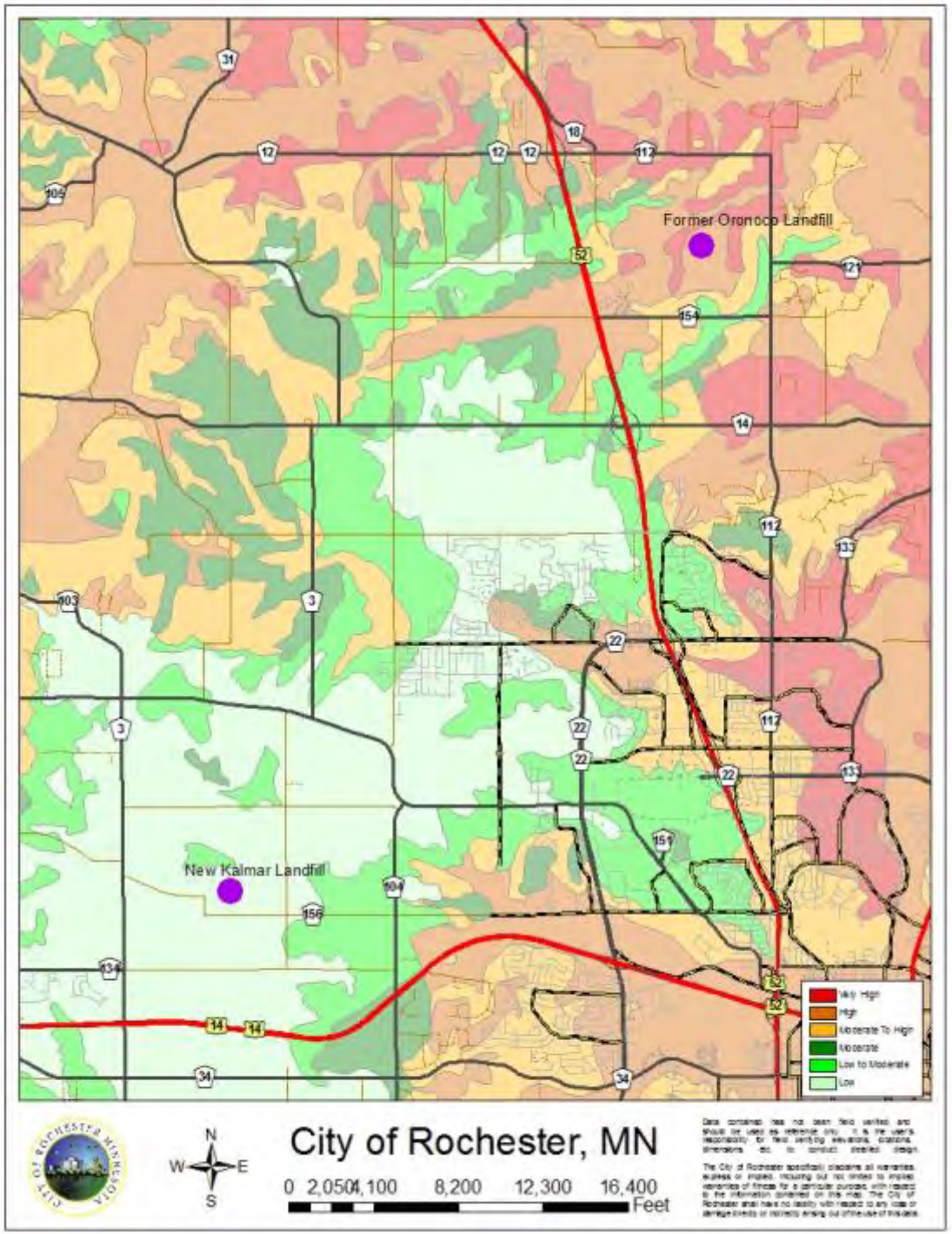
Tritium age

Color indicates tritium age of water sampled in well.

Recent—Water entered the ground since about 1953 (10 or more tritium units [TU]).

Mixed—Water is a mixture of recent and vintage waters (greater than 1 TU to less than 10 TU).

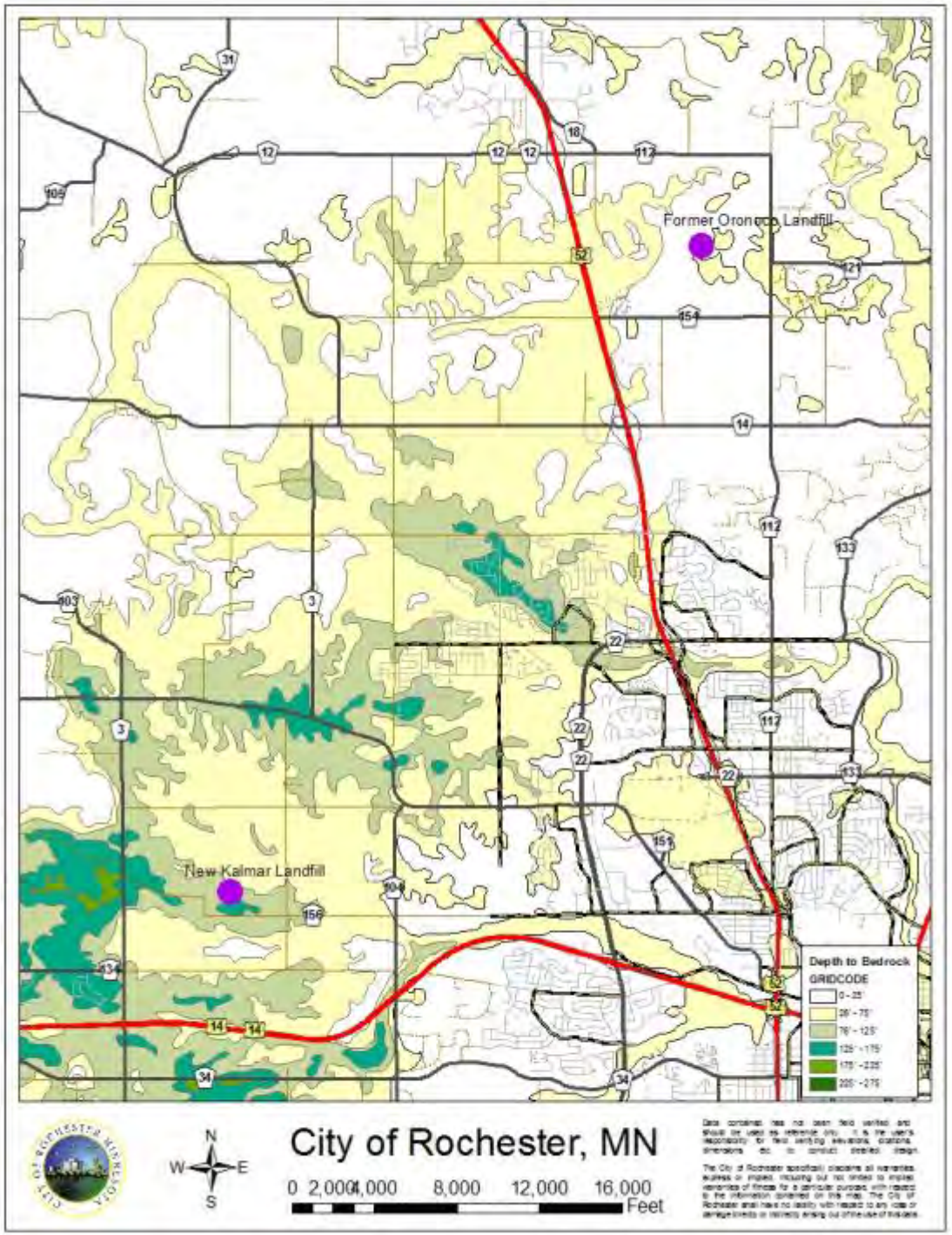
Vintage—Water entered the ground before 1953 (less than or equal to 1 TU).



Applicable to **land use planning**, wellhead protection, source water protection, remediation, appropriation, monitoring, and support for permitting decisions.

Bedrock pollution sensitivity

Olmsted County



Land use planning

Oronoco landfill 1972-1994

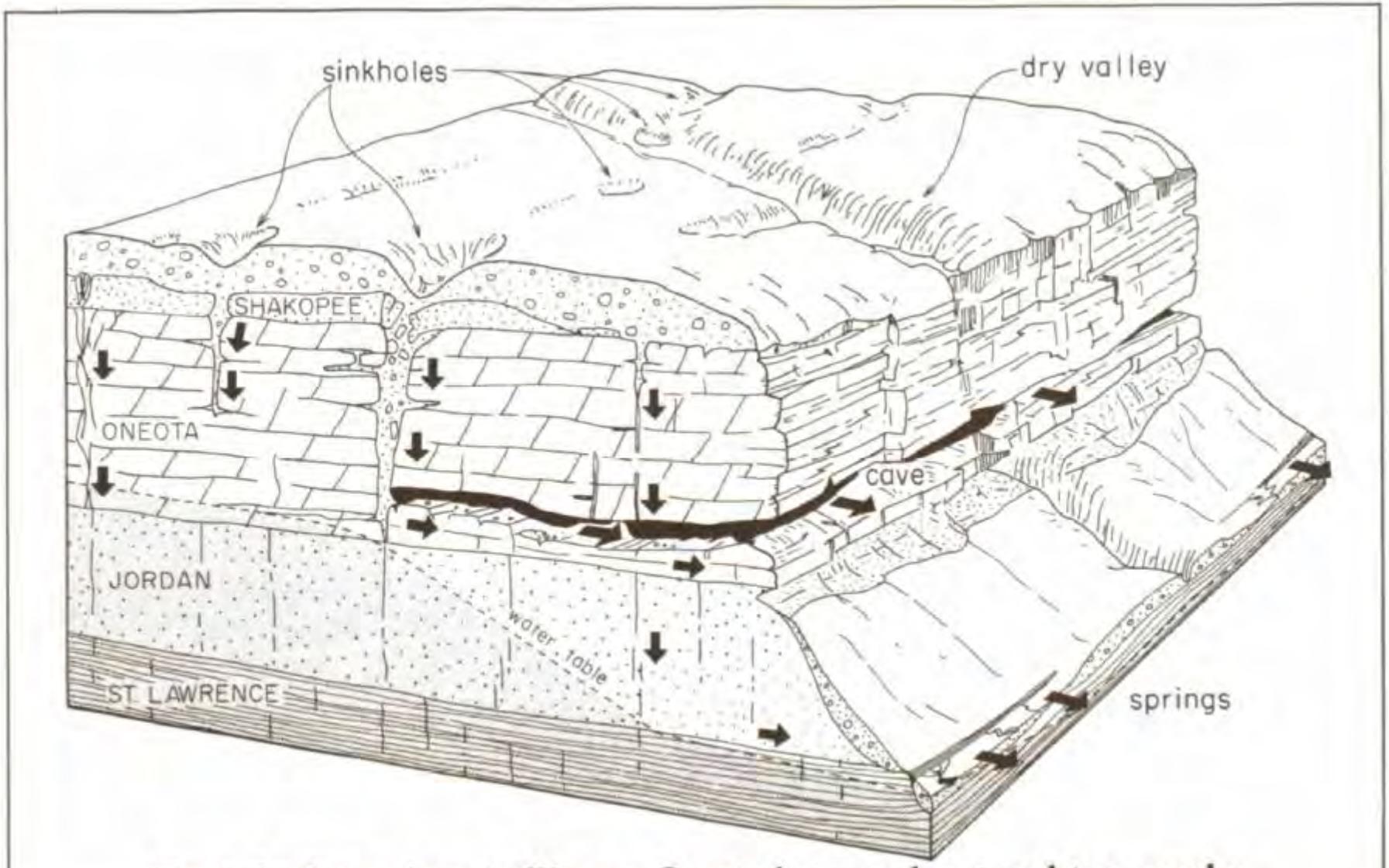
1983 VOCs found in monitoring wells

1988 Olmsted County Geologic Atlas

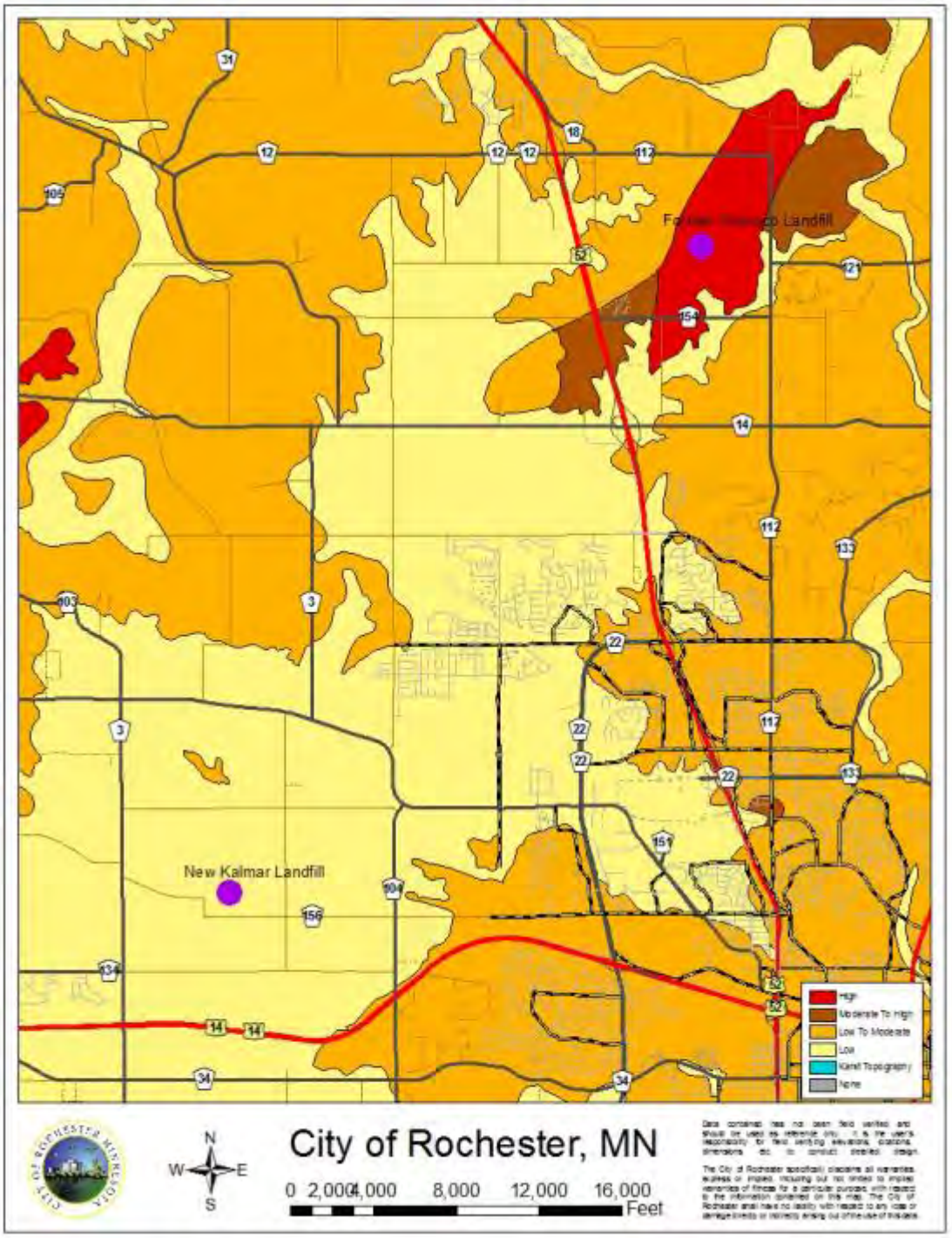
1990 Kalmar landfill

Depth to Bedrock

Olmsted County



Typical relationships in Winona County between karst and topography

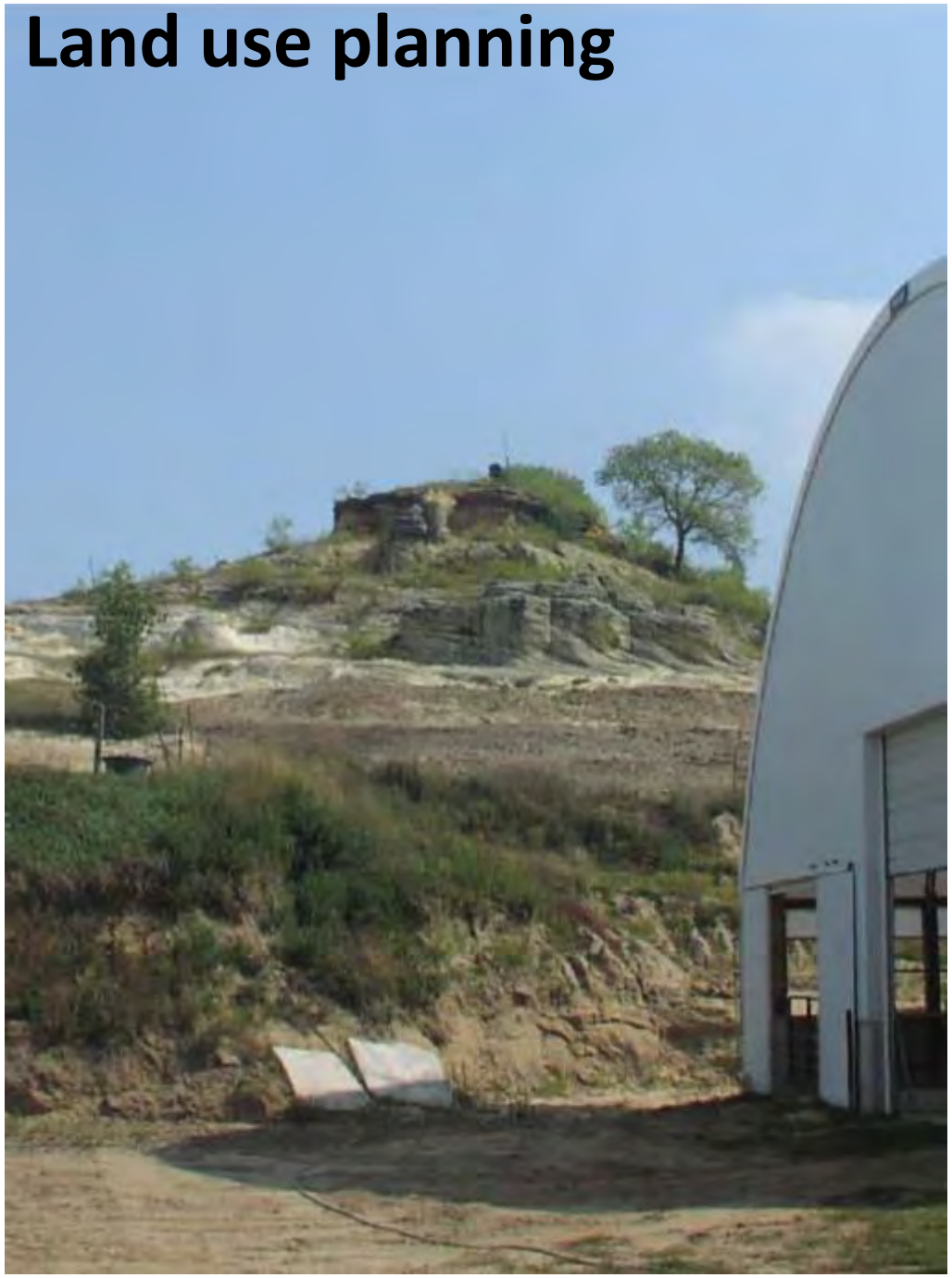


2008 local aeronautics club uses site to fly model airplanes

Sinkhole probabilty

Olmsted County

Land use planning

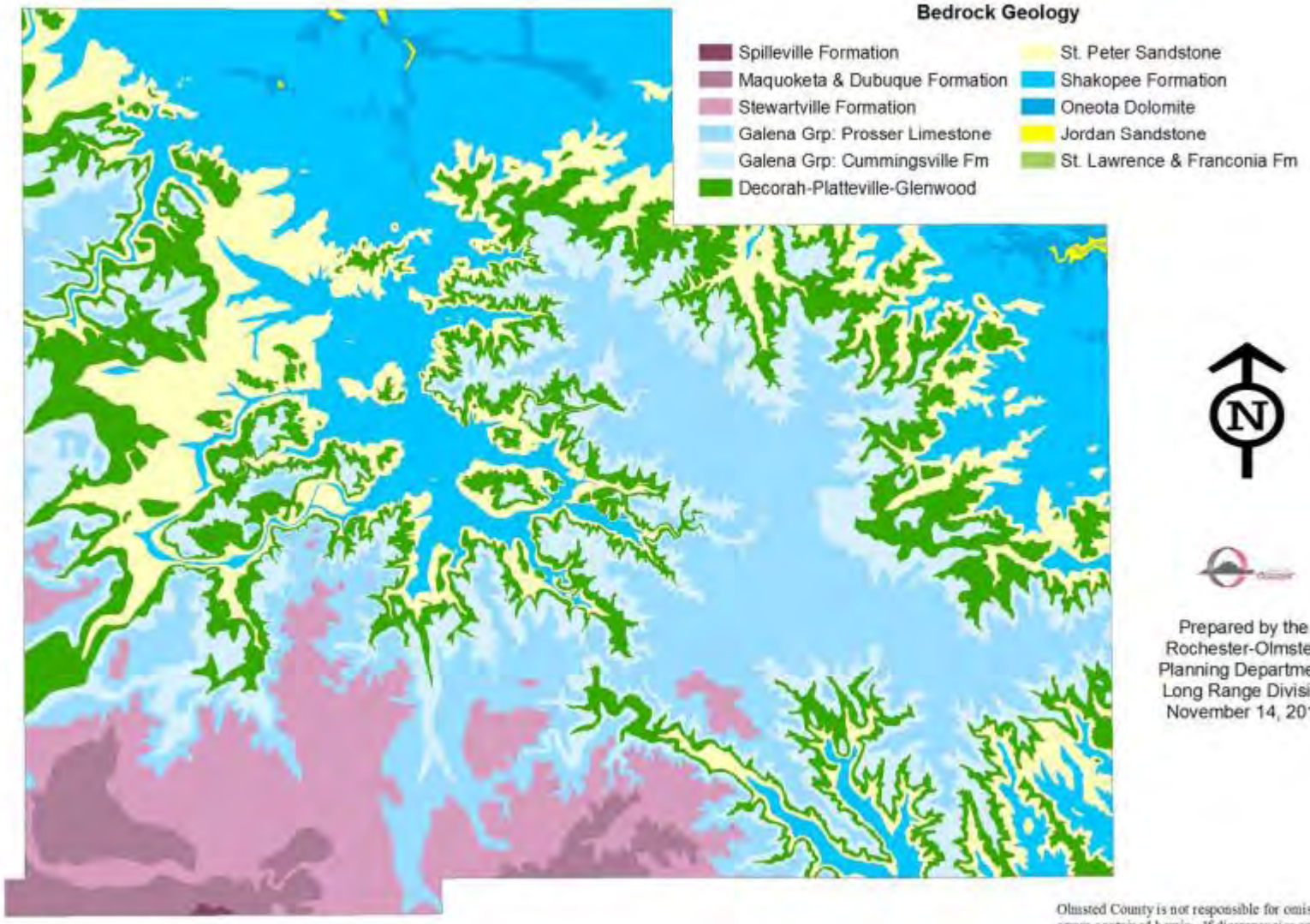


St. Peter Sandstone

Olmsted County

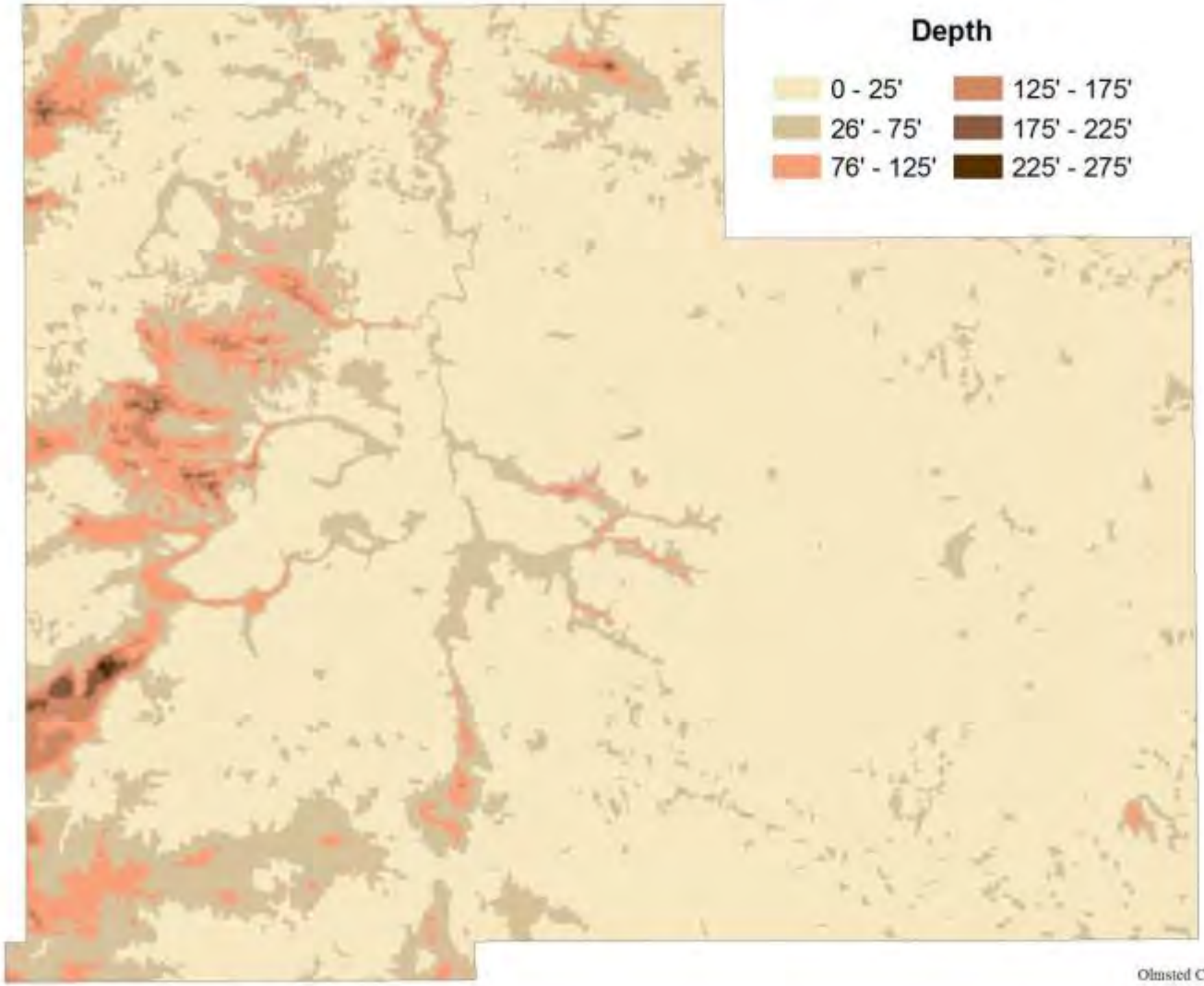
- Depth
- Population centers and planned land uses
- 10 ton roads and railroads
- Public waters, trout streams
- Parks, open space
- County Biological Survey
- Decorah Edge features
- Monadnocks and other geologic/aesthetic features

