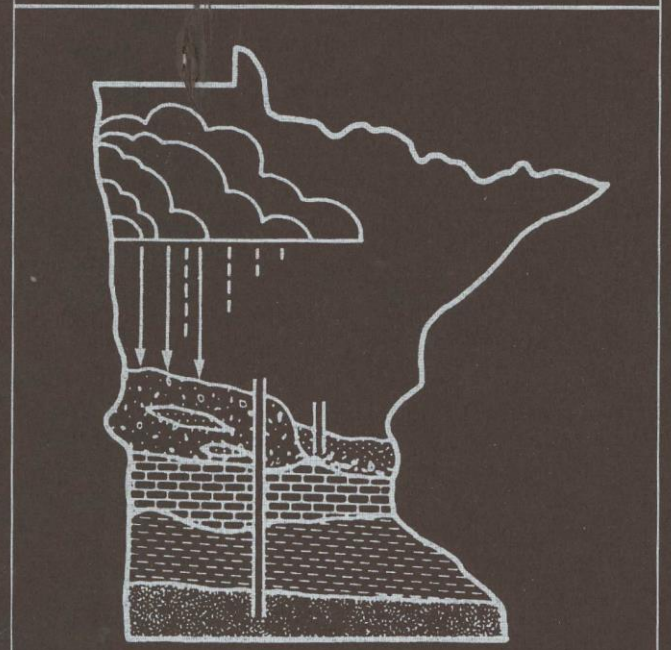
Minnesota Ground Water Association Spring Conference

Assessing vertical recharge through Minnesota's glacial sediments – A mapping perspective

Bob Tipping
Minnesota Geological Survey
April 25, 2019

UNIVERSITY OF MINNESOTA
Driven to Discover℠

Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota



Department of Natural Resources
Division of Waters

June 1991

Criteria and Guidelines for Assessing Geologic Sensitivity of Ground Water Resources in Minnesota

MINNESOTA
Department of Natural Resources
Division of Waters

June 1991

Fred Bergsrud, Minnesota Extension Service
Jan Falteisek, Minnesota Department of Natural Resources
Jeff Green, Minnesota Department of Natural Resources
John Hines, Minnesota Department of Agriculture
Howard Hobbs, Minnesota Geological Survey
Eric Mohring, Minnesota Board of Water and Soil Resources
Bruce Olsen, Minnesota Department of Health
James Piegat, Hennepin Conservation District
Eric Porcher, Minnesota Pollution Control Agency
Carl Schenk, Metropolitan Council

the program administrator. Jim Zicopula drafted many of the figures. Katie Gorres assisted with word processing and mailing.

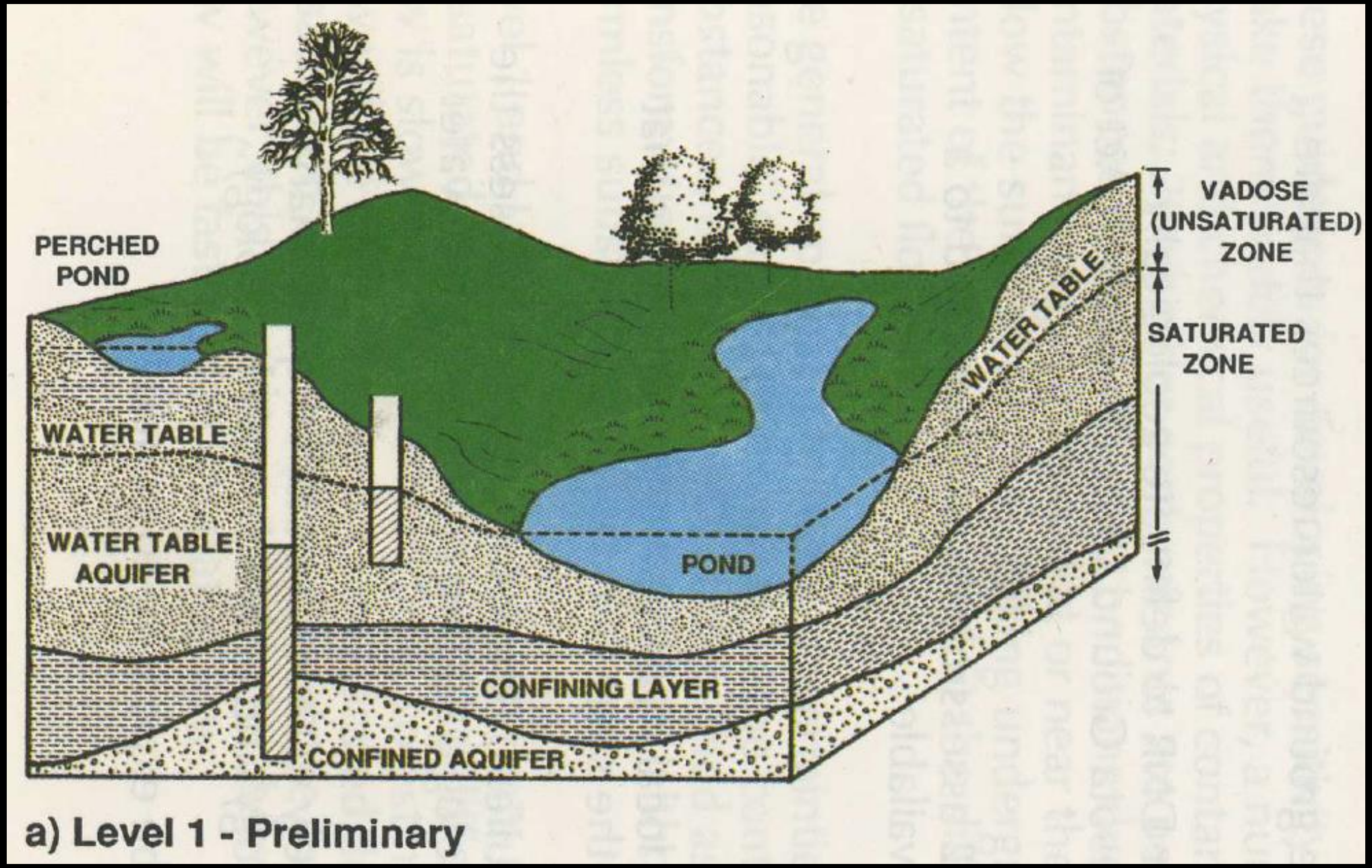
This project was funded by the Legislative Commission on Minnesota Resources.

Sincere thanks to all reviewers of earlier drafts; while not all comments could be accommodated, this report was substantially improved by your timely and thoughtful critique.

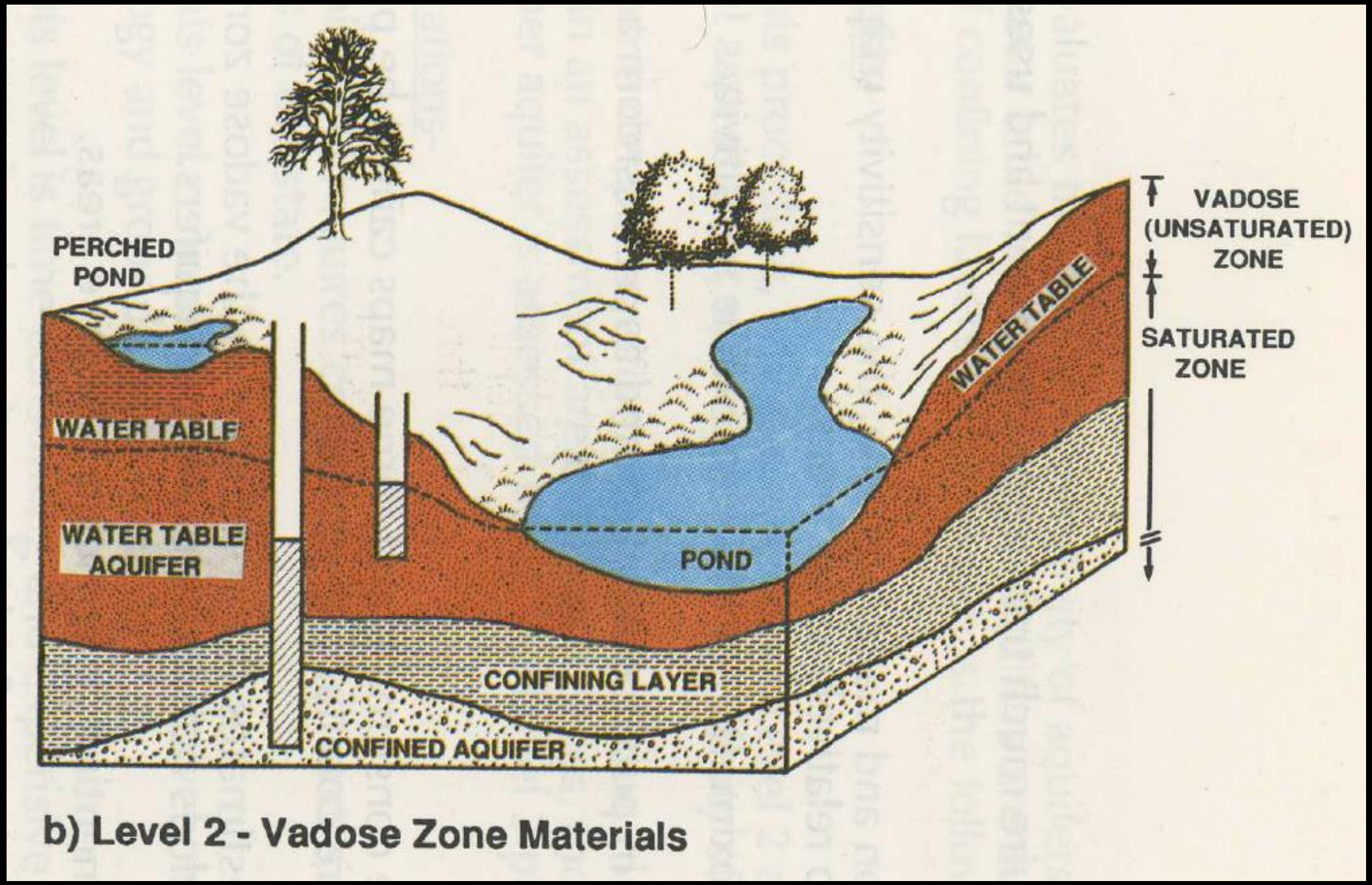
Jan Falteisek
Project Coordinator
Division of Waters
Department of Natural Resources

TABLE III-2. Information required to complete geologic sensitivity assessments at each of the three levels.

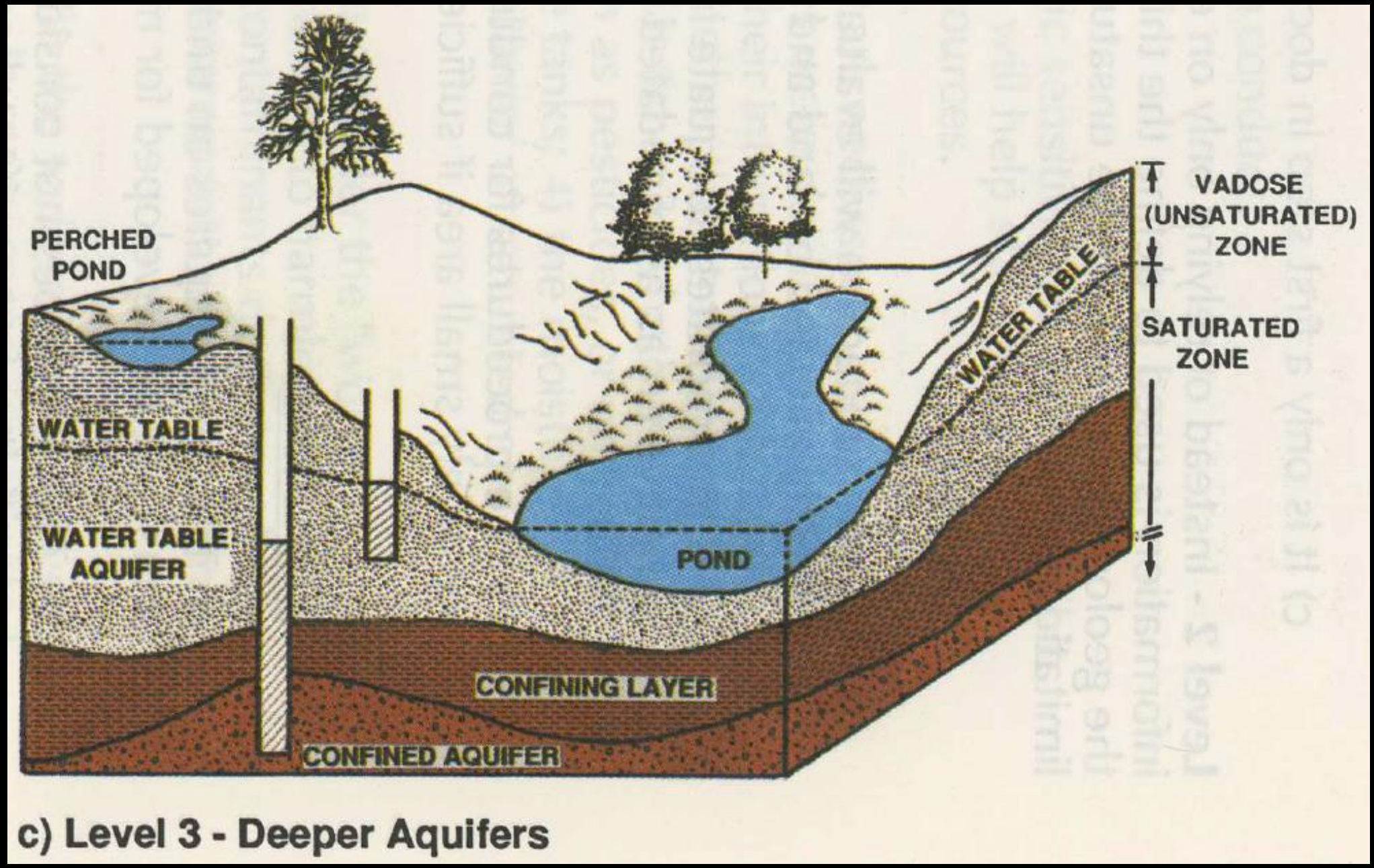
Information needed to evaluate geological sensitivity	Assessment Level 1	2	3
Soil texture/parent materials	X		
Depth to water	X	X	
Vadose zone material		X	
Deeper aquifers/confining units			X



a) Level 1 - Preliminary



b) Level 2 - Vadose Zone Materials



c) Level 3 - Deeper Aquifers

Sensitivity ratings, based on estimated vertical travel time:

