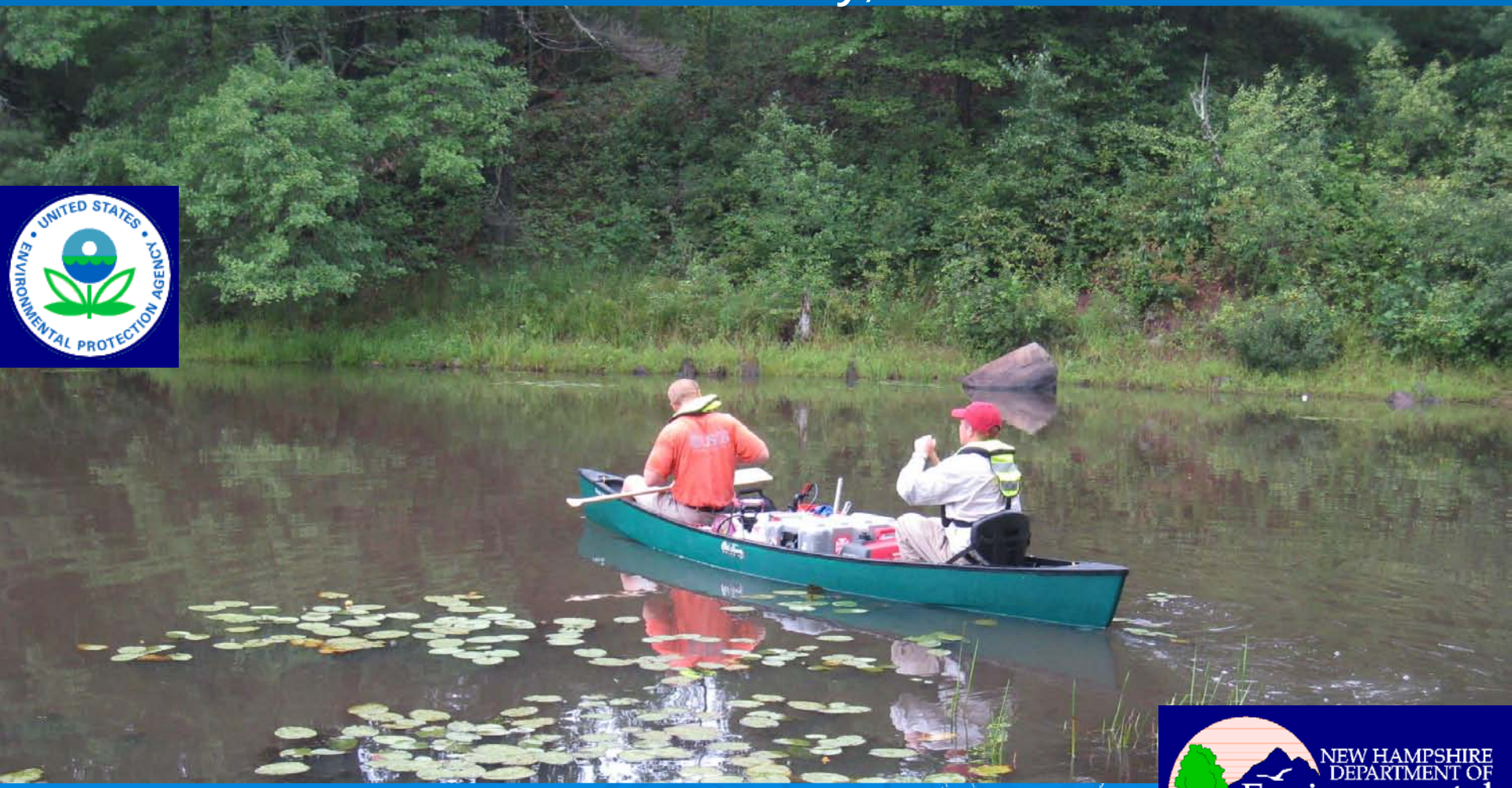
Characterization of Leachate Distribution, Redox Conditions, and the Persistence of Arsenic in Groundwater at the Auburn Rd. Landfill Site, Londonderry, NH



By James Degnan and Philip Harte

Acknowledgements

- U.S. Environmental Protection Agency
- NH Department of Environmental Services

Previous investigations by:

- Weston, Late 80s and 2000-2012
- Sevee and Maher, 90s
- NUS corporation, 80s

Outline

- Site background and problem
  - Hydrogeology
  - Surface water
- Water quality data
  - Oxidation-reduction indicators
  - Arsenic
  - Additional analysis
- Characterization
  - Existing data
  - Geophysical surveys

Background

1979 State of NH investigates

1982 EPA NPL list

1986-1988: 2,216 drums removed

Capped 1996

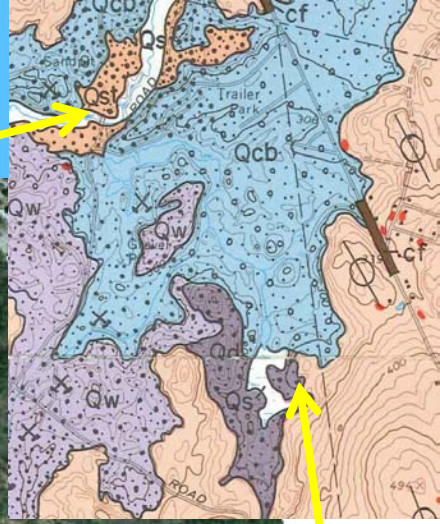
Groundwater flow north northwest towards Cohas Brook