First Encountered Bedrock



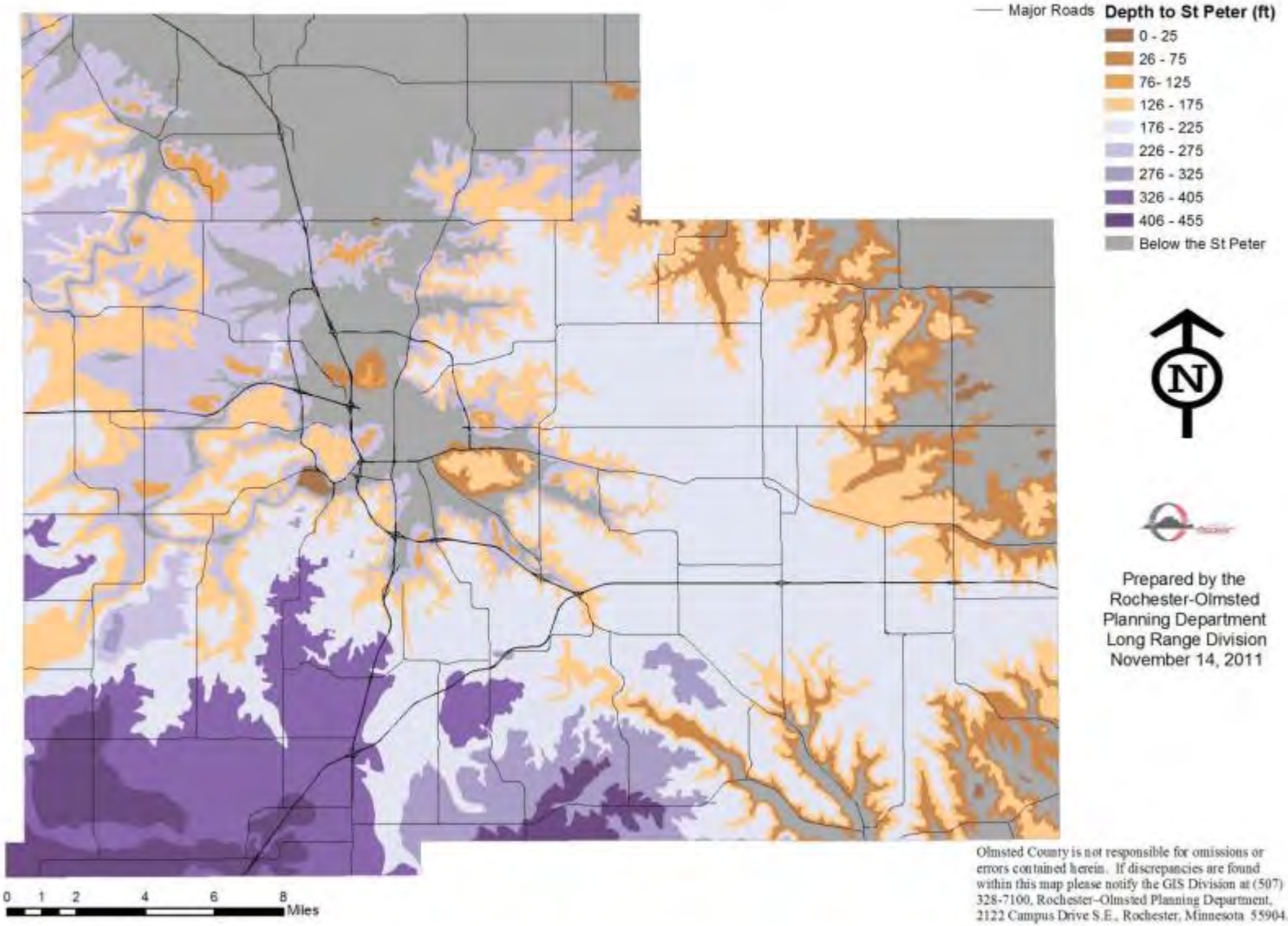
Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

Depth to First Encountered Bedrock



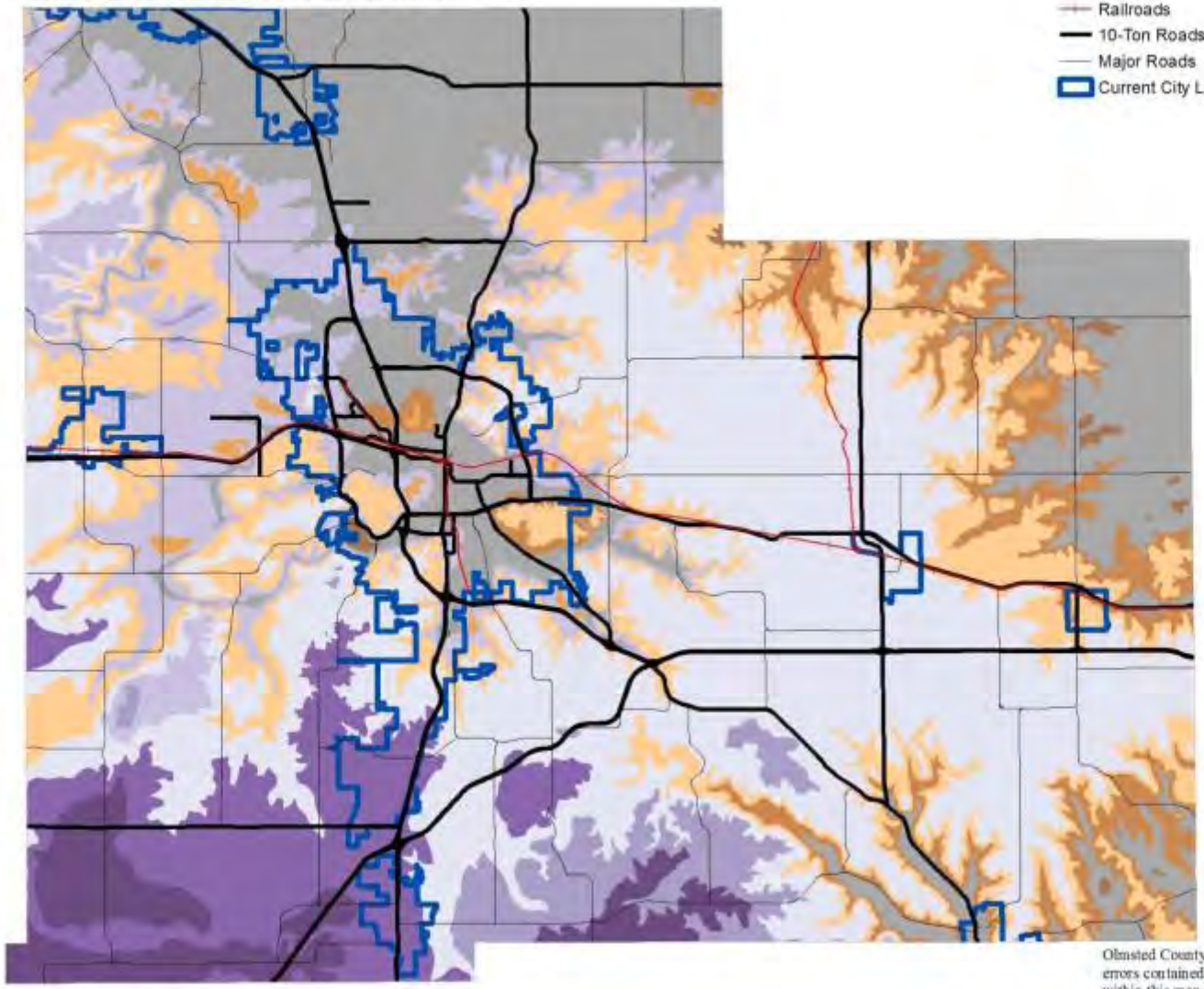
Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

Depth to the St Peter Sandstone



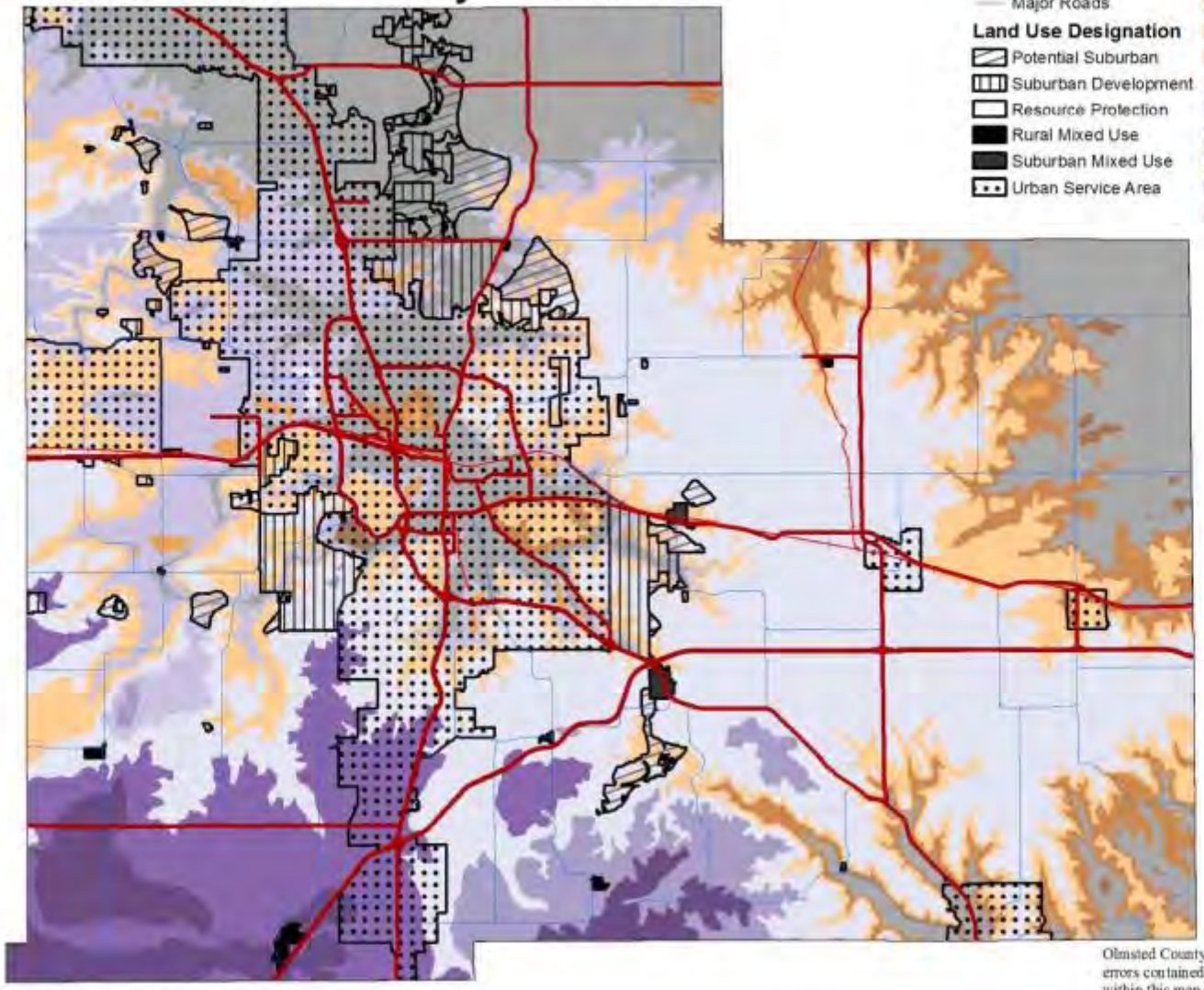
Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

Depth to the St Peter Sandstone and Urban Areas



Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

Depth to the St Peter Sandstone and Future County Land Use



Railroads
10-Ton Roads
Major Roads

Land Use Designation
Potential Suburban
Suburban Development
Resource Protection
Rural Mixed Use
Suburban Mixed Use
Urban Service Area

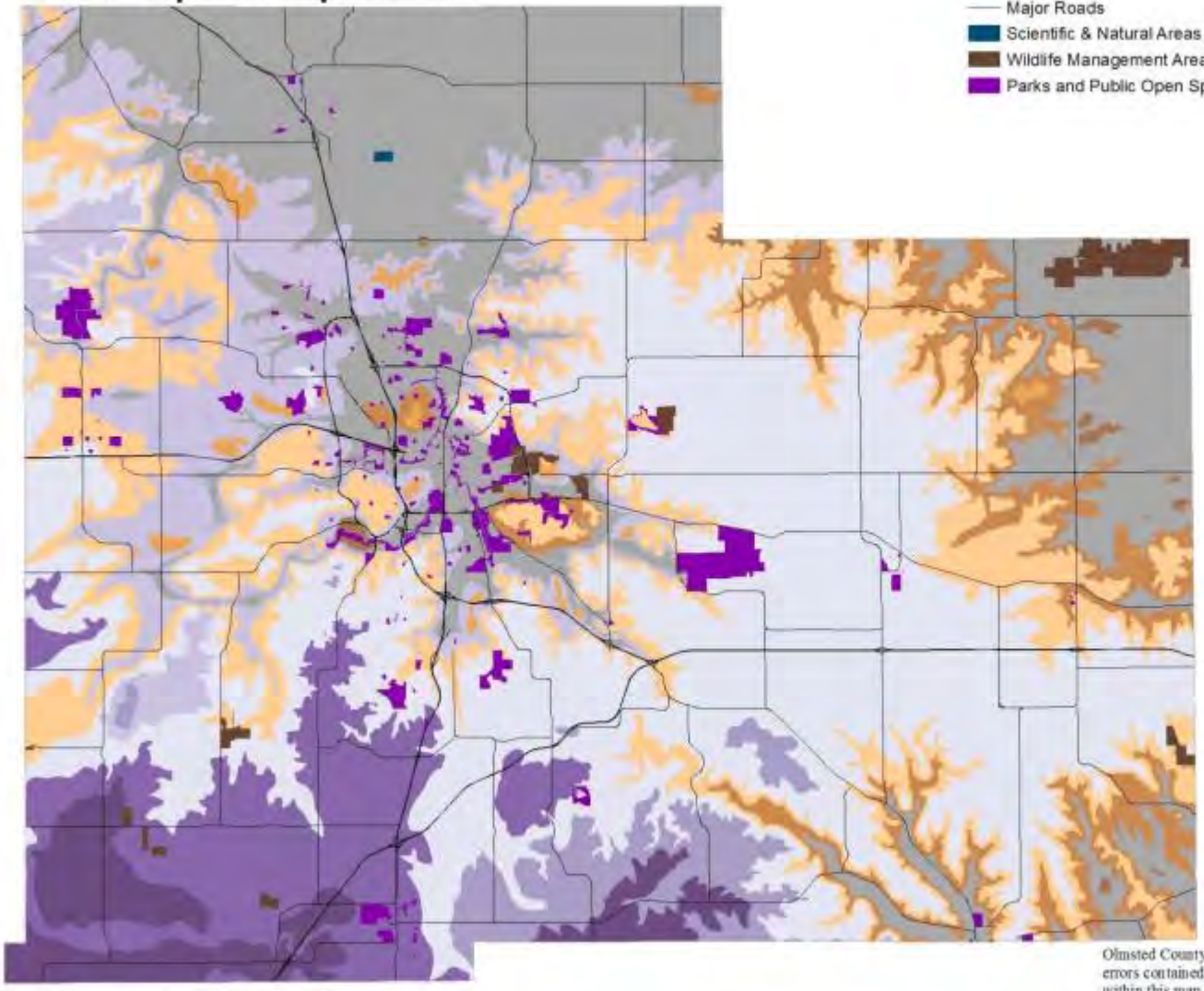
Depth to St Peter (ft)
0 - 25
26 - 75
76- 125
126 - 175
176 - 225
226 - 275
276 - 325
326 - 405
406 - 455
Below the St Peter

N

0 1 2 4 6 8 Miles

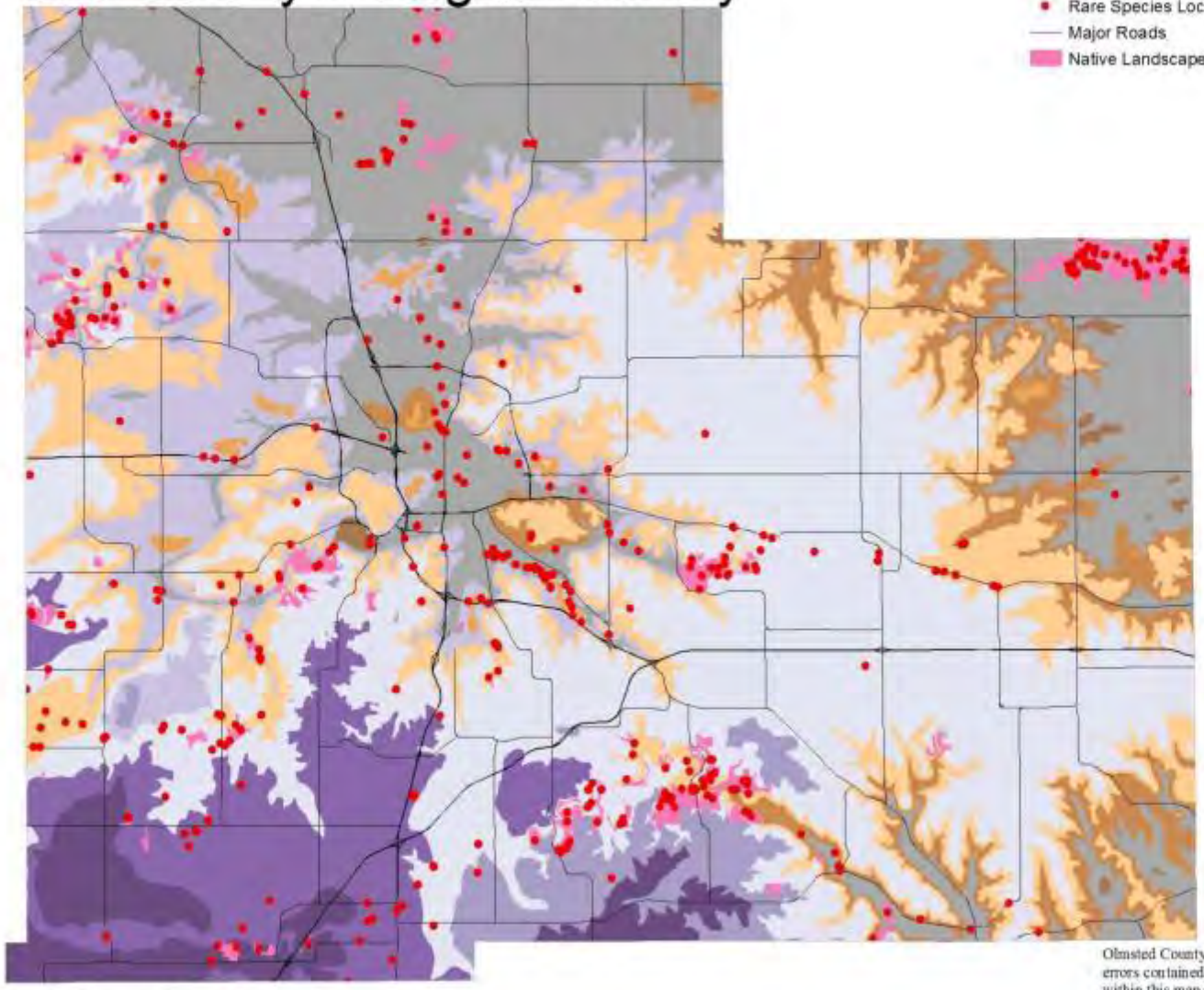
Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

Depth to the St Peter Sandstone and Open Spaces



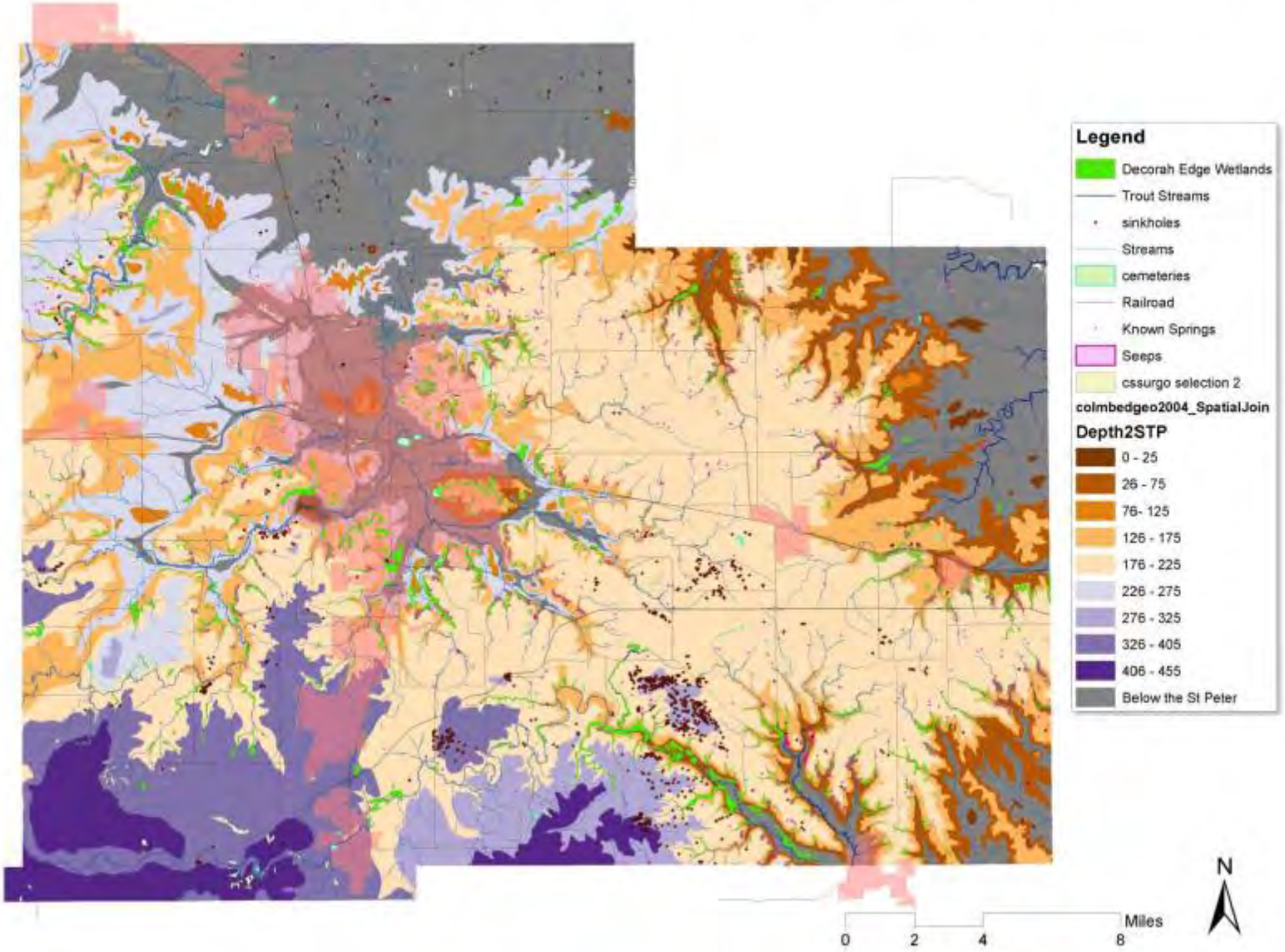
Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

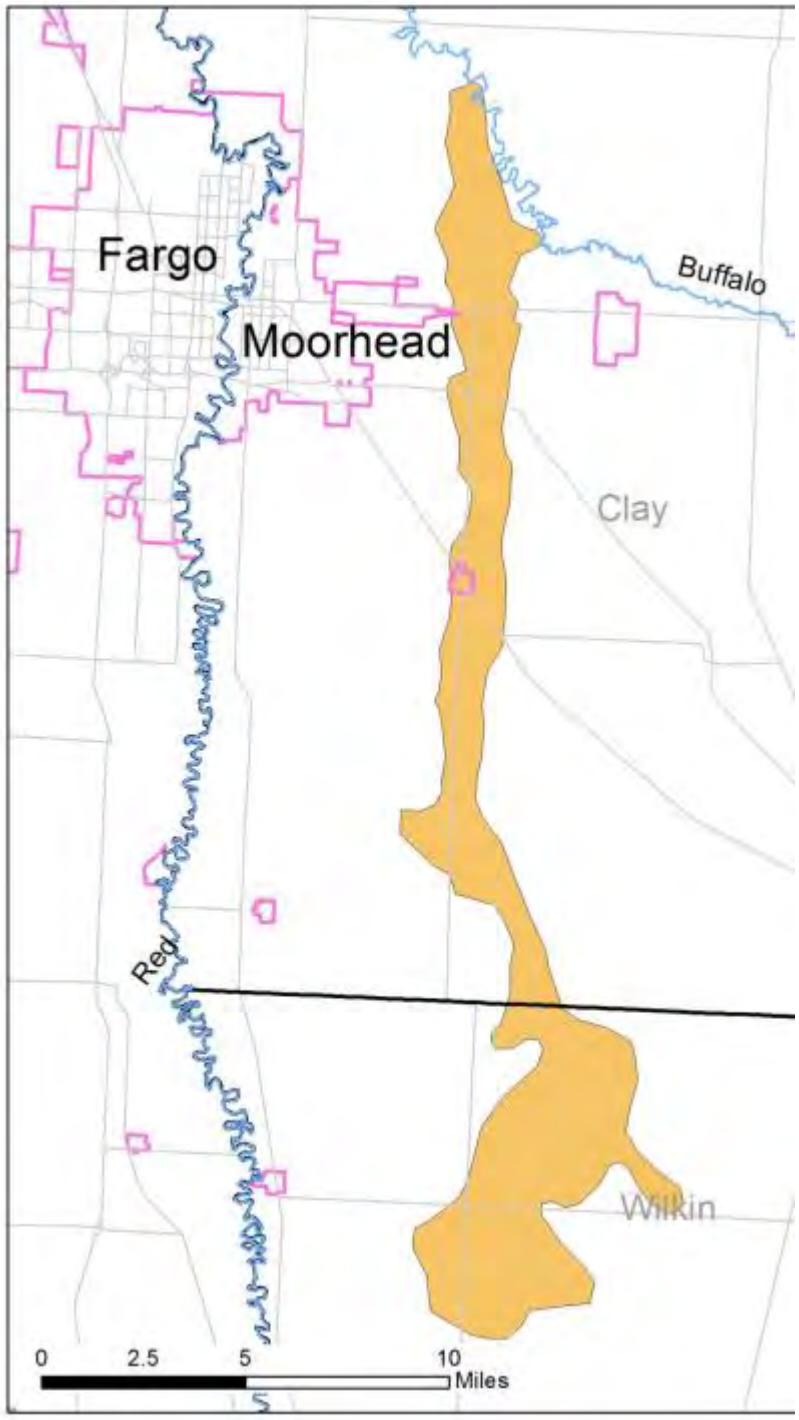
Depth to the St Peter Sandstone and County Biological Survey