- Very high – hours to months
- High – weeks to years
- Moderate – years to decades
- Low – several decades to a century

L score calculation

For a single well, divide each confining layer thickness by 10, round down, sum the totals

- L-5 or greater = very low
- < L-5, low

MATRIX FOR ASSIGNING GEOLOGIC SUSCEPTIBILITY IN OLMSTED COUNTY

BEDROCK CONDITIONS

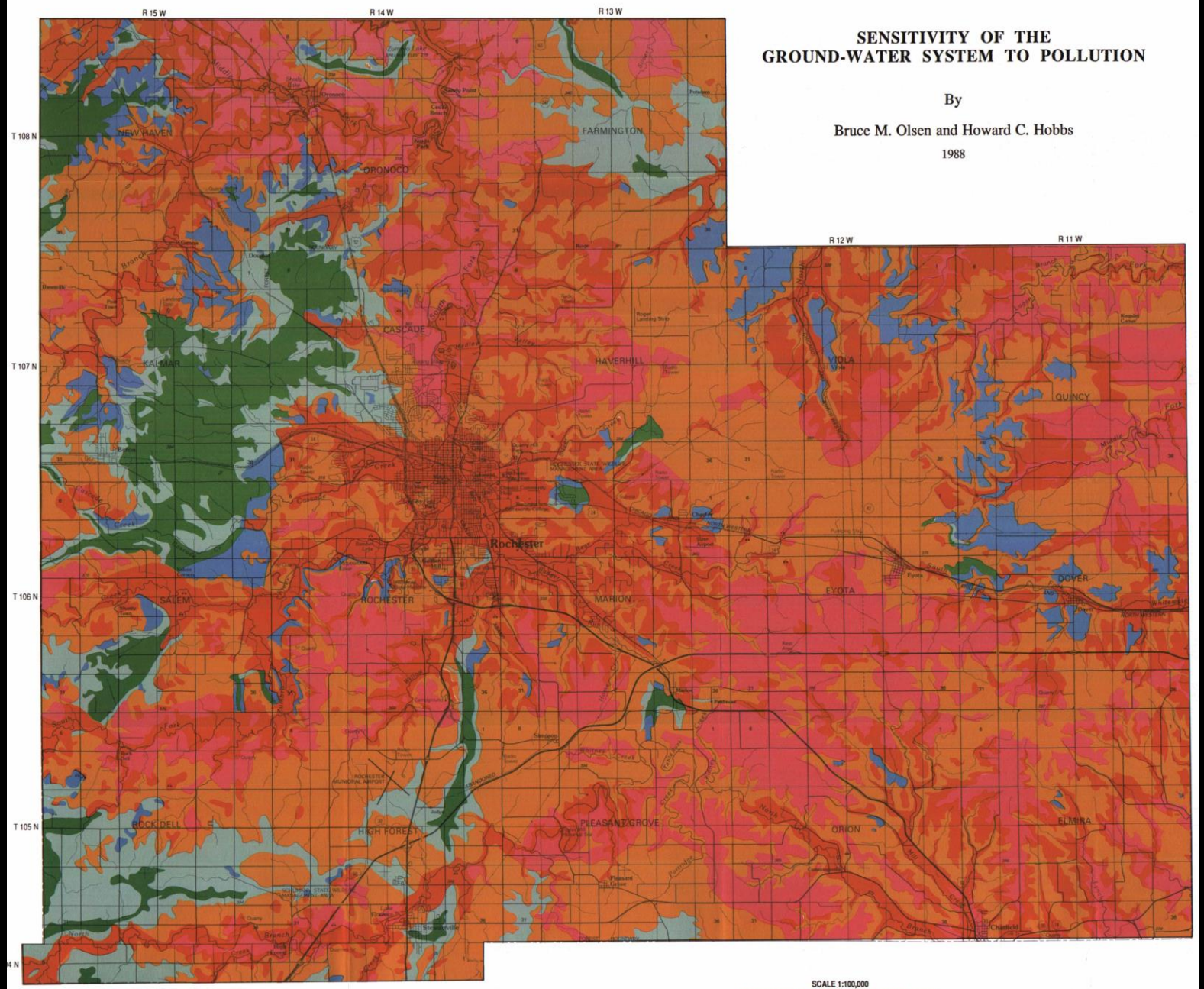
PROPERTIES OF MATERIALS COVERING BEDROCK		THESE TYPES OF BEDROCK MAY CONTAIN GROUND WATER, BUT WELL YIELDS WILL BE DETERMINED BY LOCAL HYDROLOGIC CONDITIONS			NON-AQUIFER
		KARSTED BEDROCK		GENERALLY UNCEMENTED AND QUARTZOSE	GENERALLY MASSIVE, SOFT
		LIMESTONE OR DOLOMITE	LIMESTONE/DOLOMITE, INTERBEDDED SHALE	SANDSTONE	SHALE
DEPTH TO BEDROCK LESS THAN 5 FEET		VH	SHALE MAY RETARD VERTICAL FLOW H	H	L
COLLUVIUM		SPRINGS AND SEEPS DISCHARGE INTO COLLUVIAL DEPOSITS AND SOME VERTICAL INFILTRATION OCCURS IN VEGETATED AREAS. ASSIGNED A STANDARDIZED RATING OF HM			
TERRACE SAND AND GRAVEL		THE HIGH POROSITY AND PERMEABILITY OF THESE MATERIALS DOES LITTLE TO PROTECT GROUND WATER PRESENT IN THEM OR UNDERLYING BEDROCK AQUIFERS. RATED UNIFORMLY H			
UPLAND SAND AND GRAVEL		THESE MATERIALS CONTAIN LATERALLY DISCONTINUOUS SILT AND CLAY LAYERS. THE GREATER THE DEPTH TO BEDROCK, THE GREATER THE LIKELIHOOD THIS UNIT WILL BE UNDERLAIN BY TILL			
DEPTH TO BEDROCK	5 TO 50 FEET	H	H	H	GROUND WATER MAY BE PERCHED ON SHALE HM
	51 TO 100 FEET	M	M	M	M
	GREATER THAN 100 FEET	LM	LM	LM	LM
TILL		OTHER THAN SHALE, THESE MATERIALS EXHIBIT THE GREATEST ABILITY TO RETARD VERTICAL INFILTRATION. THEIR SUSCEPTIBILITY RATING DECREASES AS THICKNESS INCREASES			
DEPTH TO BEDROCK	5 TO 50 FEET	HM	HM	HM	GROUND WATER PROBABLY NOT PRESENT L
	51 TO 100 FEET	LM	LM	LM	L
	GREATER THAN 100 FEET	L	L	L	L

SENSITIVITY OF THE GROUND-WATER SYSTEM TO POLLUTION

By

Bruce M. Olsen and Howard C. Hobbs

1988

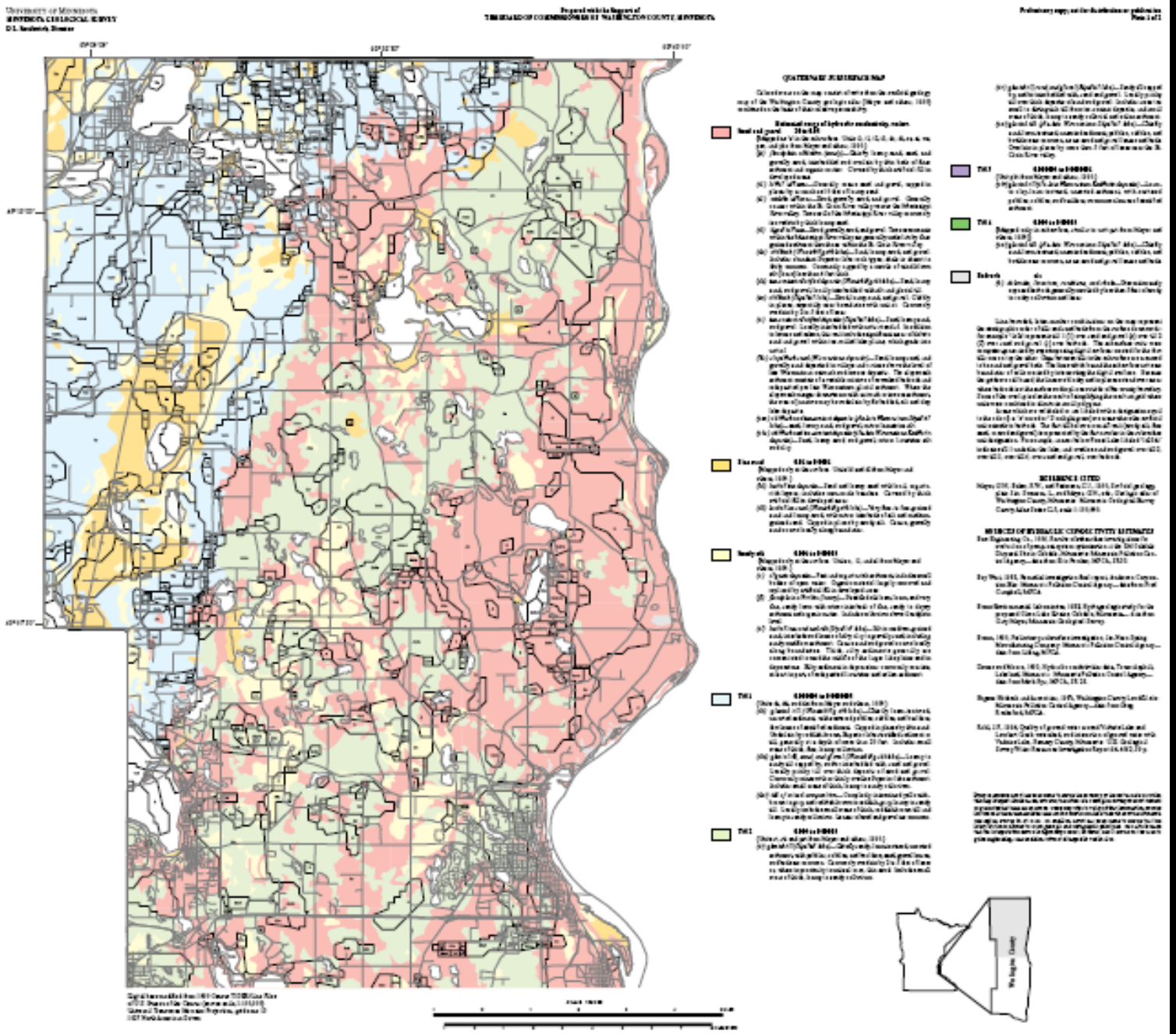


Base modified from U.S. Geological Survey, Austin and Rochester, 1985.