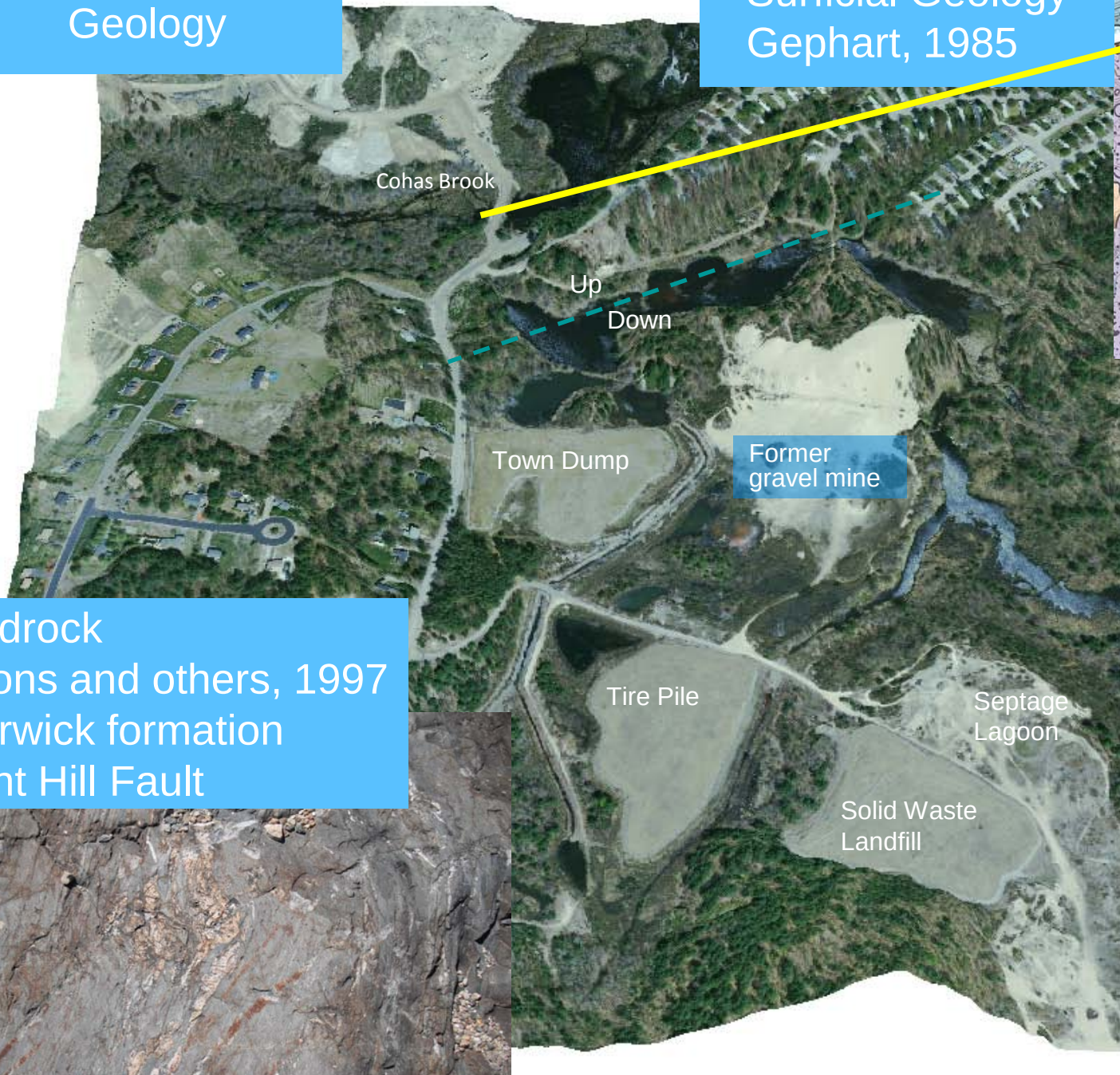
Problem

Persistent Arsenic

Geology

Surficial Geology
Gephart, 1985

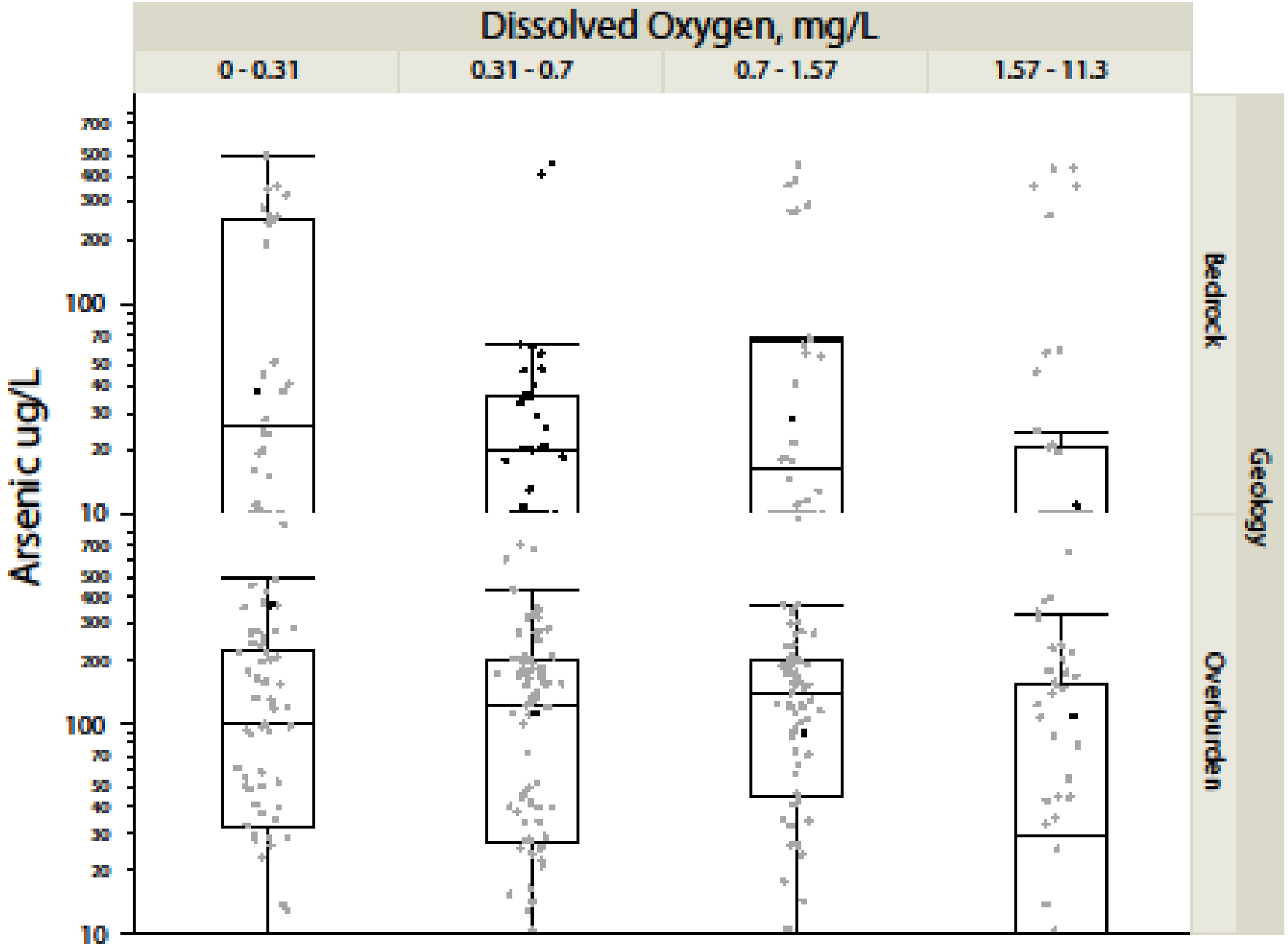




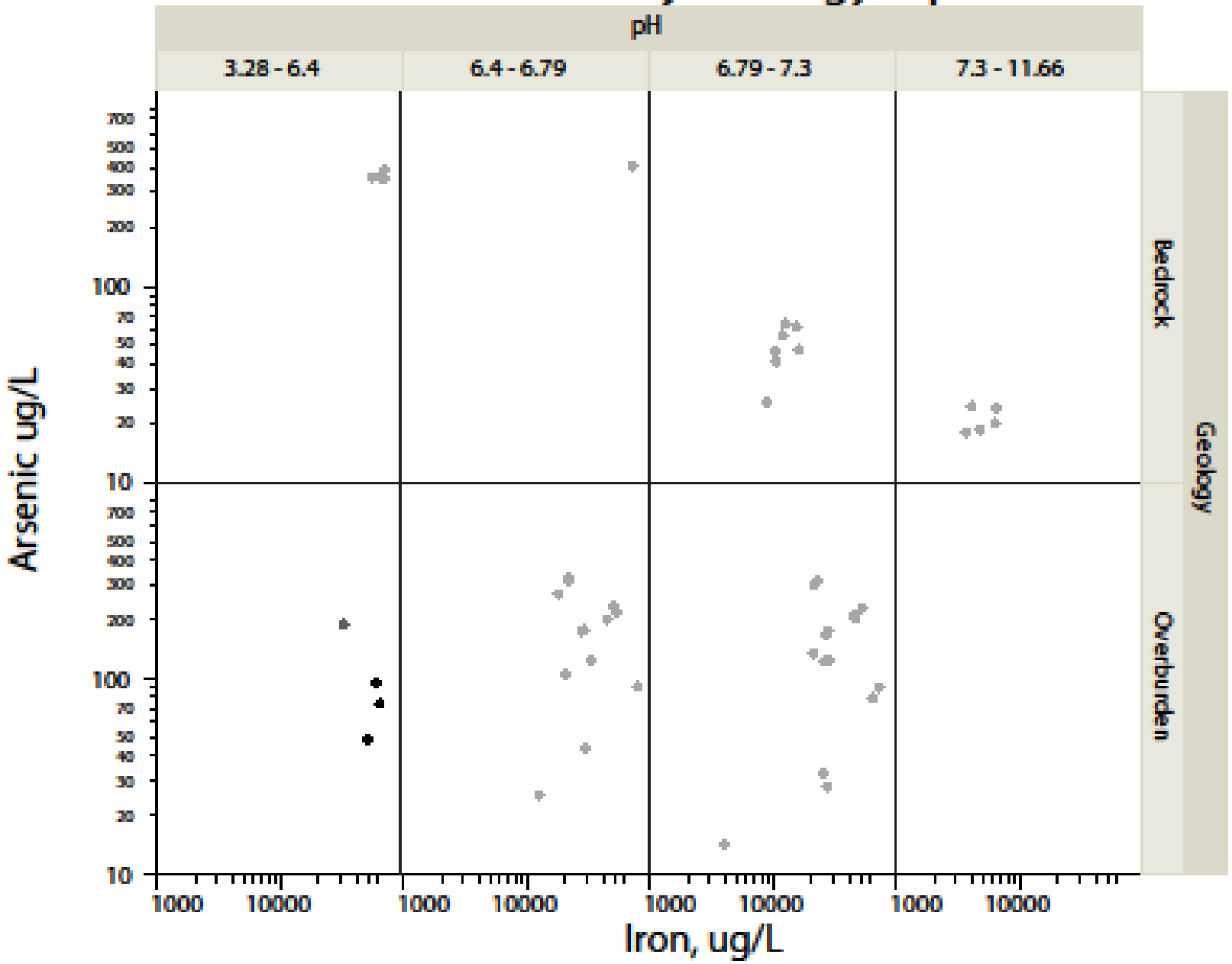
Bedrock
Lyons and others, 1997
Berwick formation
Flint Hill Fault

Glacial Lake
Cohas Brook,
300ft elevation
Outlet
Delta Top
Buried
esker?
Approximate Ice Position
Glacial Lake Wilson
Ice Contact Delta?
Glacial Lake
Wilson, 350ft
elevation, outlet