Prepared by the
Rochester-Olmsted
Planning Department
Long Range Division
November 14, 2011

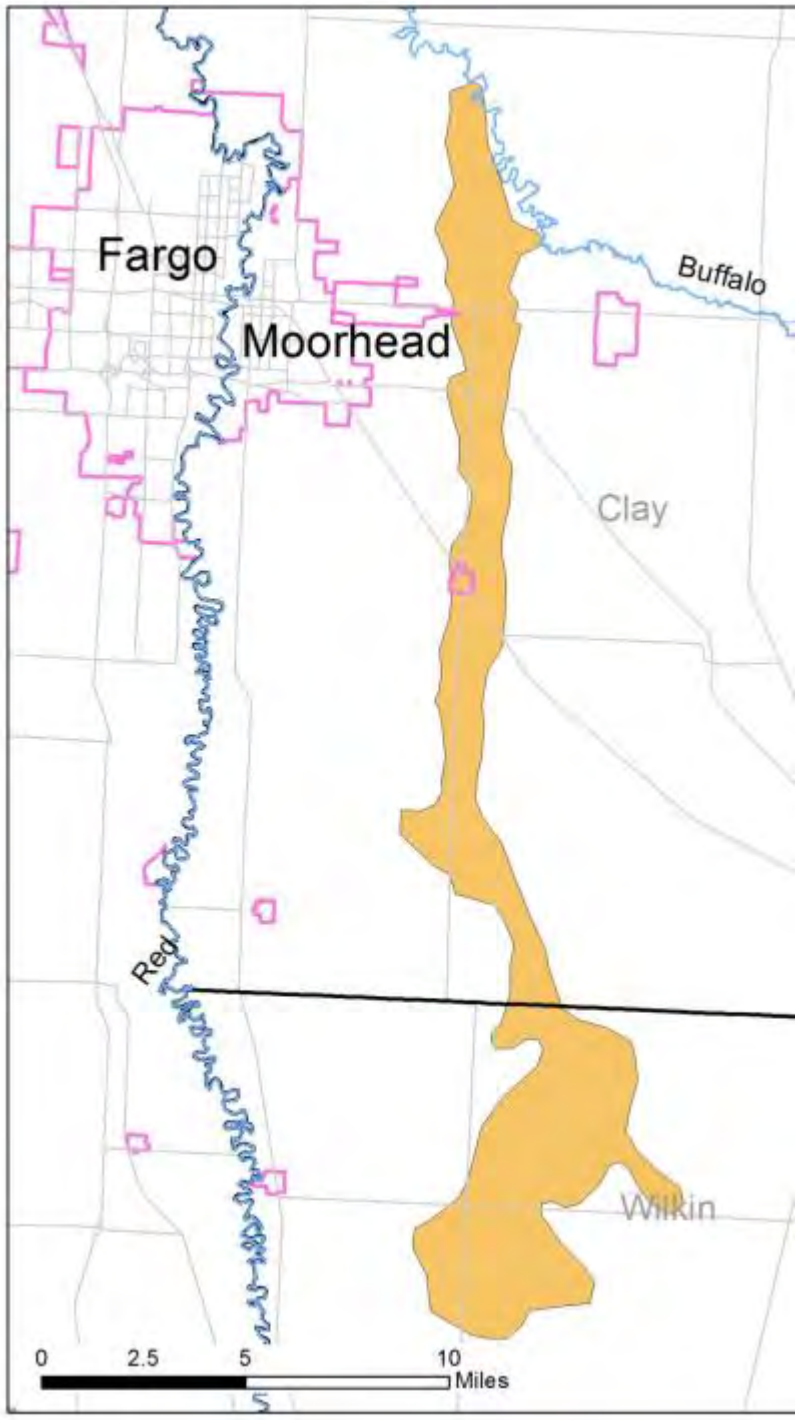
Sinkholes, Springs, Decorah Edge, and Other Features





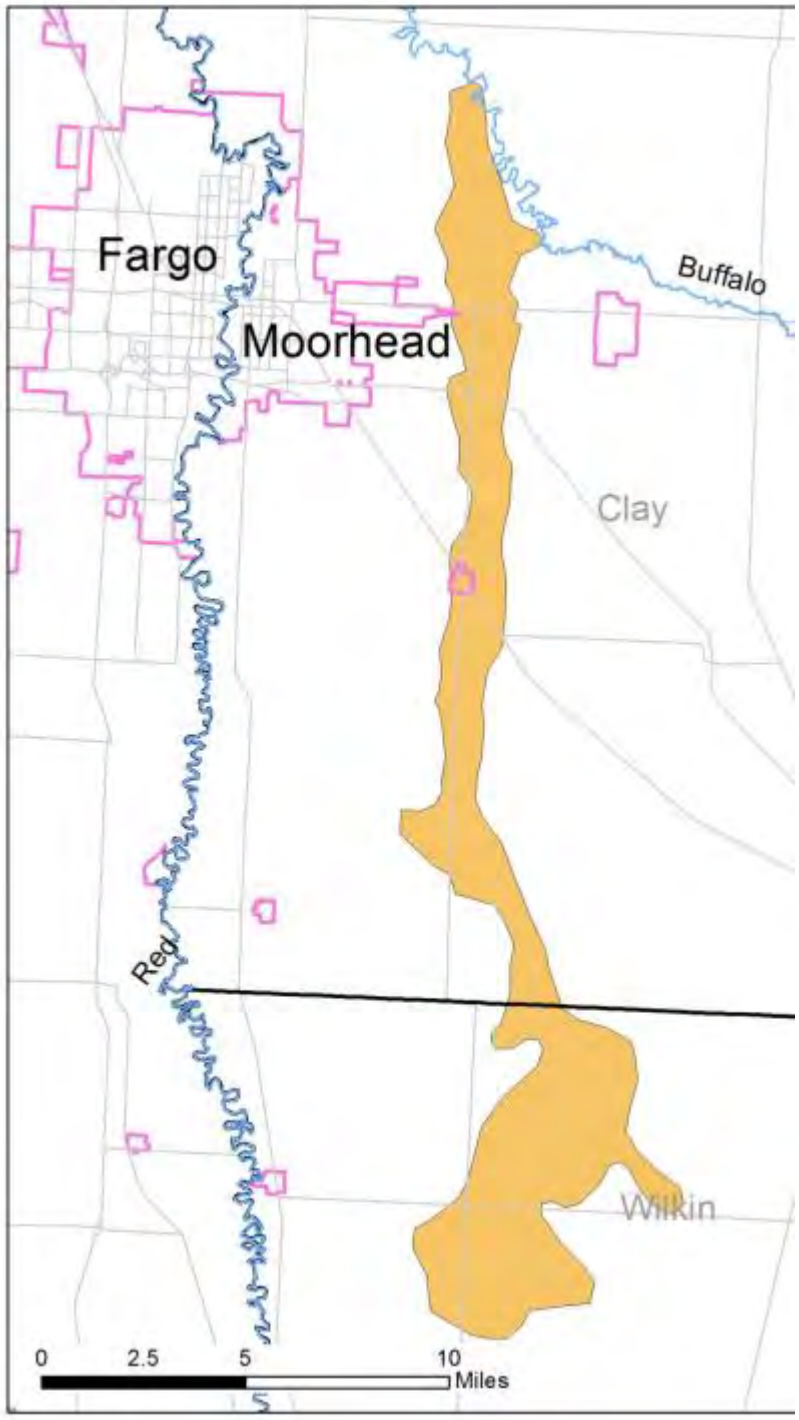
Land use planning
Clay County

- Aquifer used during periods of poor water quality in Red River.
- Backup supply during contamination event on Red River.
- Primary Supply during Long-term Drought.
- Aquifer serves 70 percent of Clay County population.



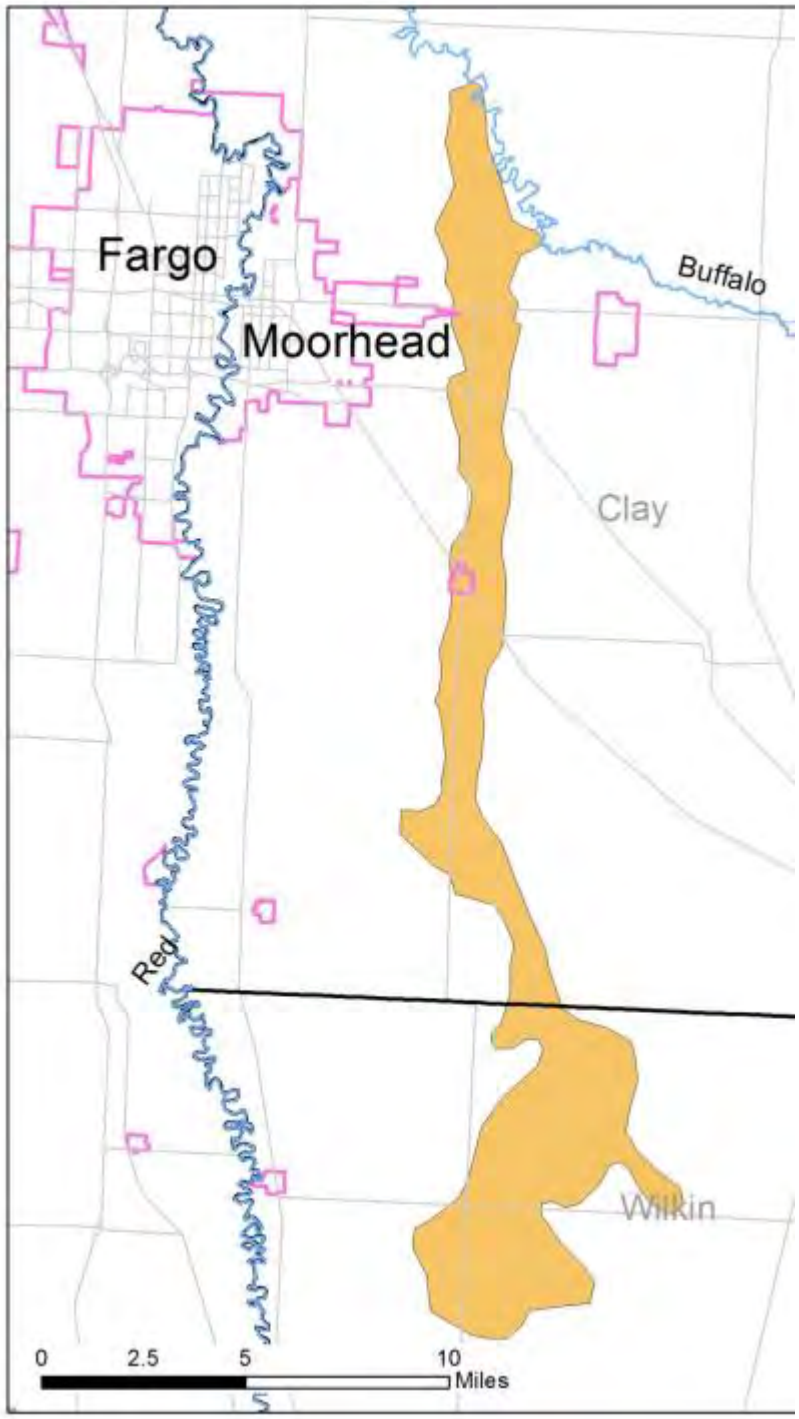
Problems with Land Use above the aquifer

- Commercial Activities
  - Truck stops with Restaurants
    - Leaking underground storage tanks
    - Dispensing spills
    - Rapid infiltration wastewater lagoons
    - Truck washing and maintenance facilities



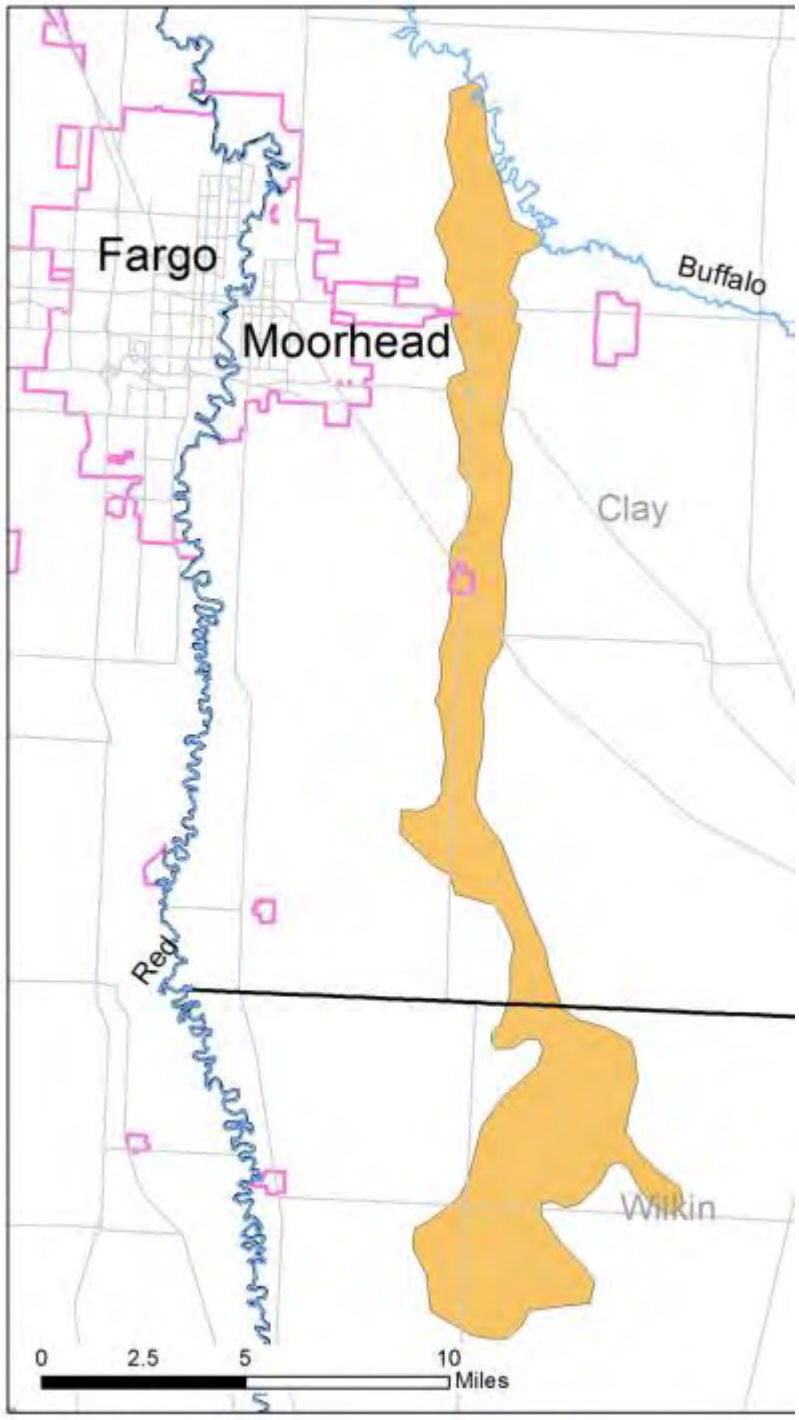
Commercial Activities (cont.)

- Fertilizer sales and storage.
- Future residential development in rural area.
- Potential shopping center development.
- Agricultural activities.



Gravel Mining Operations

- Removal of protective soil layers.
- Asphalt plant operations.
- Fuel storage and dispensing.
- Disposal of demolition materials in abandoned pits.
- Conflict: gravel mining vs. water supply



Buffalo aquifer - Resource Protection Overlay District

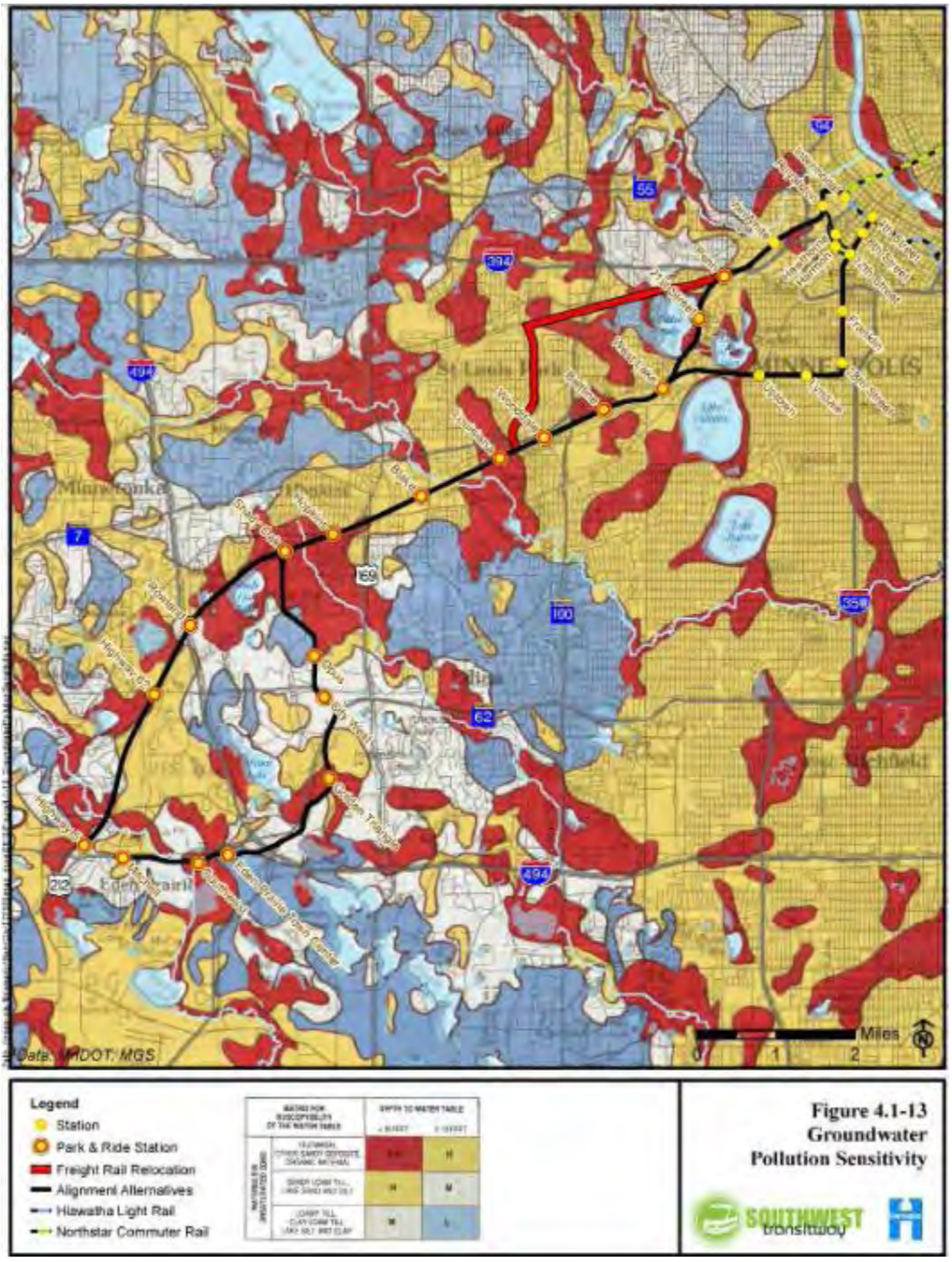
- No cluster subdivisions or major subdivisions – maximum density standards
- Storm water management
- Phosphorus use limited
- Commercial uses must connect to public water and sewer
- No expansion of aggregate mining, setback and runoff control required for development near mines
- Spill containment for above-ground tanks
- No underground tanks
- No hazardous material storage

Land use planning

Southwest transitway

Surficial Geology

Hennepin Co.

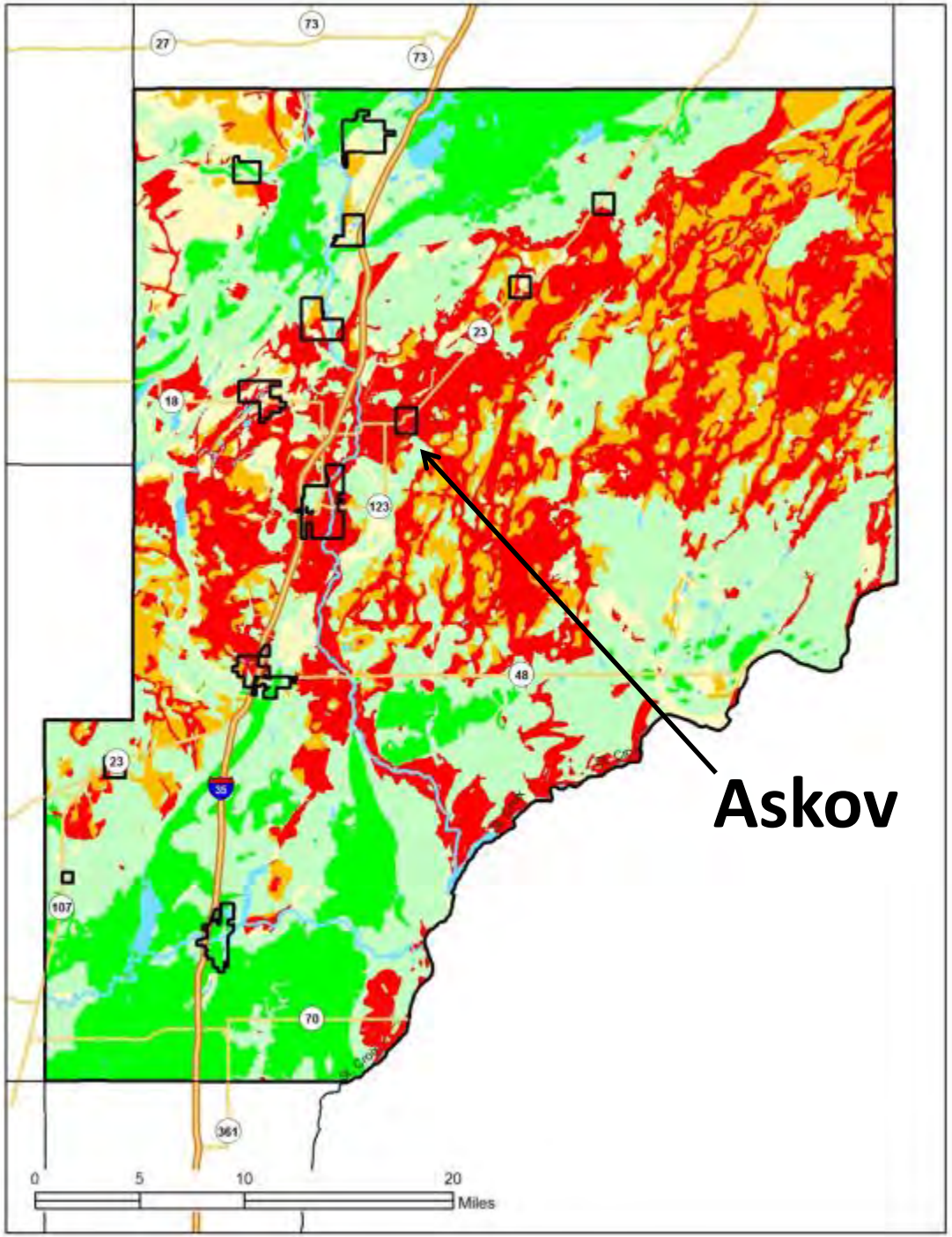


Land use planning

Southwest transitway

Pollution Sensitivity

Hennepin Co.