SCALE 1:100,000
1 INCH ON THE MAP REPRESENTS NEARLY 1.6 MILES ON THE GROUND

KILOMETERS 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

MILES 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13

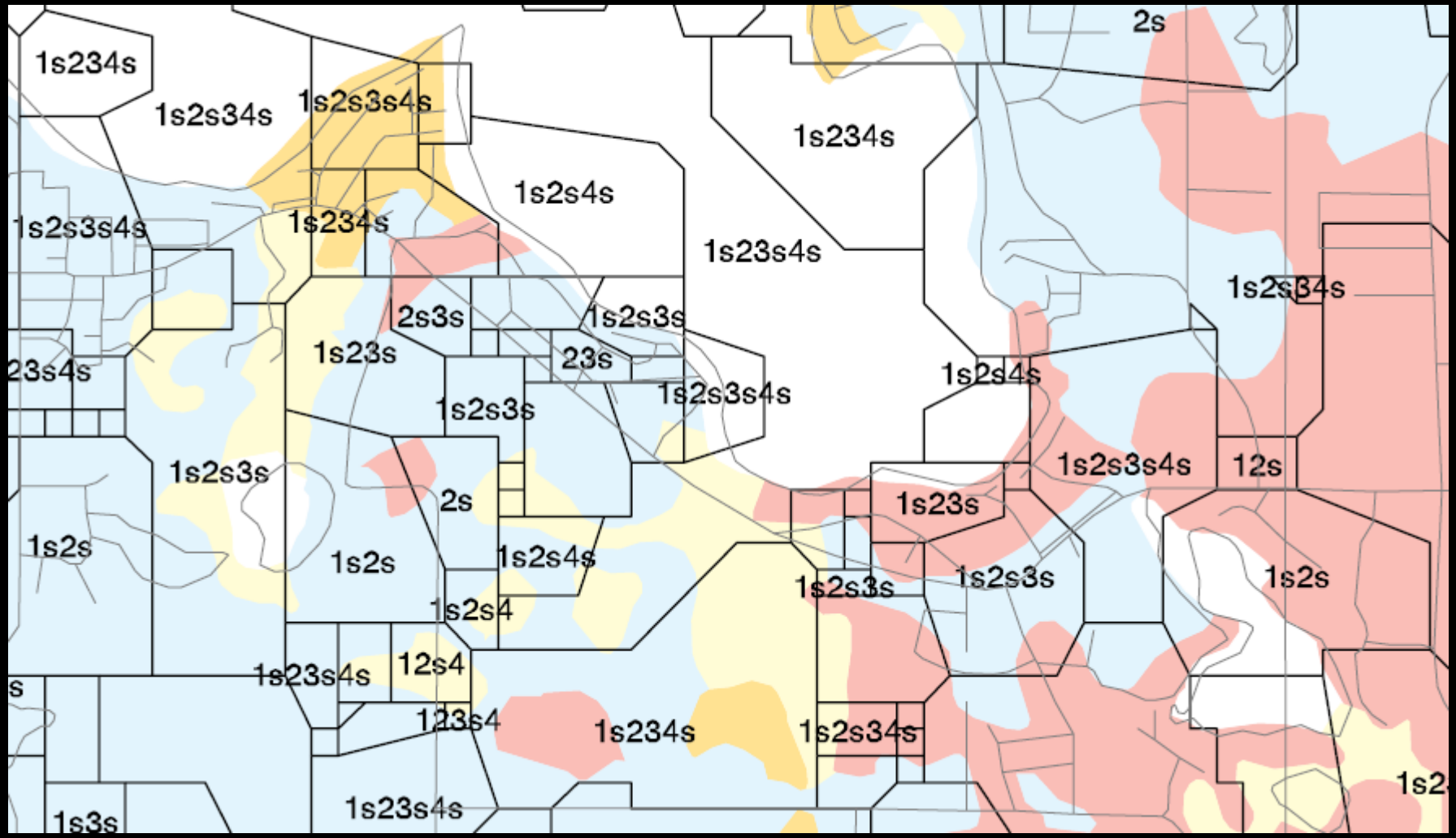


QUATERNARY SUBSURFACE MAP OF WASHINGTON COUNTY, MINNESOTA—NORTHERN HALF

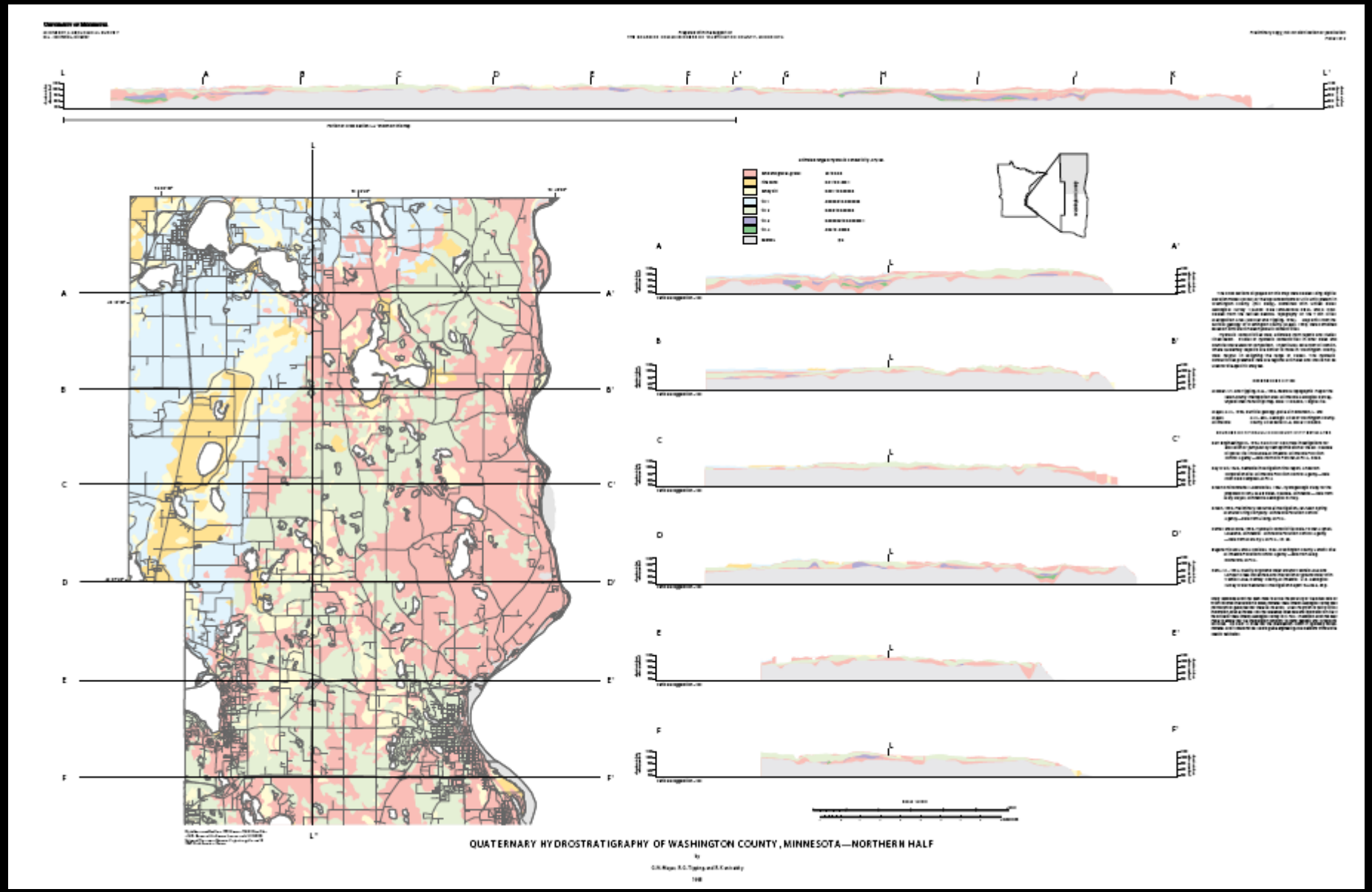
by

1998

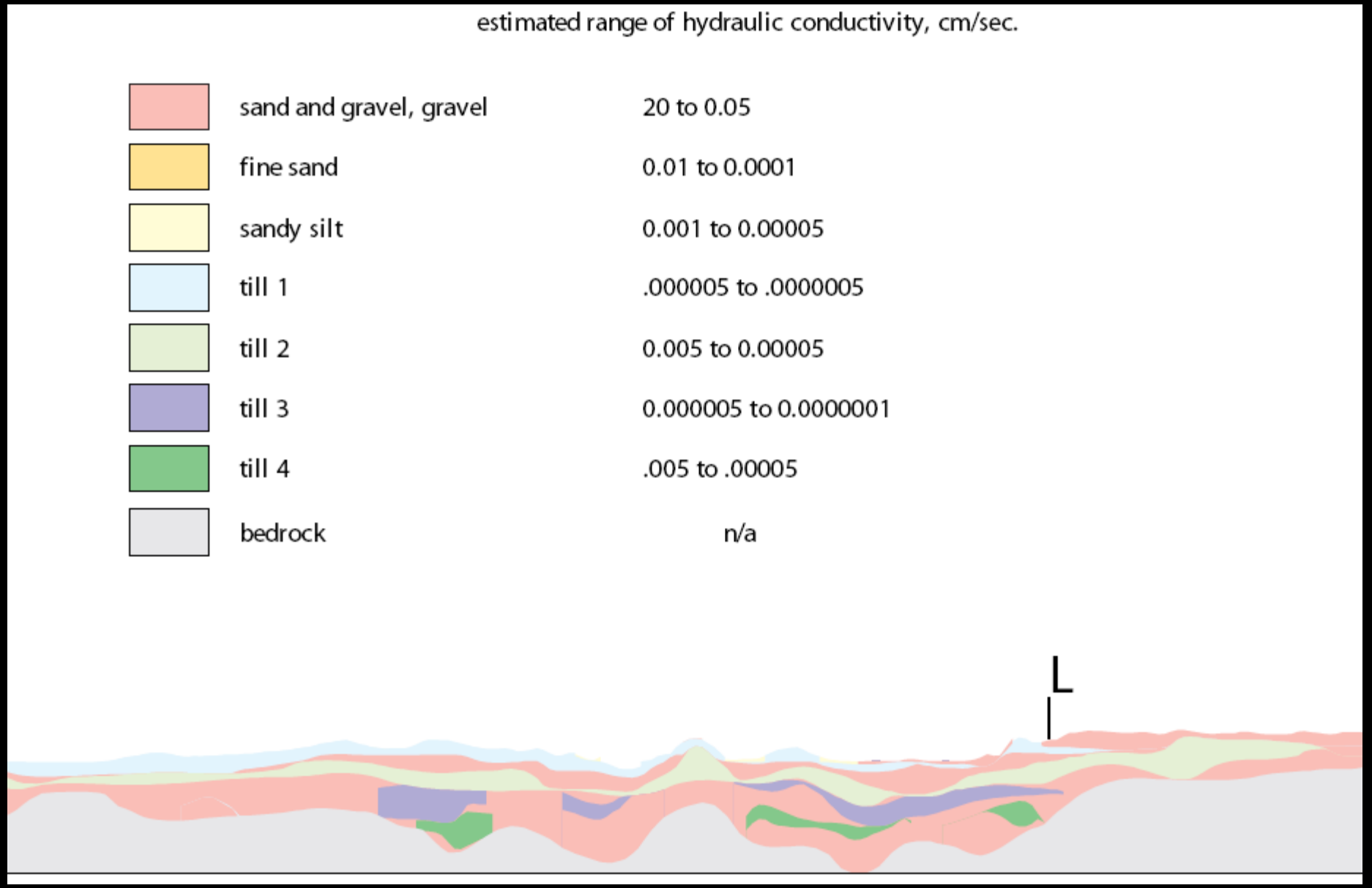
Meyer etal, 1998



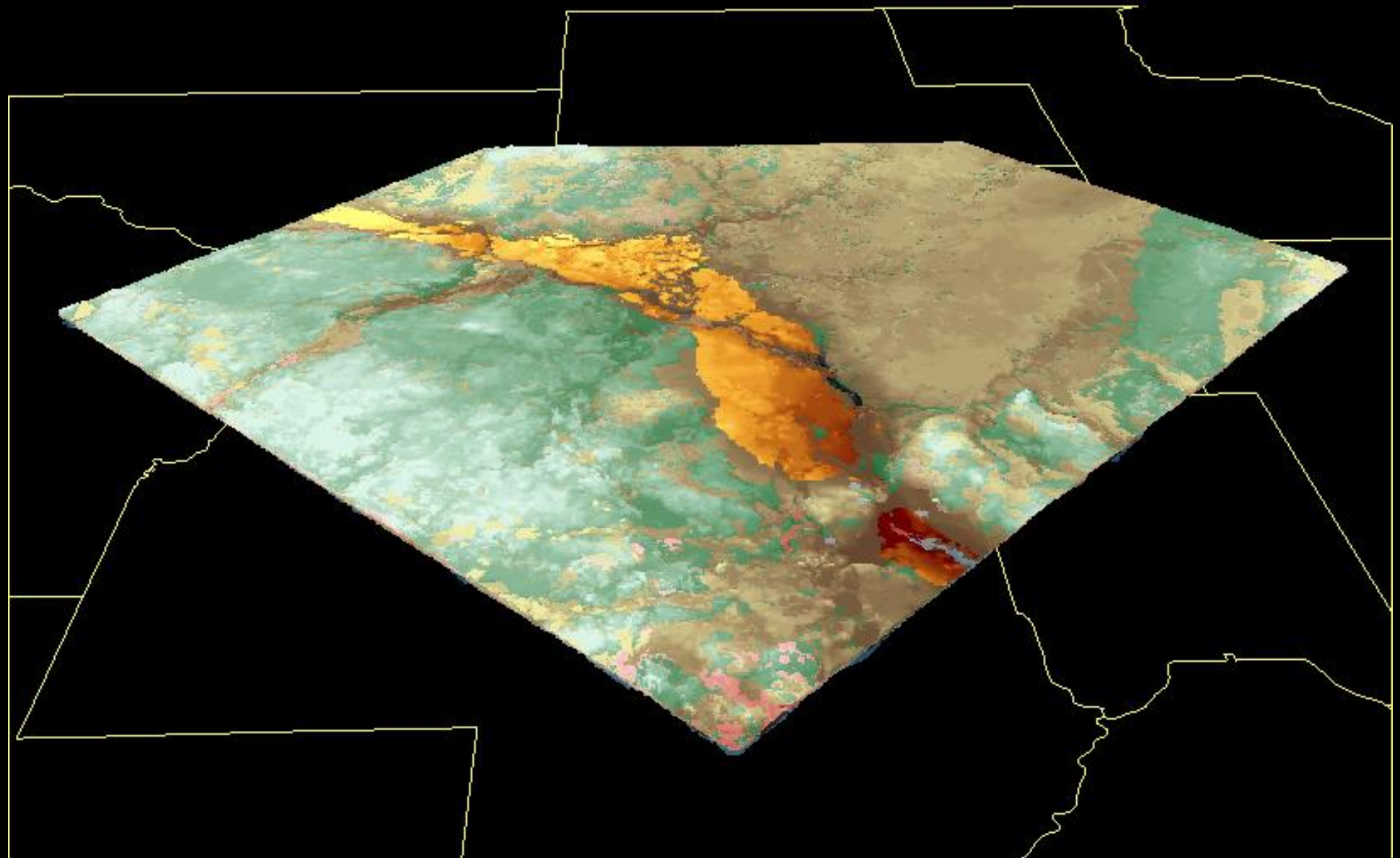
Meyer etal, 1998



Meyer etal, 1998



Meyer etal, 1998



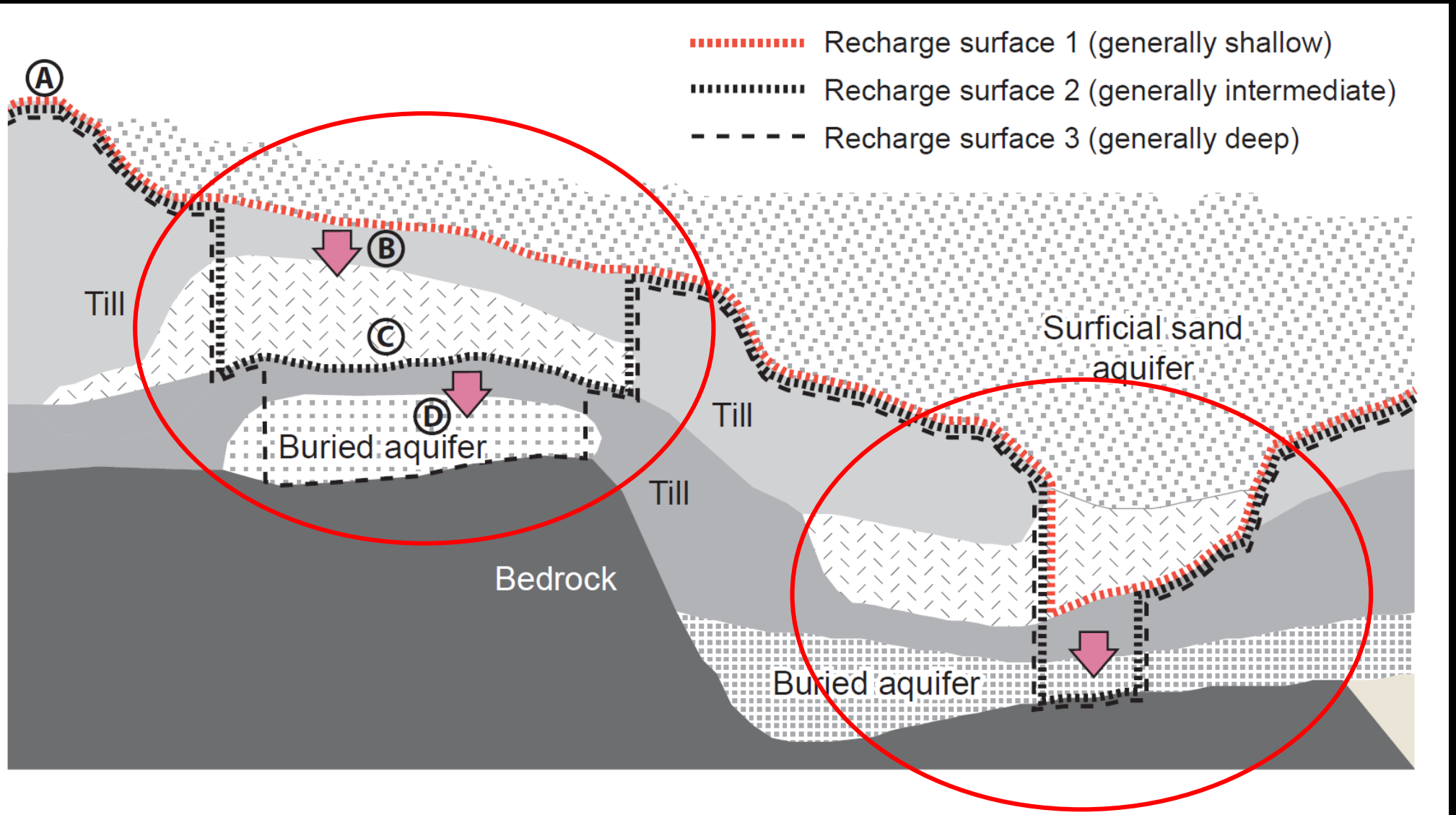
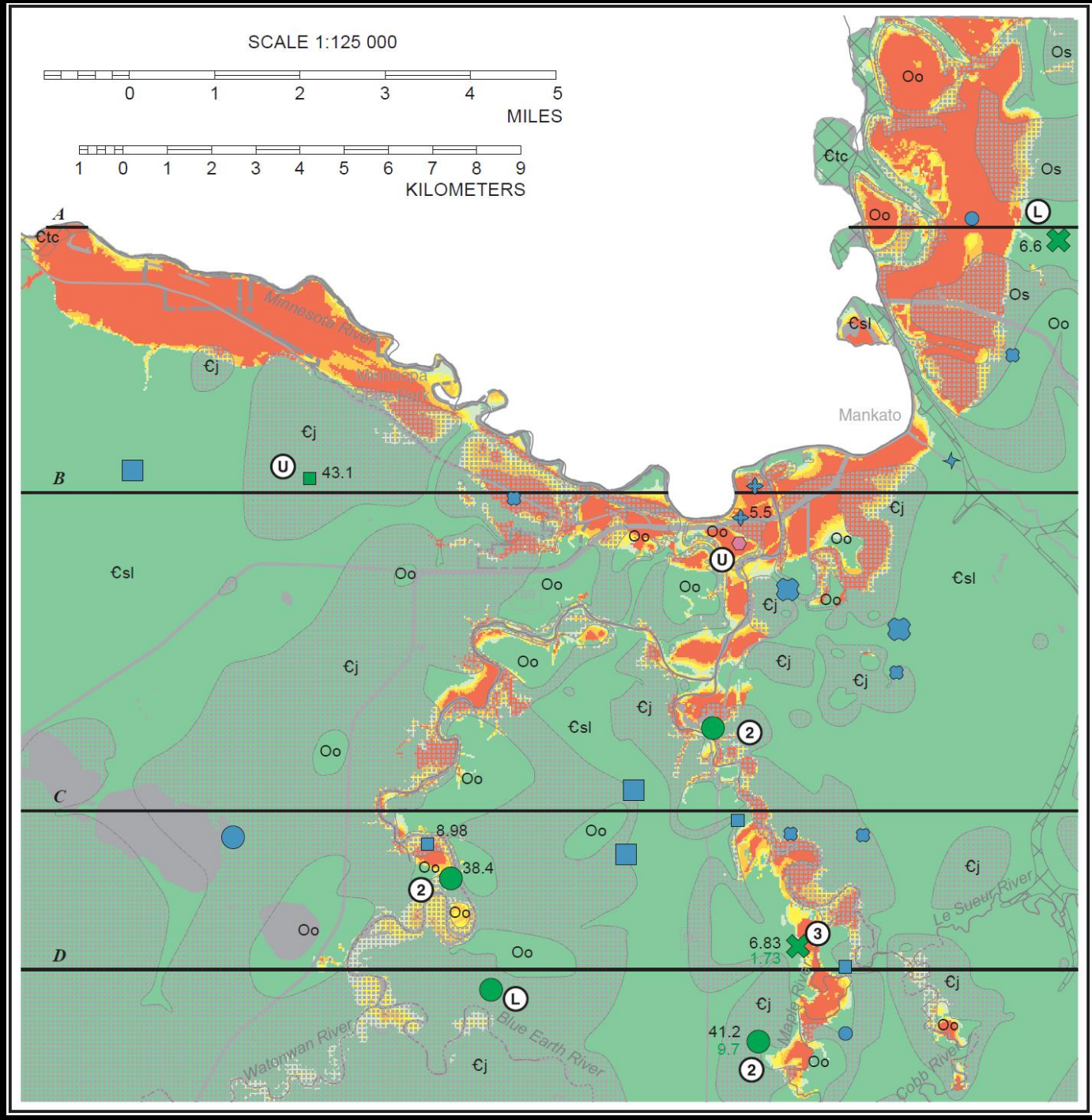