Arsenic by Geology & Dissolved Oxygen

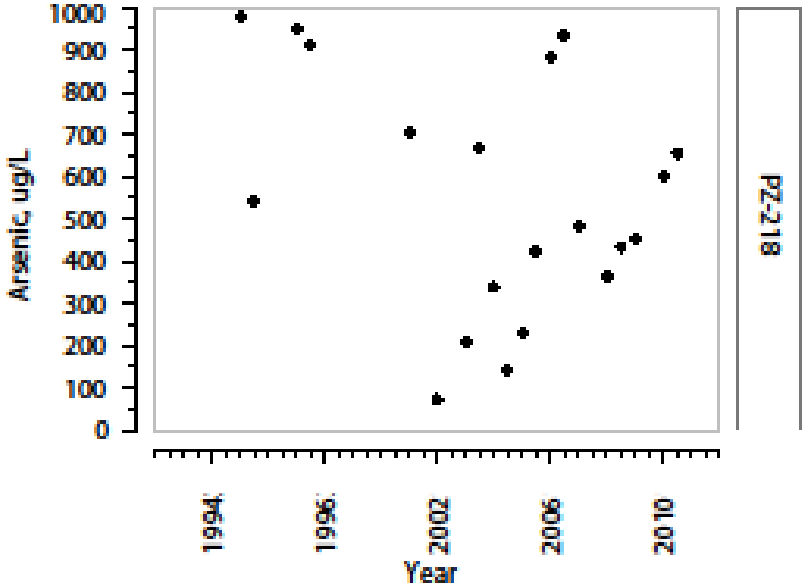


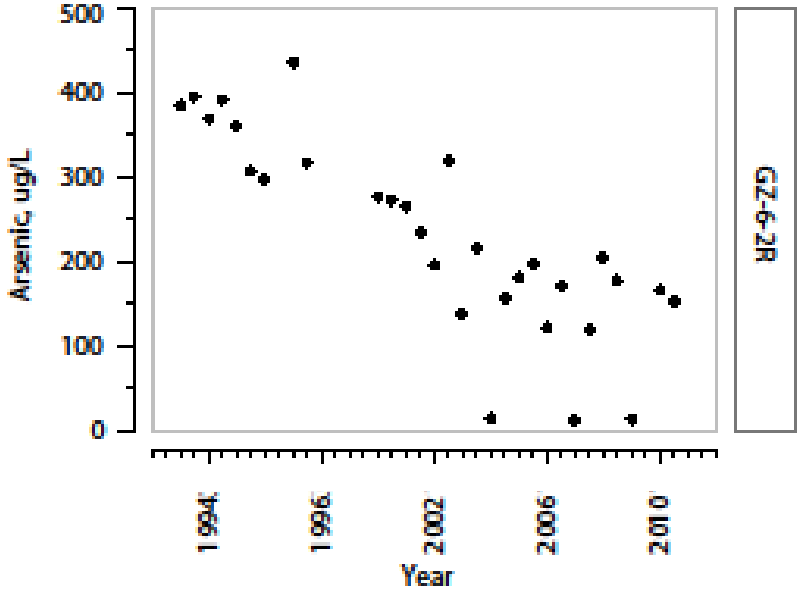
Arsenic vs. Iron by Geology & pH

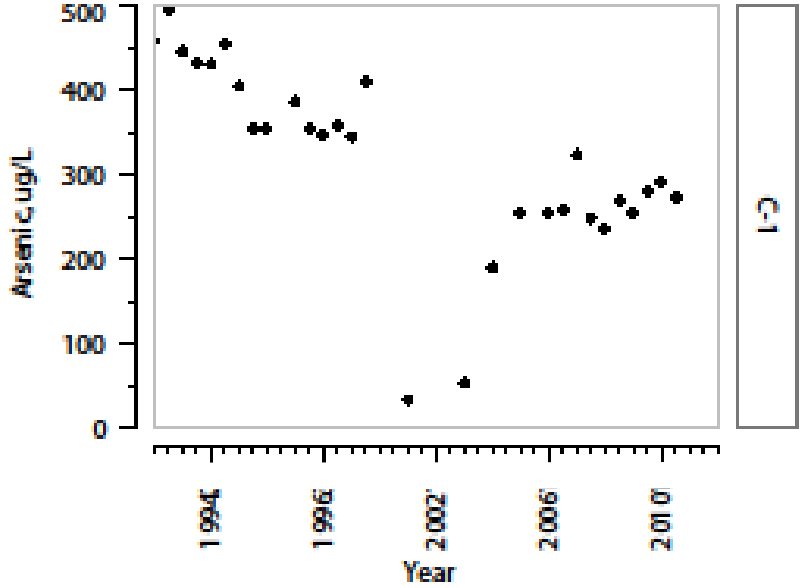


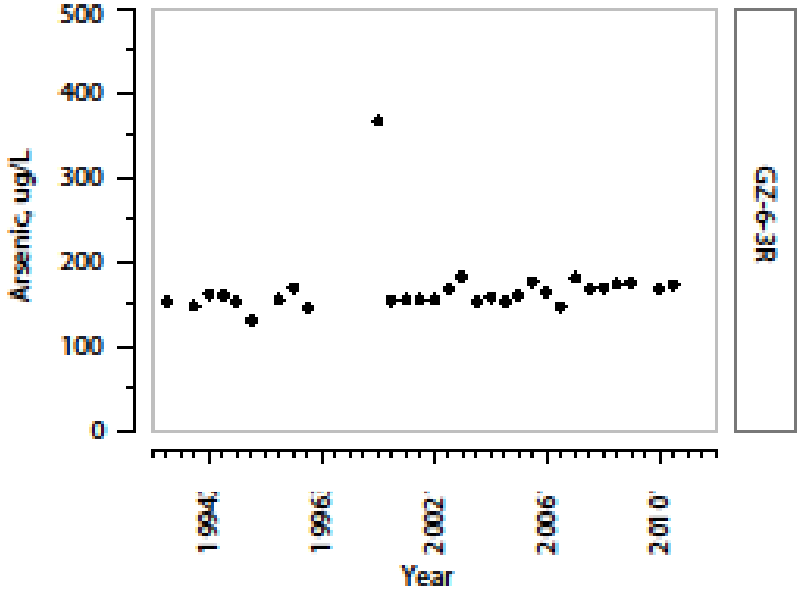
Between landfills

Center of former gravel pit

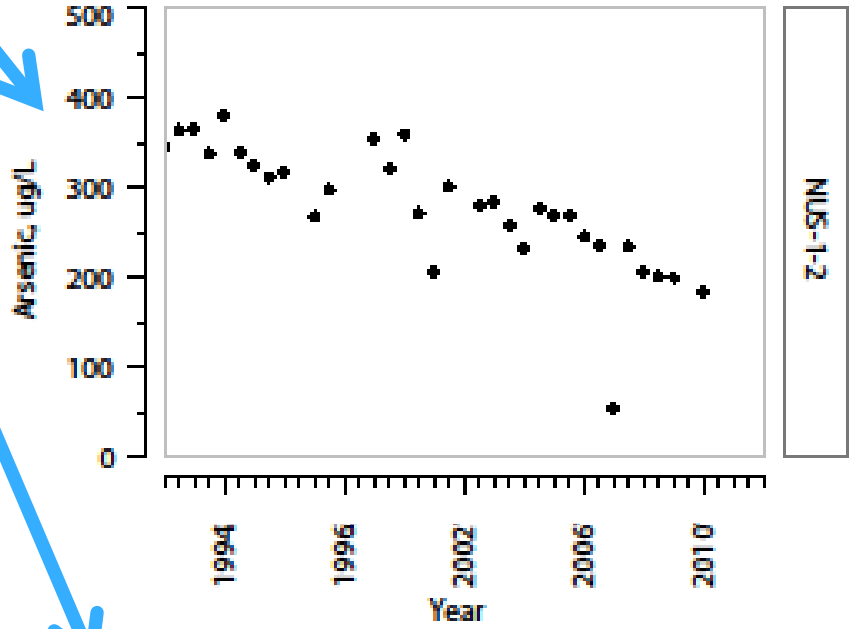




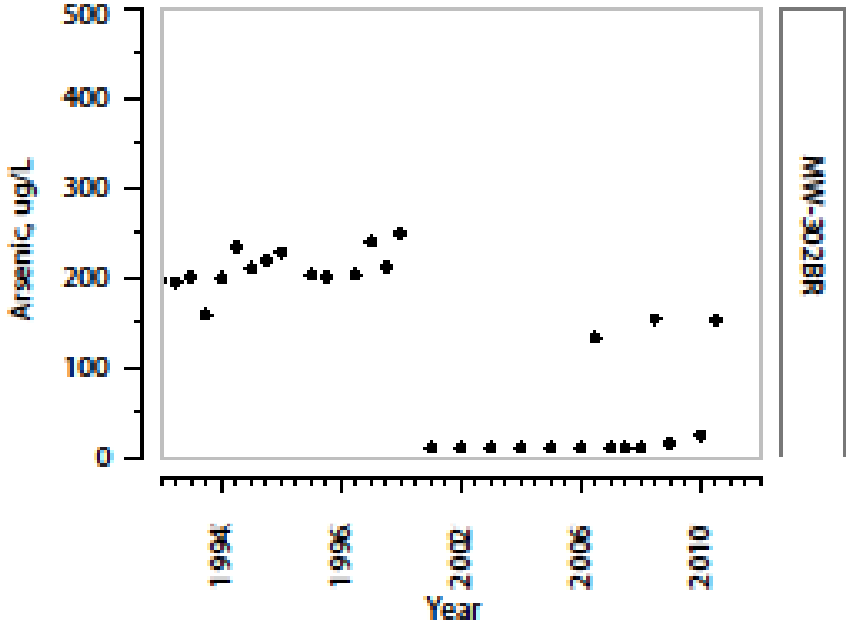


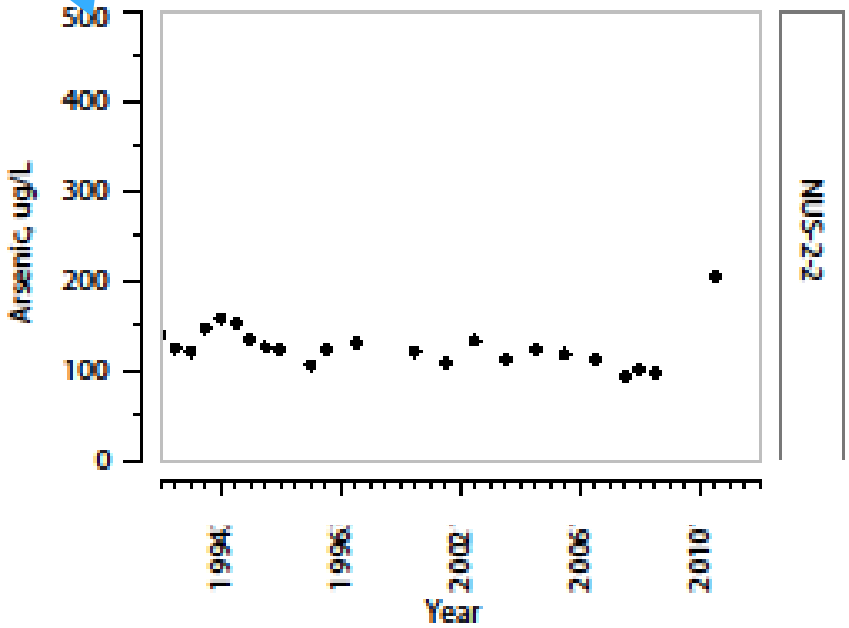


Northern Shore of Whispering Pines Pond



Northern edge of former gravel pit



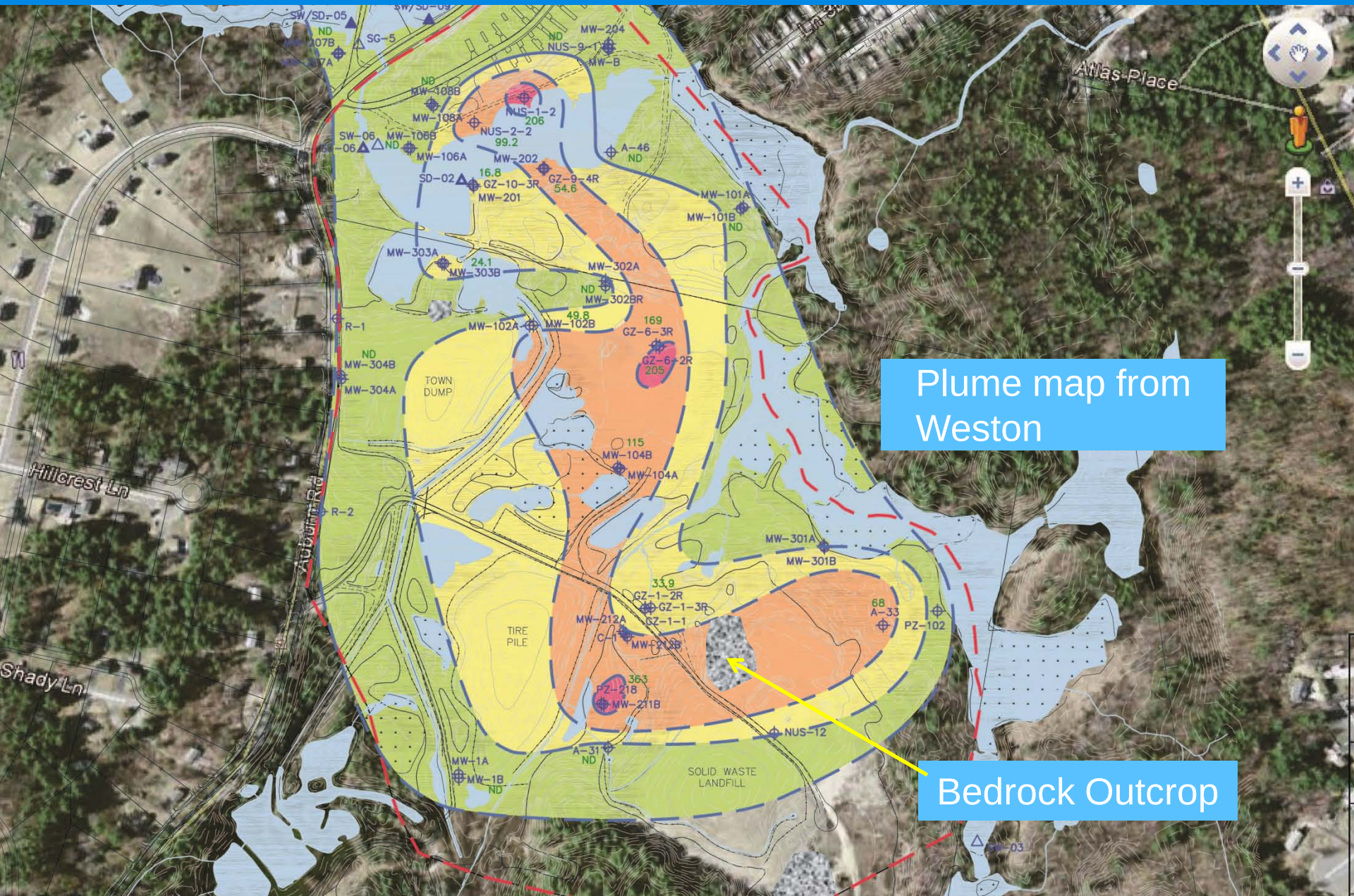


Spring 2008

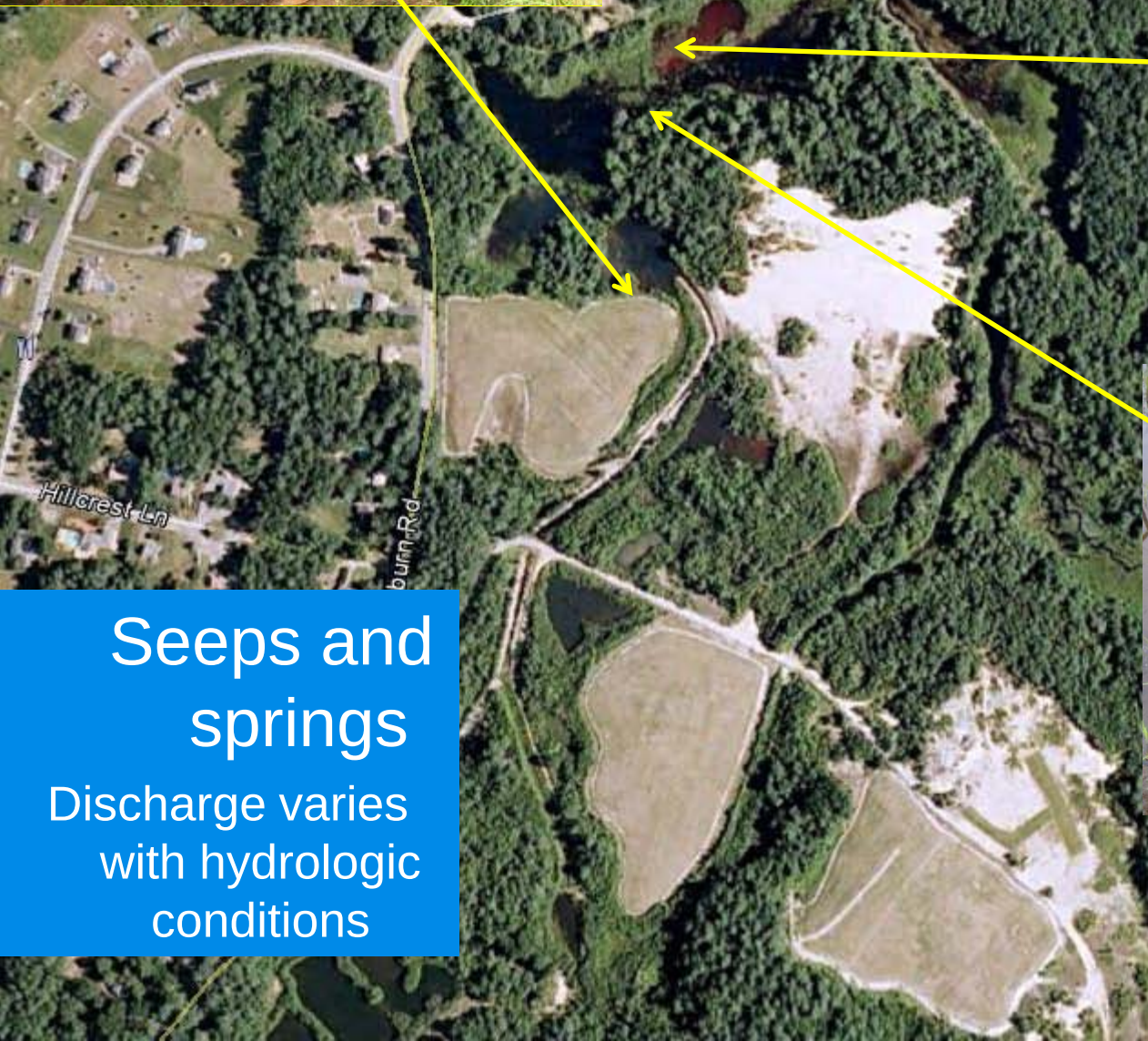
Seeps and springs

Discharge varies with hydrologic conditions

Spring 2008


Plume map from Weston
Bedrock Outcrop
Atlas Place
Hillcrest Ln
Shady Ln
TOWN DUMP
TIRE PILE
SOLID WASTE LANDFILL
MW-204
NUS-9-1
MW-B
MW-108B
MW-108A
NUS-1-2
206
NUS-2-2
99.2
MW-105B
MW-106A
MW-202
A-46
ND
16.8
GZ-10-3R
MW-201
GZ-9-4R
54.6
MW-101A
MW-101B
MW-303A
24.1
MW-303B
MW-302A
MW-302BR
MW-102A
49.8
MW-102B
169
GZ-6-3R
GZ-6-2R
205
MW-304B
MW-304A
115
MW-104B
MW-104A
MW-301A
MW-301B
33.9
GZ-1-2R
GZ-1-3R
GZ-1-1
MW-212A
C-1
68
A-33
PZ-102
363
PZ-218
MW-211B
NUS-12
A-31
MW-1A
MW-1B
SG-5
SW-06
SD-02
R-1
R-2