Land use planning

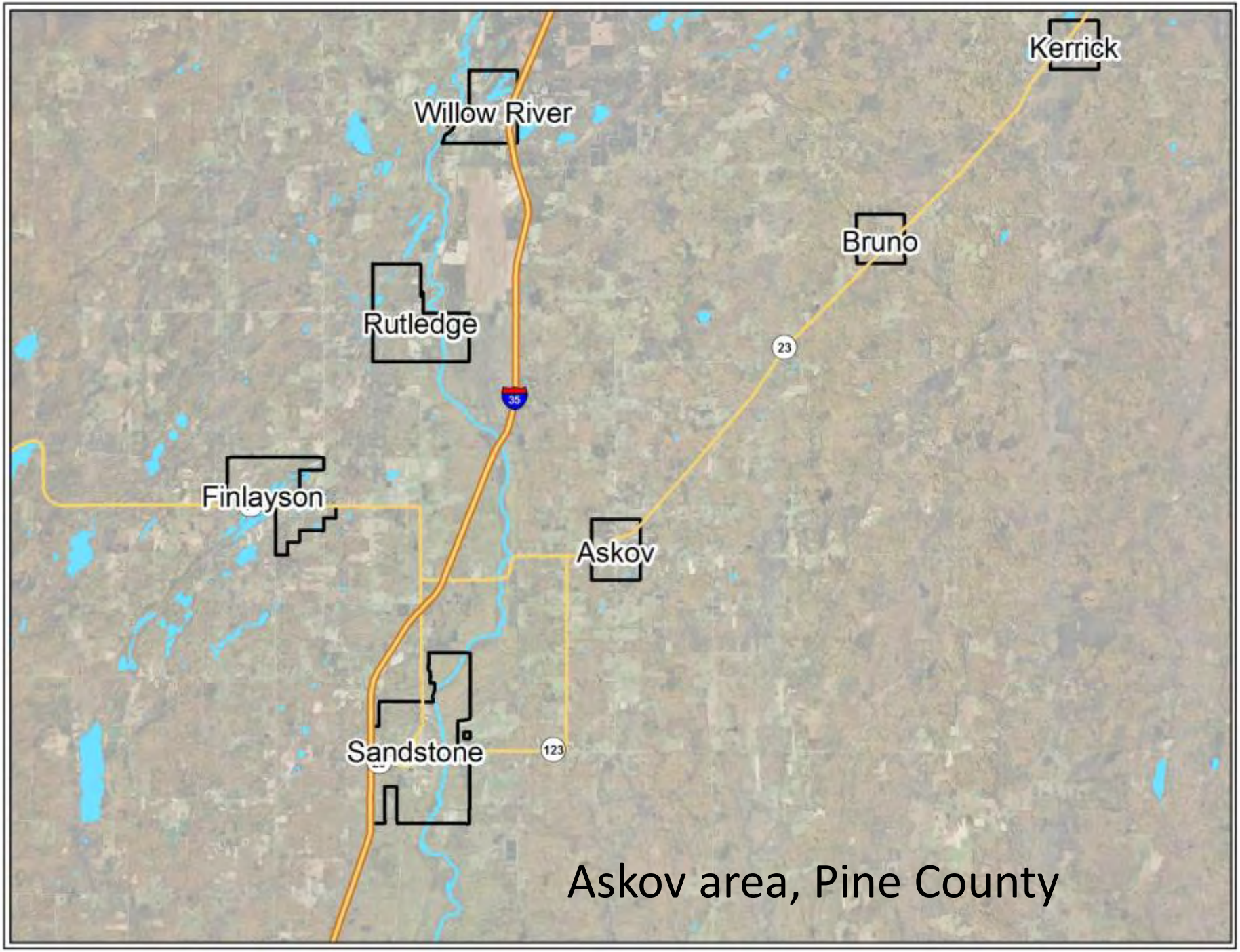
City of Askov

Sewage lagoon

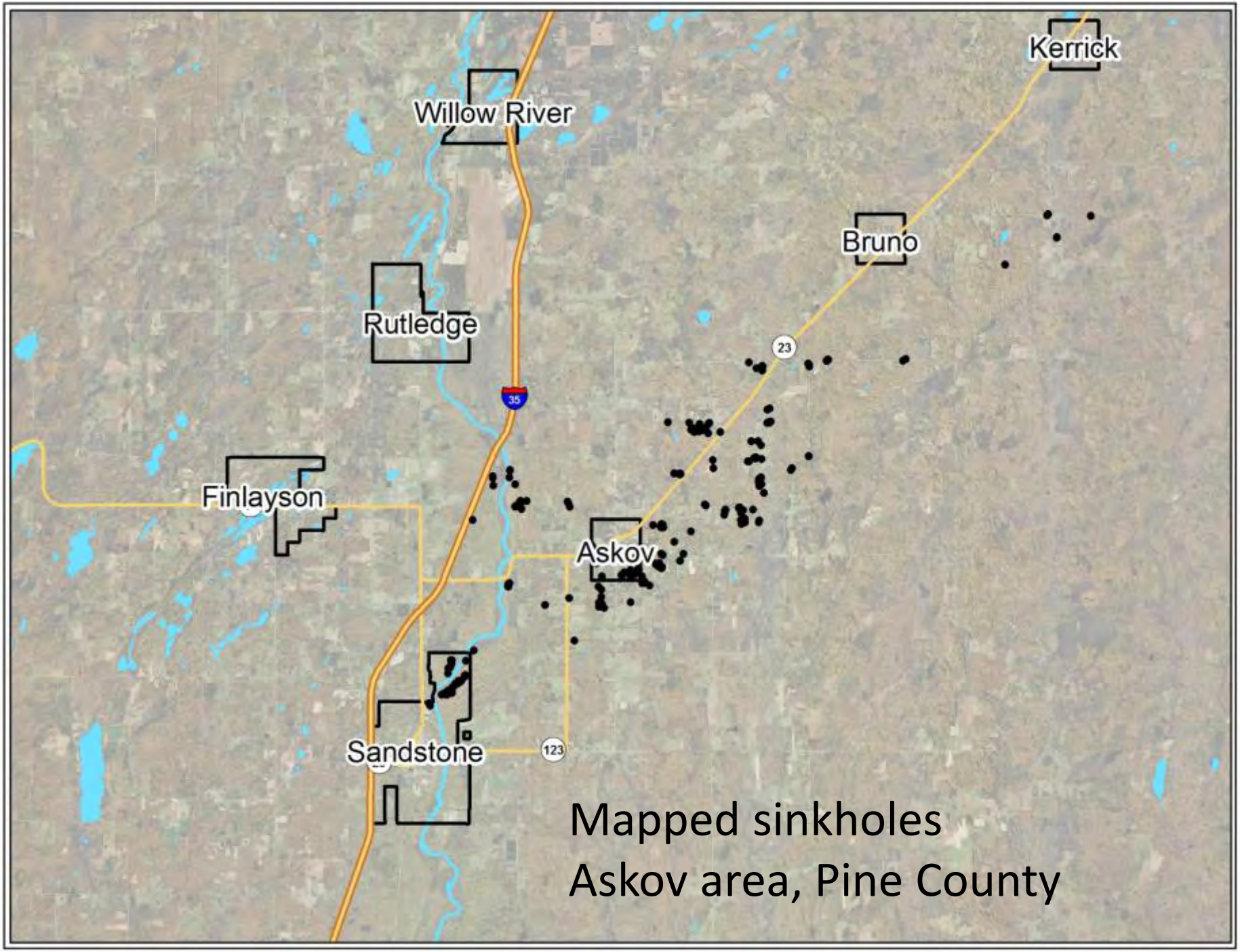
Pine County

2001 Pine Co Geologic Atlas Part A
with sinkhole map

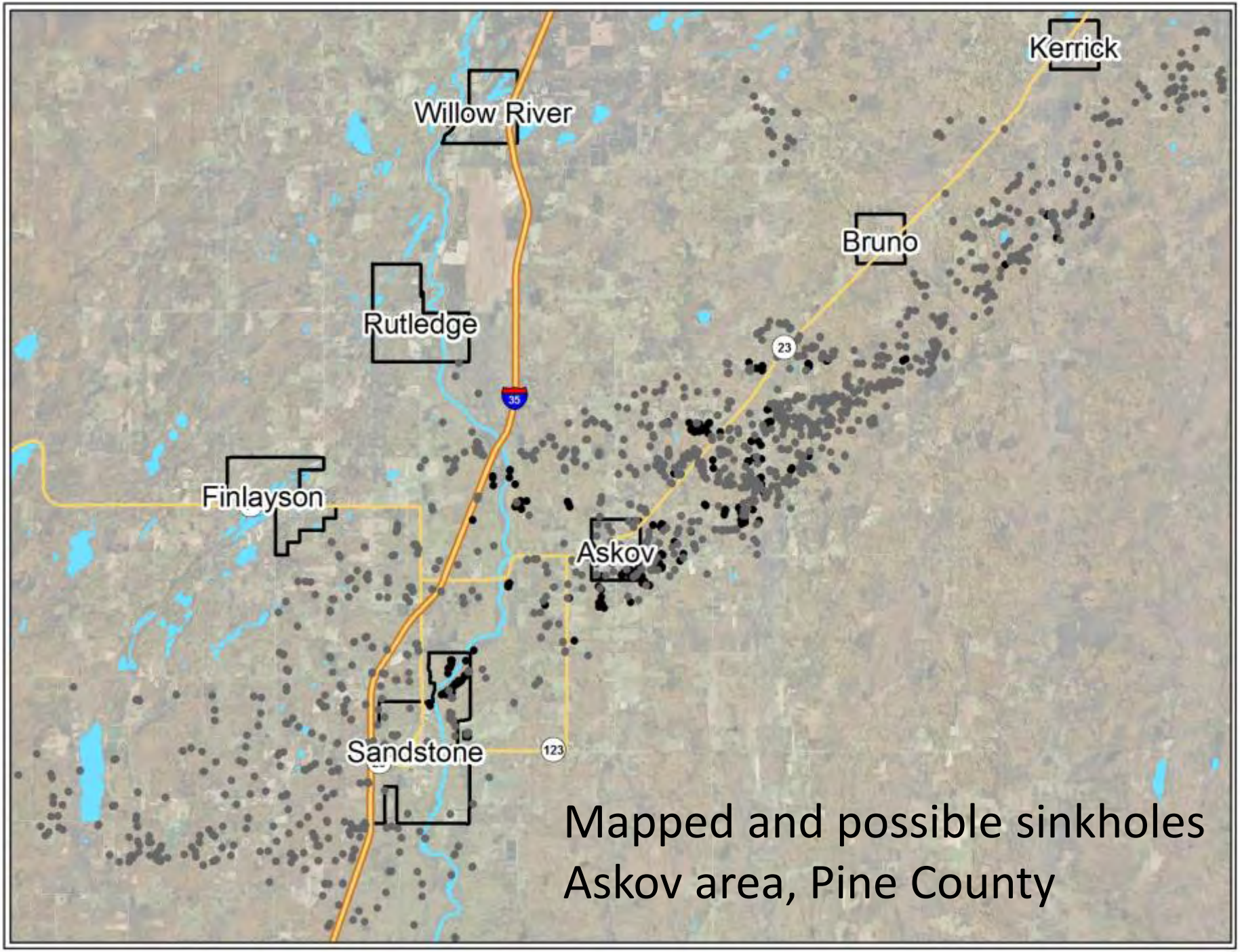
2004 Part B atlas with pollution
sensitivity map

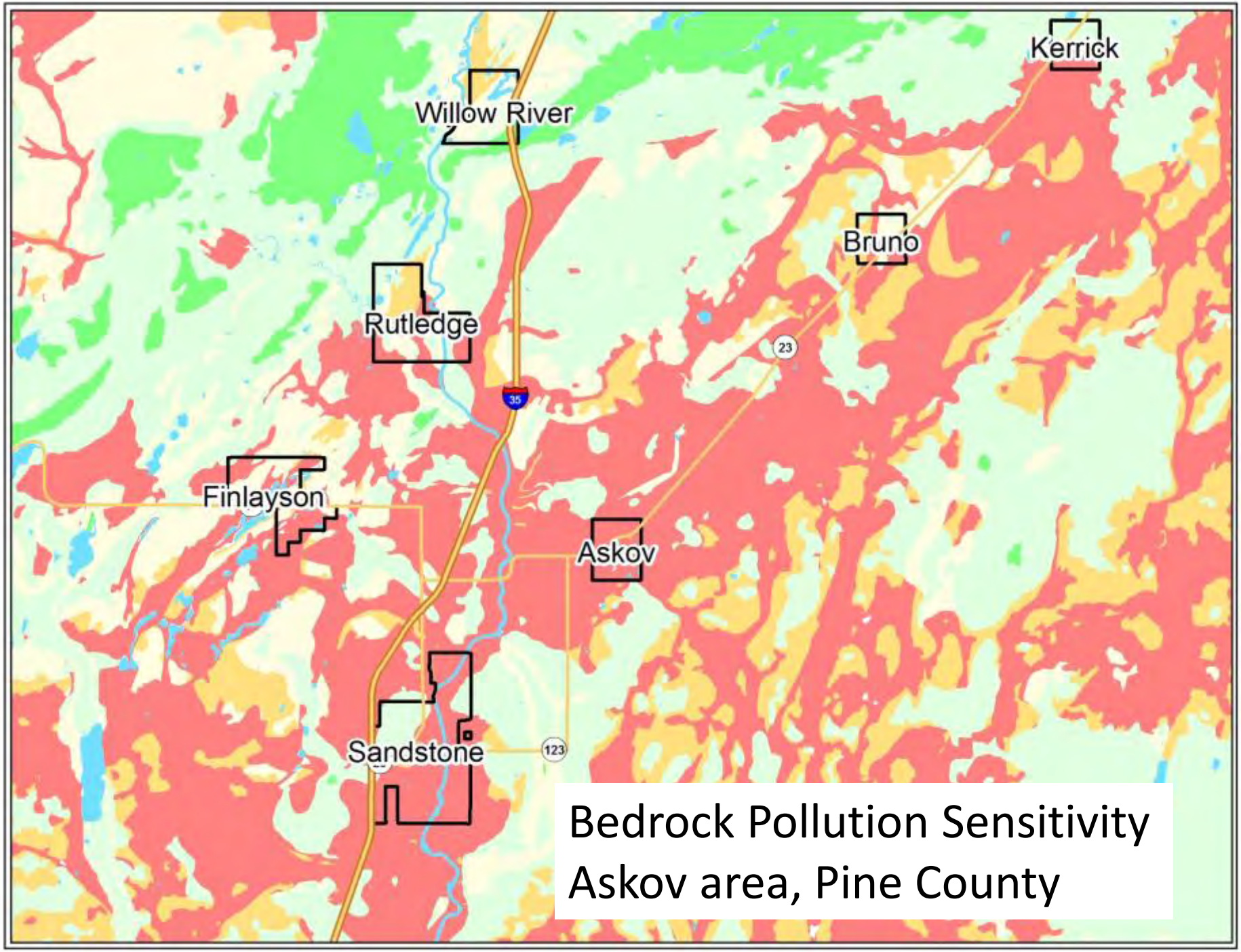


Askov area, Pine County

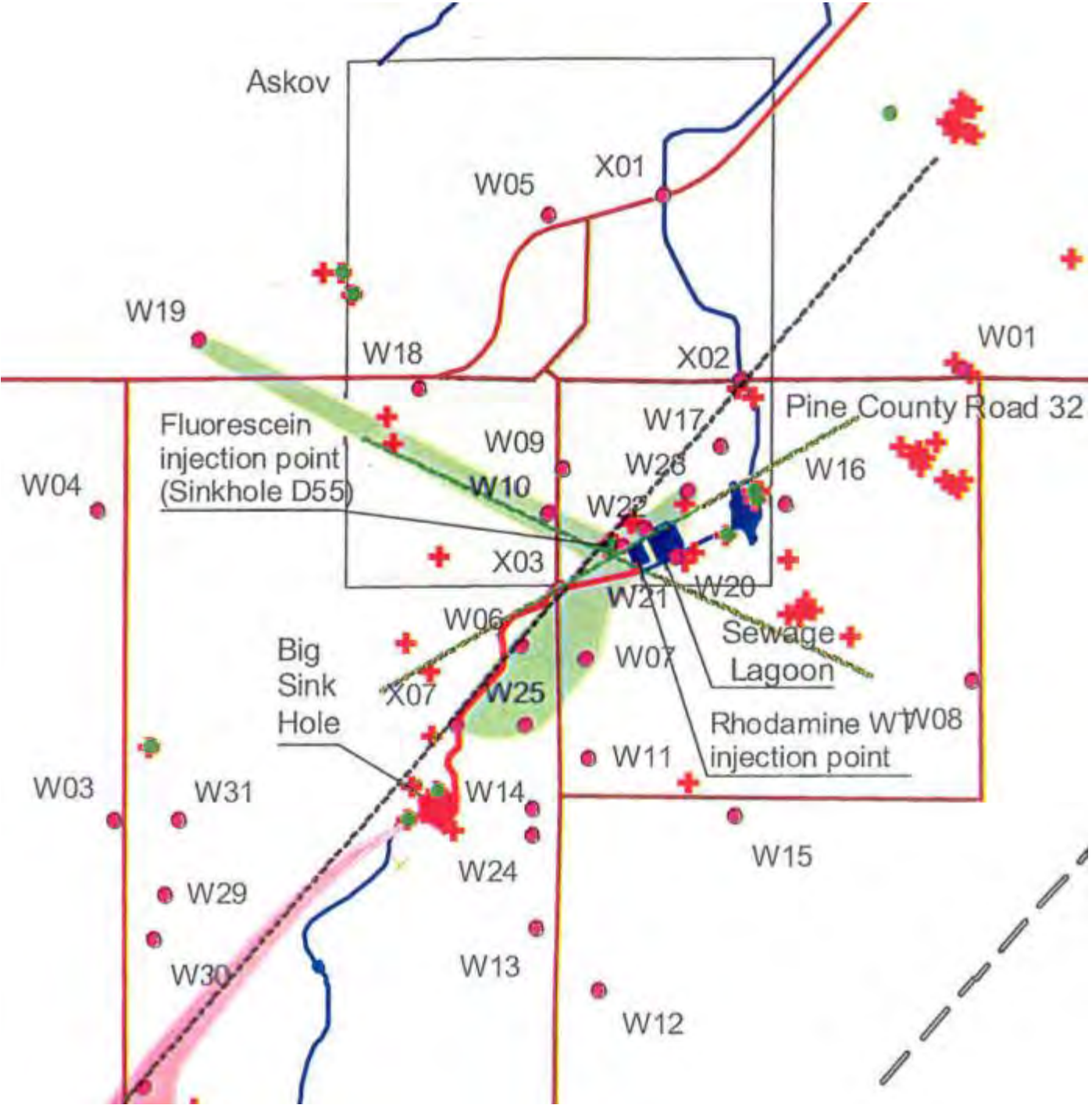


Mapped sinkholes
Askov area, Pine County

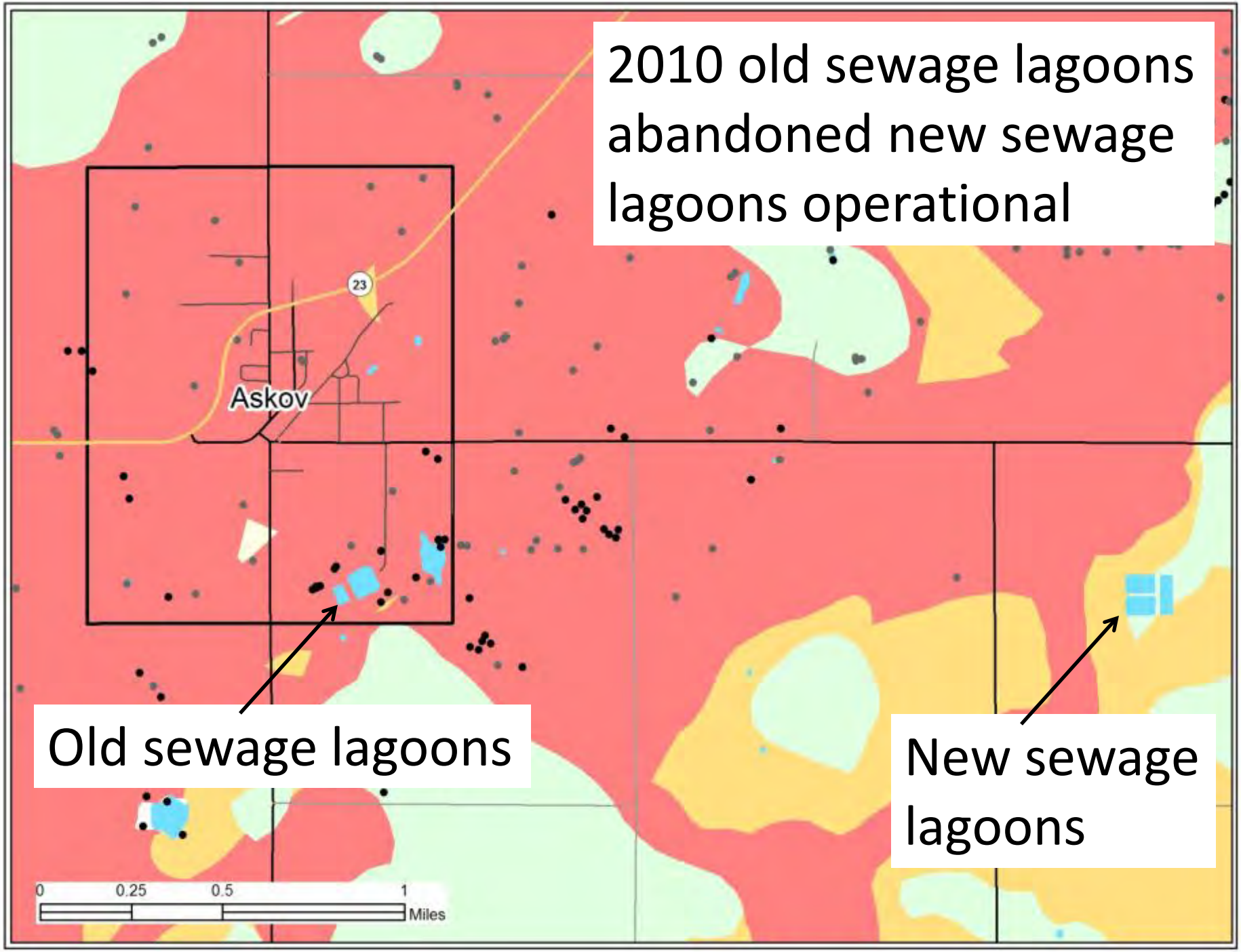

Kerrick
Willow River
Bruno
Rutledge
23
35
Finlayson
Askov
Sandstone
123
Mapped and possible sinkholes
Askov area, Pine County



Bedrock Pollution Sensitivity
Askov area, Pine County

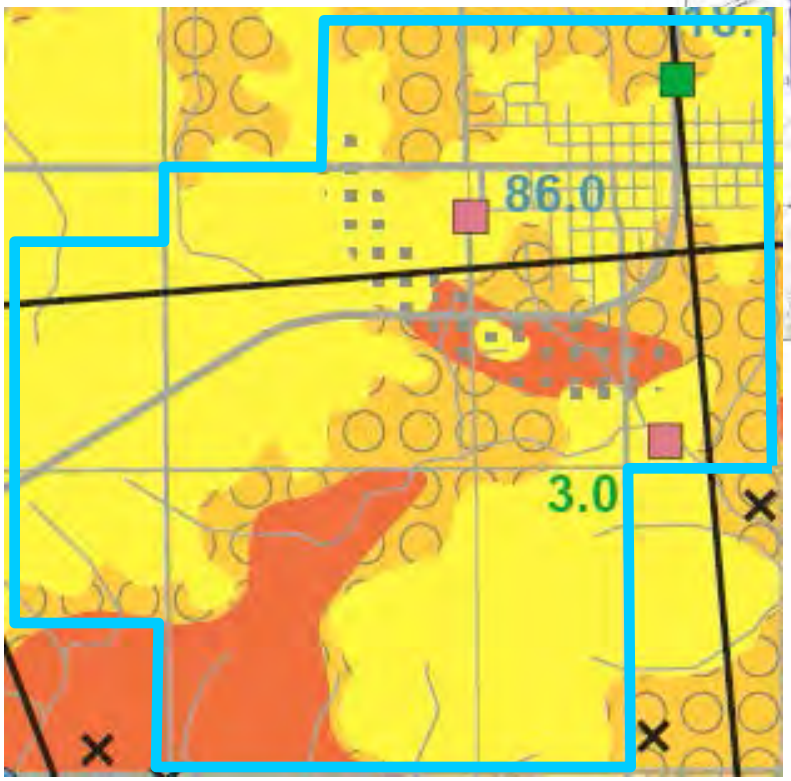


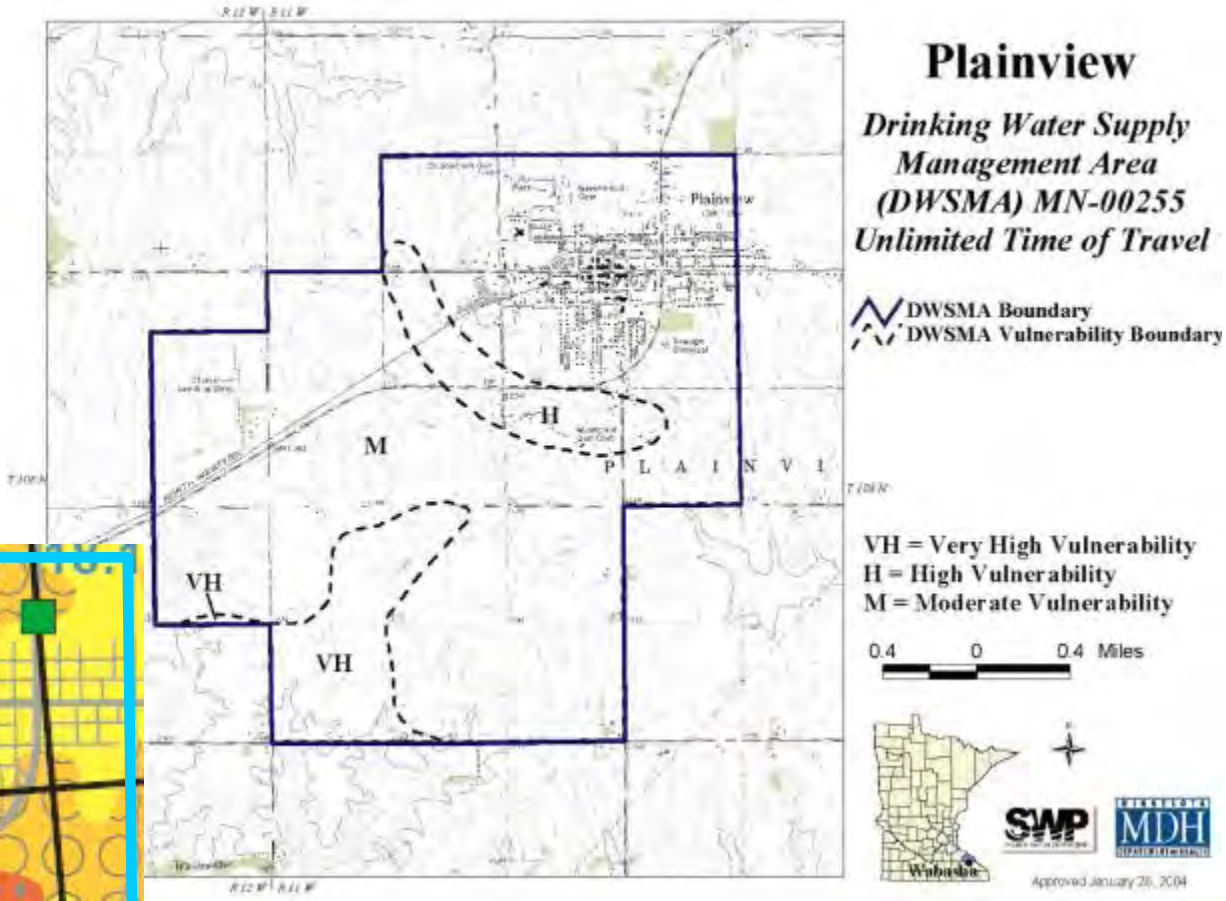
City of Askov dye trace Study (2004)


2010 old sewage lagoons abandoned new sewage lagoons operational
23
Askov
Old sewage lagoons
New sewage lagoons
0
0.25
0.5
1
Miles

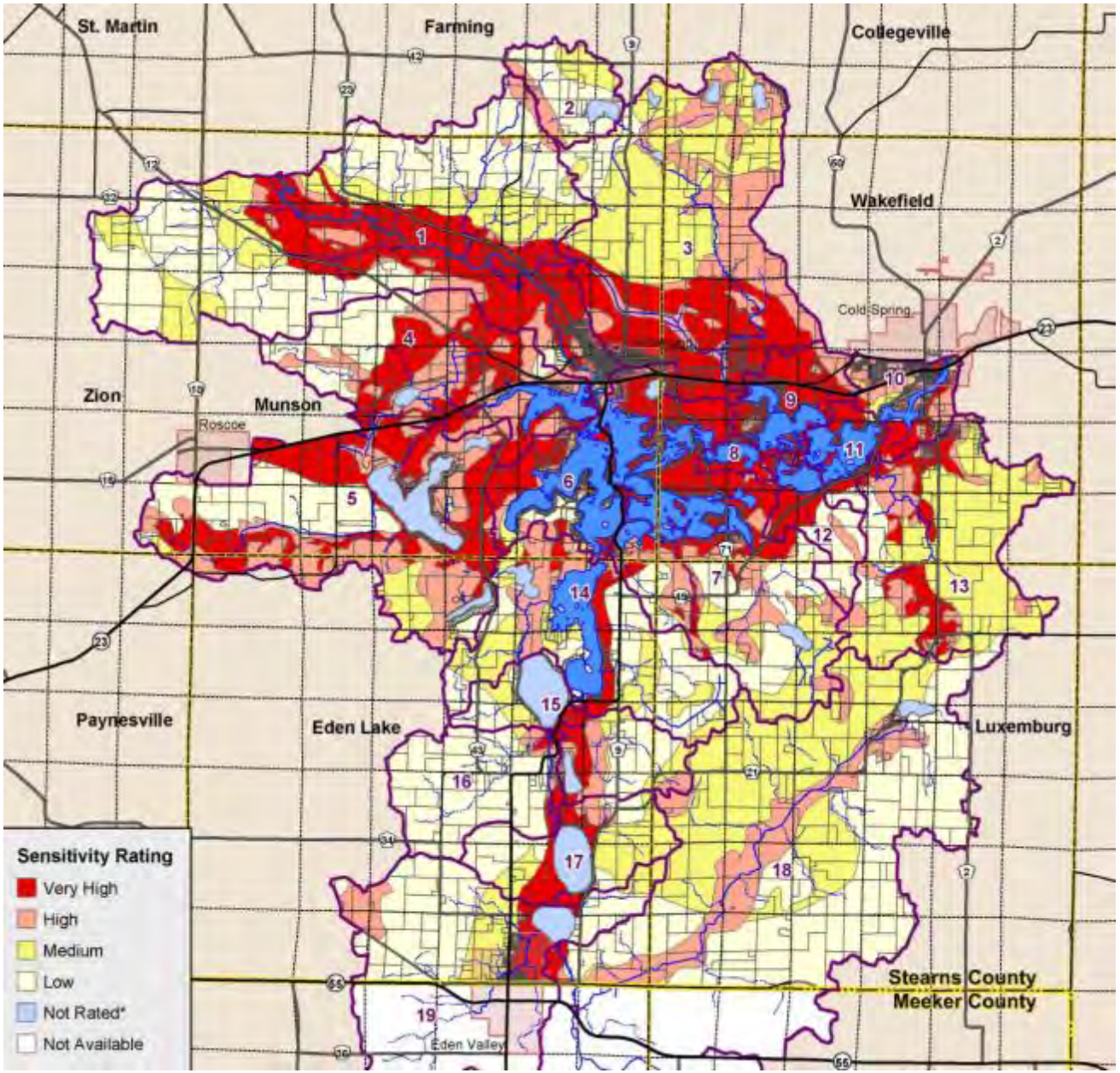
Wellhead protection

Wabasha County





…designed to protect public water supply wells. States are required to have wellhead protection programs under the provisions of the 1986 amendments to the federal Safe Drinking Water Act.