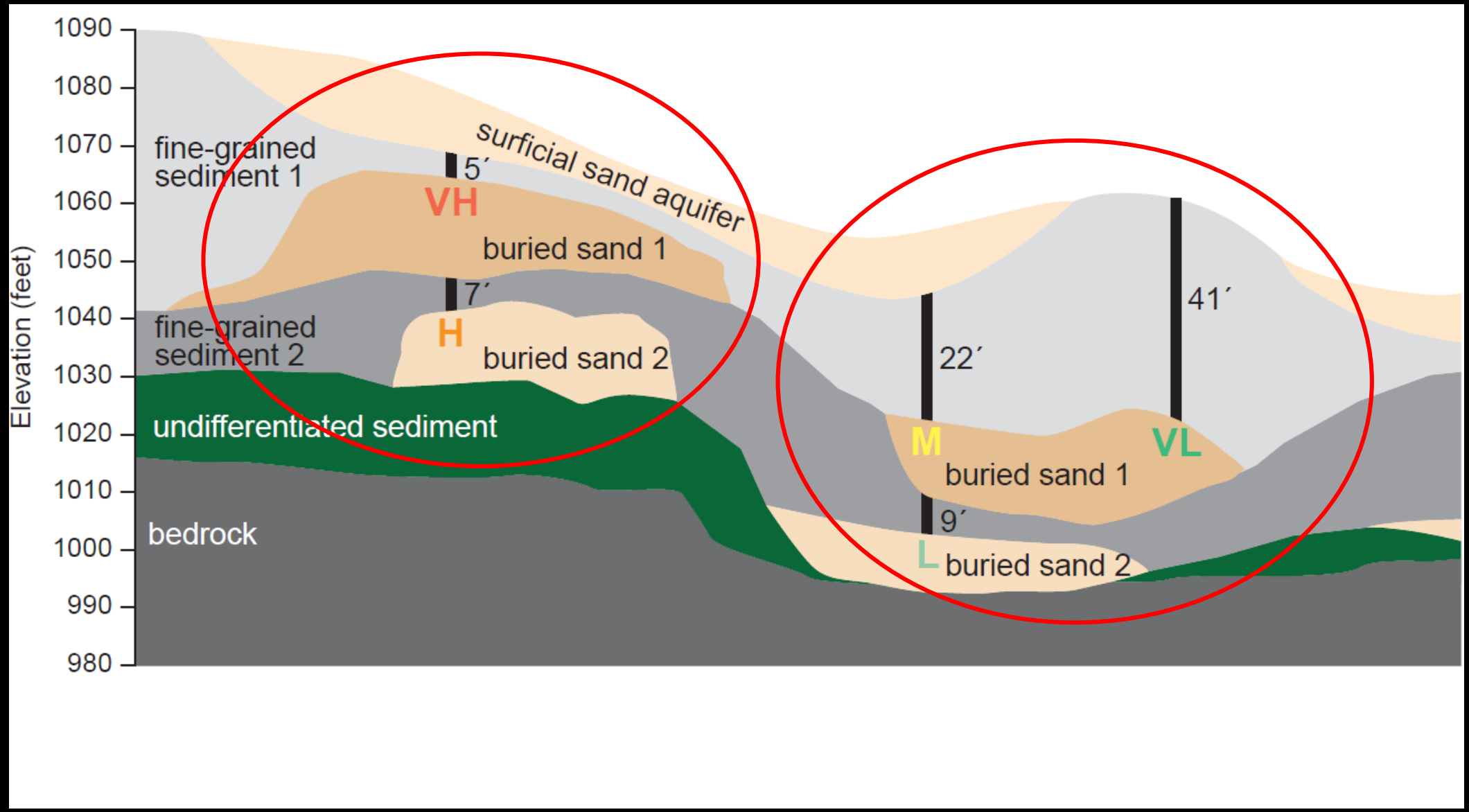


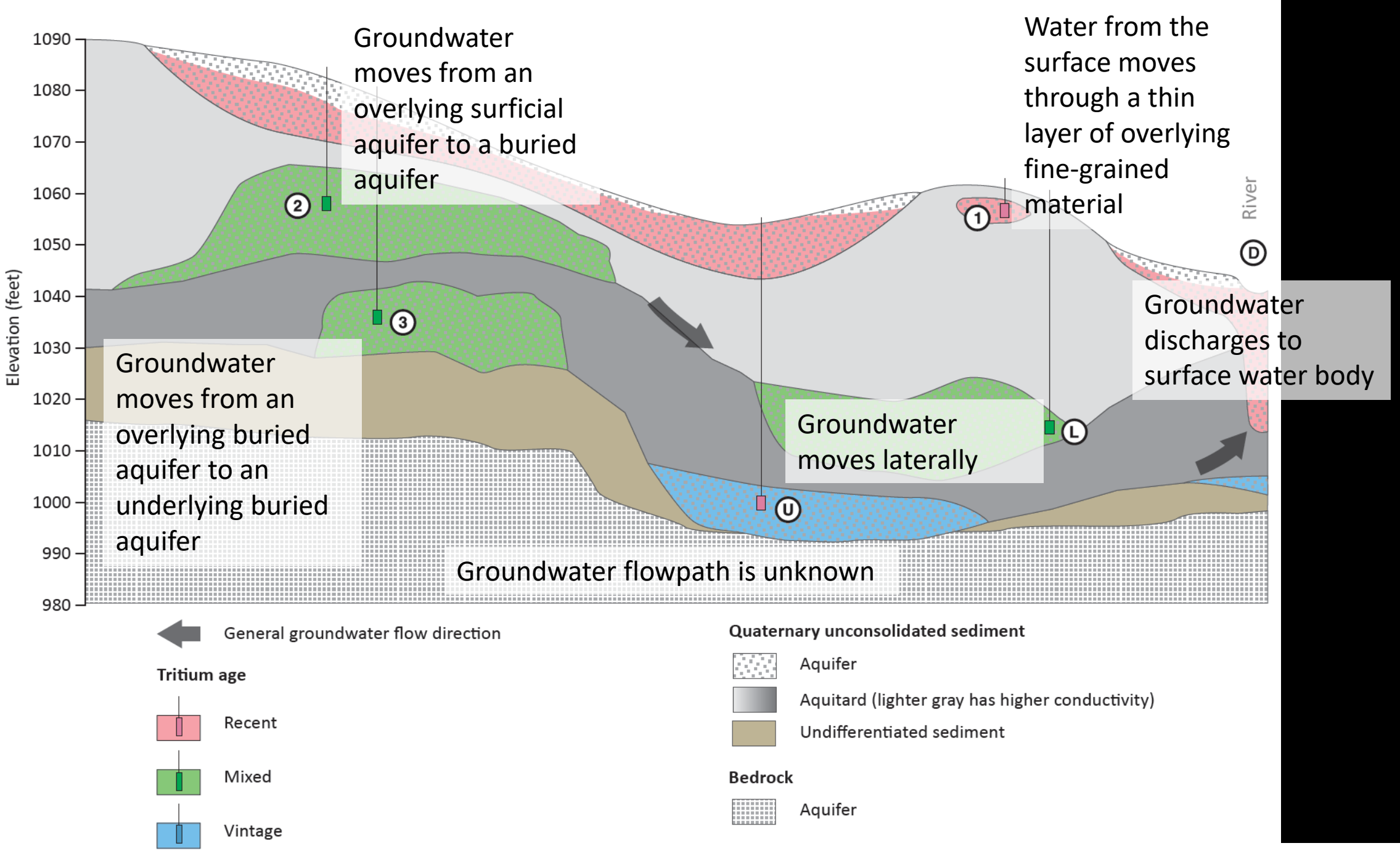
Figure 23. Generalized cross section showing recharge surfaces for sensitivity evaluations of buried aquifers and bedrock surface

Berg, 2016


SCALE 1:125 000
0 1 2 3 4 5
MILES
1 0 1 2 3 4 5 6 7 8 9
KILOMETERS
A
B
C
D
Mankato
Minnesota River
Watonwan River
Blue Earth River
Le Sueur River
Maple River
Cobb River
43.1
5.5
6.6
8.98
38.4
6.83
1.73
41.2
9.7
Ctc
Cj
Csl
Oo
Os
U
L
2
3



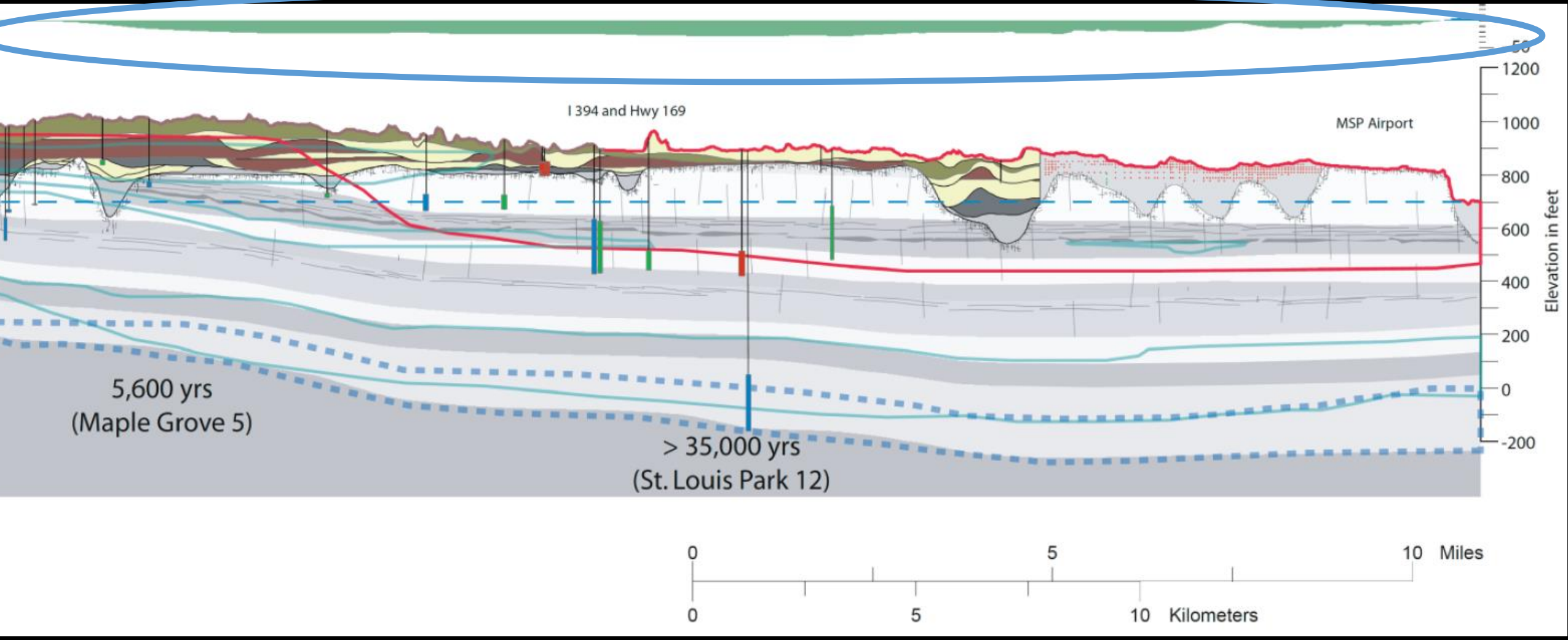
Geologic Atlas of Clay County, Minnesota, Part B, County Atlas Series C-29