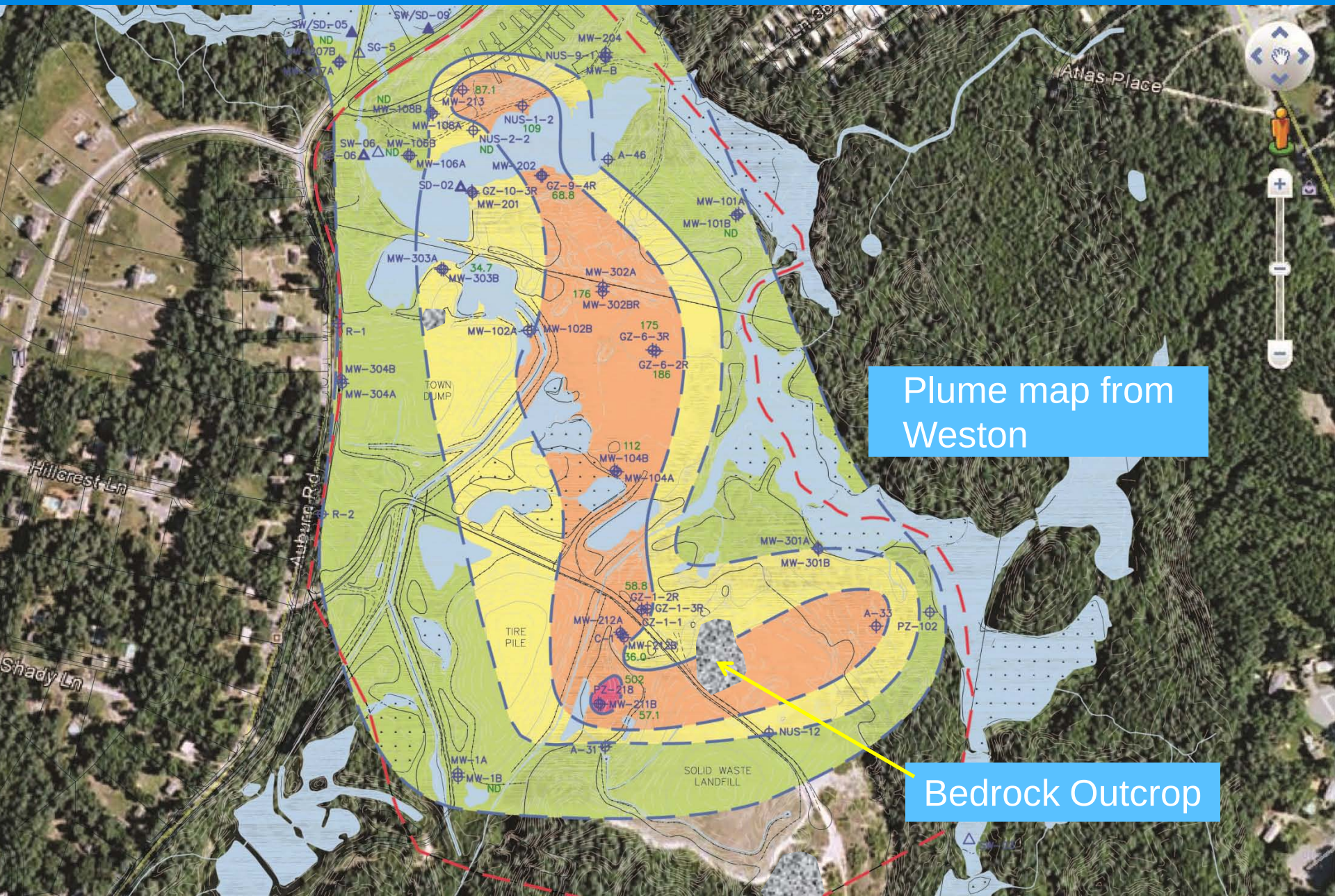
Fall 2009



Seeps and springs

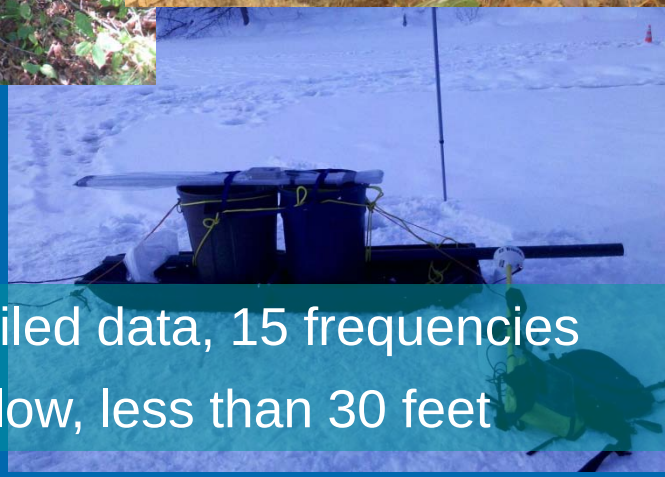
Discharge varies with hydrologic conditions

Fall 2009


Plume map from Weston
Bedrock Outcrop
SW/SD-05
SW/SD-09
SG-5
MW-204
NUS-9-1
MW-B
87.1
MW-213
NUS-1-2
109
NUS-2-2
ND
MW-108B
MW-108A
MW-106B
MW-106A
SW-06
SD-02
GZ-10-3R
MW-201
MW-202
GZ-9-4R
68.8
A-46
MW-101A
MW-101B
ND
MW-303A
34.7
MW-303B
MW-302A
176
MW-302BR
R-1
MW-102A
MW-102B
175
GZ-6-3R
GZ-6-2R
186
MW-304B
MW-304A
TOWN DUMP
112
MW-104B
MW-104A
R-2
MW-301A
MW-301B
58.8
GZ-1-2R
GZ-1-3R
GZ-1-1
MW-212A
C-1
MW-212B
36.0
TIRE PILE
A-33
PZ-102
502
PZ-218
MW-211B
57.1
NUS-12
A-31
MW-1A
MW-1B
ND
SOLID WASTE LANDFILL
Atlas Place
Hillcrest Ln
Auburn Rd
Shady Ln