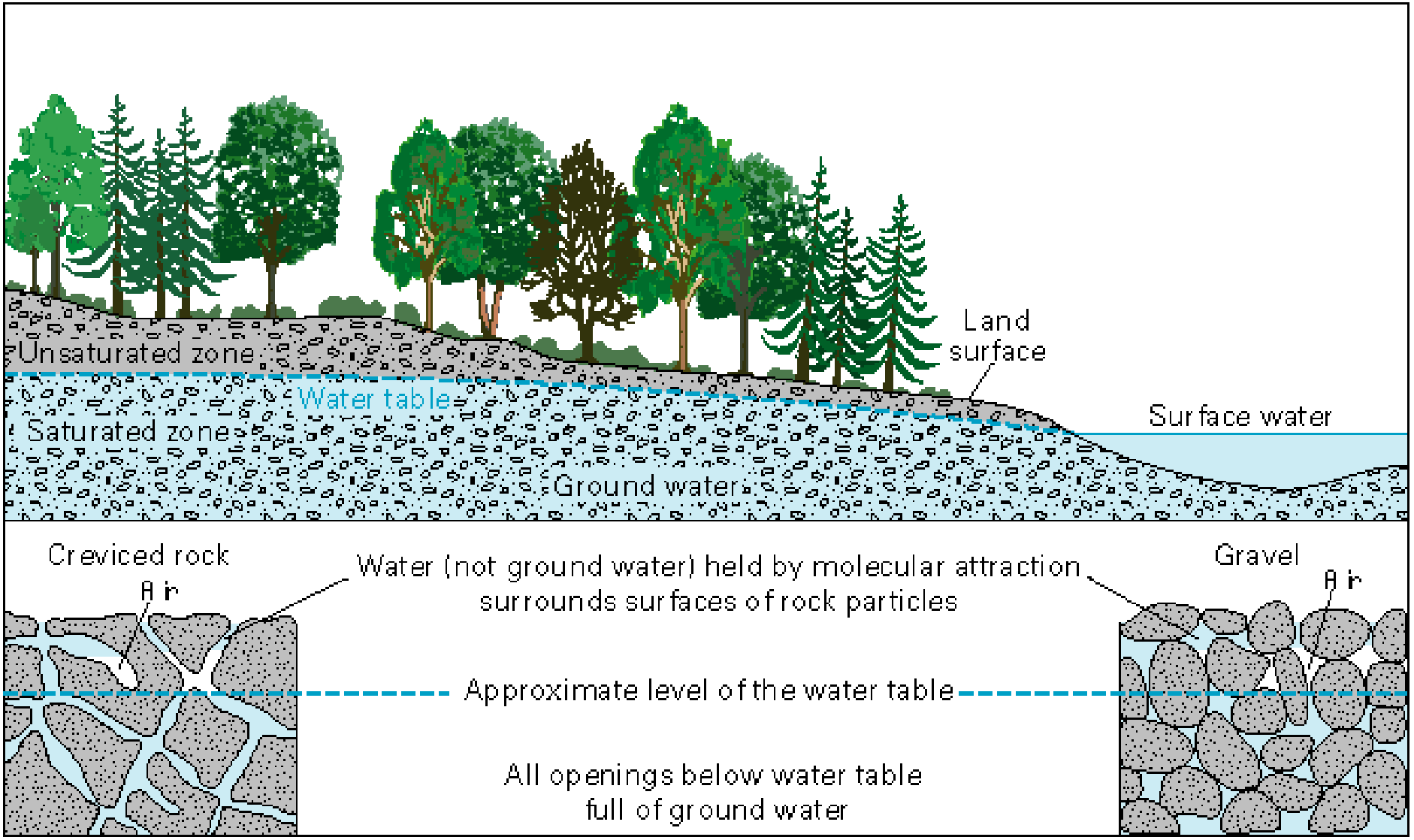


Source water Protection (quality)

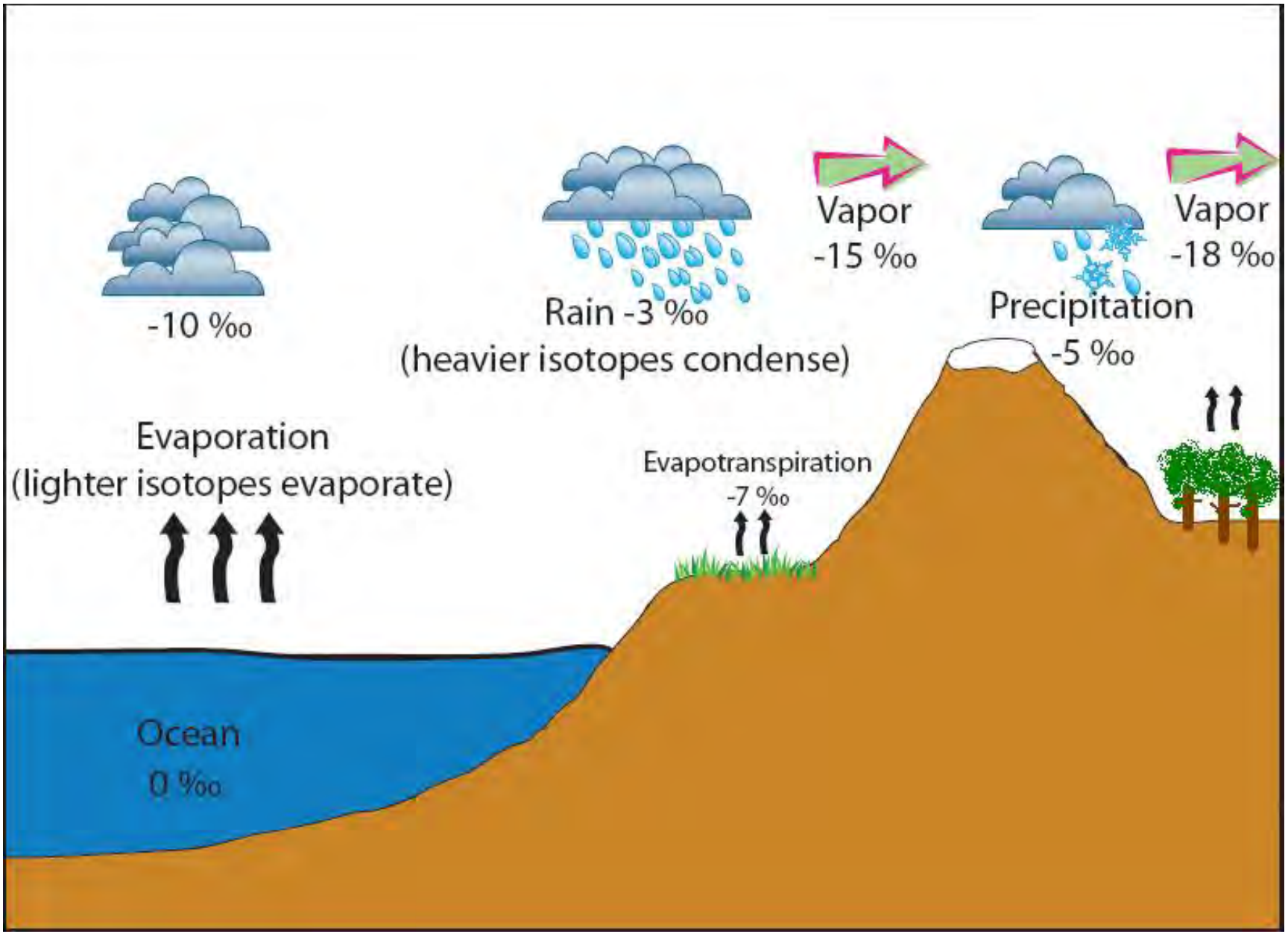
Sauk River Chain of Lakes Lakeshed management plan

Stearns Co Soil and Water Conservation District

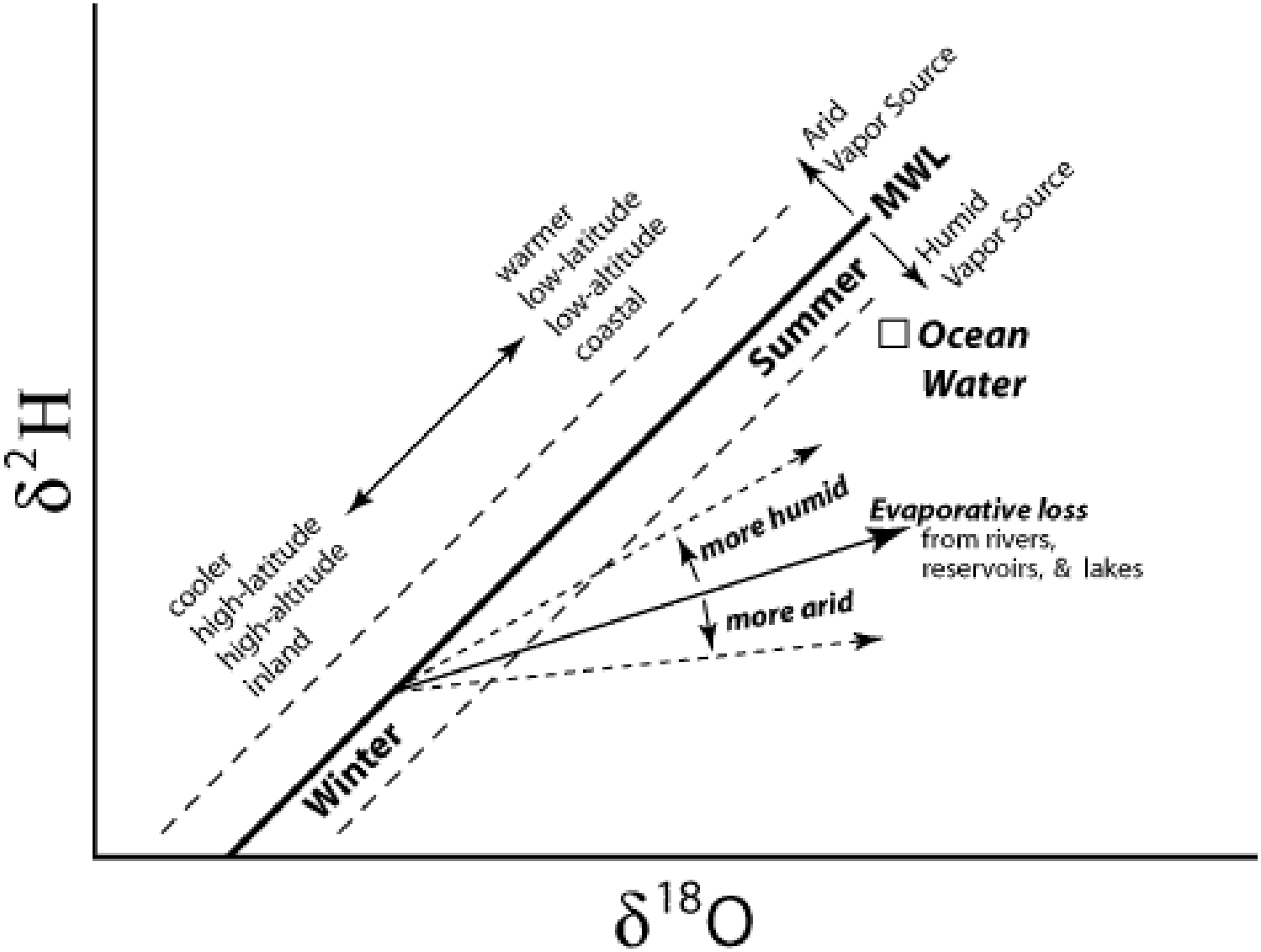
Appropriation - Minnesota Lakes are commonly connected directly or indirectly to aquifers



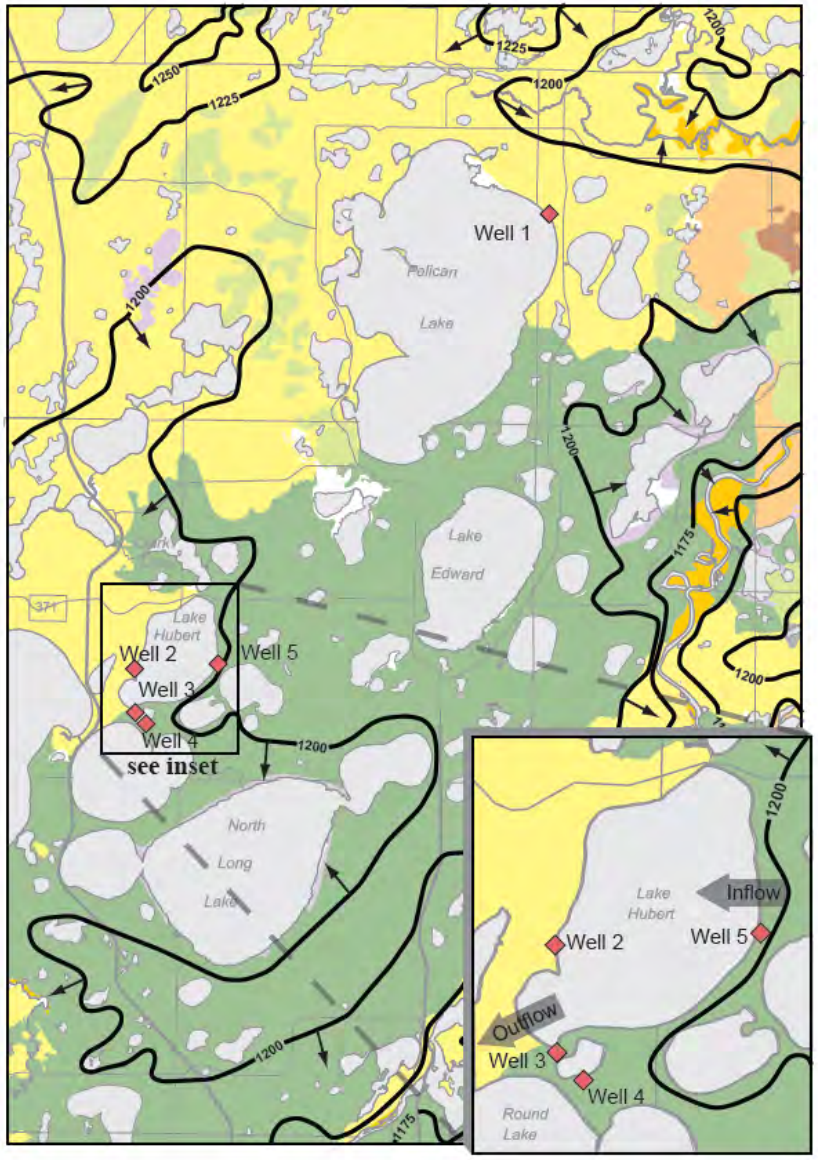
Fingerprints of Water

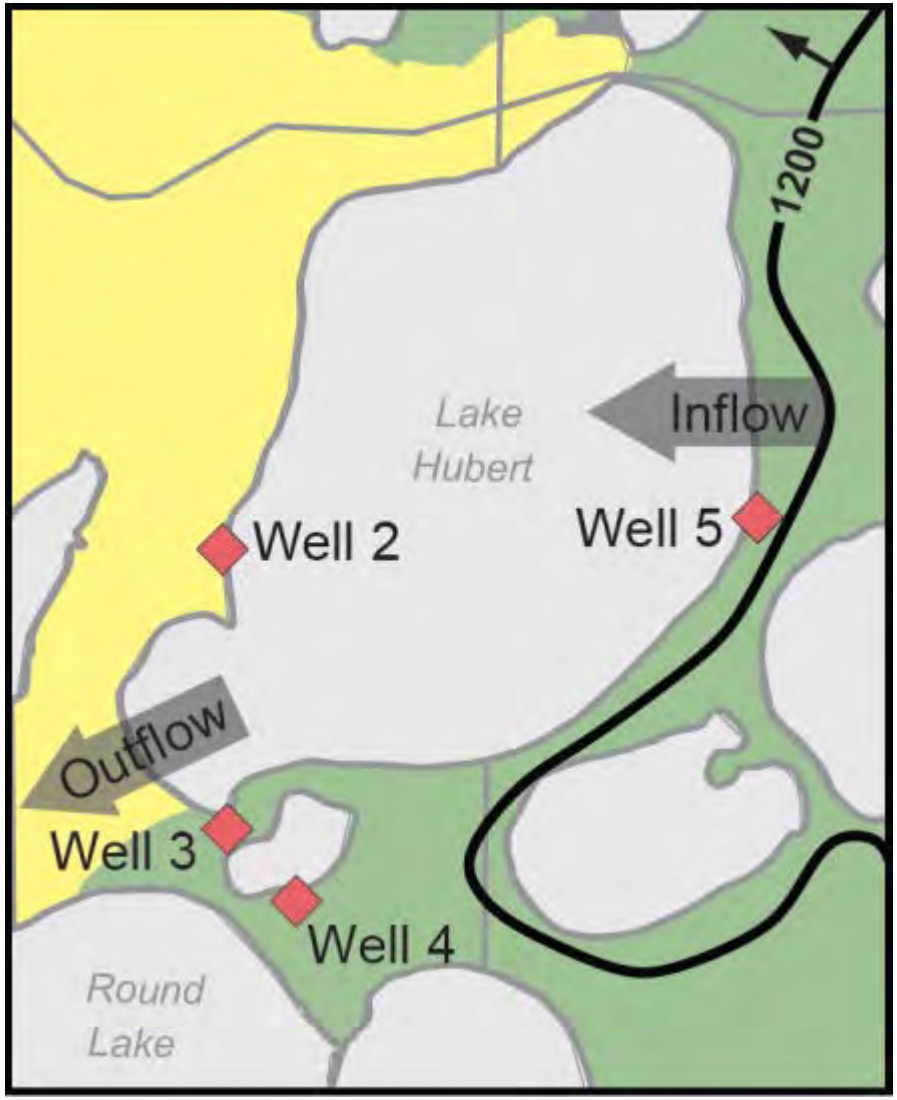


Fingerprints of Water



Ground-Water Flow through Lake Hubert

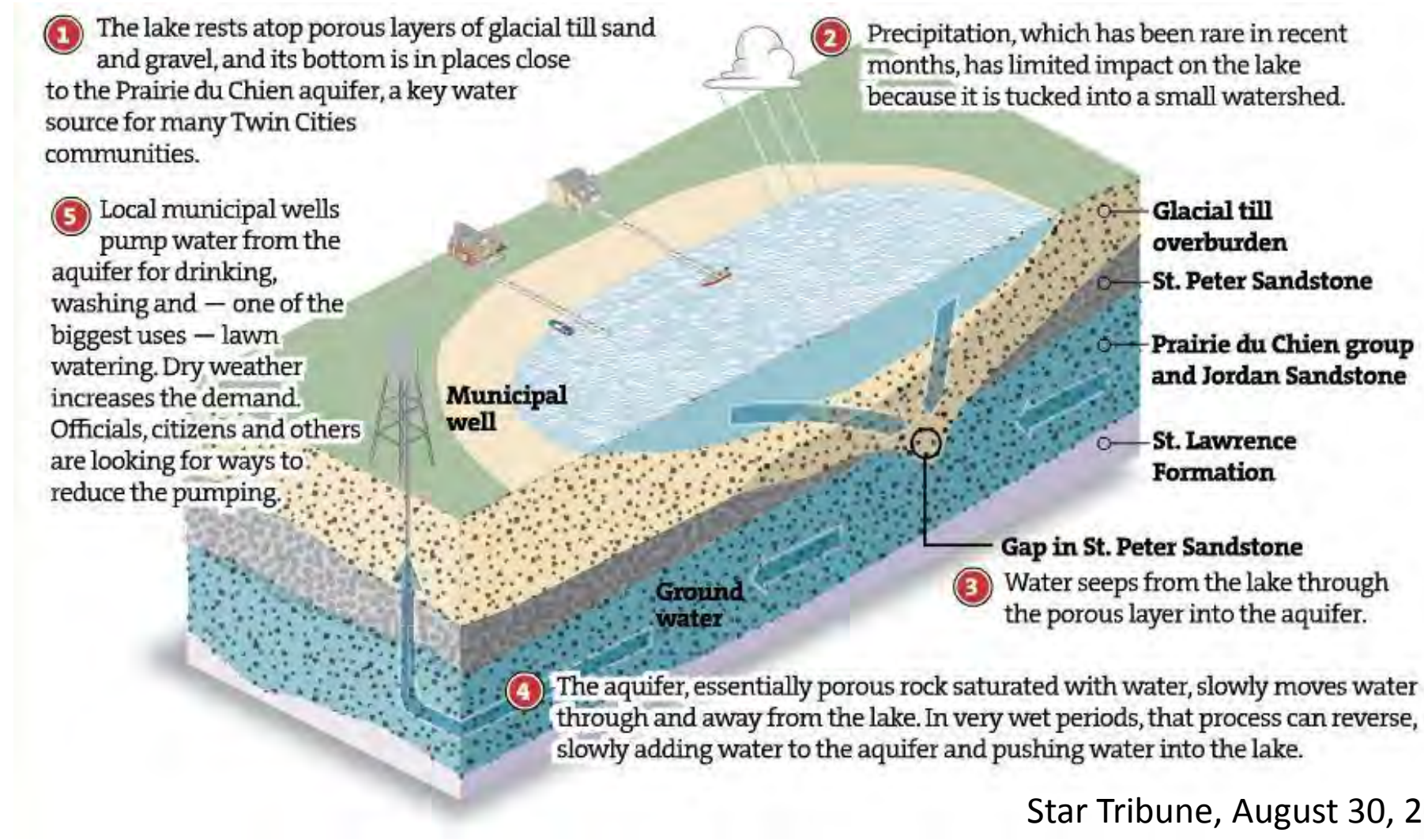




Appropriation

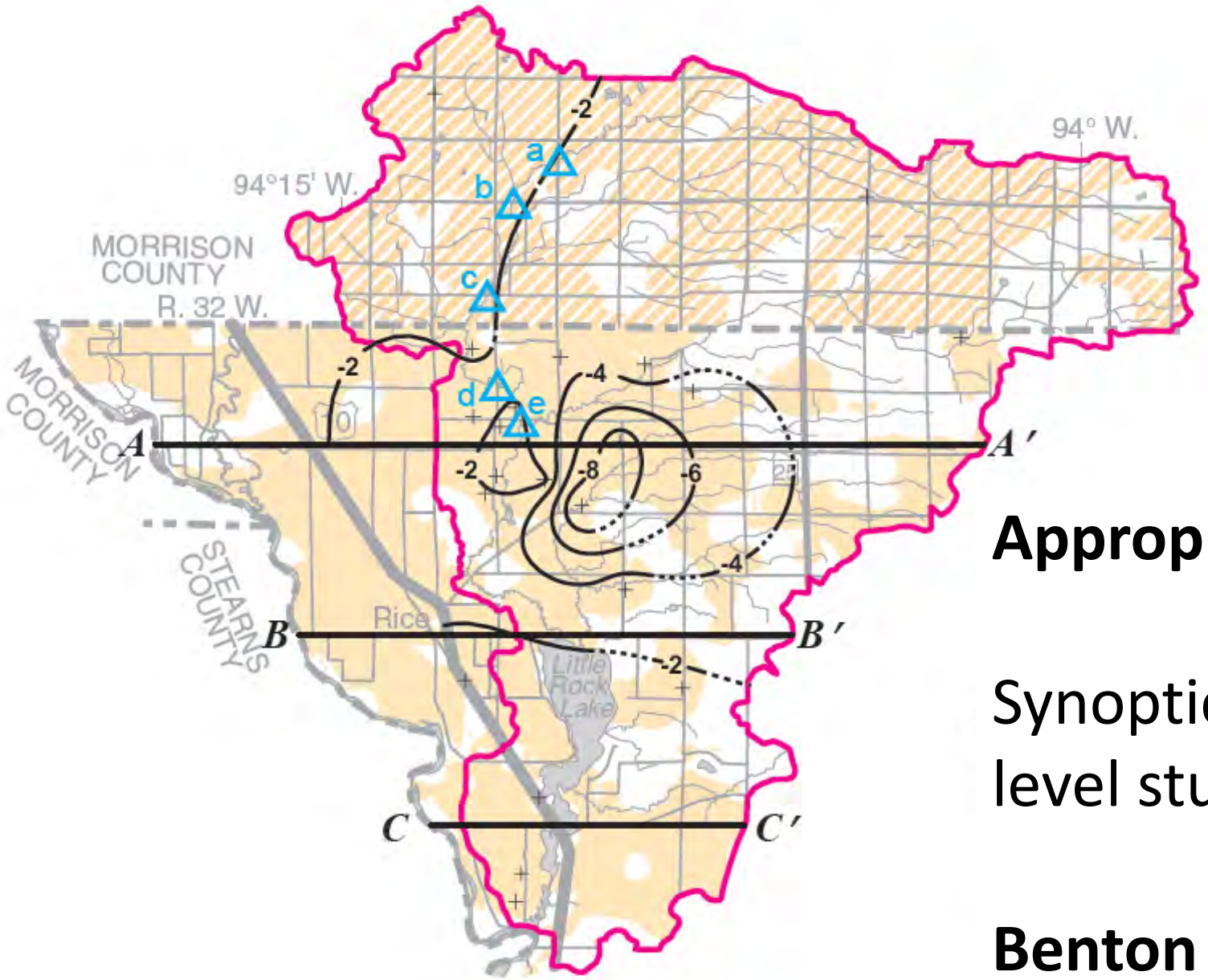
White Bear Lake groundwater management area