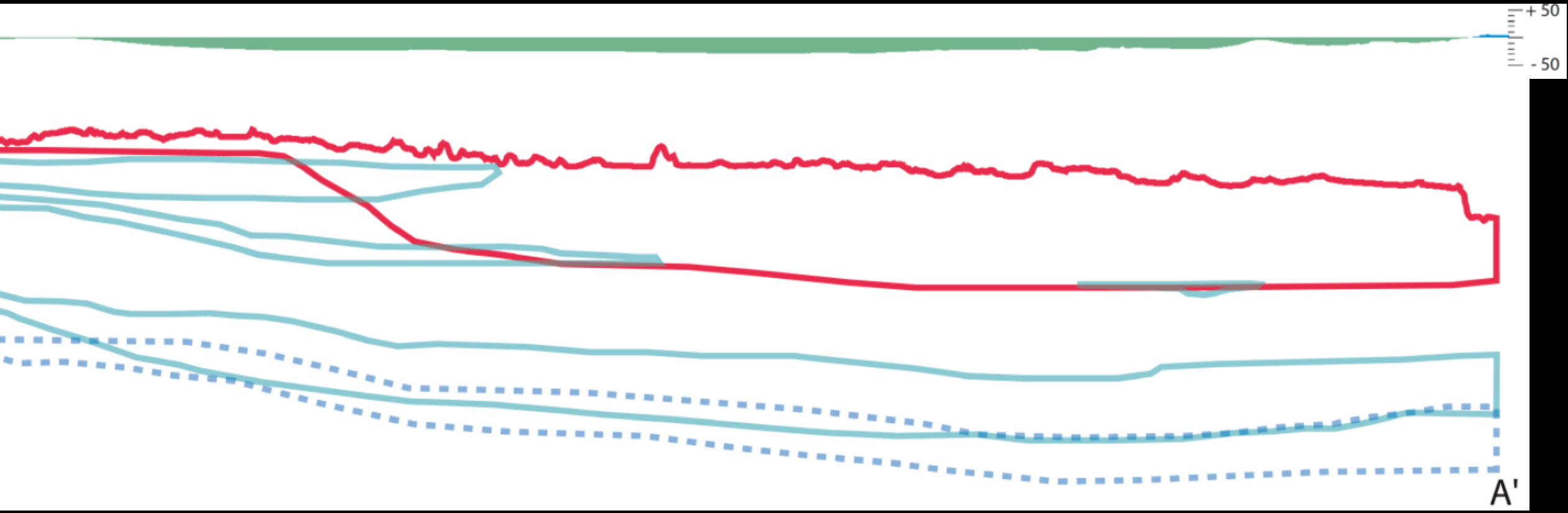


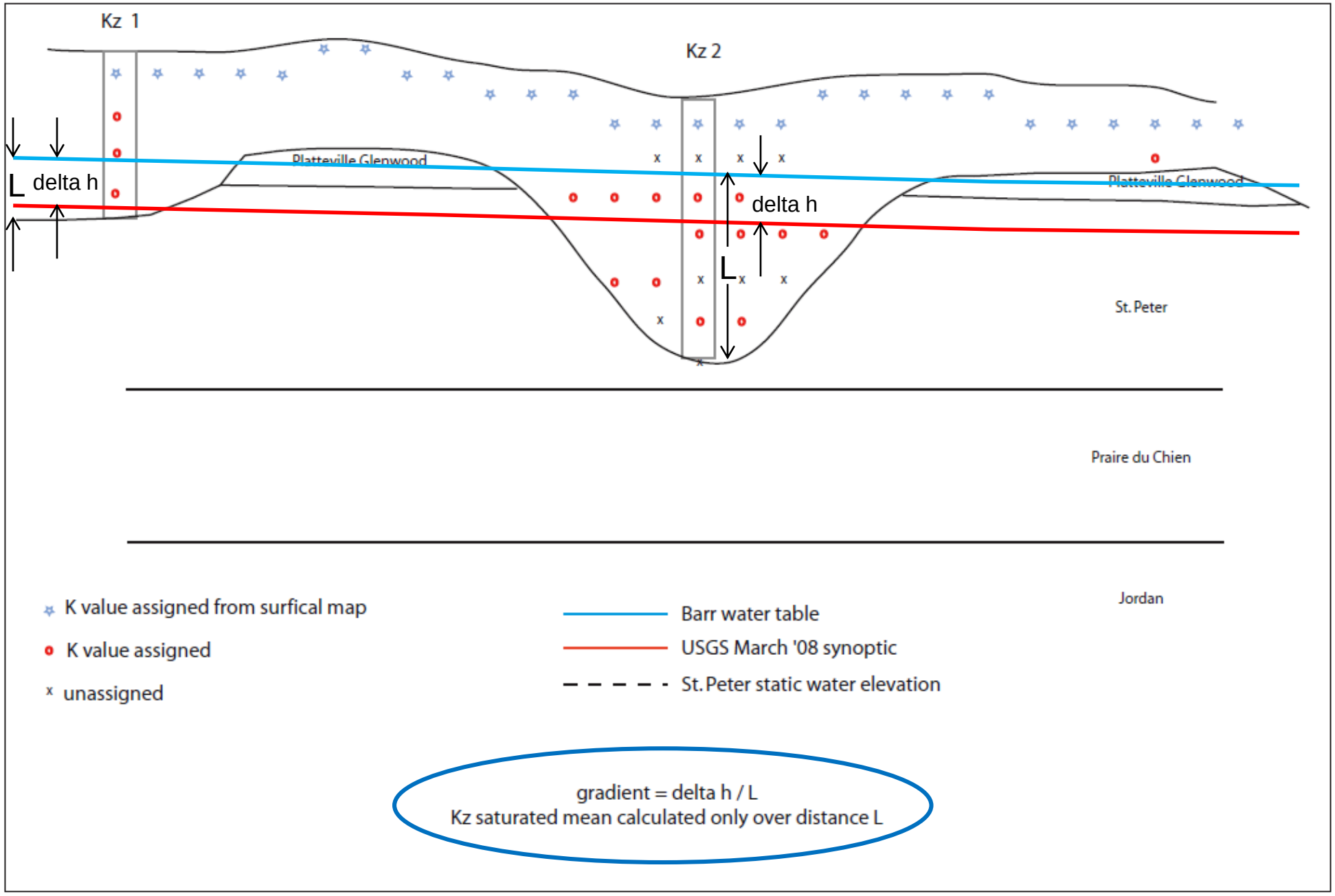
Geologic Atlas of Clay County, Minnesota, Part B, County Atlas Series C-29

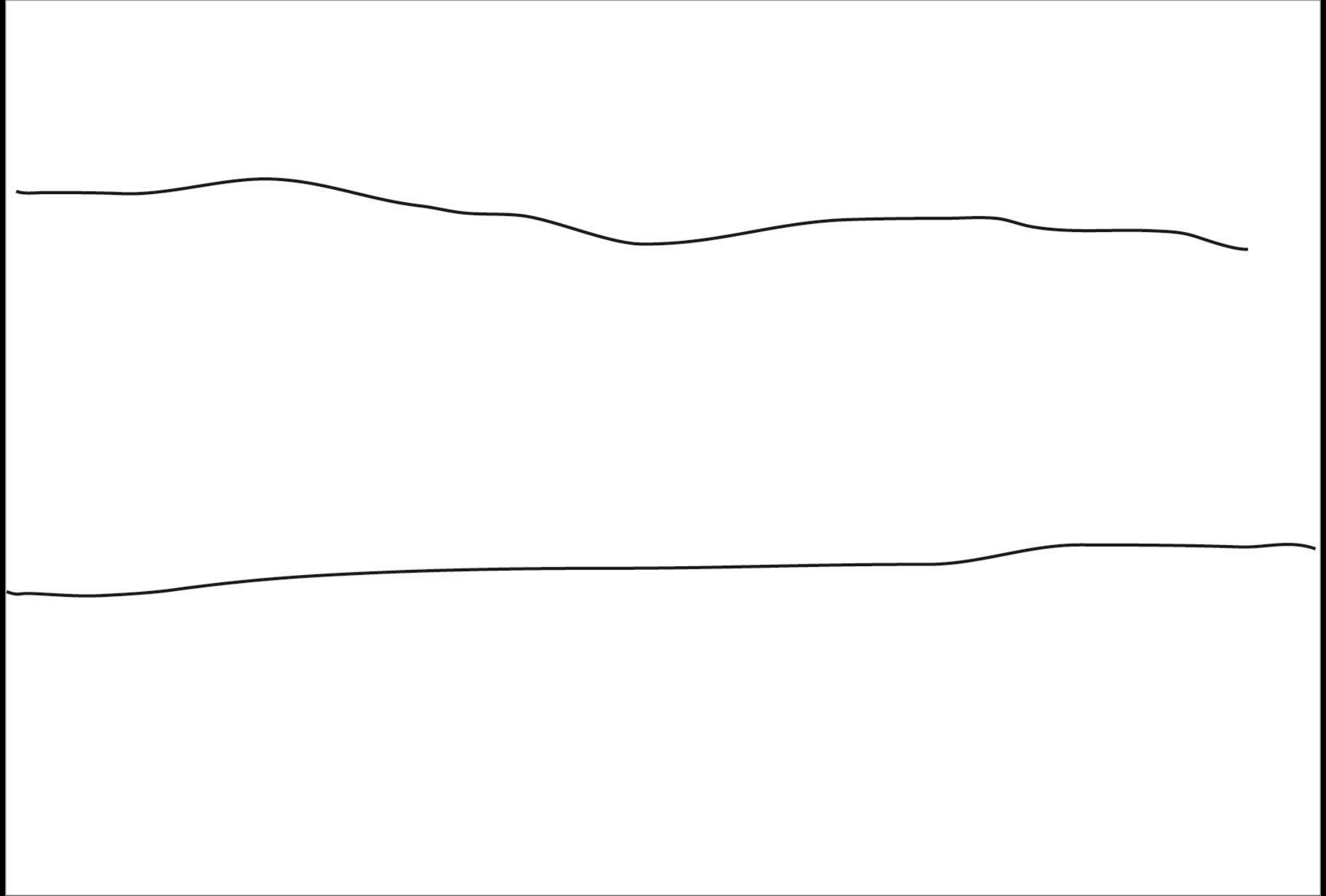
Table 1. Transmission rates used to assess the pollution sensitivity rating of near-surface materials

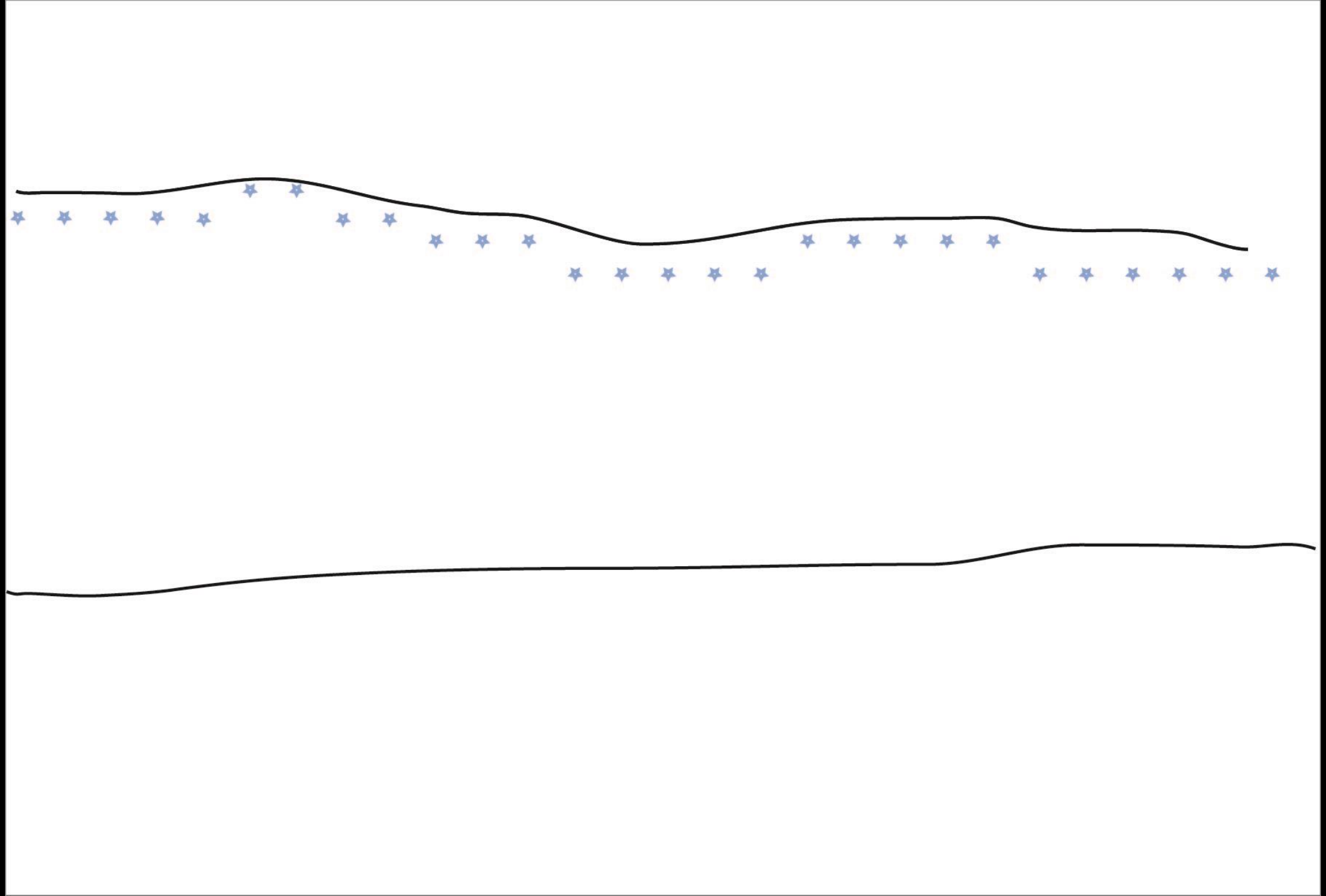
Hydrologic Soil Group (0–3 feet)		Surficial Geologic Texture (3–10 feet)		
Group*	Transmission rate (in/hr)	Classification	Transmission rate (in/hr)	Surficial geology map unit (Part A, Plate 3)
A, A/D	1	gravel, sandy gravel, silty gravel	1	ha, grb, grc, gro, ro, roc, wlg
		sand, silty sand	0.71	Not mapped in county
B, B/D	0.50	silt, loamy sand	0.50	wls
		sandy loam	0.28	ruw
C, C/D	0.075	silt loam, loam	0.075	rgs, rl, rlw, ru, gsw
		sandy clay loam	0.035	Not mapped in county
D	0.015	clay, clay loam, silty clay loam, sandy clay, silty clay	0.015	gst, sld**, slw**
--	--	glacial lake sediments of Lake Agassiz	0.000011	sld, slw