DC Resistivity Geophysical Surveys

Electromagnetic Induction



- Detailed data, 15 frequencies
- Shallow, less than 30 feet

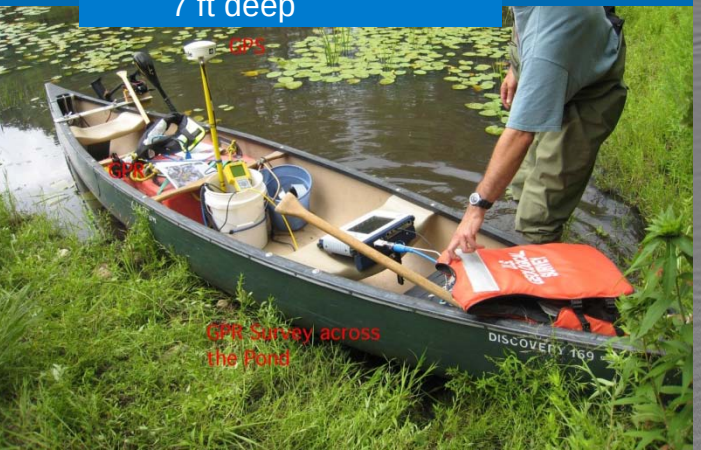
Ground Penetrating Radar

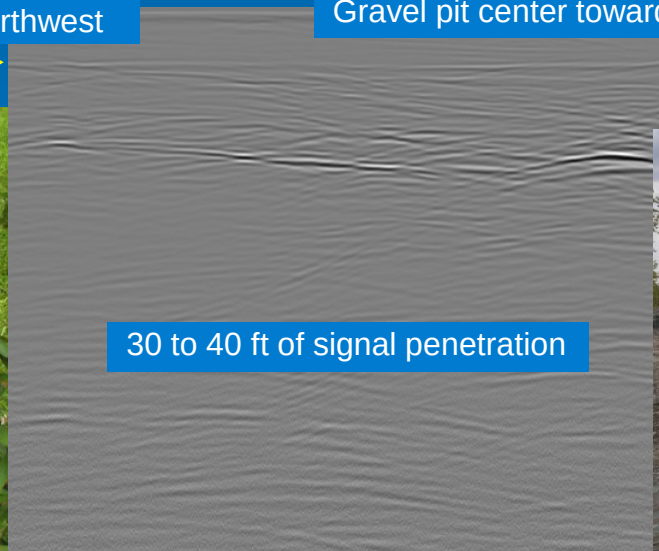
northwest

Gravel pit center towards town dump

southeast

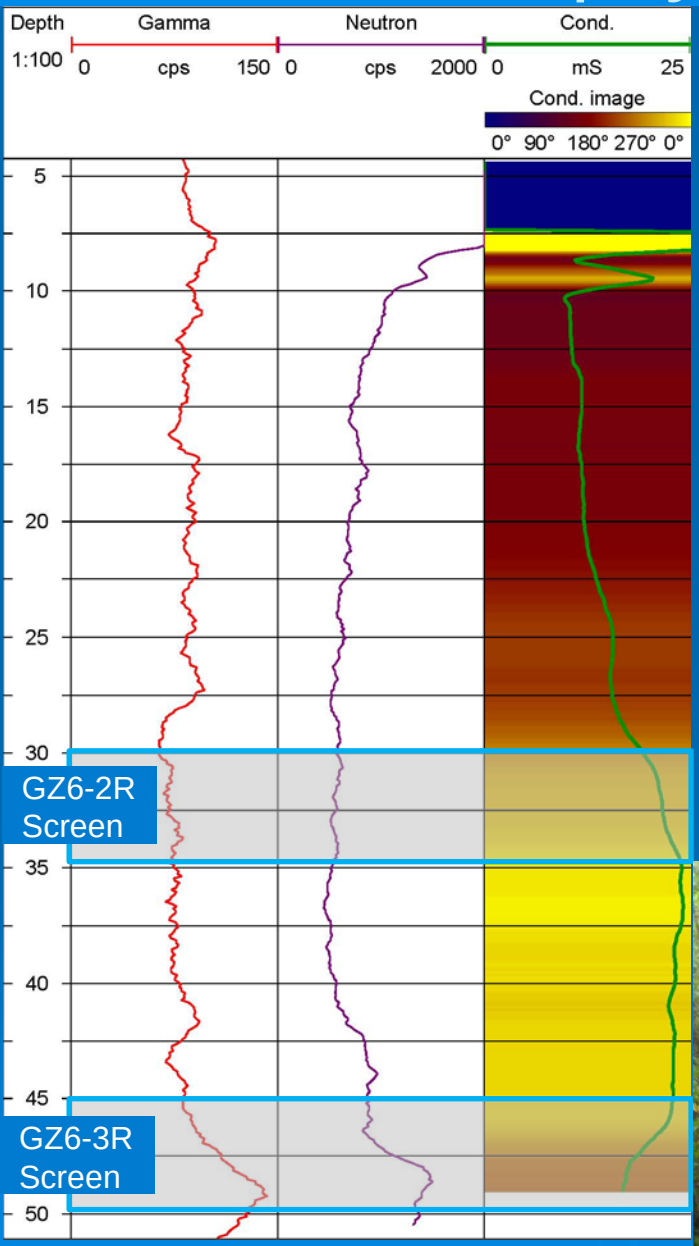
Water table approximately 7 ft deep

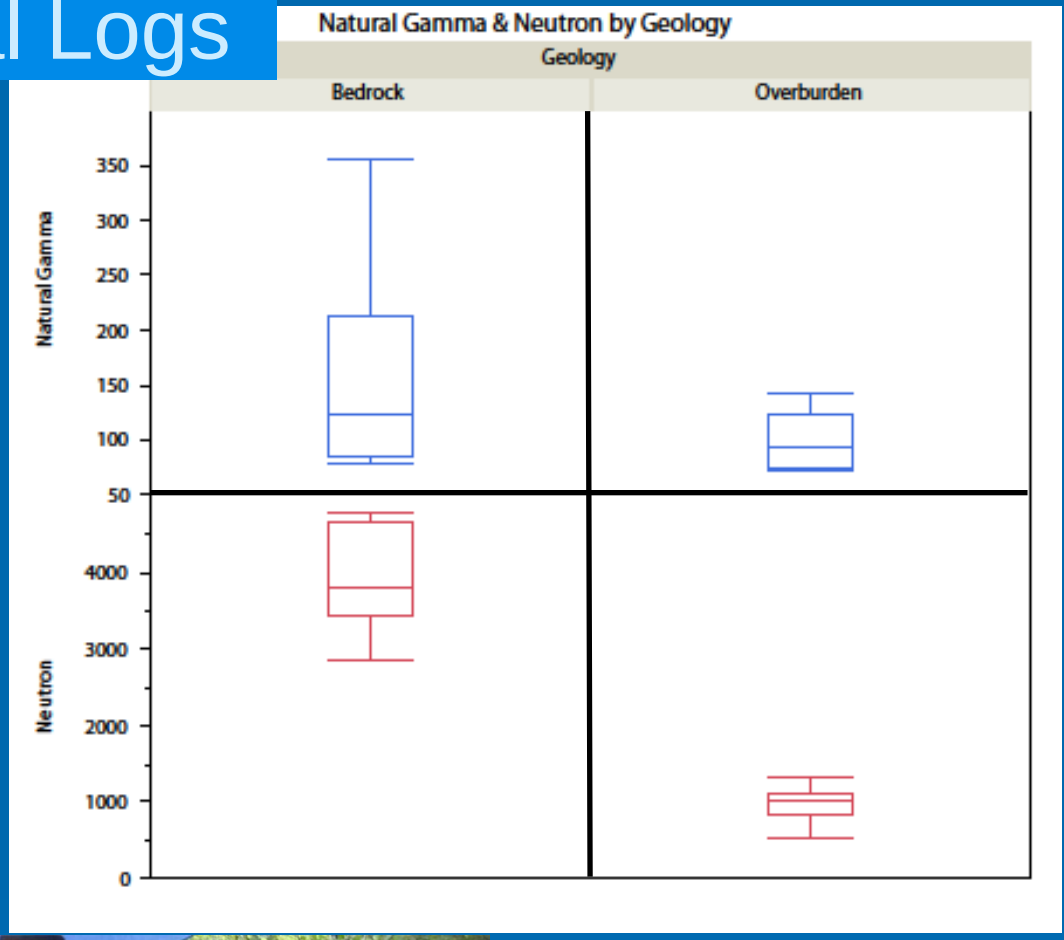




30 to 40 ft of signal penetration

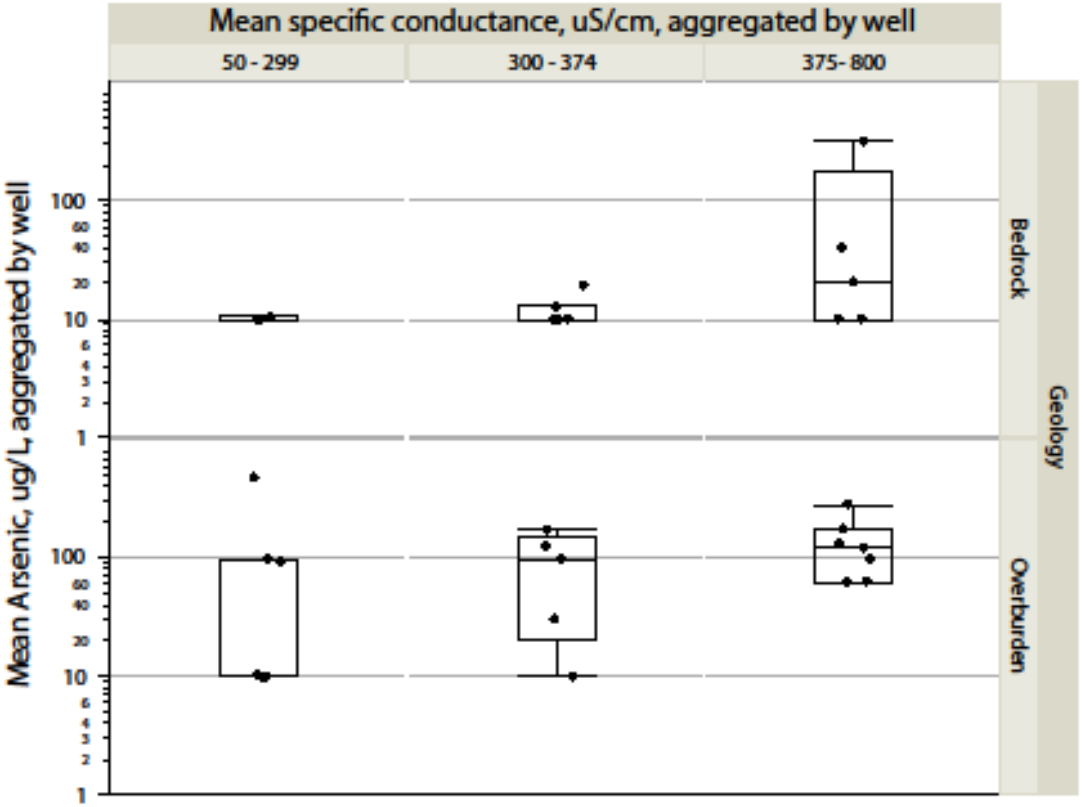
Borehole Geophysical Logs

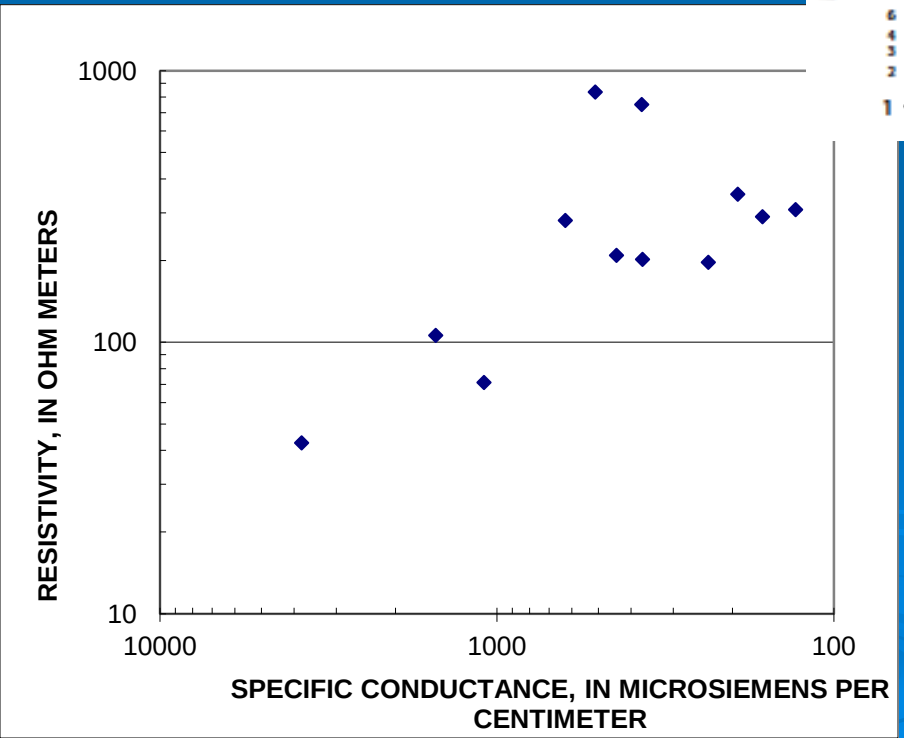




USGS

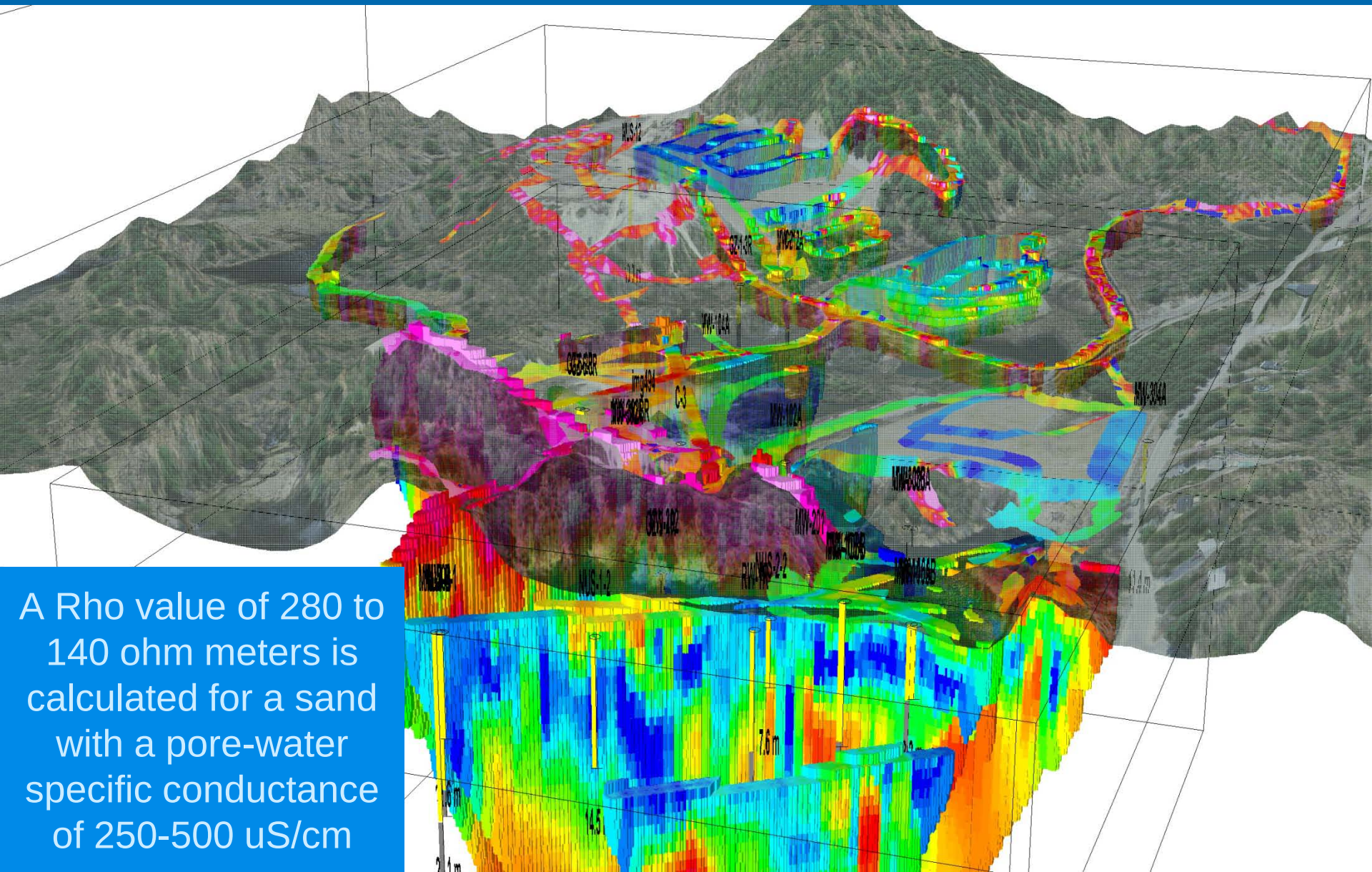
Specific conductance correlates well with leachate and arsenic contamination at this site