Ramsey and Washington counties



Star Tribune, August 30, 2013

April 2010 to July 2010 change in water levels



Appropriation

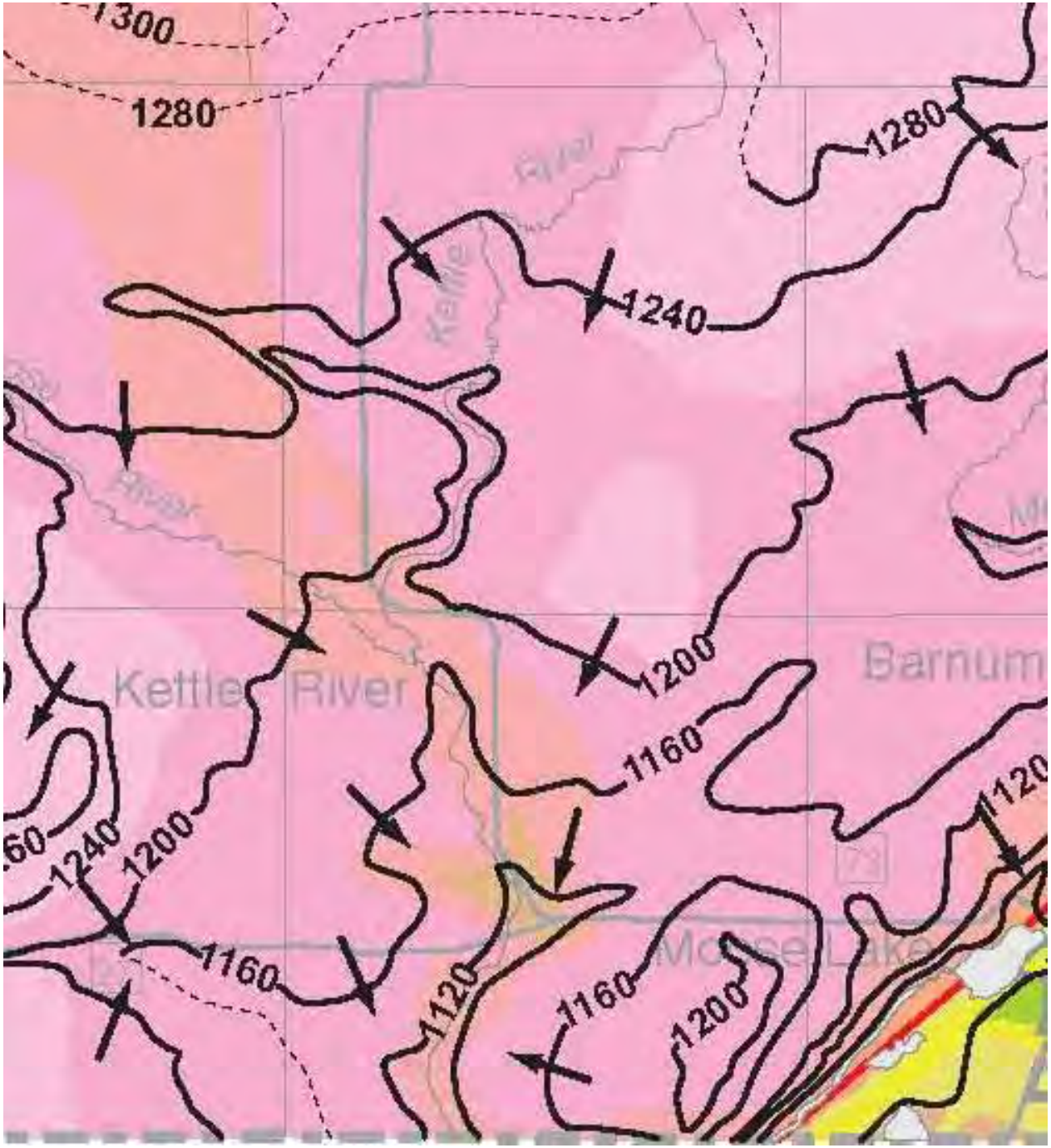
Synoptic water level study

Benton County

Appropriation

Straight River and irrigated farm land

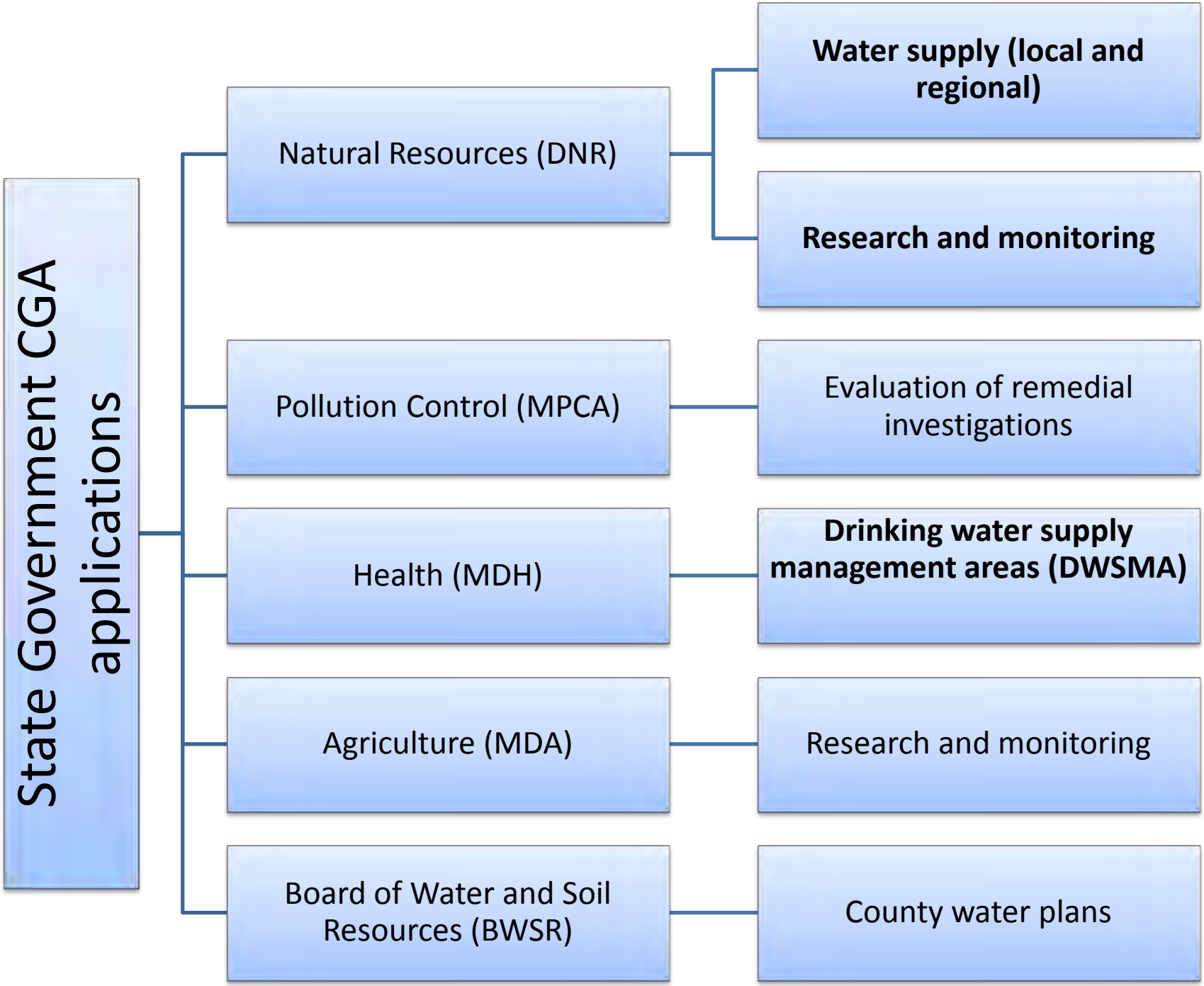
Becker and Hubbard counties

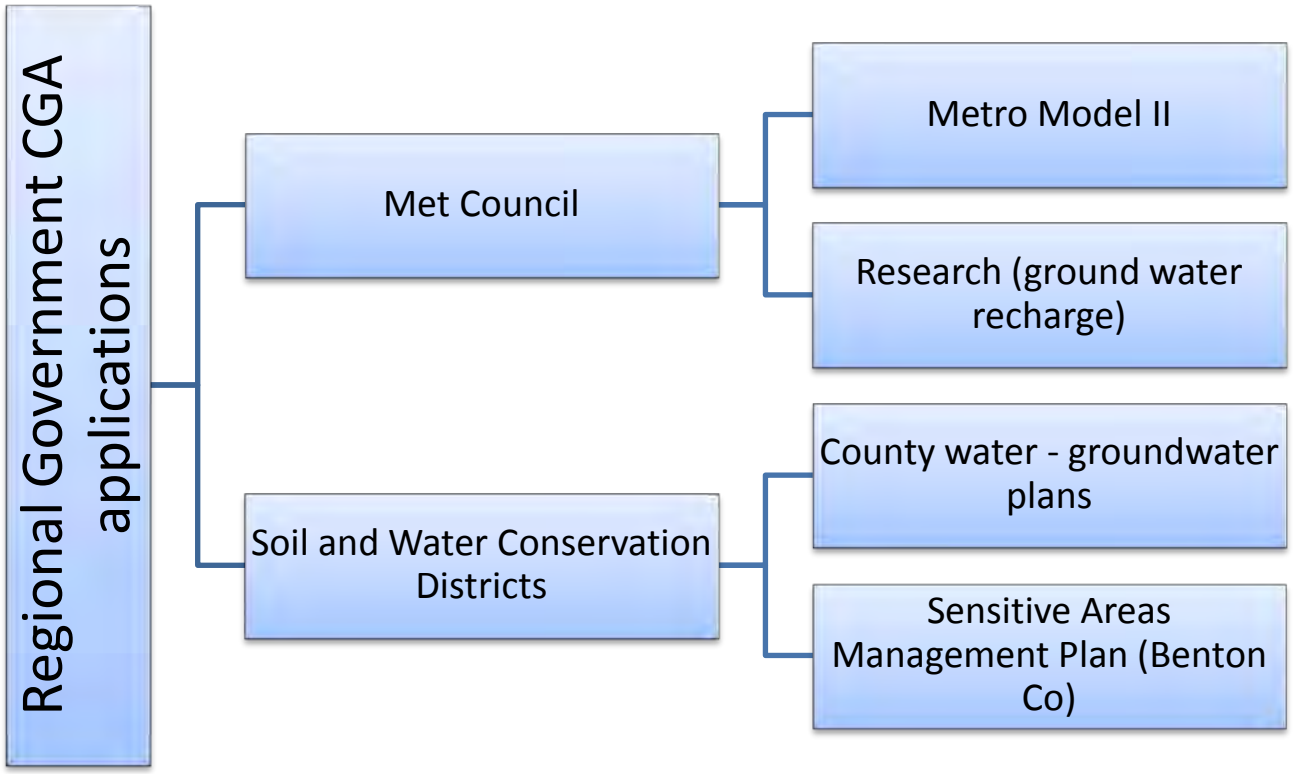


Remediation

Groundwater flow directions buried sand and gravel units and bedrock aquifers

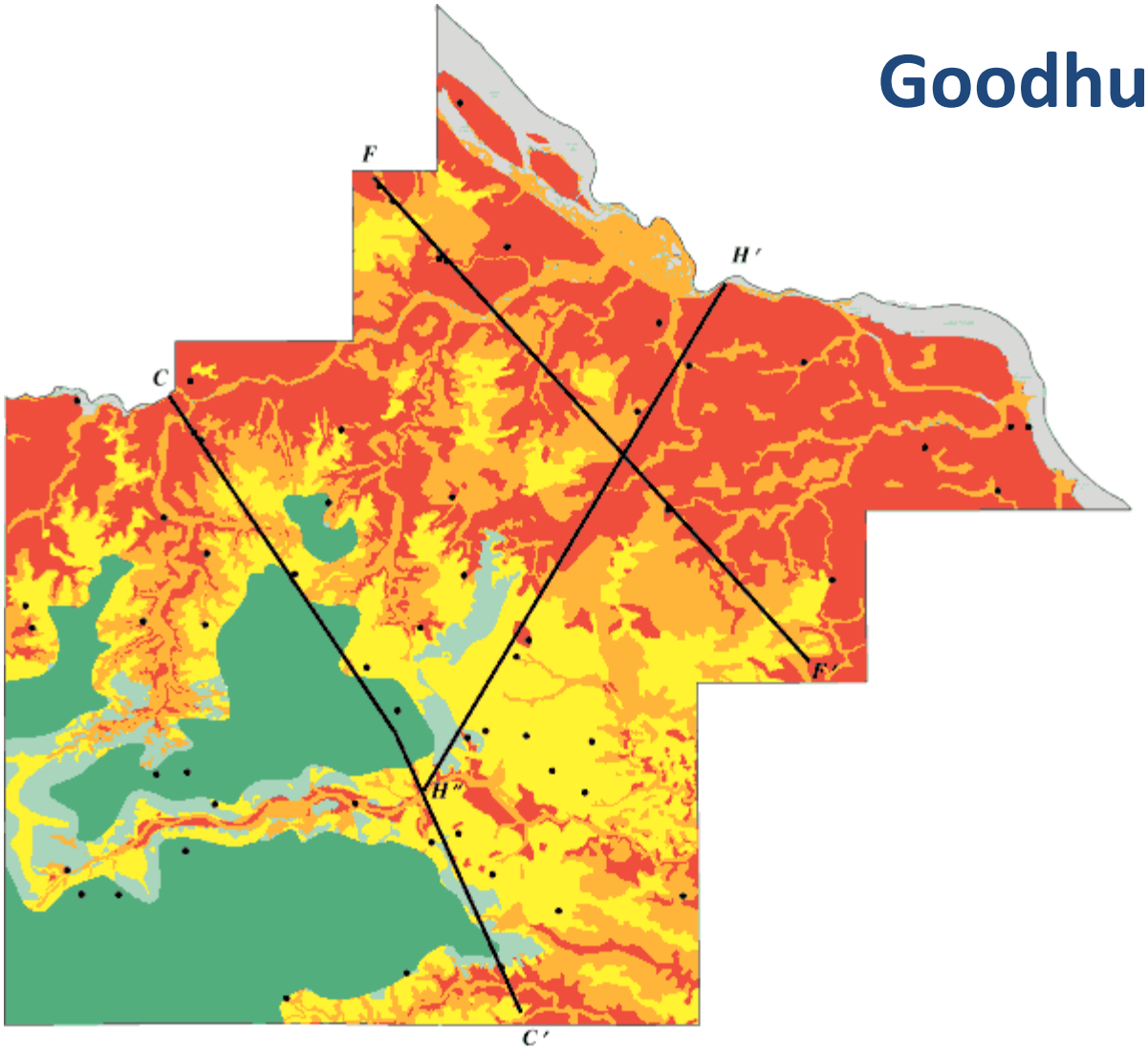
Carlton County


State Government CGA applications
Natural Resources (DNR)
Water supply (local and regional)
Research and monitoring
Pollution Control (MPCA)
Evaluation of remedial investigations
Health (MDH)
Drinking water supply management areas (DWSMA)
Agriculture (MDA)
Research and monitoring
Board of Water and Soil Resources (BWSR)
County water plans

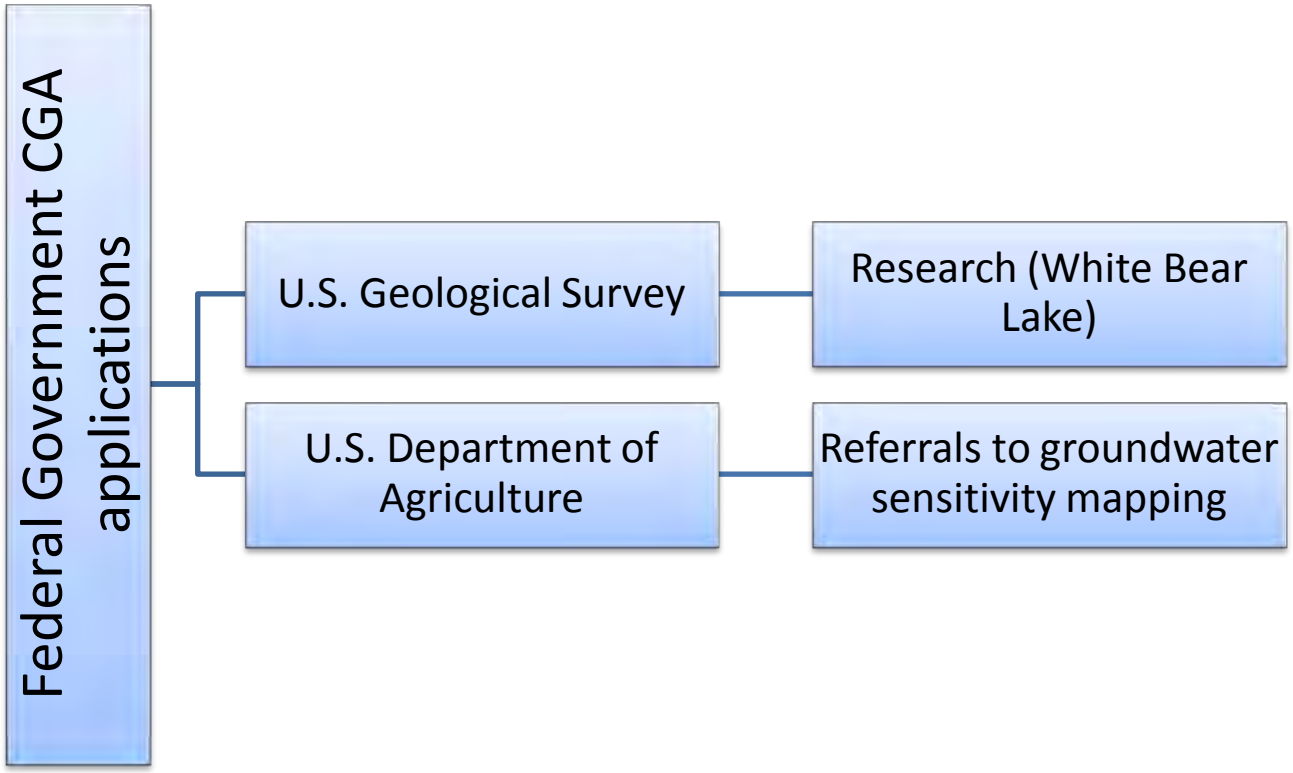

Regional Government CGA applications
Met Council
Metro Model II
Research (ground water recharge)
Soil and Water Conservation Districts
County water - groundwater plans
Sensitive Areas Management Plan (Benton Co)

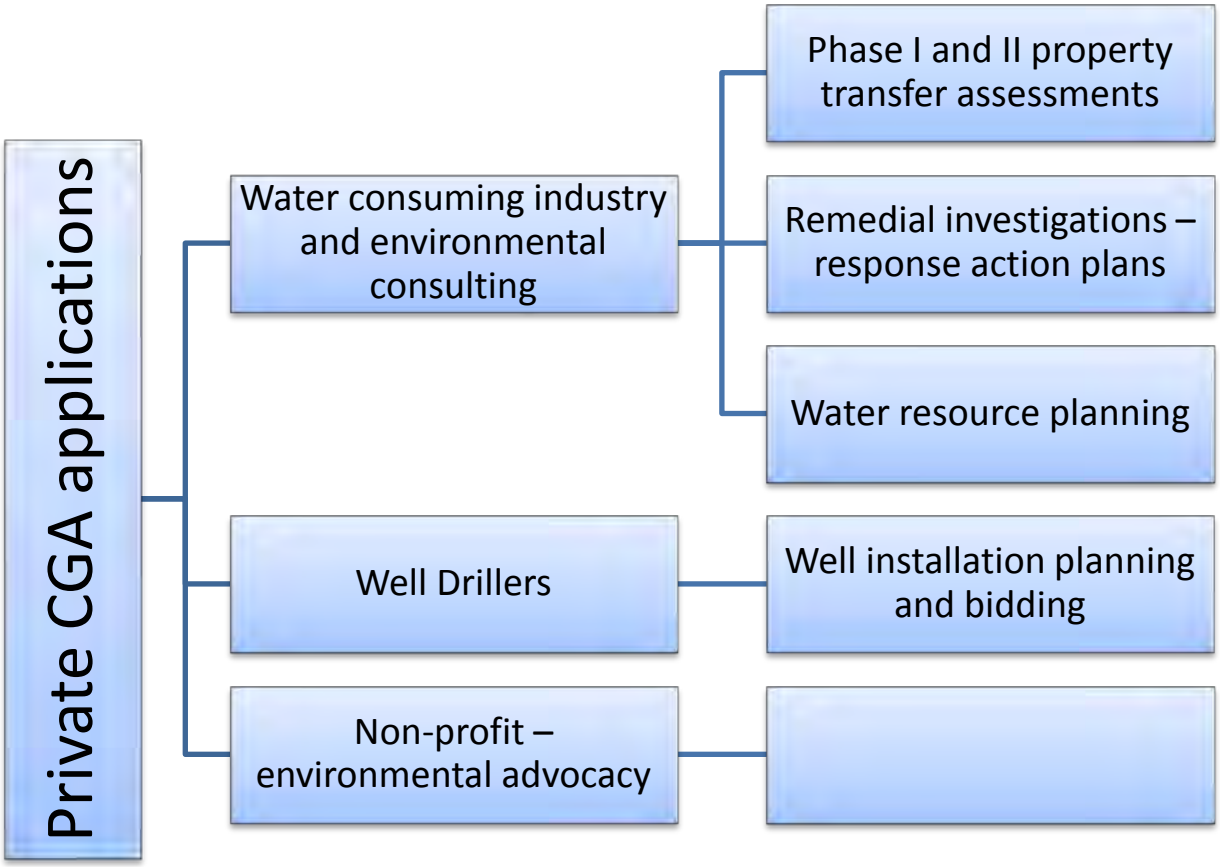
County Government CGA applications	County Water - Groundwater Plans	Olmsted Stearns Dakota Hennepin Ramsey Scott Washington
	Feedlots	Rice
	Septic systems	**Scott** Olmsted
	Landfill planning	**Olmsted**
	Zoning	**Clay**
	Delegated well permitting authority (MDH well code)	Blue Earth Dakota Goodhue Olmsted Wabasha Winona

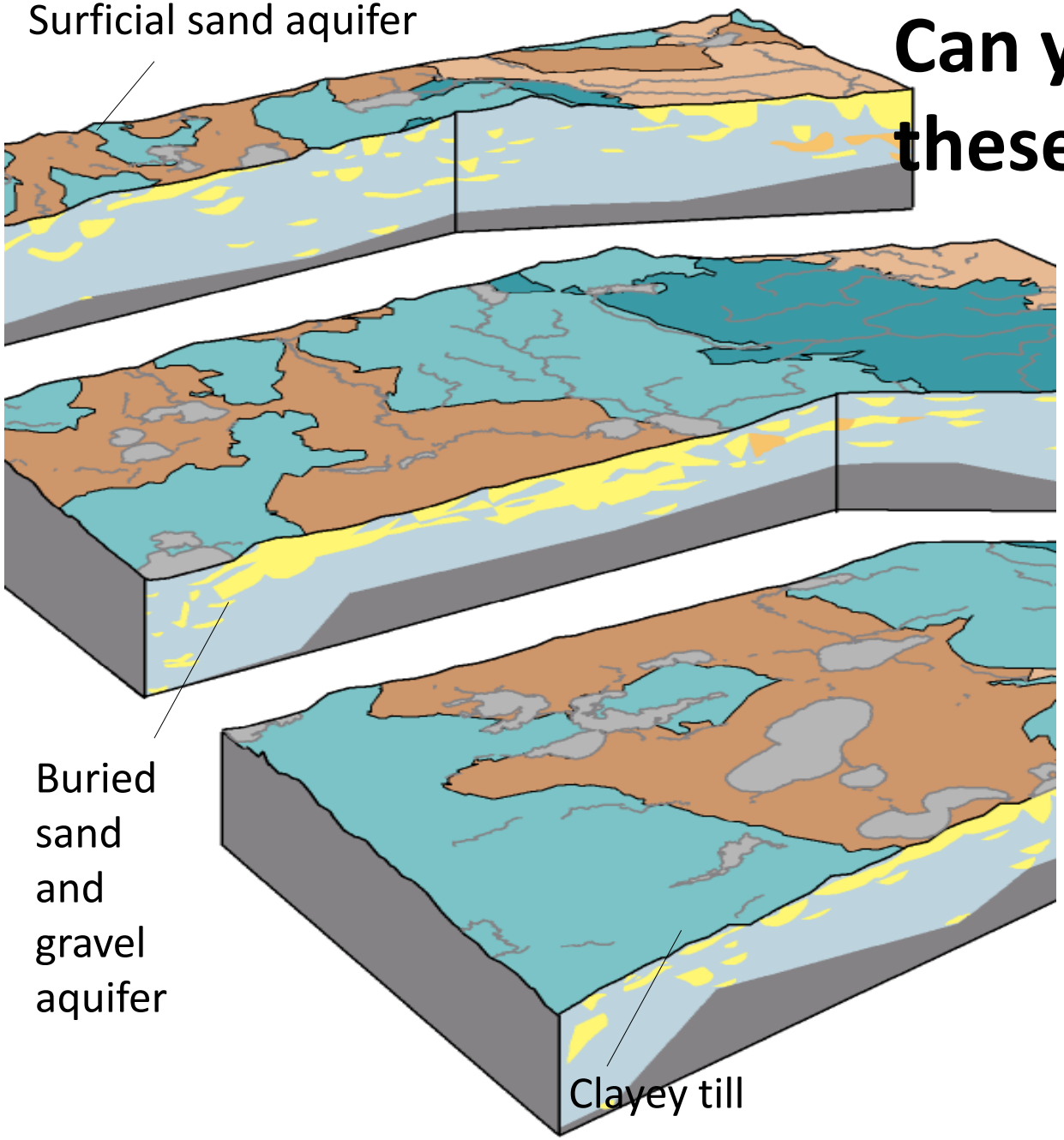
Goodhue County



- Comprehensive plan
- Planning commission reviews
- Subdivision proposals
- Conditional Use permits
- Zoning/rezoning


Federal Government CGA applications
U.S. Geological Survey
Research (White Bear Lake)
U.S. Department of Agriculture
Referrals to groundwater sensitivity mapping


Private CGA applications
Water consuming industry and environmental consulting
Phase I and II property transfer assessments
Remedial investigations – response action plans
Water resource planning
Well Drillers
Well installation planning and bidding
Non-profit – environmental advocacy

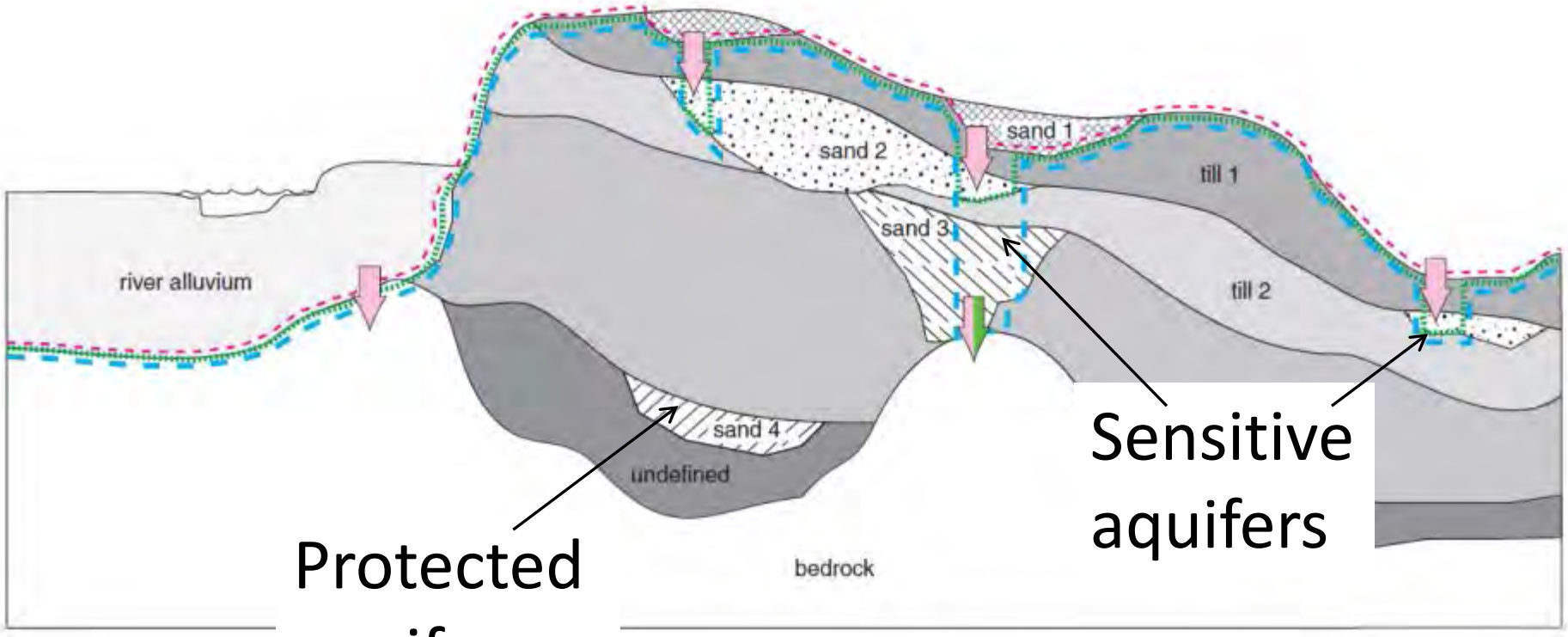


Can you answer these questions?

