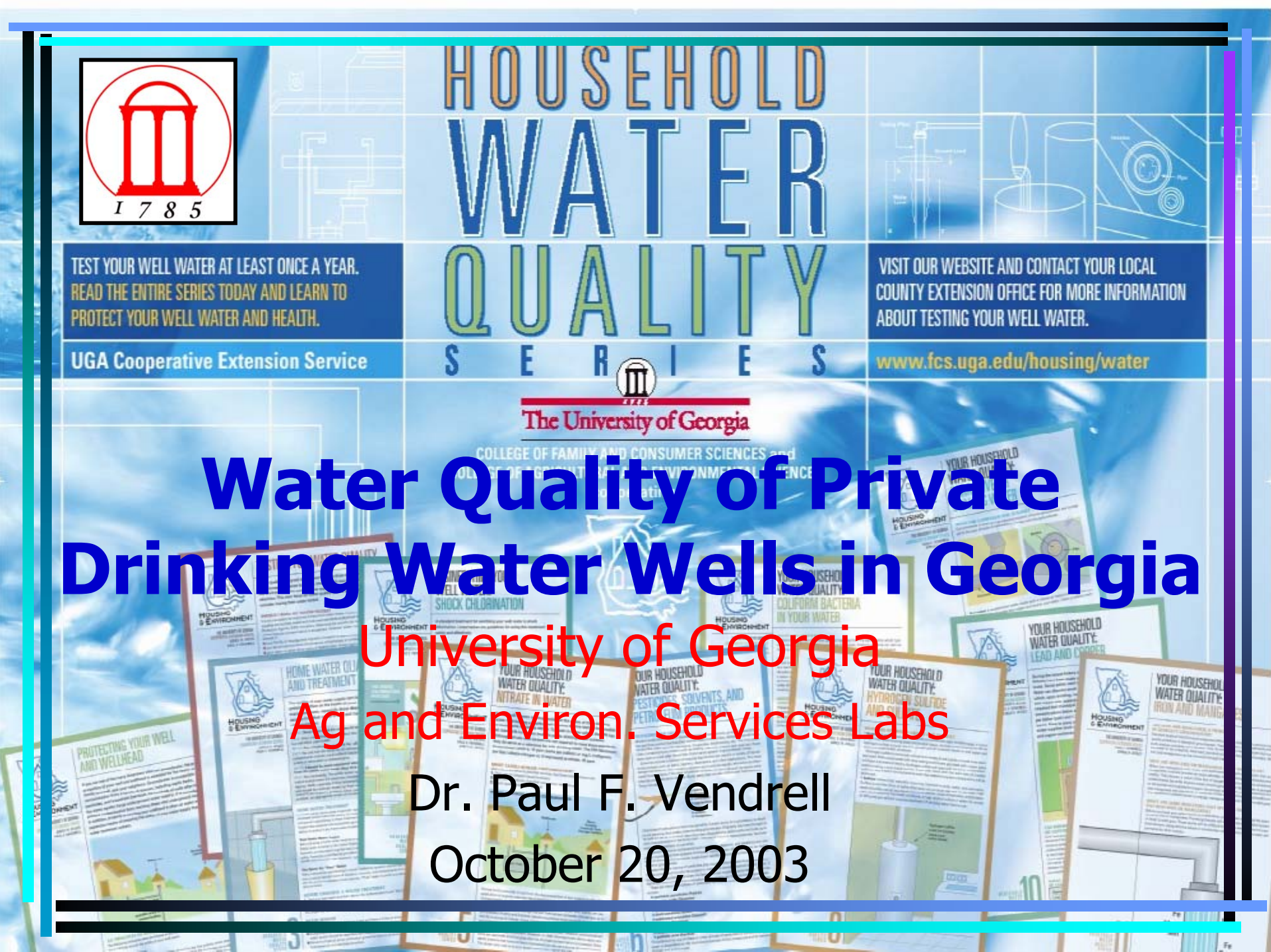


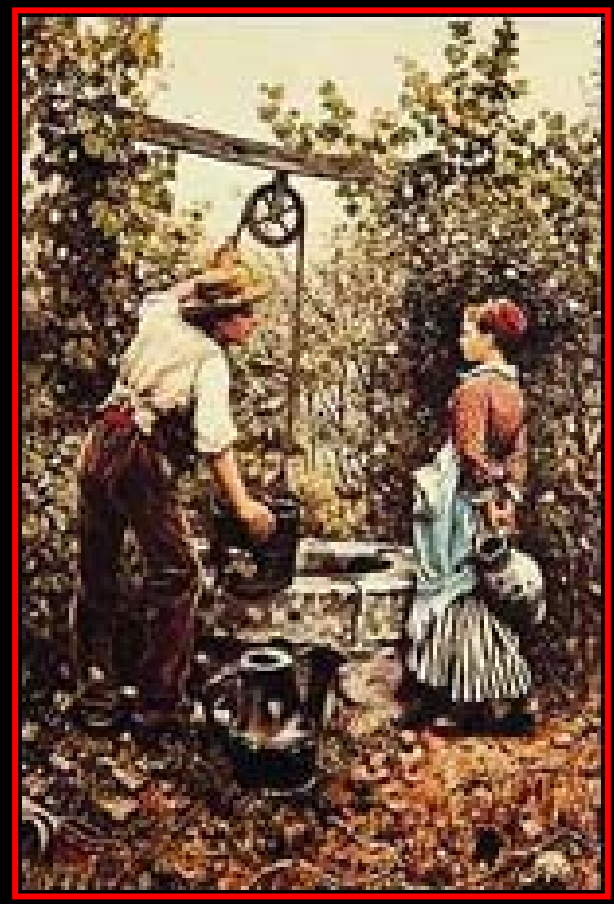
Water Quality of Private Drinking Water Wells in Georgia