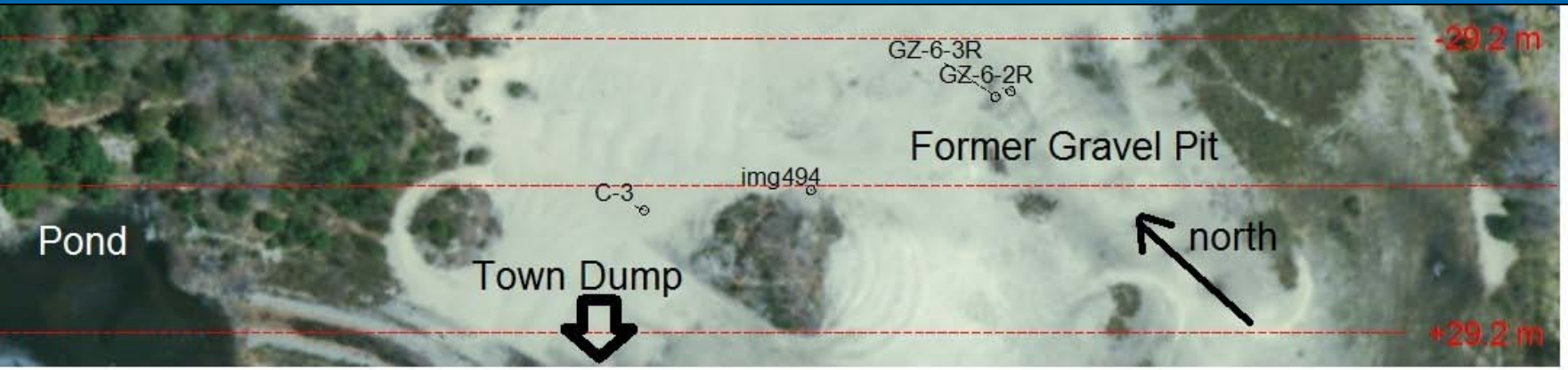


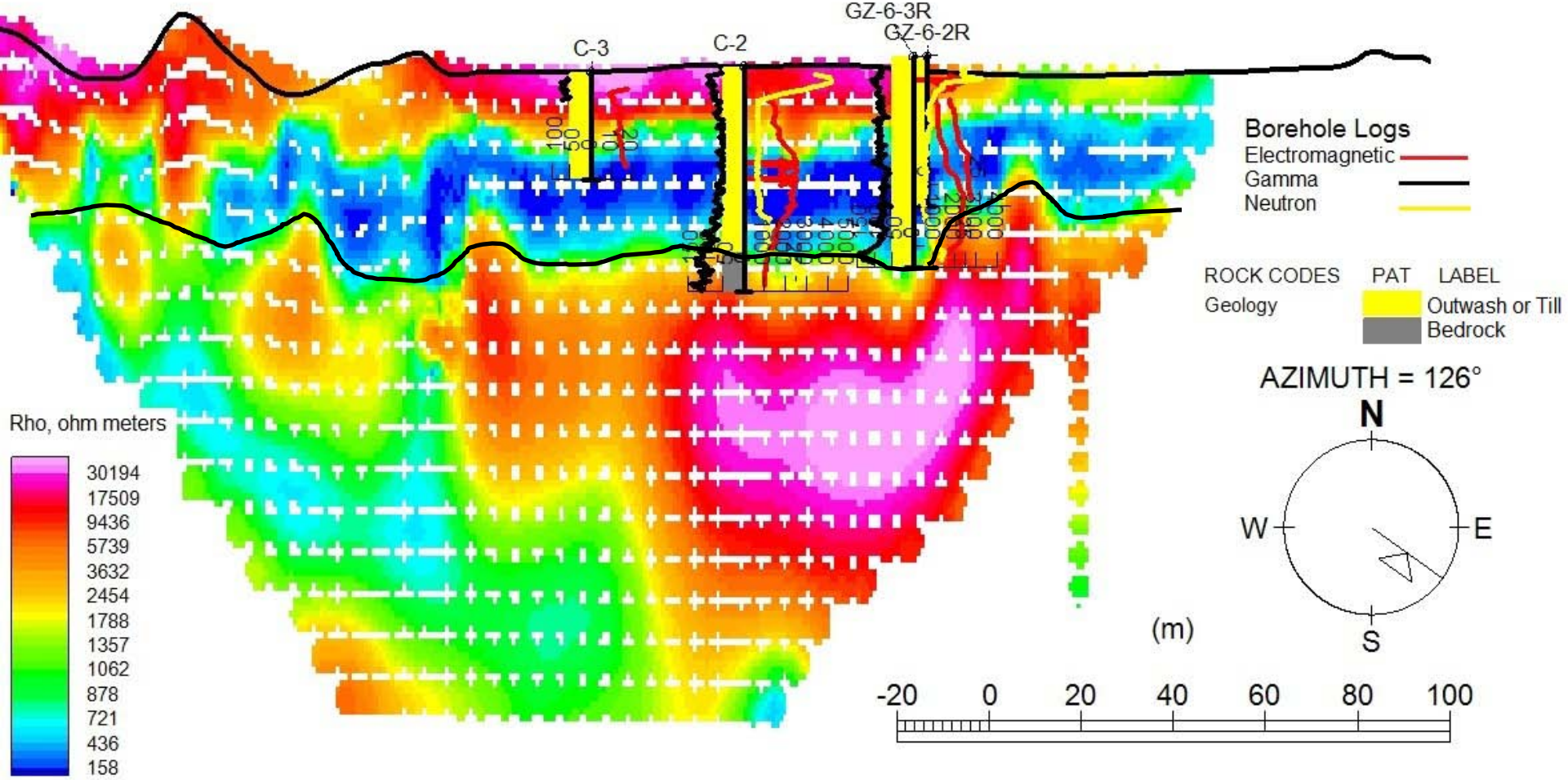
Example of how specific conductance is related to resistivity OFR 2010-1058

Combined, calibrated data

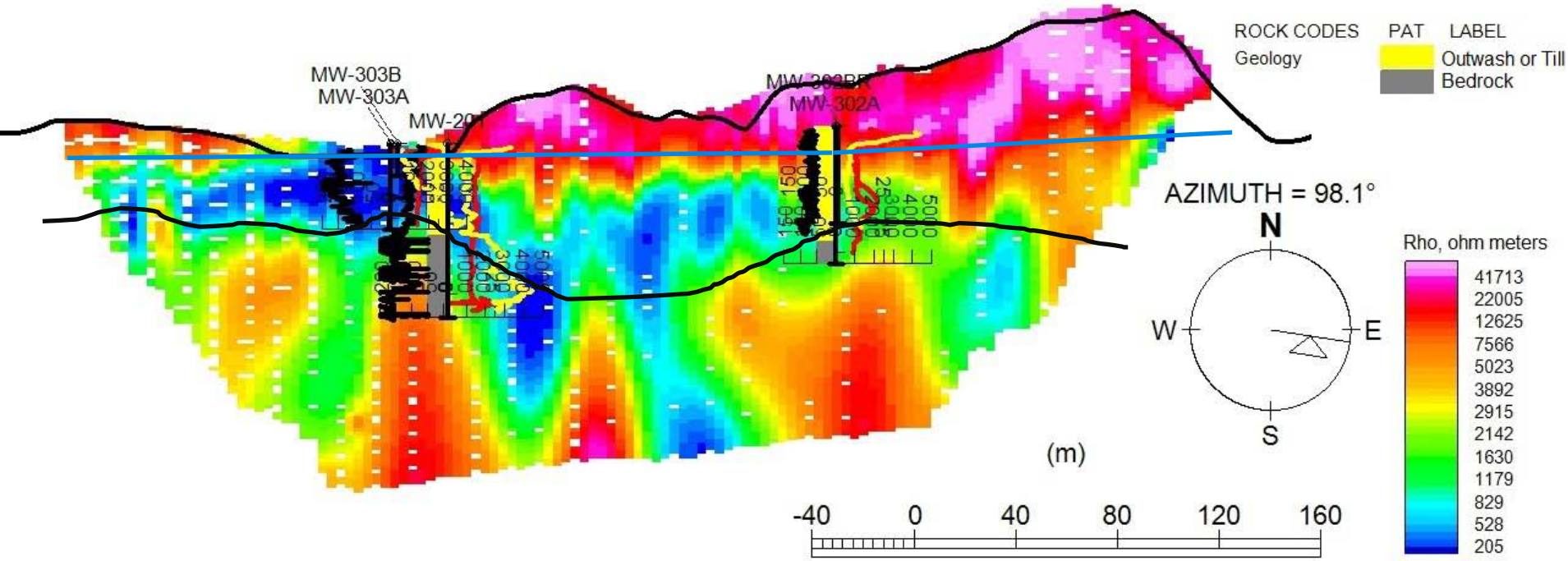


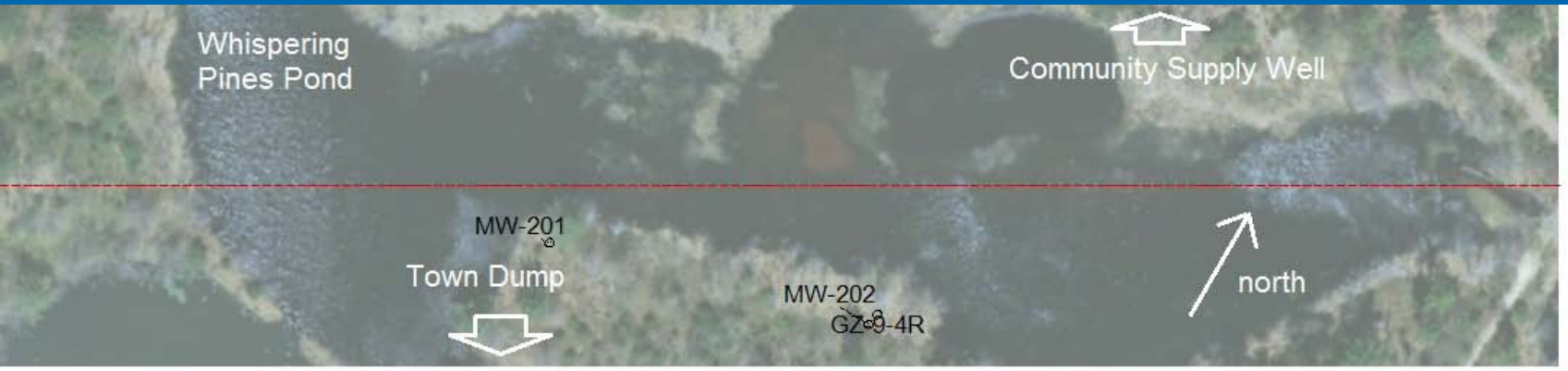
A Rho value of 280 to 140 ohm meters is calculated for a sand with a pore-water specific conductance of 250-500 uS/cm