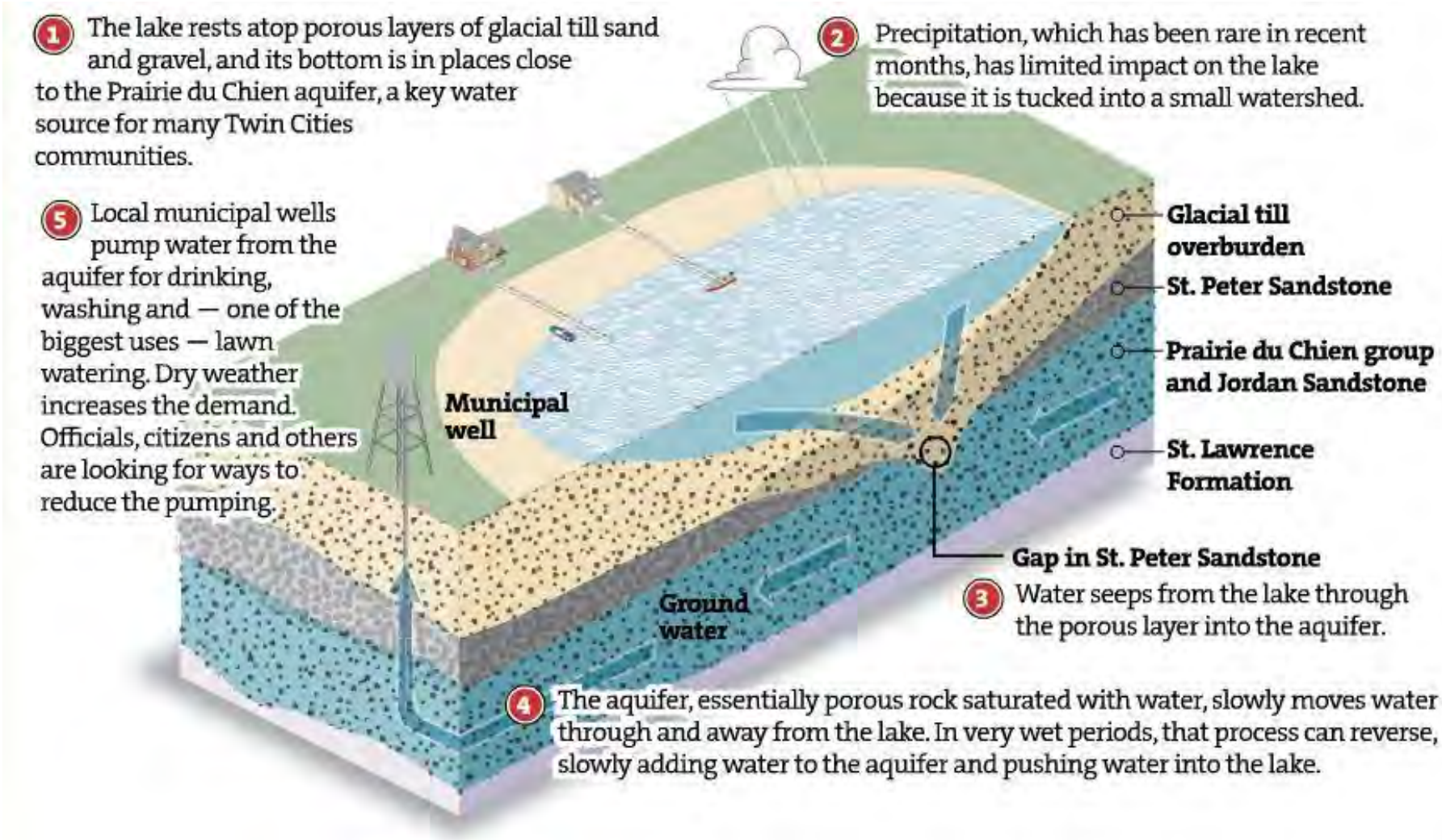
Where are the major aquifers that supply water to your county?

Do those aquifers Have the capacity to supply your water needs now, and into the future?

Are those aquifers vulnerable to contamination or overuse?

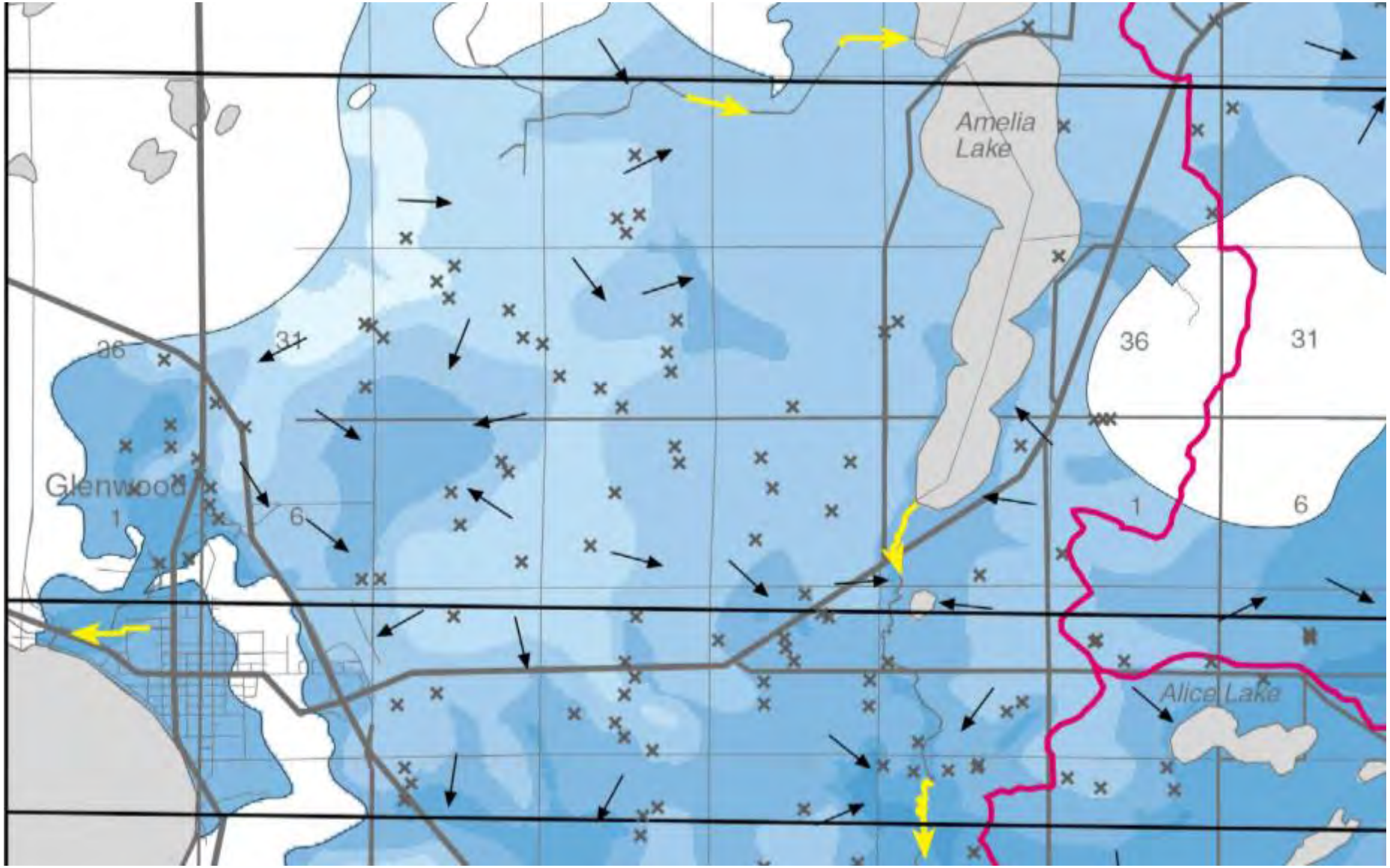


How are those aquifers related to surface water features?



If you needed to choose a location for a facility that needed lots of water, where would be the best place?

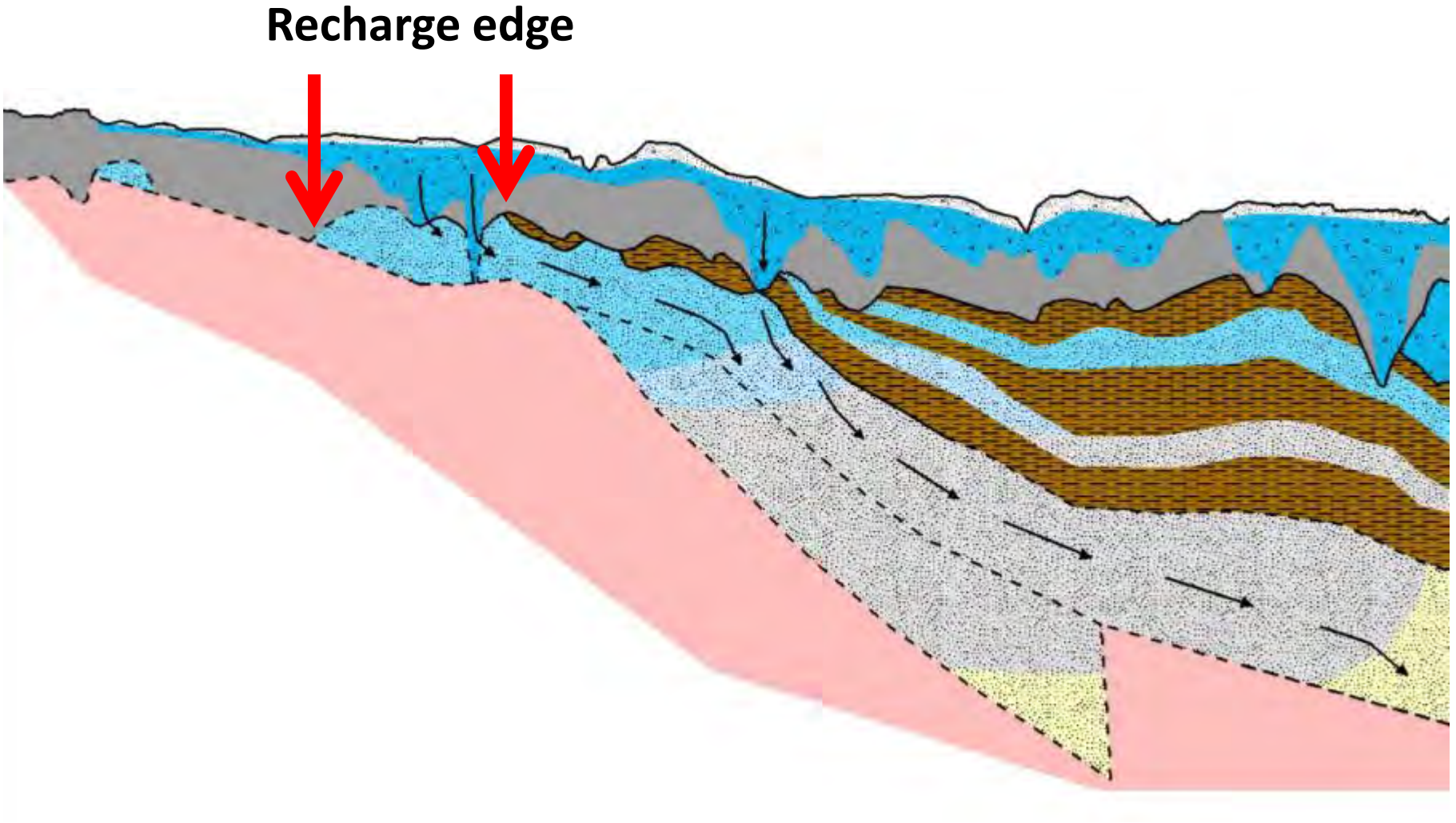
What is the direction of ground water flow and what wells will be affected by a contamination event?

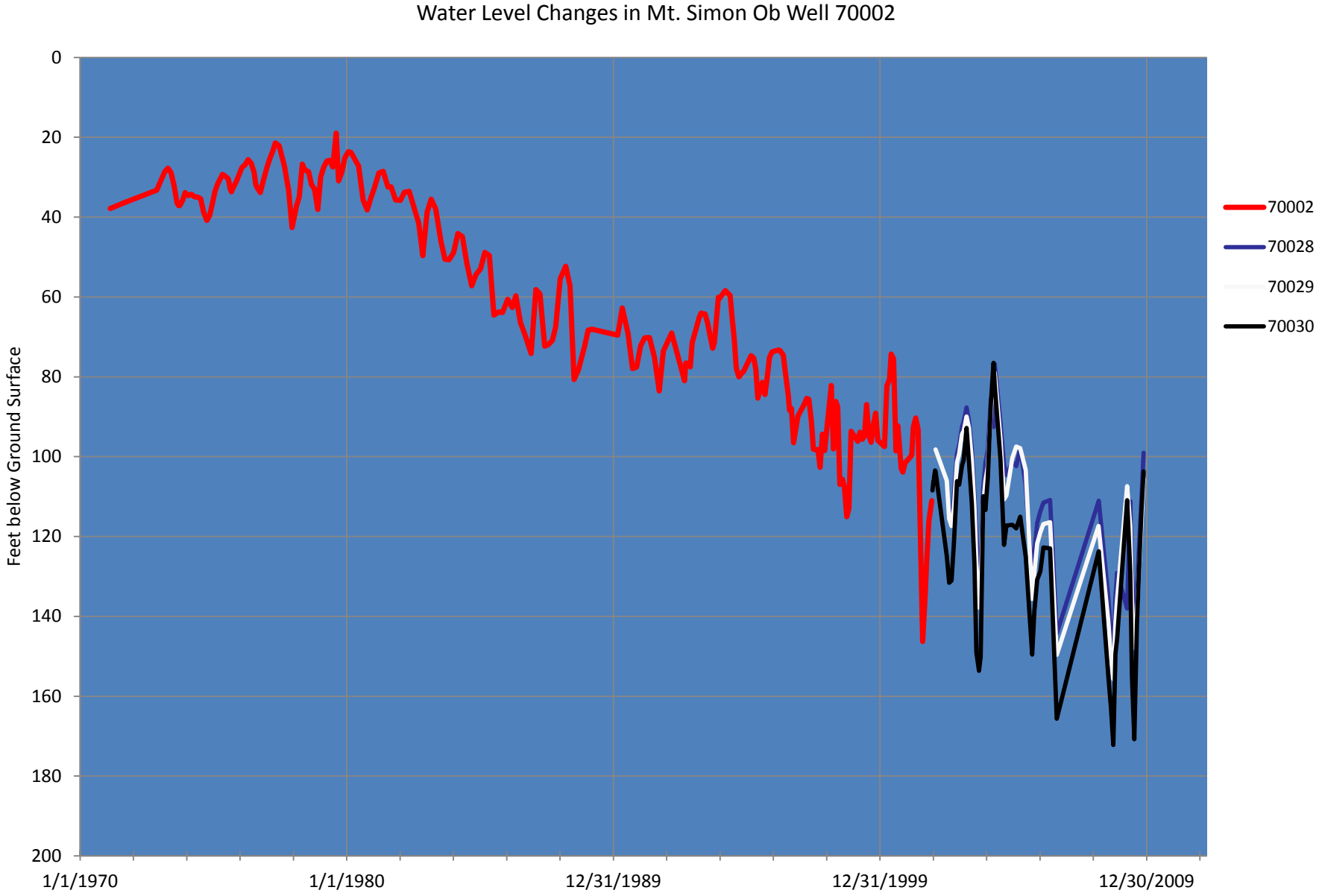


Making it happen…

- Digital well locations established- local contribution of in-kind services
- MGS completes part A at a cost of about $350,000 and presents products and User's Guide- 3 years
- DNR completes part B at similar cost- 2.5 years
- Workshop (possibly a field trip) held for all interested users

Conceptual model: recharge along the western edge of the Mt. Simon aquifer



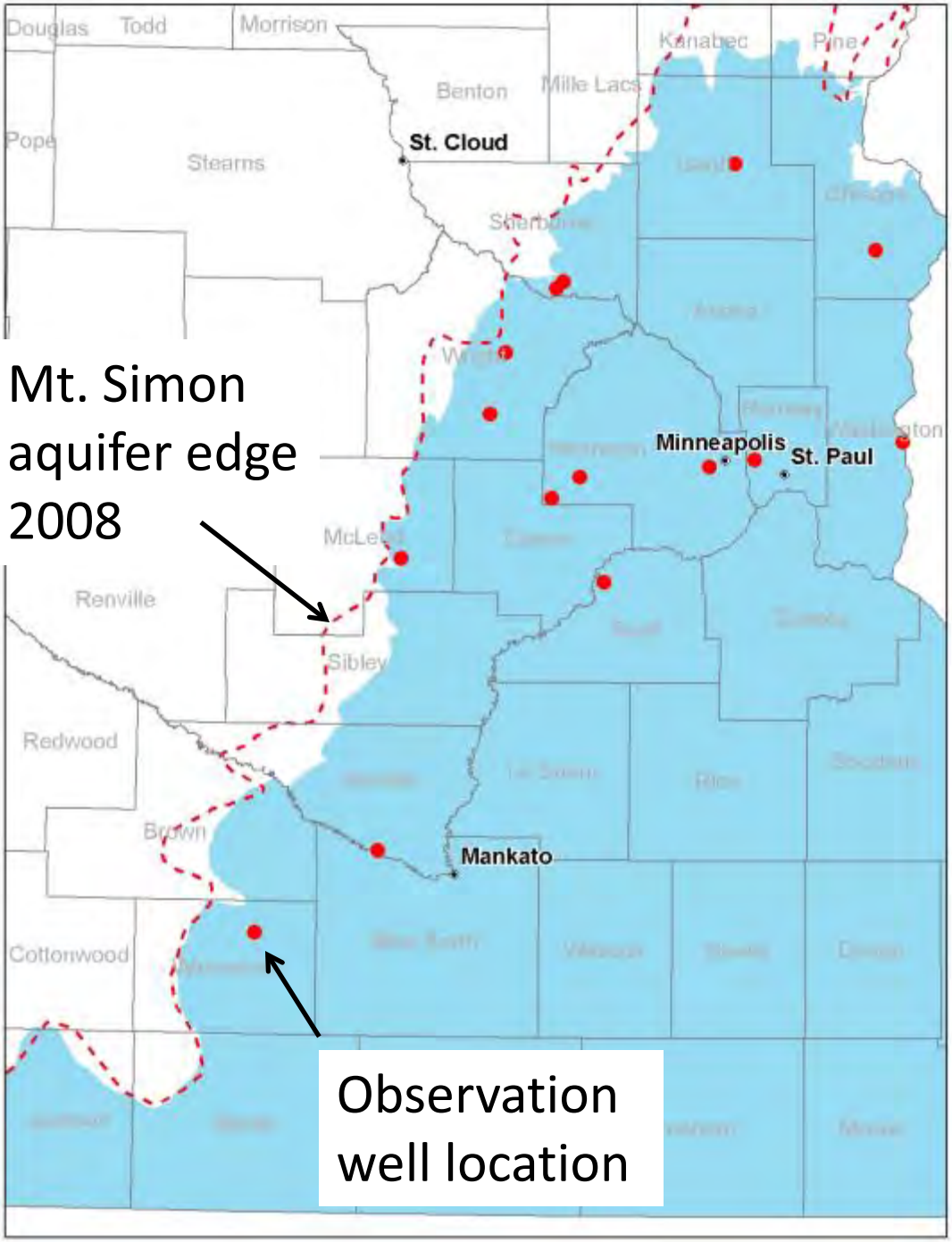


Hydrograph from Mt. Simon aquifer observation well

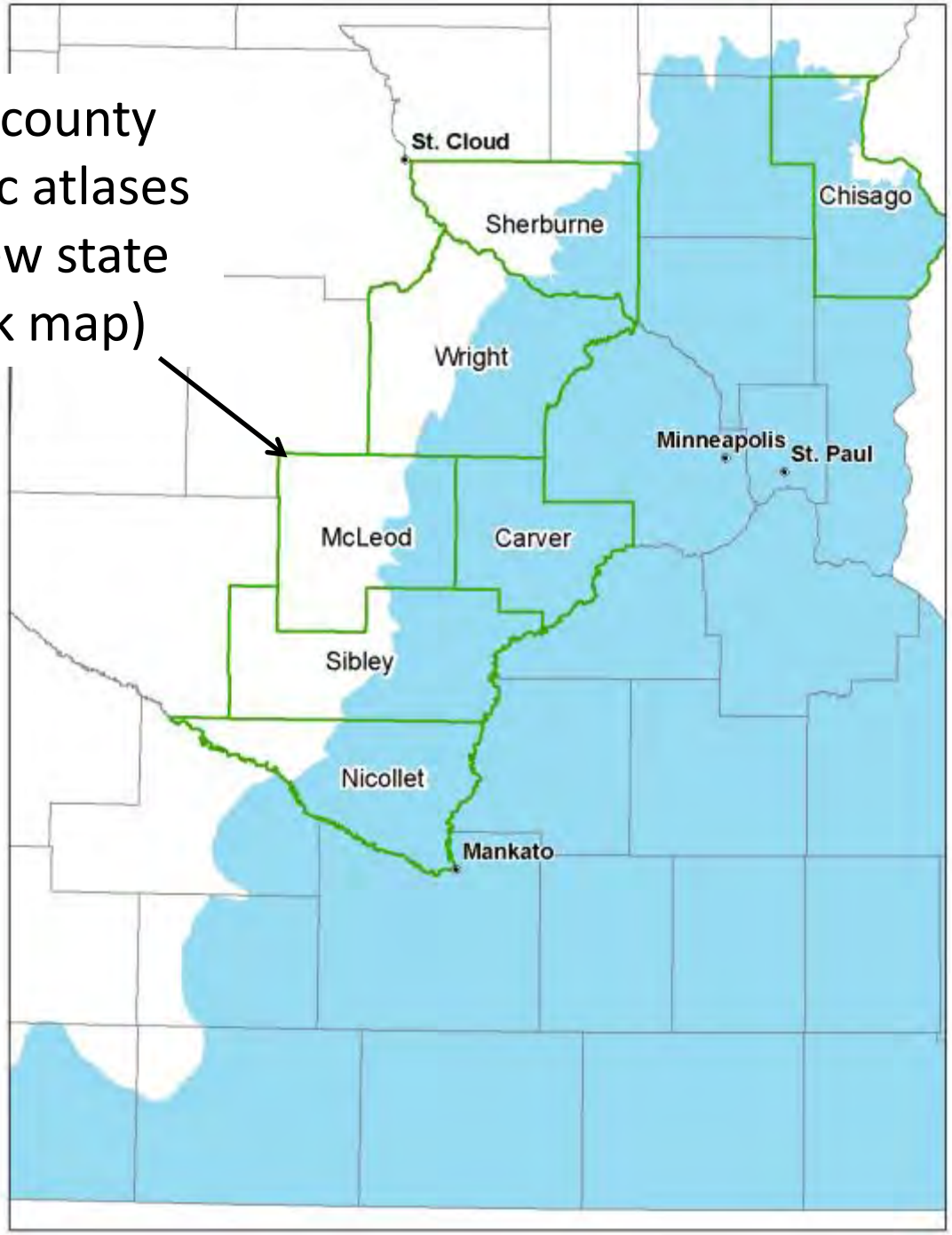
Mapping and Monitoring

Mt. Simon - Hinckley aquifer observation wells pre-2008

15 wells



Recent county geologic atlases (and new state bedrock map)