University of Georgia
Ag and Environ. Services Labs
Dr. Paul F. Vendrell

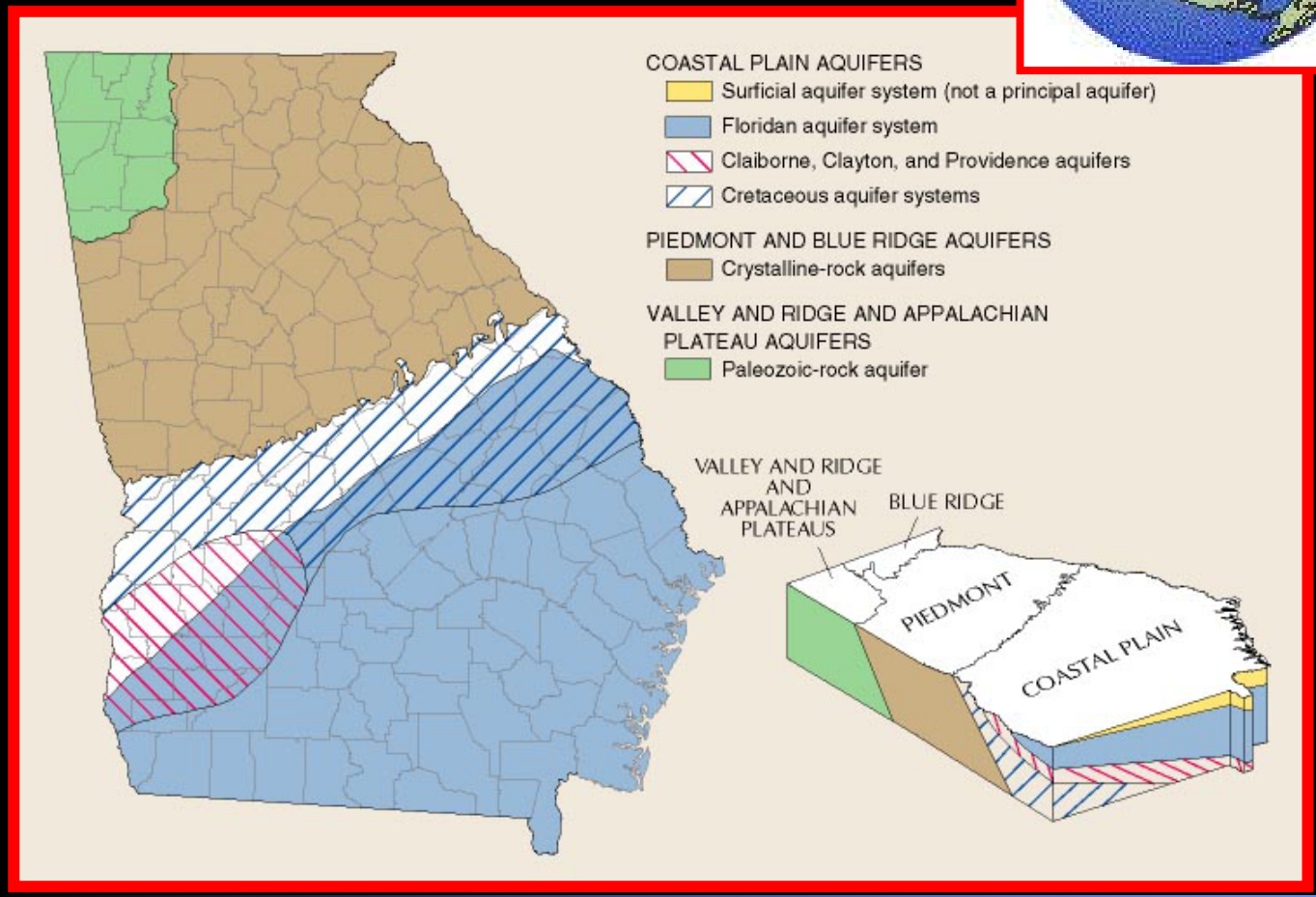
October 20, 2003

Agenda

- Georgia's aquifers
- Well types
- Groundwater quality data
- Quality parameters
- Problem water
- Conclusions
- New testing package
- New series of water quality circulars



Aquifers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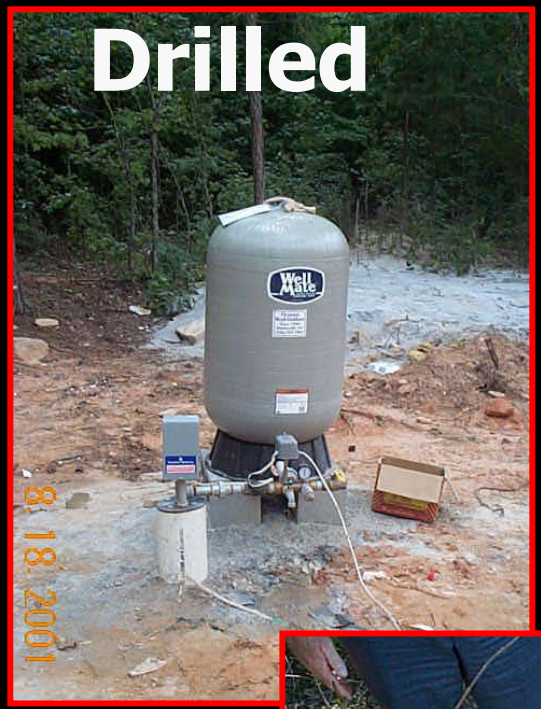
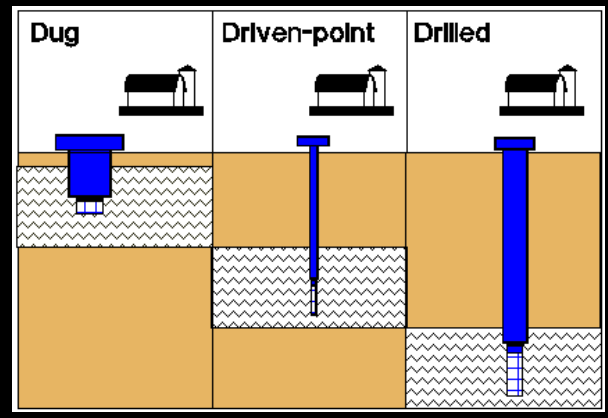
Well Types