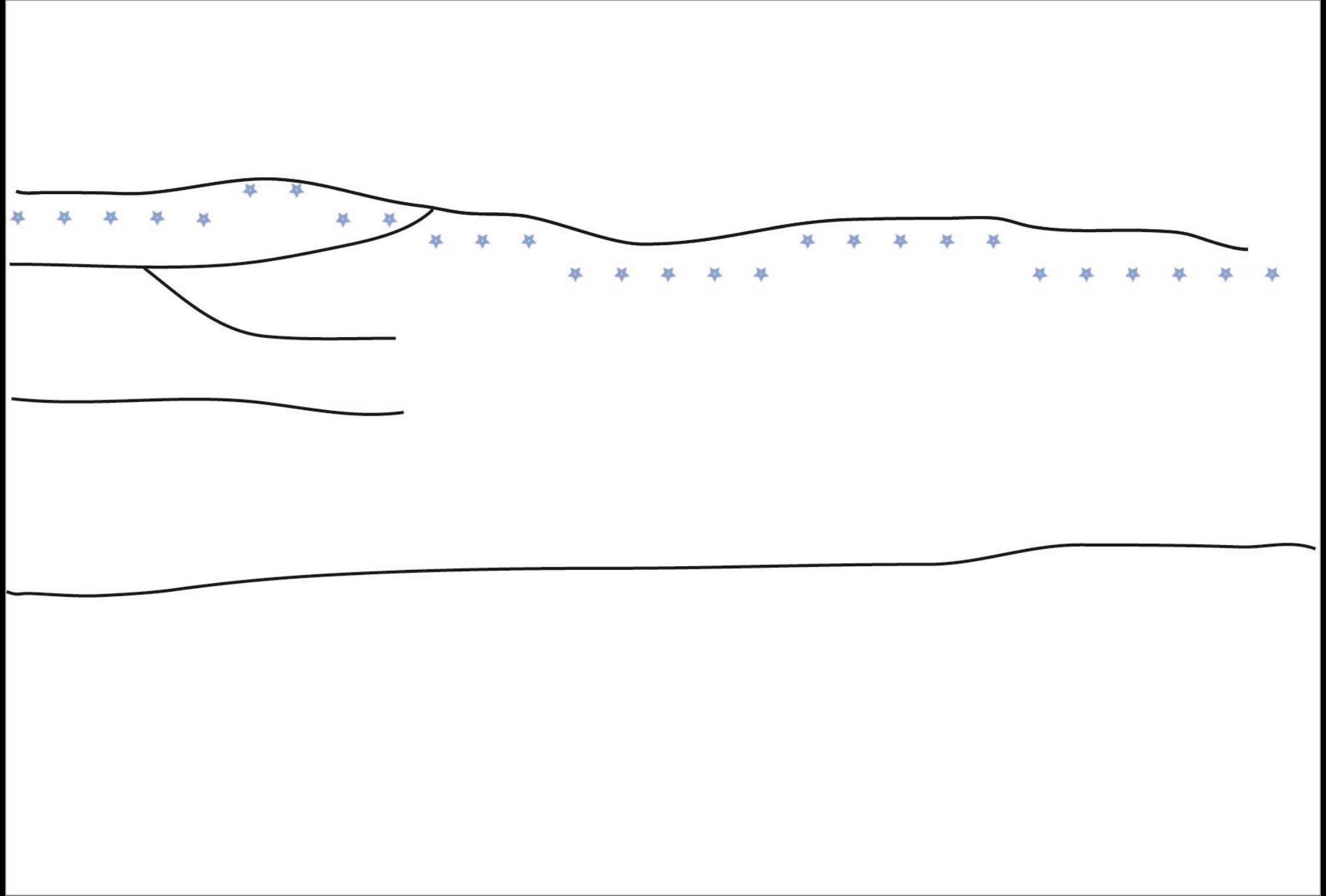

I 394 and Hwy 169
MSP Airport
1200
1000
800
600
400
200
0
-200
Elevation in feet
5,600 yrs
(Maple Grove 5)
> 35,000 yrs
(St. Louis Park 12)
0
5
10 Miles
0
5
10 Kilometers

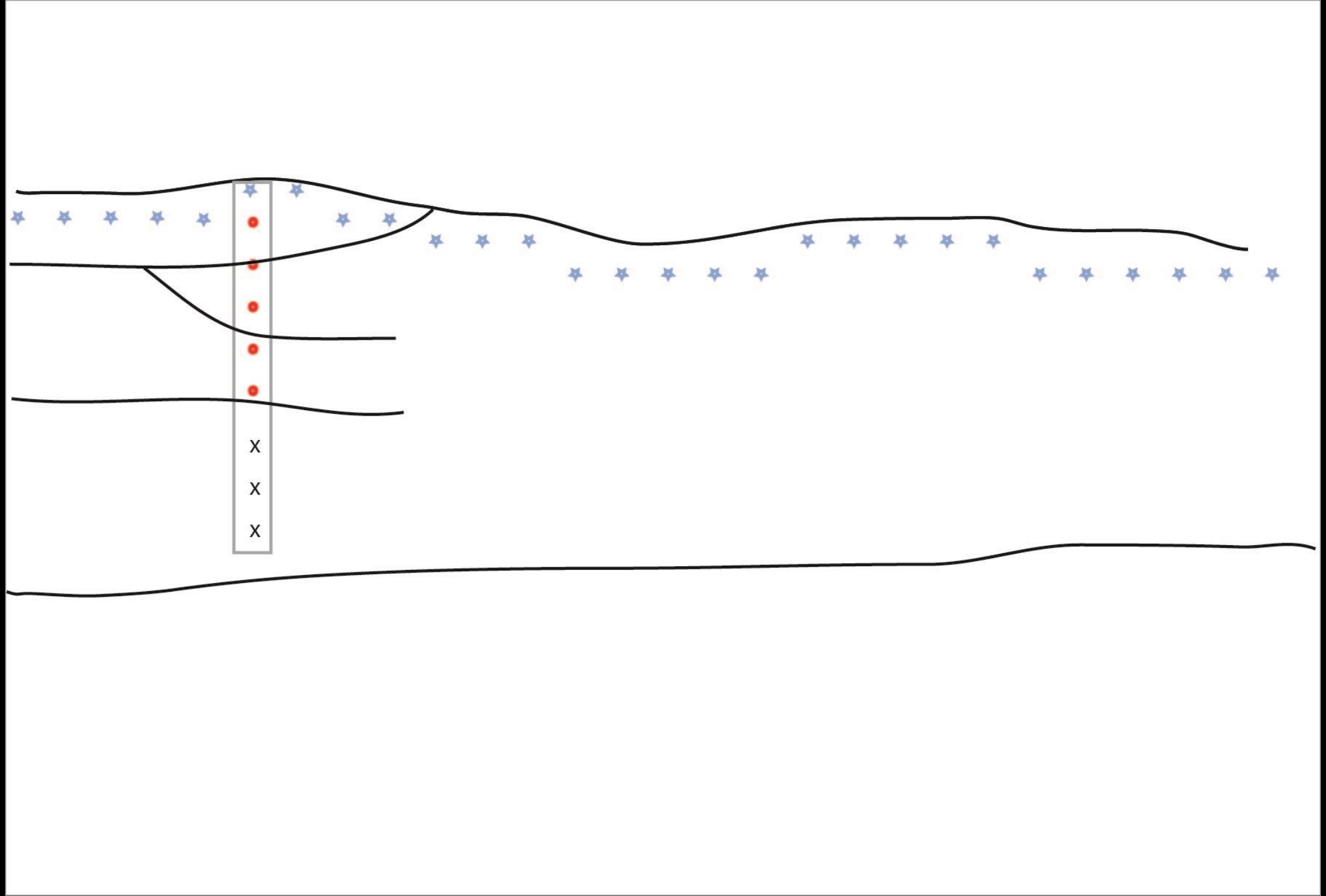

+ 50
- 50
A'

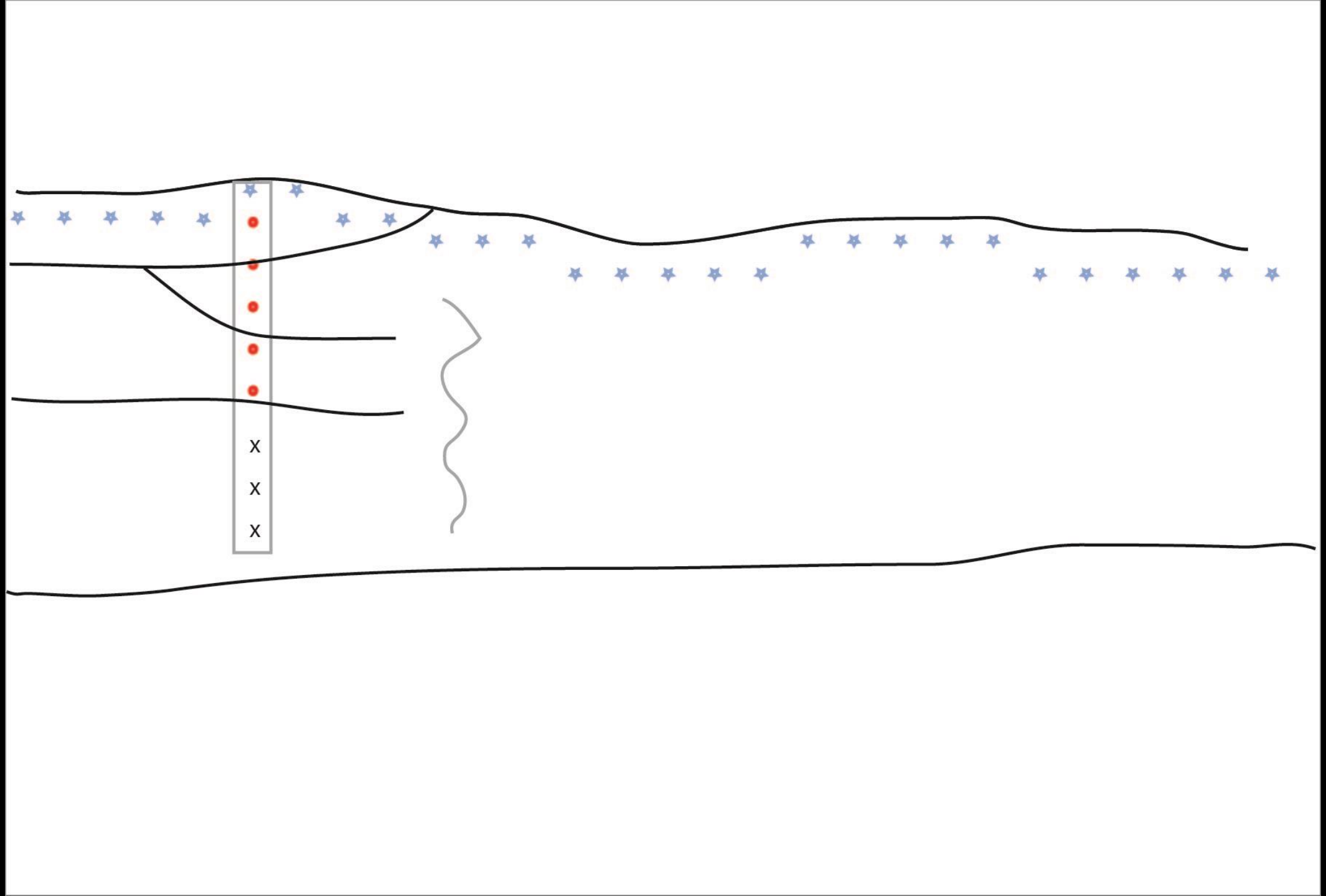

Kz 1
Kz 2
L
delta h
Platteville Glenwood
delta h
L
Platteville Glenwood
St. Peter
Praire du Chien
Jordan
K value assigned from surfical map
K value assigned
unassigned
Barr water table
USGS March '08 synoptic
St. Peter static water elevation
gradient = delta h / L
Kz saturated mean calculated only over distance L