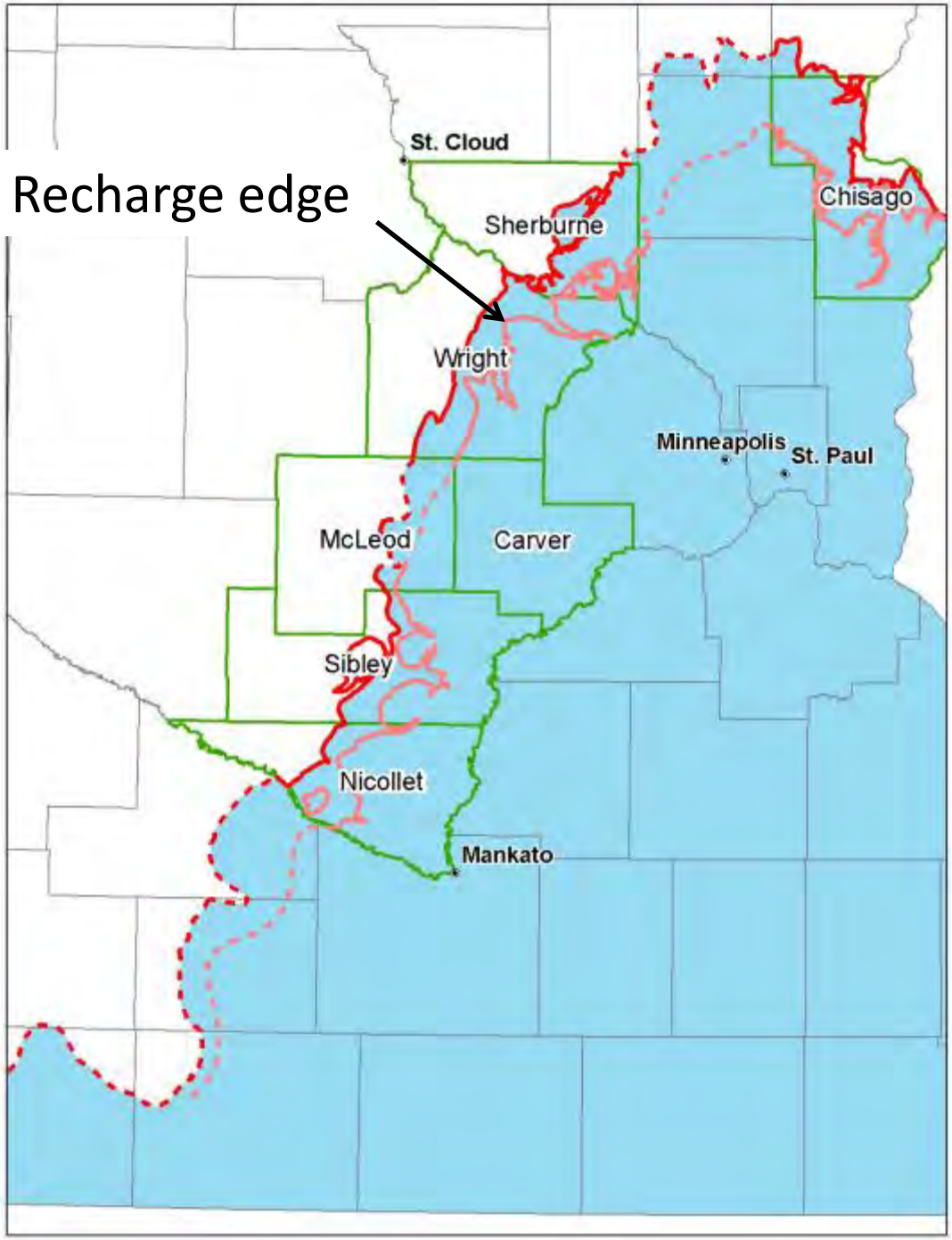


Mapping and Monitoring

Mt. Simon aquifer well nest installations and associated mapping projects

Mapping and Monitoring

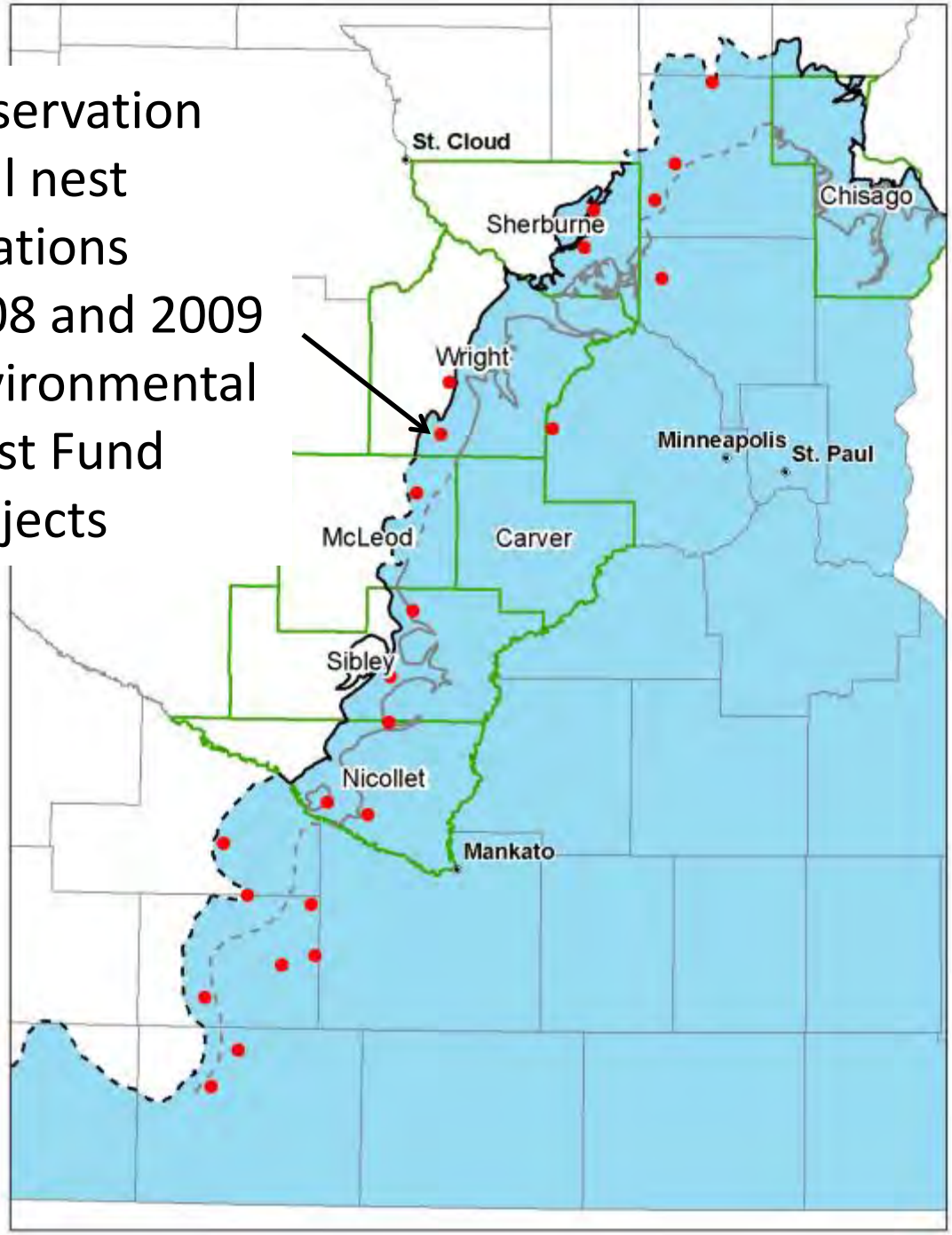
Mt. Simon aquifer well nest installations and associated mapping projects



Mapping and Monitoring

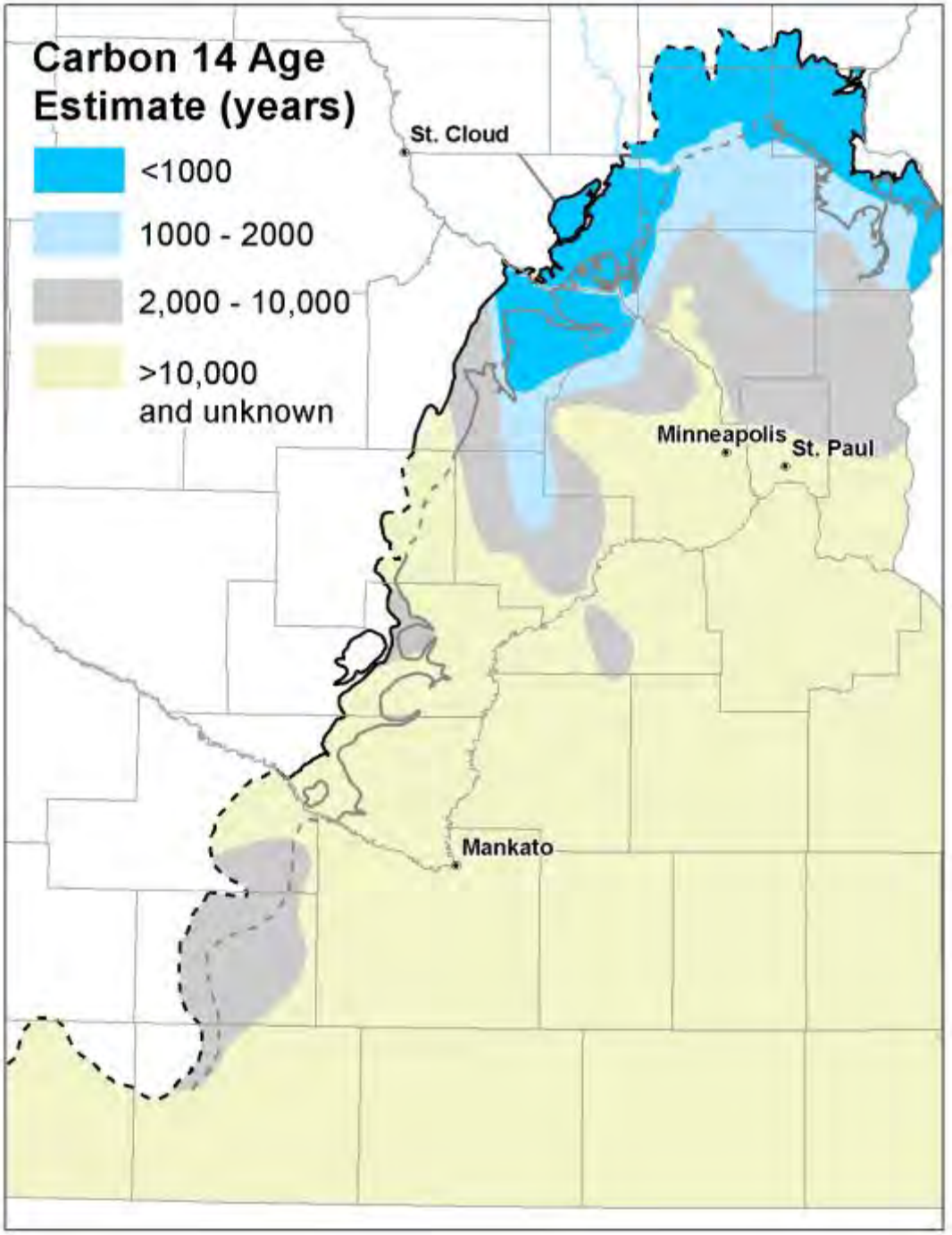
Mt. Simon aquifer well nest installations and associated mapping projects

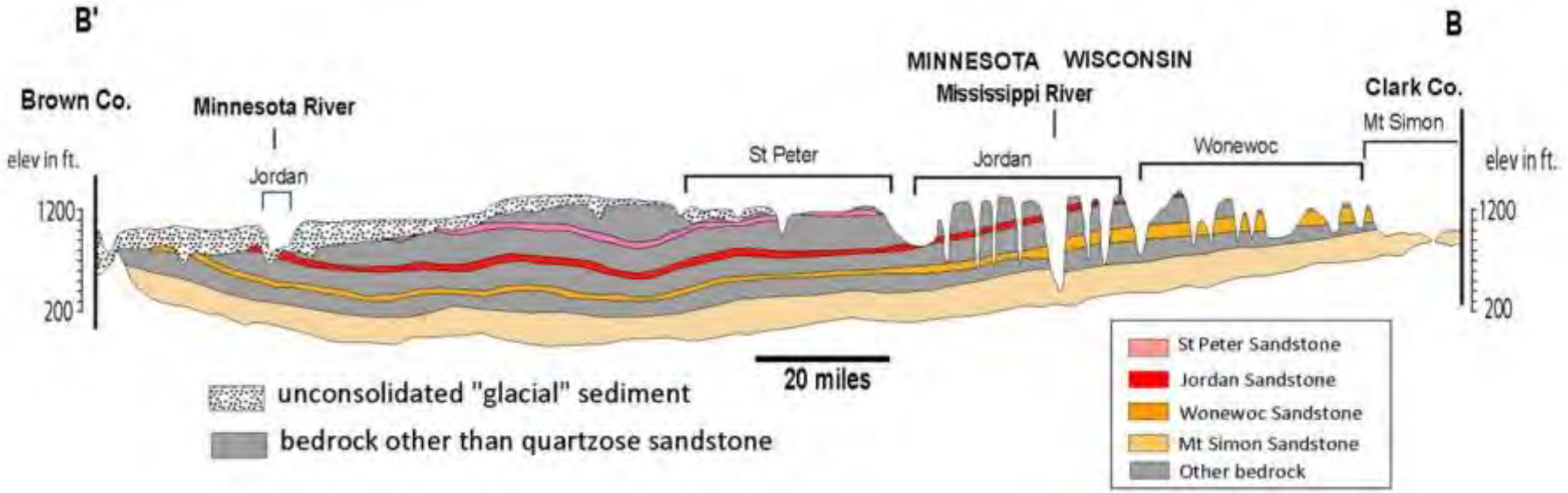
Observation well nest locations 2008 and 2009 Environmental Trust Fund projects

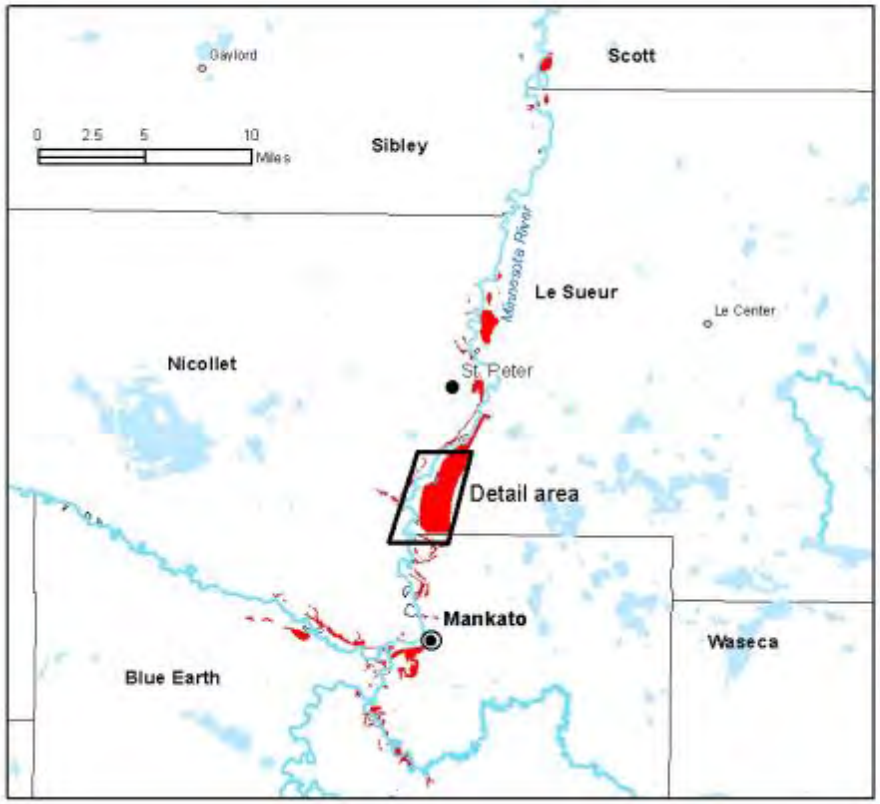


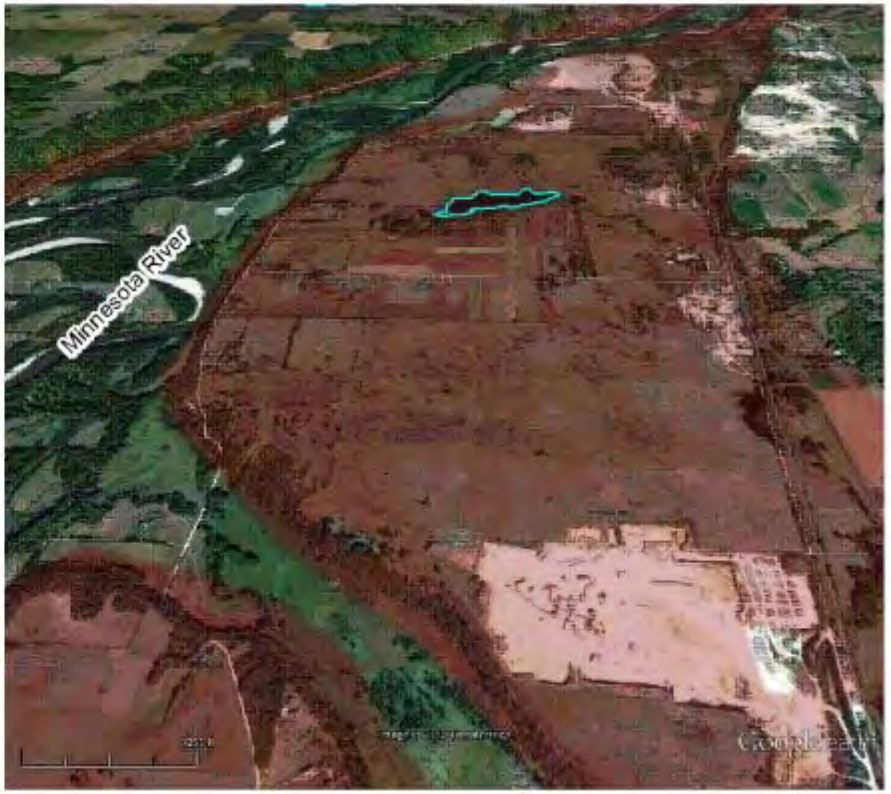
Mapping and Monitoring

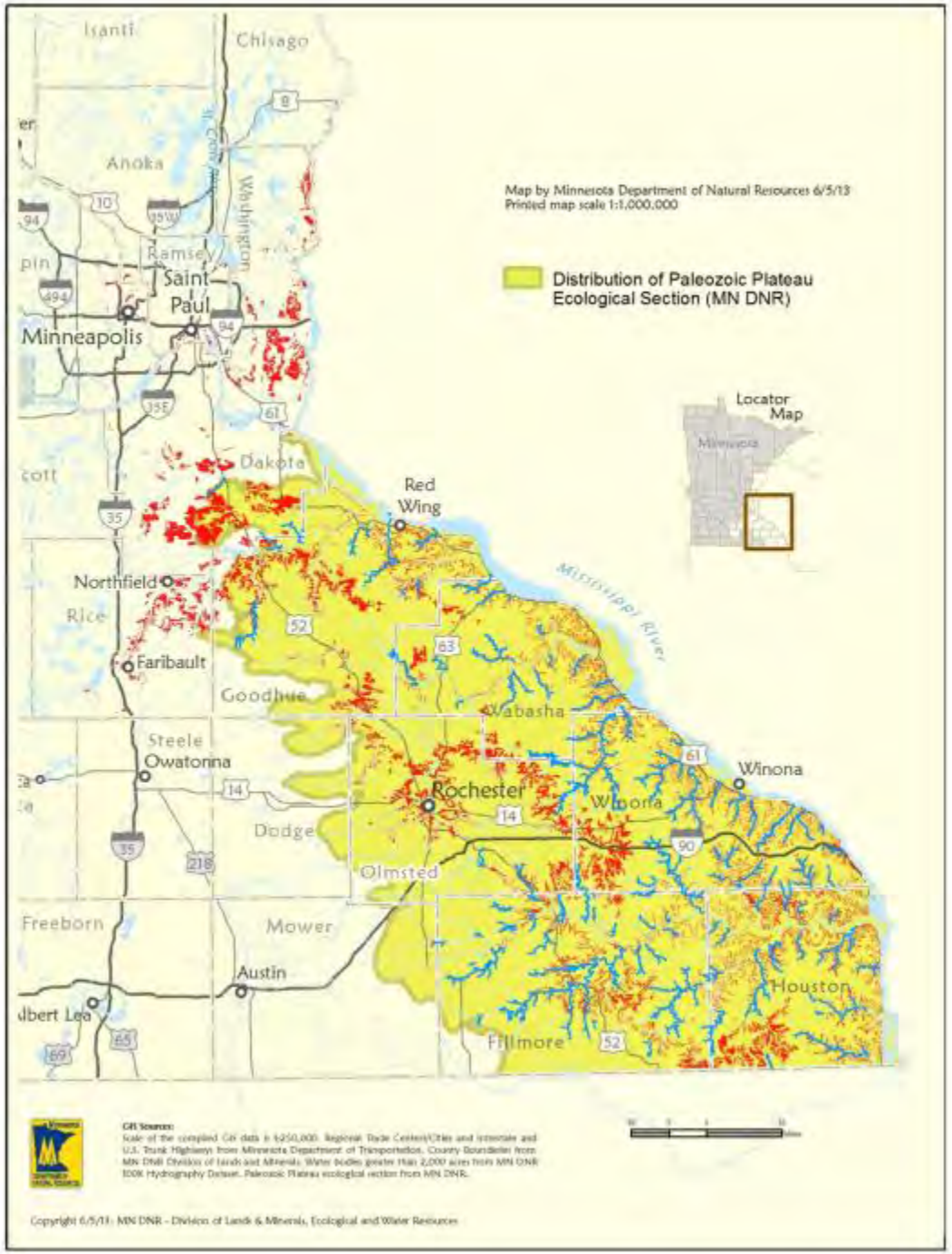
Mt. Simon aquifer Carbon 14 age distribution




B'
B
Brown Co.
Minnesota River
MINNESOTA
WISCONSIN
Mississippi River
Clark Co.
Mt Simon
elev in ft.
1200
200
Jordan
St Peter
Jordan
Wonewoc
elev in ft.
1200
200
20 miles
unconsolidated "glacial" sediment
bedrock other than quartzose sandstone
St Peter Sandstone
Jordan Sandstone
Wonewoc Sandstone
Mt Simon Sandstone
Other bedrock

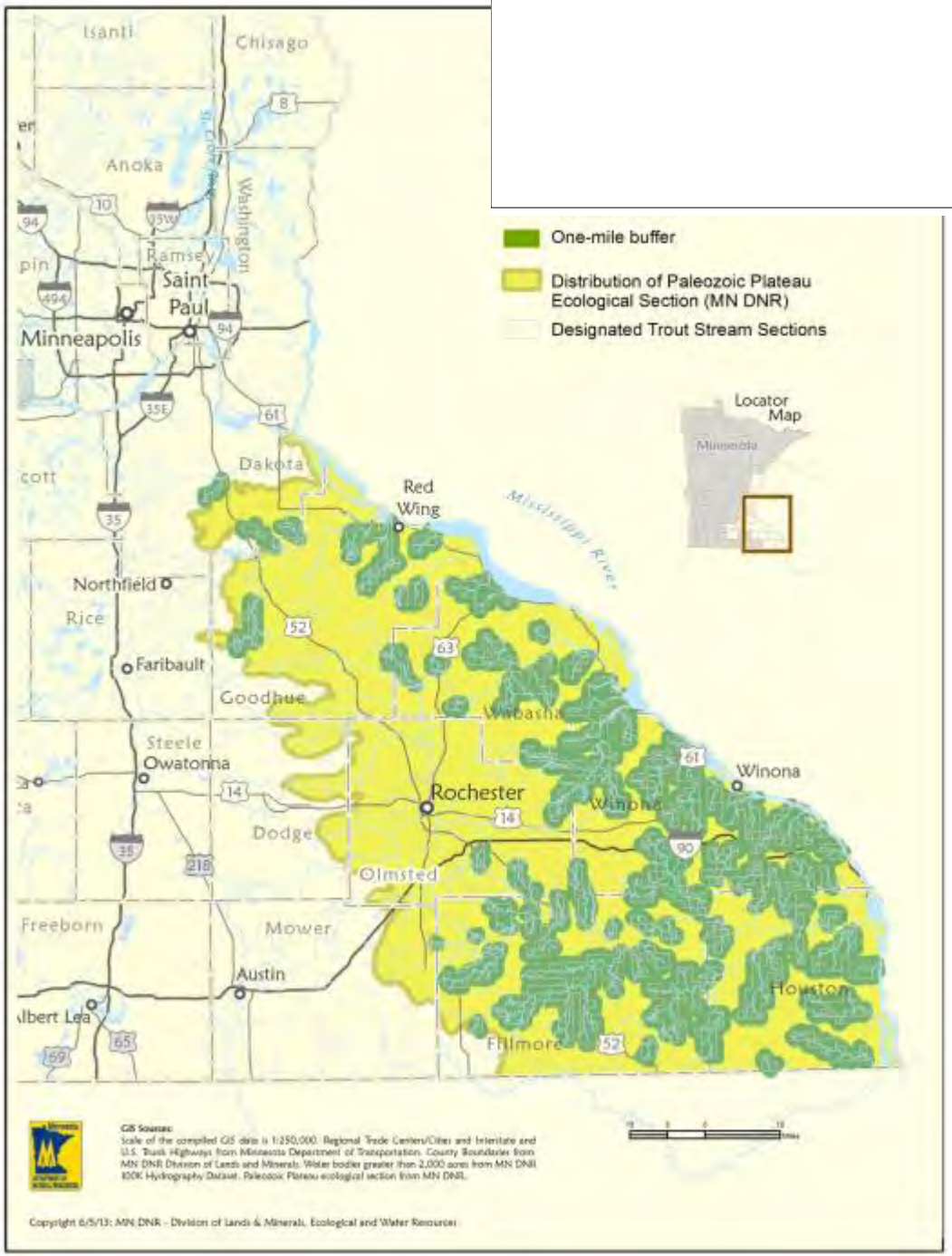

Gaylord
Scott
0 2.5 5 10
Miles
Sibley
Minnesota River
Le Sueur
Le Center
Nicollet
St. Peter
Detail area
Mankato
Waseca
Blue Earth


Minnesota River



Trout streams and Sandstone less than 50-foot depth

Minnesota Geological Survey


Isanti
Chisago
Anoka
Washington
Ramsey
Saint Paul
Minneapolis
Dakota
Red Wing
Mississippi River
Northfield
Rice
Faribault
Goodhue
Wabasha
Steele
Owatonna
Rochester
Winona
Dodge
Olmsted
Freeborn
Mower
Austin
Albert Lea
Fillmore
Houston
One-mile buffer
Distribution of Paleozoic Plateau Ecological Section (MN DNR)
Designated Trout Stream Sections
Locator Map
Minnesota
GIS Sources:
Scale of the compiled GIS data is 1:250,000. Regional Trade Centers/Cities and Interstate and U.S. Trunk Highways from Minnesota Department of Transportation. County Boundaries from MN DNR Division of Lands and Minerals. Water bodies greater than 2,000 acres from MN DNR 100K Hydrography Dataset. Paleozoic Plateau ecological section from MN DNR.
Copyright 6/5/13: MN DNR - Division of Lands & Minerals, Ecological and Water Resources

County Geologic Atlas Part B groundwater studies include "standard" elements such as the hydrogeology & distribution of aquifer systems, groundwater chemistry, aquifer sensitivity to pollution, hydrogeologic cross sections, groundwater potentiometric surfaces & flow direction, and aquifer characteristics.

Some county atlases include additional information such as the interaction of lakes and groundwater (Crow Wing), springshed mapping (Fillmore), or Karst Hydrogeomorphic Units(Mower).

Crow Wing CGA

Fillmore CGA

Mower CGA