Drilled
8. 18. 2001

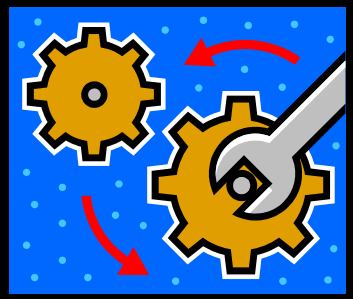

Dug
Driven-point
Drilled


Springs


Bored
6. 6. 2000

CES Agricultural and Environmental Services Laboratories

- Homeowner well water 1992 to 2002
- 0ver 12,800 total samples
- 2,700 Nitrate test
- Depths from 1 to 1000 feet



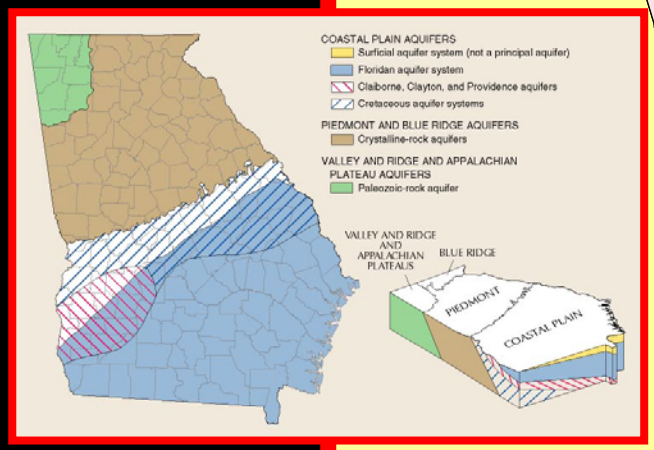
Water Quality Parameters

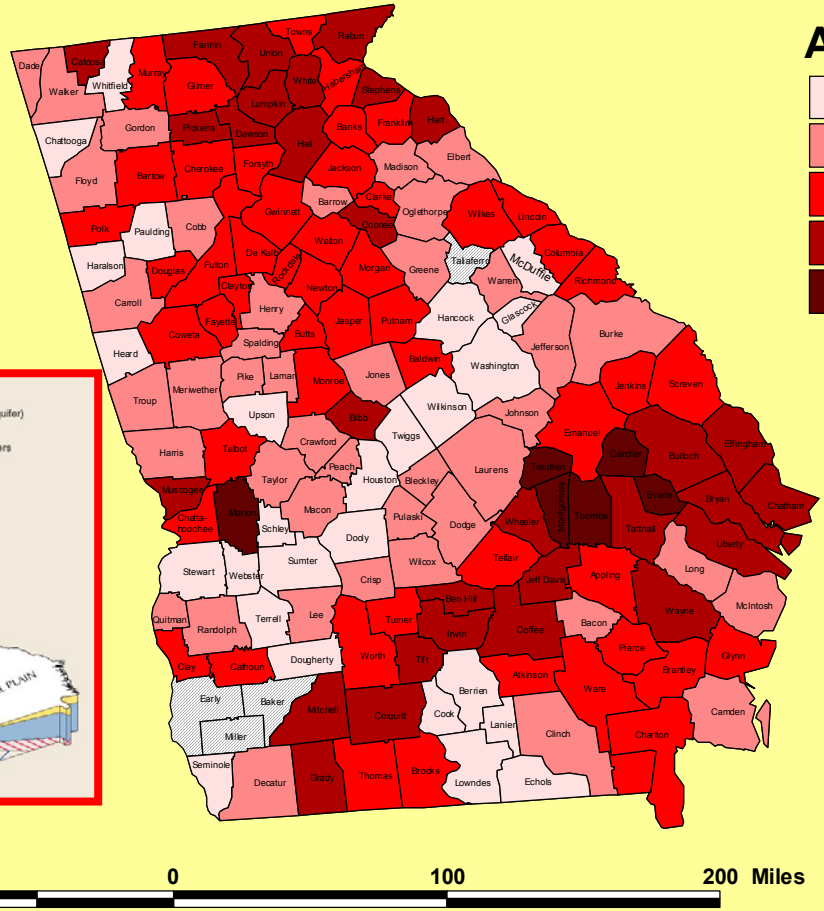
- pH
- Hardness
- Nitrate-N
- Aluminum
- Copper
- Lead
- Iron
- Manganese
- Cadmium
- Chromium
- Zinc
- Sulfate
- Chloride
- Phosphorus
- Sodium

Samples Above Critical Levels

Parameter	Maximum Level	# Above	Total Number	% Above
Low pH	<6.5	2656	12,881	30.1
High pH	>8.5	116	12,881	0.9
Aluminum	>0.2 mg/l	824	12,881	6.4
Copper	>1.0 mg/l	721	12,881	5.6
Lead	>15 ug/l	79	1802	4.4
Iron	>0.3 mg/l	2190	12,881	17.0
Nitrate	>10 mg/l	100	2769	3.6
Nitrate	>5 mg/l	199	2769	7.2

Well Depth (feet)