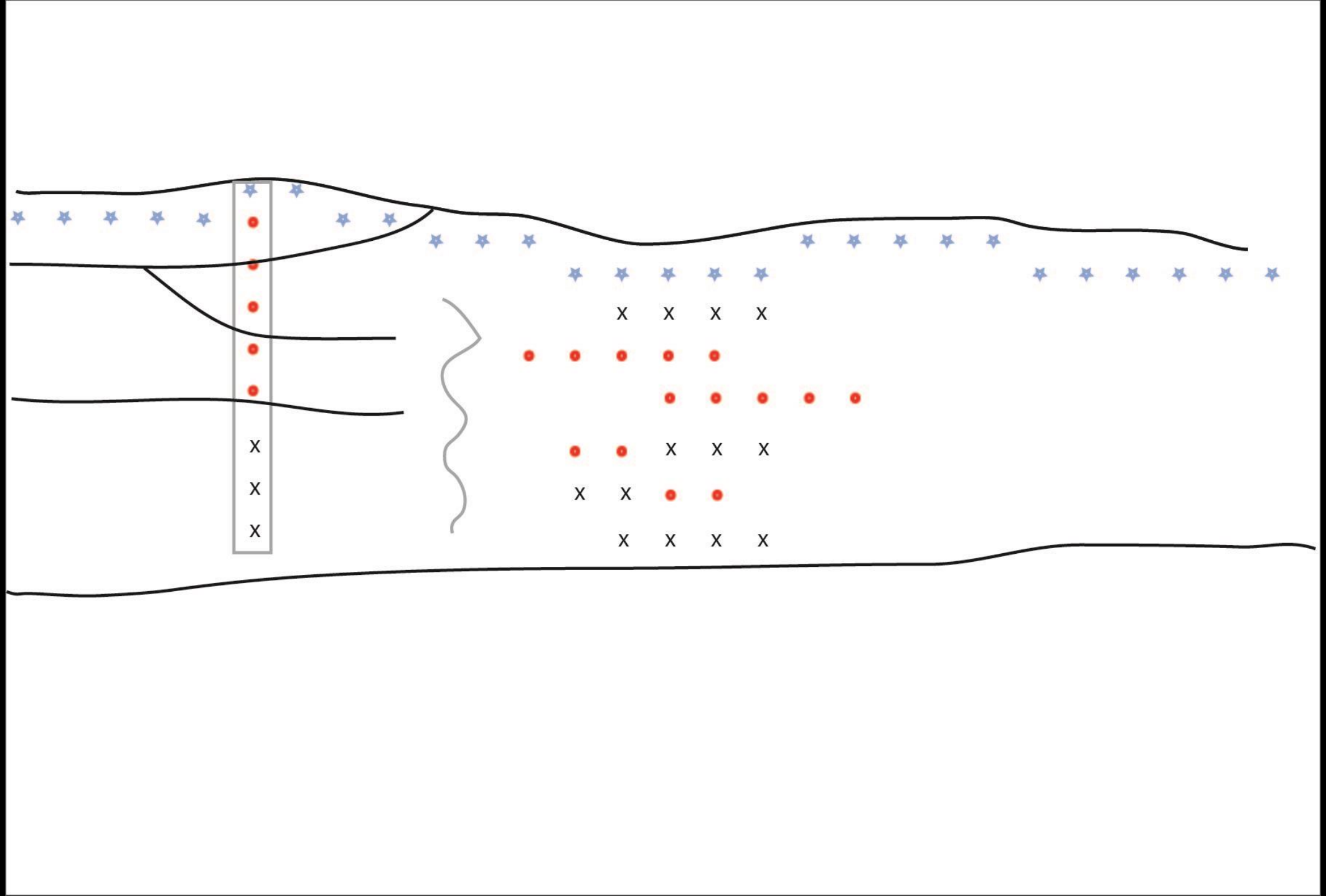


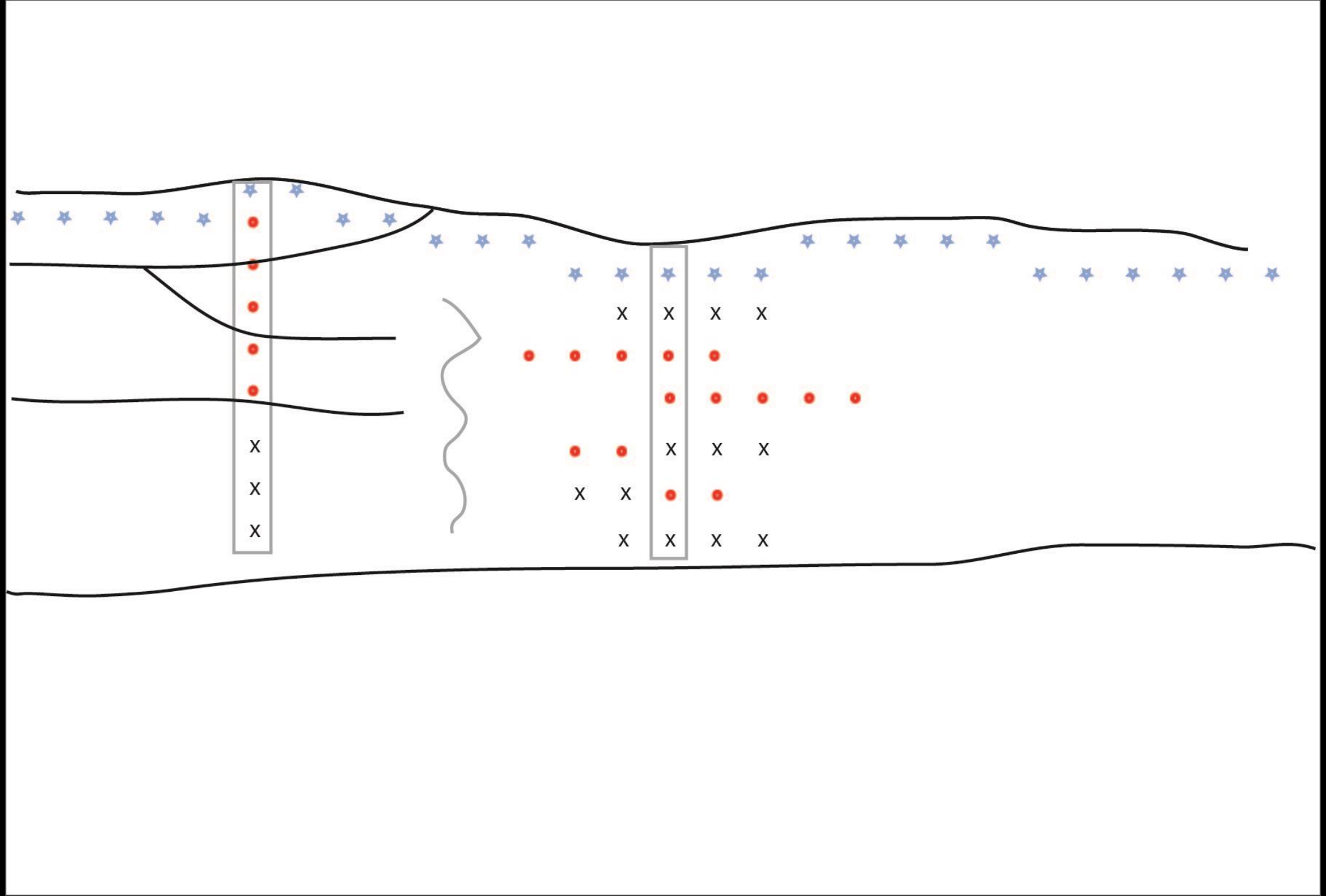


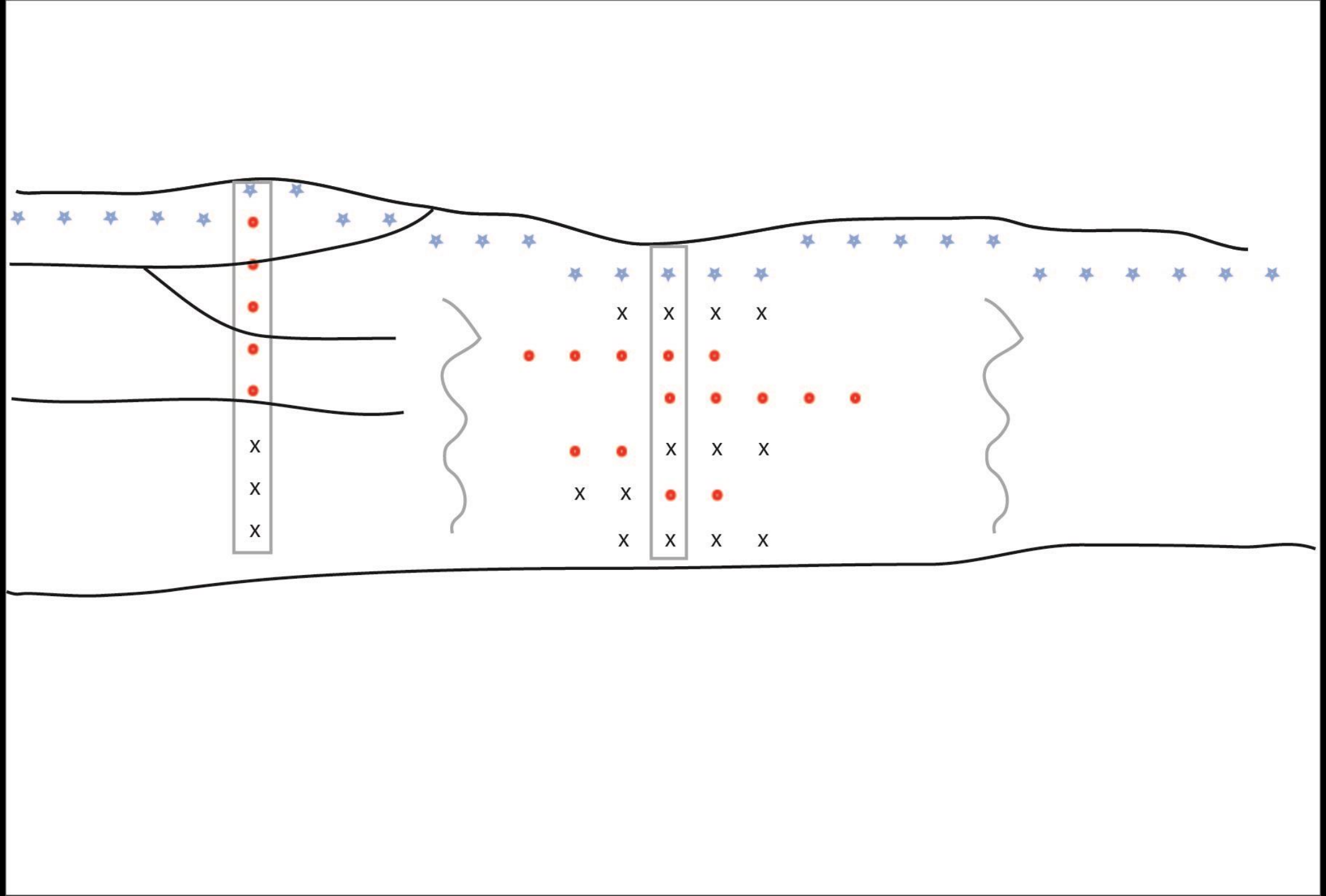


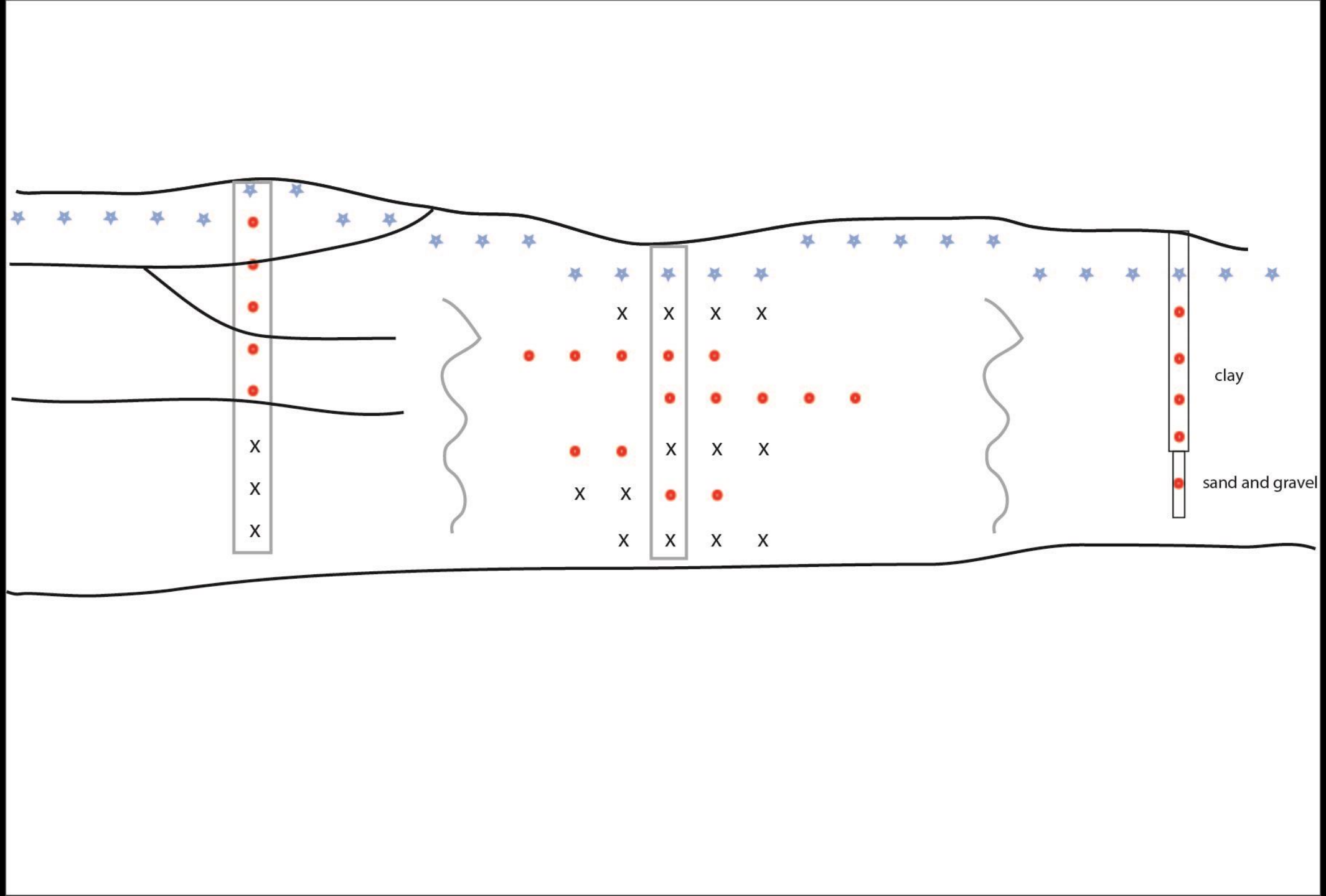

X
X
X

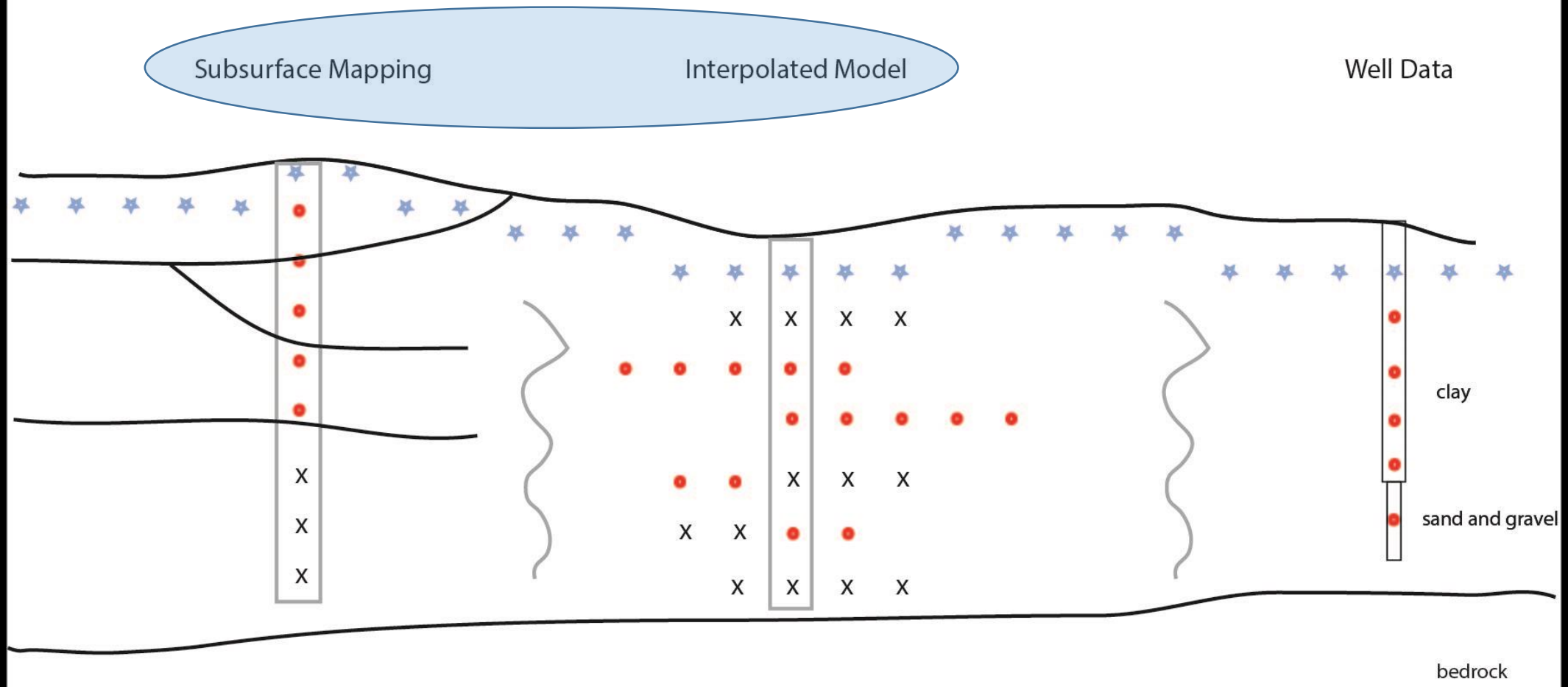

X
X
X








clay
sand and gravel


Subsurface Mapping
Interpolated Model
Well Data
clay
sand and gravel
bedrock
K value assigned from surfical map
K value assigned
unassigned

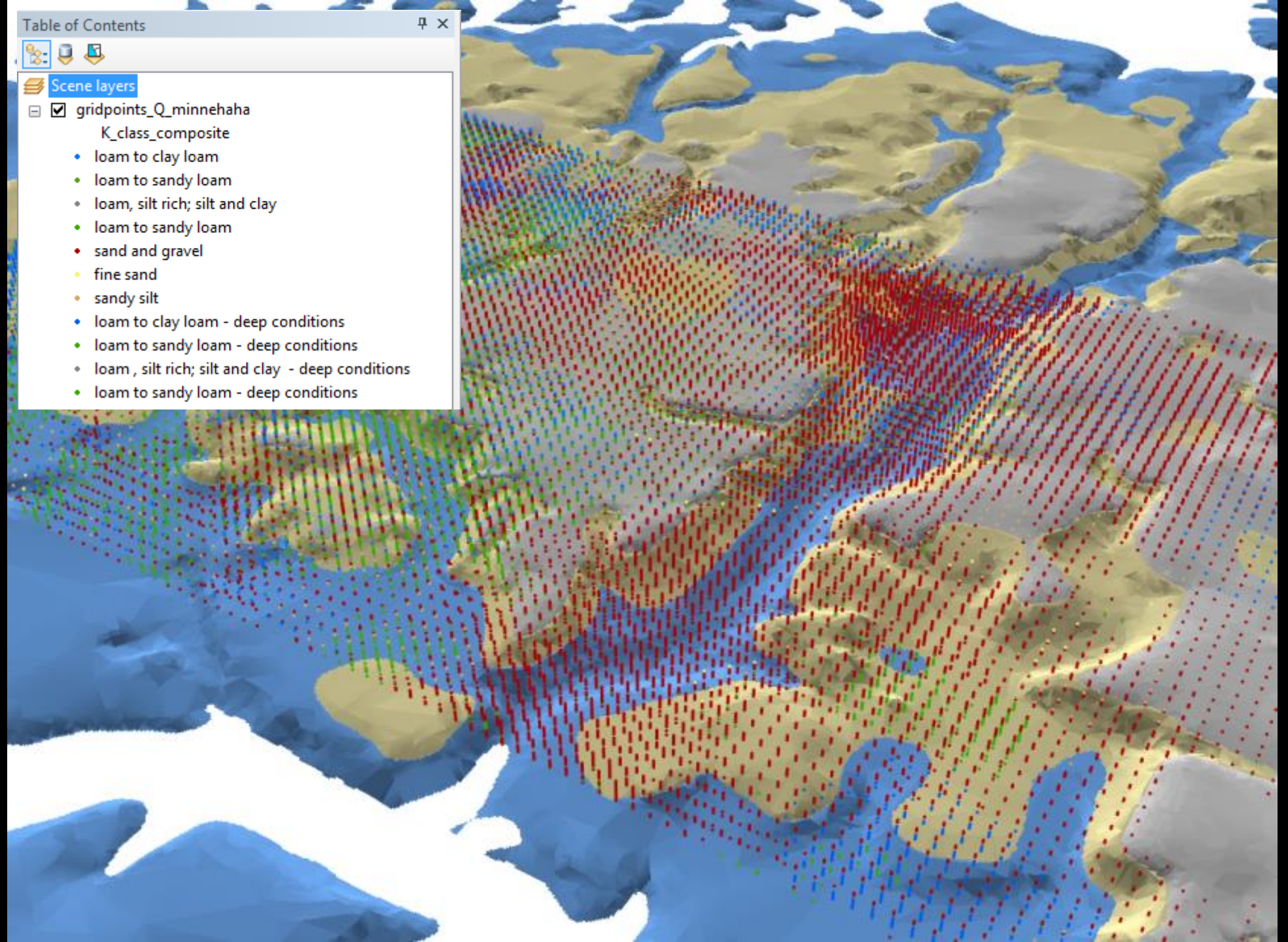
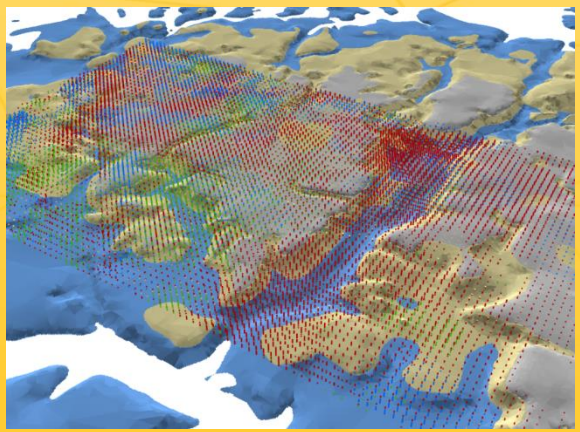


Table of Contents
Scene layers
gridpoints_Q_minnehaha
K_class_composite
loam to clay loam
loam to sandy loam
loam, silt rich; silt and clay
loam to sandy loam
sand and gravel
fine sand
sandy silt
loam to clay loam - deep conditions
loam to sandy loam - deep conditions
loam , silt rich; silt and clay - deep conditions
loam to sandy loam - deep conditions

Conclusions

- *Methods to map vertical infiltration are consistent with 1991 guidelines*
- *Subsurface mapping methods have changed*
- *Additional methods to consider adding:*
  - *Vertical hydraulic gradient*
  - *Mapping chemical types/facies in 3 dimensions*



UNIVERSITY OF MINNESOTA

Questions?

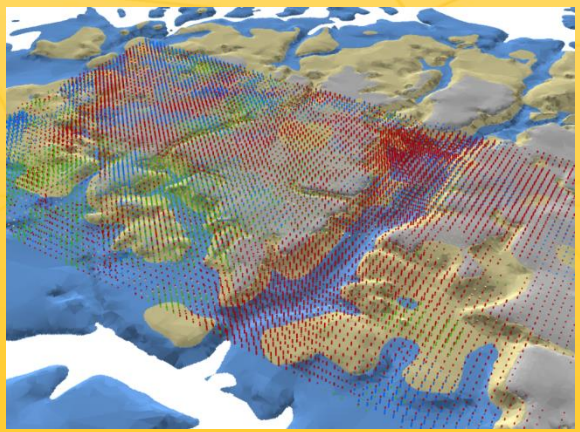


Table of Contents

Scene layers

gridpoints_Q_minnehaha

K_class_composite

Table

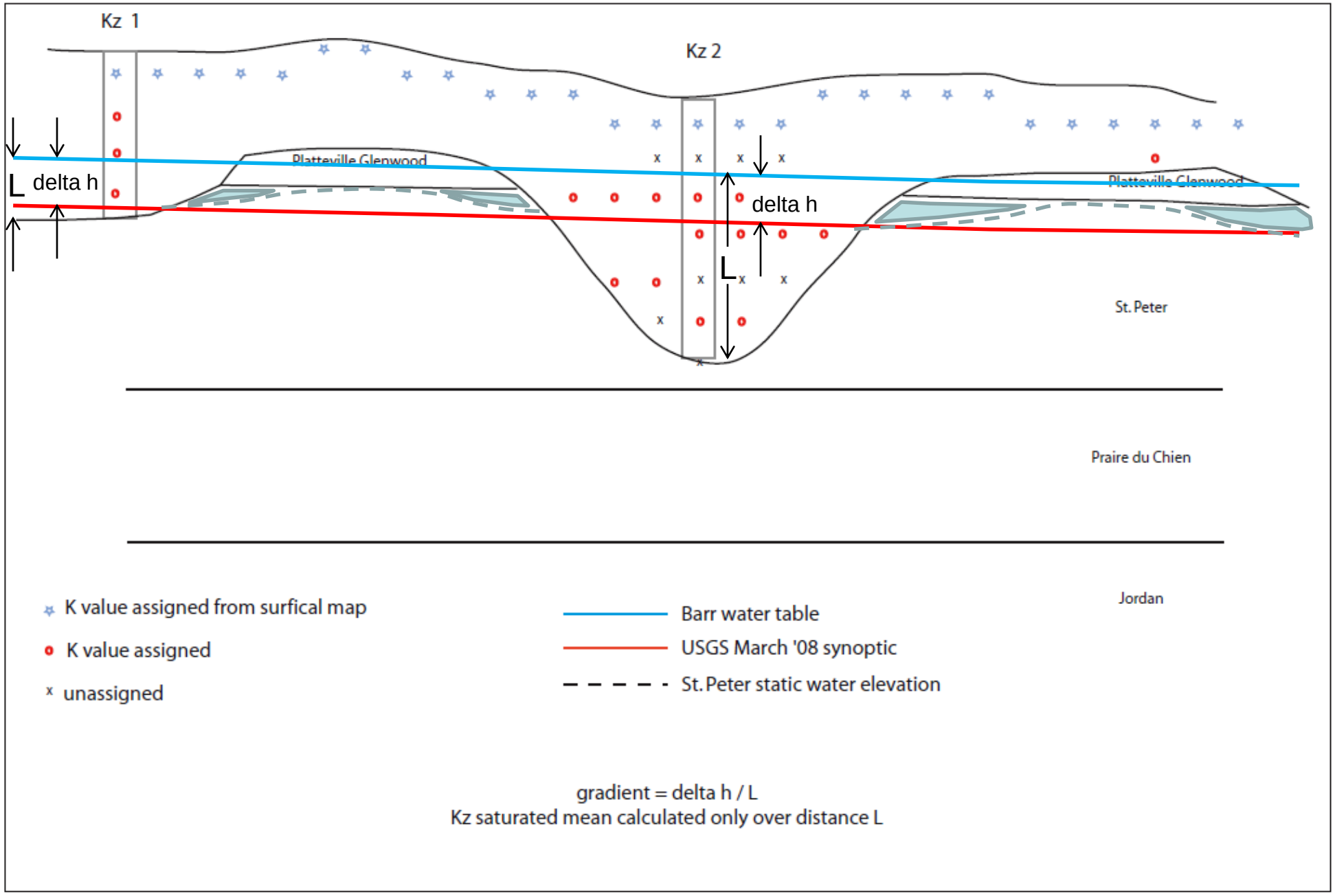
gridpoints_Q_minnehaha

h2	b	sat	sand_prob	mix_prob	clay_prob	K_class	grid_code	maplabel	K_classM	K_classSG	K_composite	K_classNULL	K_class_composite