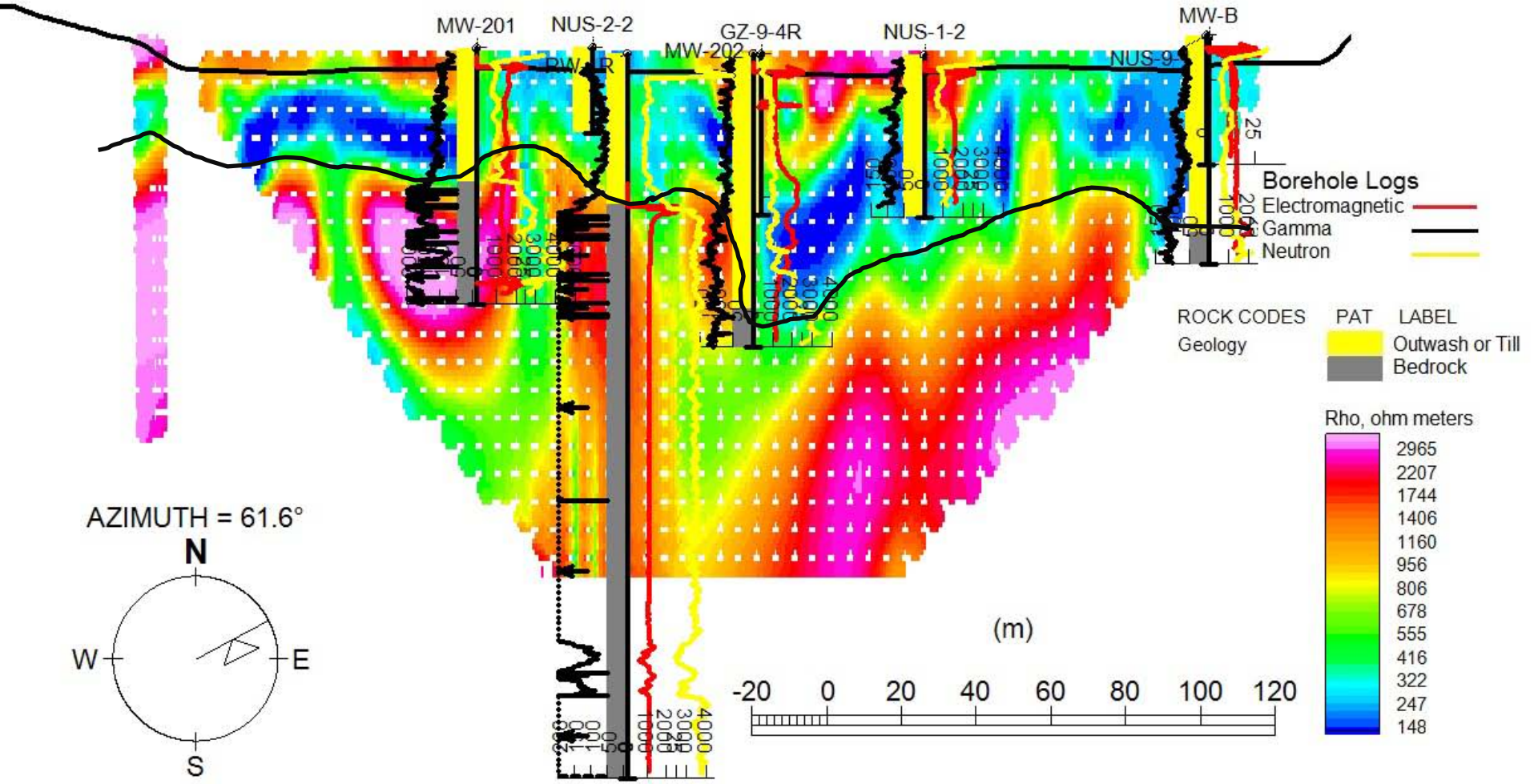

-29.2 m
GZ-6-3R
GZ-6-2R
Former Gravel Pit
img494
C-3
Pond
north
Town Dump
+29.2 m


GZ-6-3R
GZ-6-2R
C-3
C-2
Borehole Logs
Electromagnetic
Gamma
Neutron
ROCK CODES
PAT
LABEL
Geology
Outwash or Till
Bedrock
AZIMUTH = 126°
N
W
E
S
Rho, ohm meters
30194
17509
9436
5739
3632
2454
1788
1357
1062
878
721
436
158
(m)
-20
0
20
40
60
80
100

Borehole Logs
Electromagnetic
Gamma
Neutron

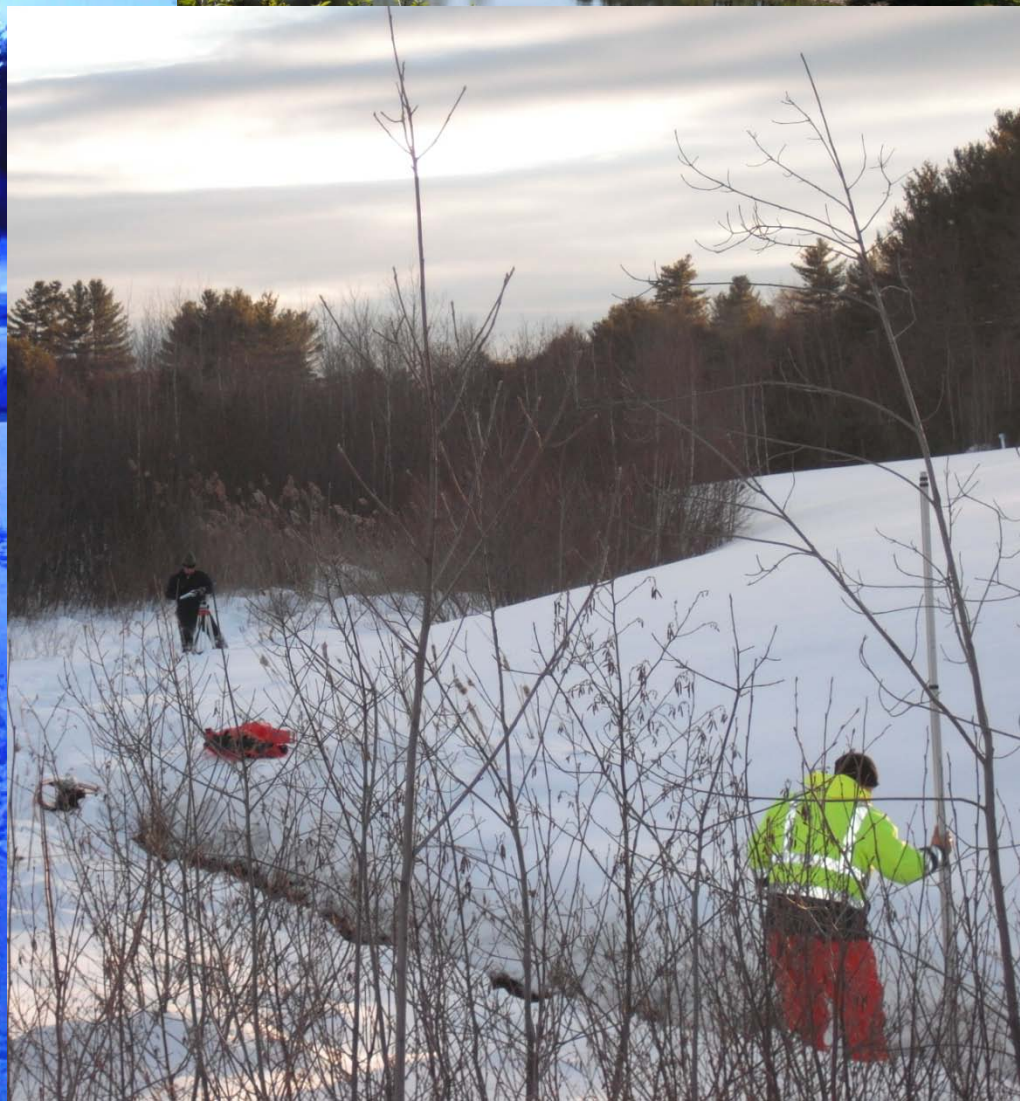



Whispering
Pines Pond
Community Supply Well
MW-201
Town Dump
MW-202
GZ-9-4R
north


MW-201
NUS-2-2
GZ-9-4R
MW-202
NUS-1-2
MW-B
Borehole Logs
Electromagnetic
Gamma
Neutron
ROCK CODES
PAT
LABEL
Geology
Outwash or Till
Bedrock
Rho, ohm meters
2965
2207
1744
1406
1160
956
806
678
555
416
322
247
148
AZIMUTH = 61.6°
N
W
E
S
(m)
-20
0
20
40
60
80
100
120

Conclusions

- Dissolved arsenic is variable
- Arsenic mobility is attributable to reductive dissolution
- Arsenic occurs with conductive groundwater at this site
- Geophysical surveys helped delineate:
  - Impacted groundwater
  - Hydrogeologic framework
  - Groundwater flowpaths



Questions?