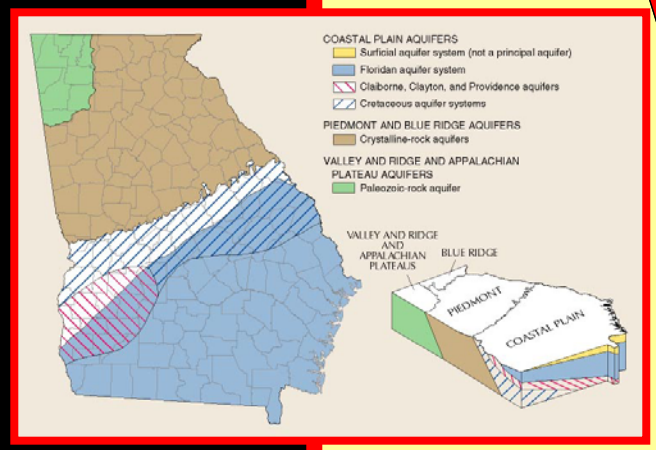
Average Depth

- 55 - 150
- 150 - 210
- 210 - 260
- 260 - 365
- 365 - 526

100 0 100 200 Miles

N
W E
S

pH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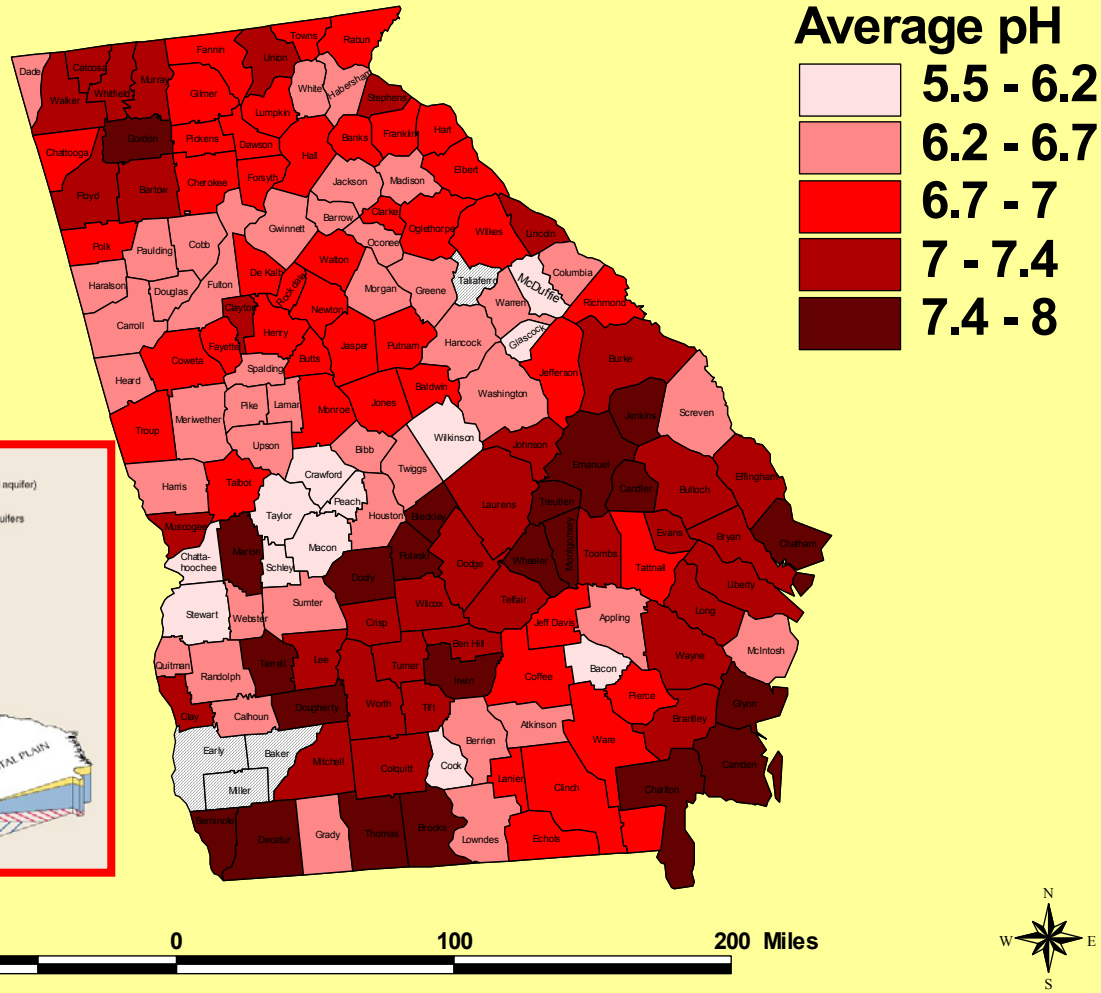
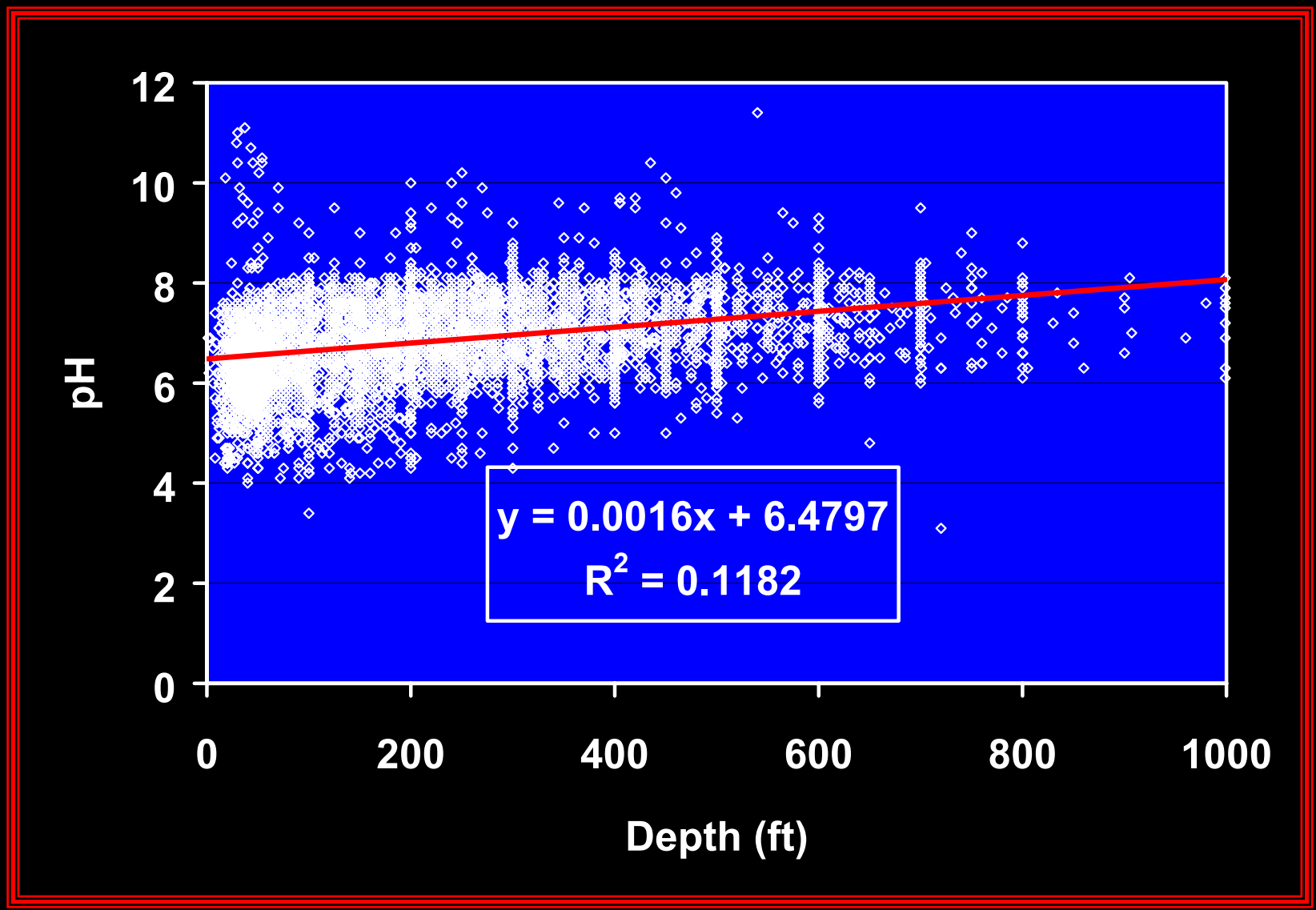
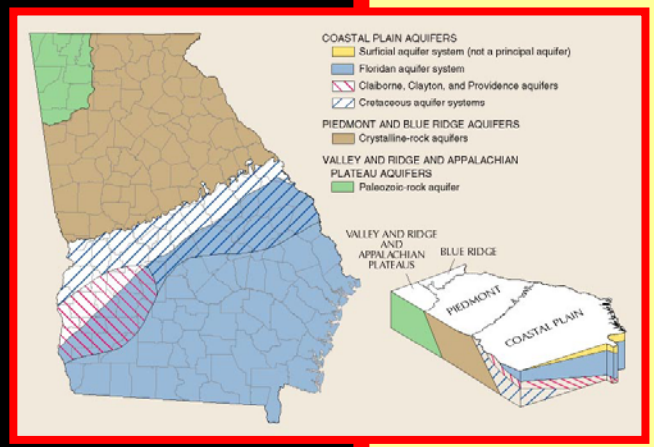