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	0.669723	<Null>	<Null>	<Null>	1	<Null>	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	<Null>	0.50075	<Null>	<Null>	<Null>	1	<Null>	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	<Null>	0.507646	<Null>	<Null>	Qnh	1	1	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	0.509908	<Null>	<Null>	<Null>	<Null>	9	<Null>	0.1005	<Null>	9
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	0.654075	<Null>	<Null>	<Null>	1	<Null>	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	<Null>	0.502399	<Null>	<Null>	<Null>	1	<Null>	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	<Null>	0.541135	<Null>	<Null>	Qnh	1	1	0.002	<Null>	1
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	0.614337	0.492119	<Null>	<Null>	<Null>	8	<Null>	0.00002	<Null>	8
<Null>	<Null>	<Null>	<Null>	0.498537	<Null>	<Null>	<Null>	<Null>	9	<Null>	0.1005	<Null>	9
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	10.05	1	<Null>
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1 (0 out of *2000 Selected)

gridpoints_Q_minnehaha

MINNESOTA


Kz 1
Kz 2
L
delta h
Platteville Glenwood
delta h
L
Platteville Glenwood
St. Peter
Praire du Chien
Jordan
K value assigned from surfical map
K value assigned
unassigned
Barr water table
USGS March '08 synoptic
St. Peter static water elevation
gradient = delta h / L
Kz saturated mean calculated only over distance L