Average pH
5.5 - 6.2
6.2 - 6.7
6.7 - 7
7 - 7.4
7.4 - 8
100
0
100
200 Miles
N
W
E
S

pH and Depth


12
10
8
6
4
2
0
pH
0
200
400
600
800
1000
Depth (ft)
y = 0.0016x + 6.4797
R2 = 0.1182

Copper (mg/l)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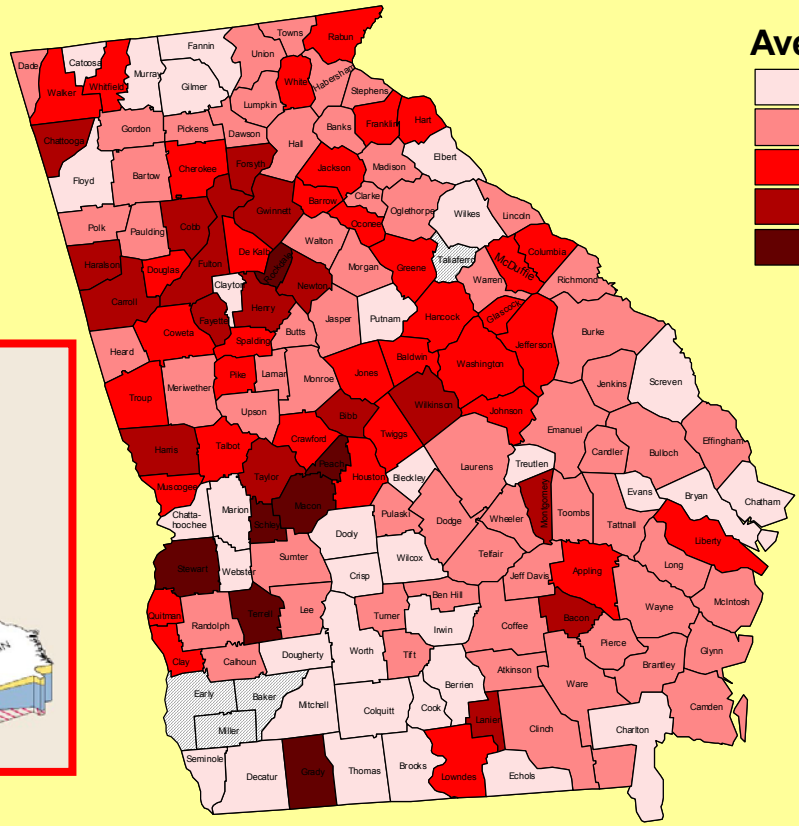
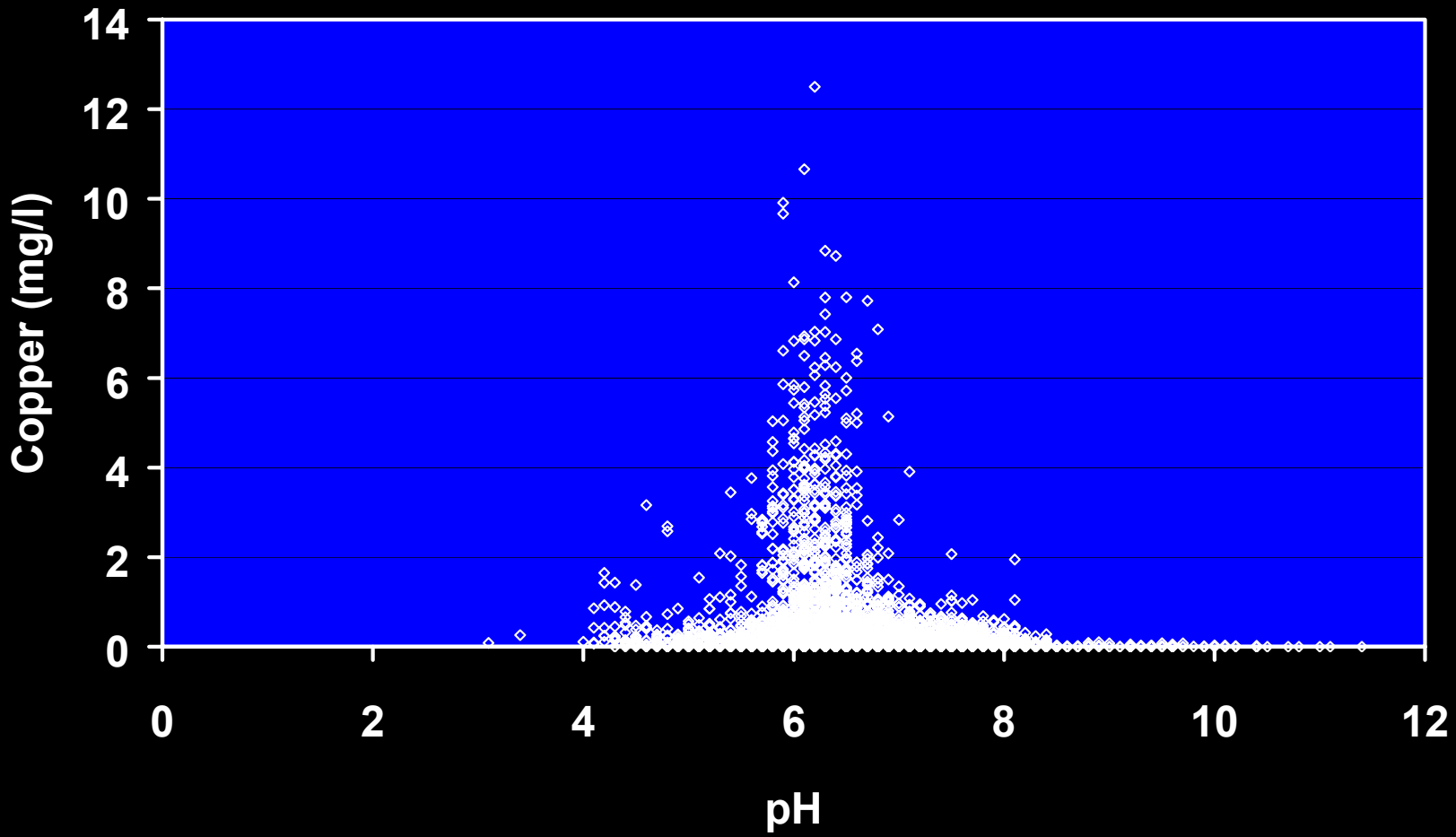
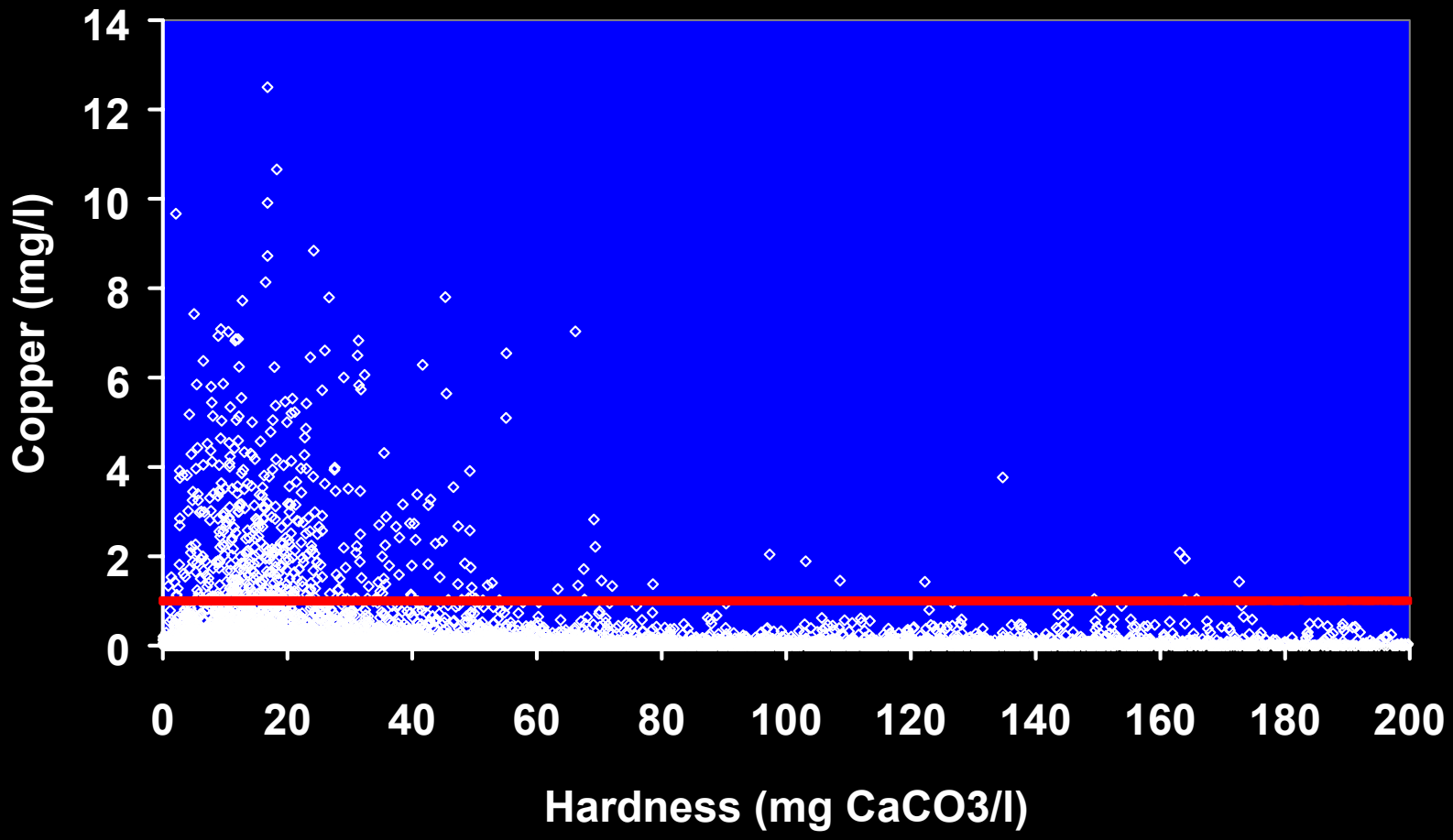

Average Copper
0.004 - 0.015
0.015 - 0.029
0.029 - 0.048
0.048 - 0.074
0.074 - 0.306
100 0 100 200 Miles
N
W
E
S

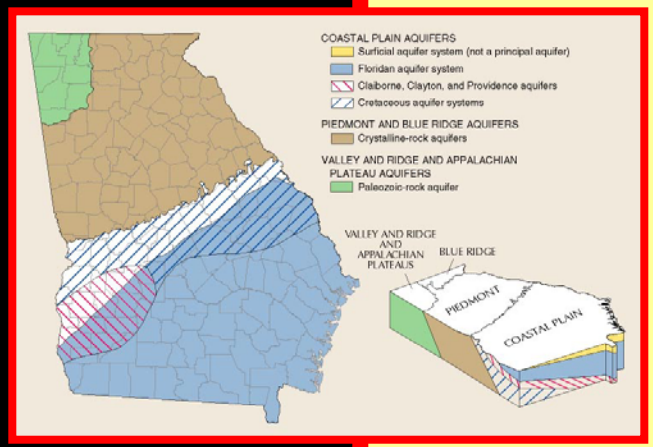
Copper and pH

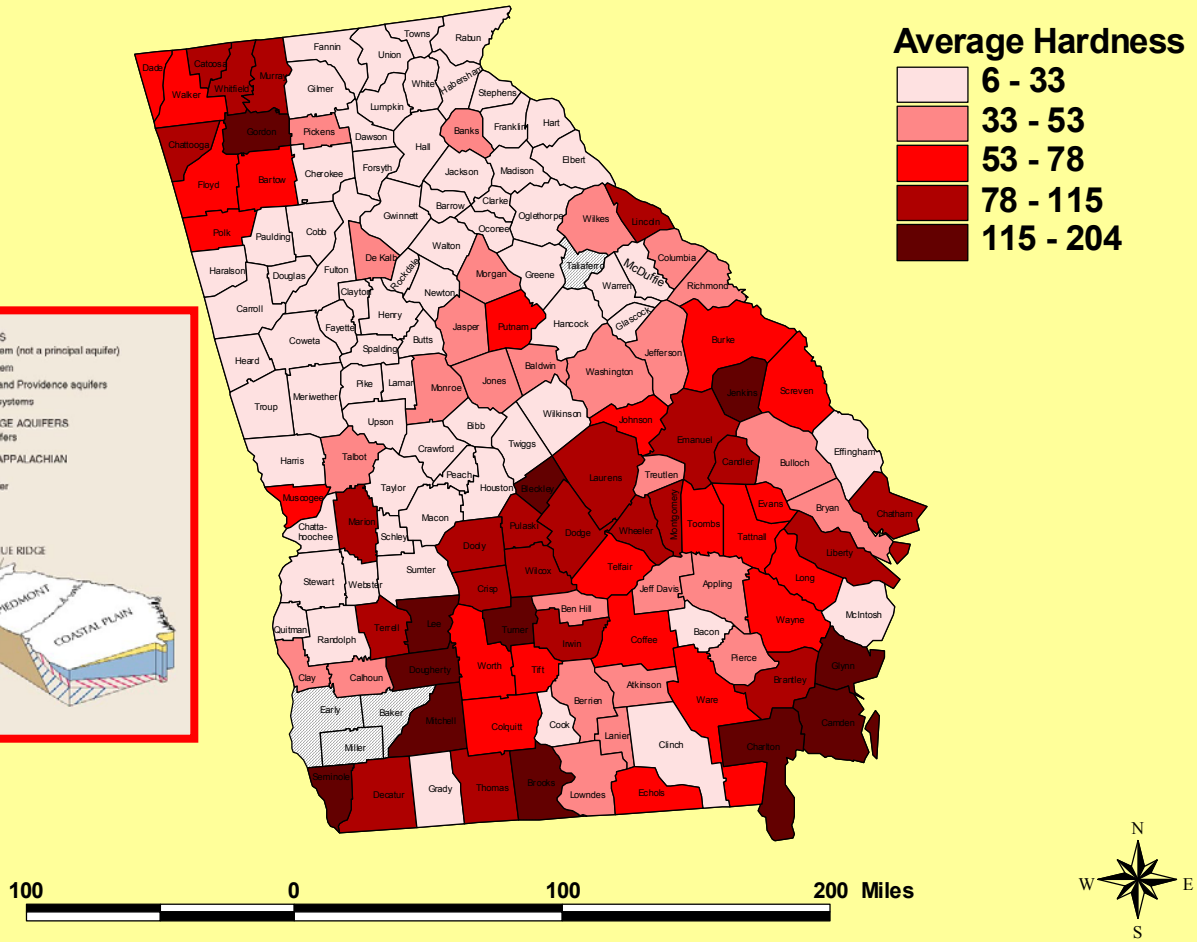


Copper and Hardness

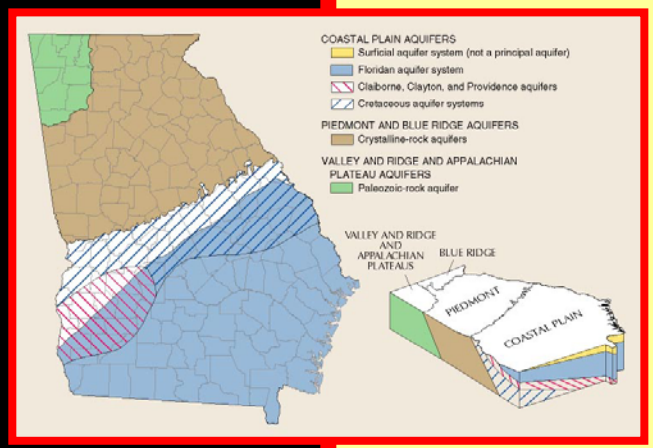


Hardness (mg-CaCO3/l)





Lead (ug/l)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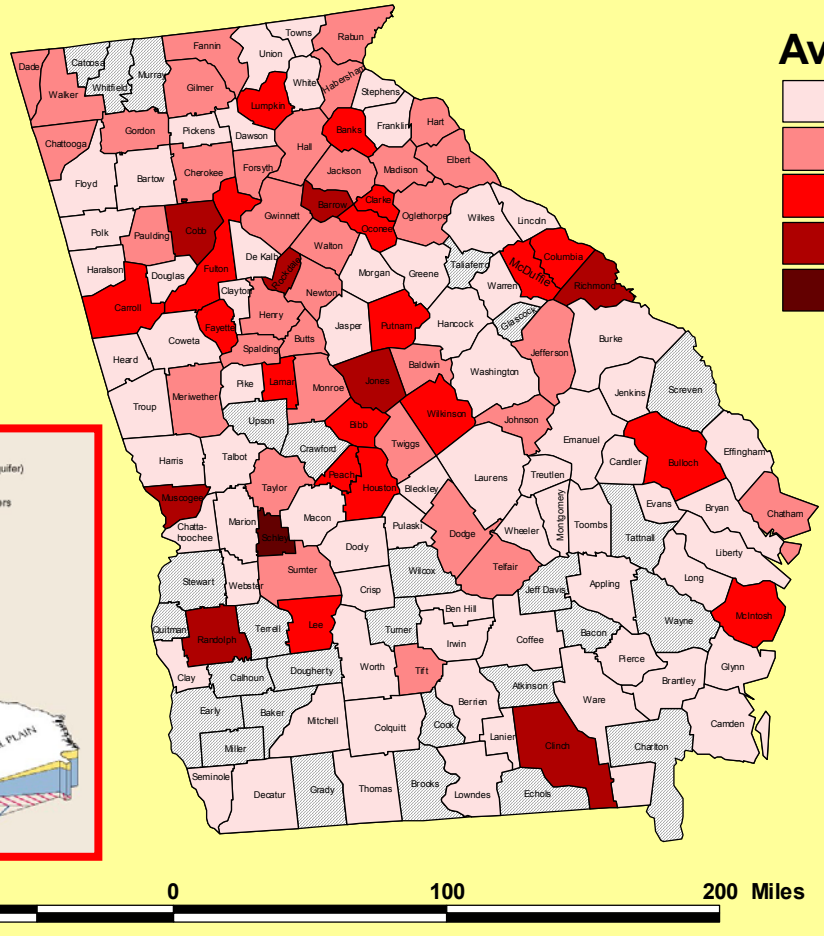
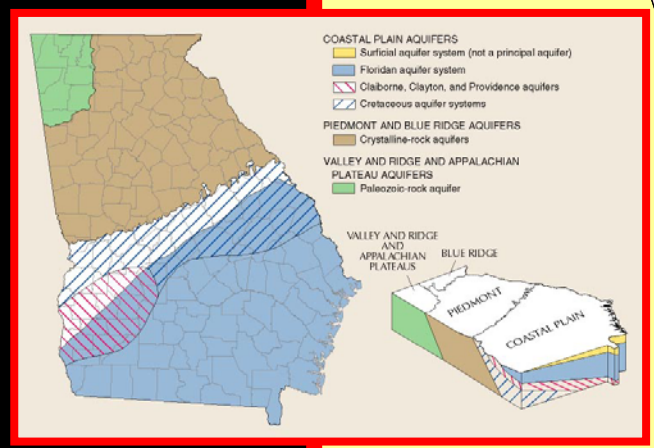
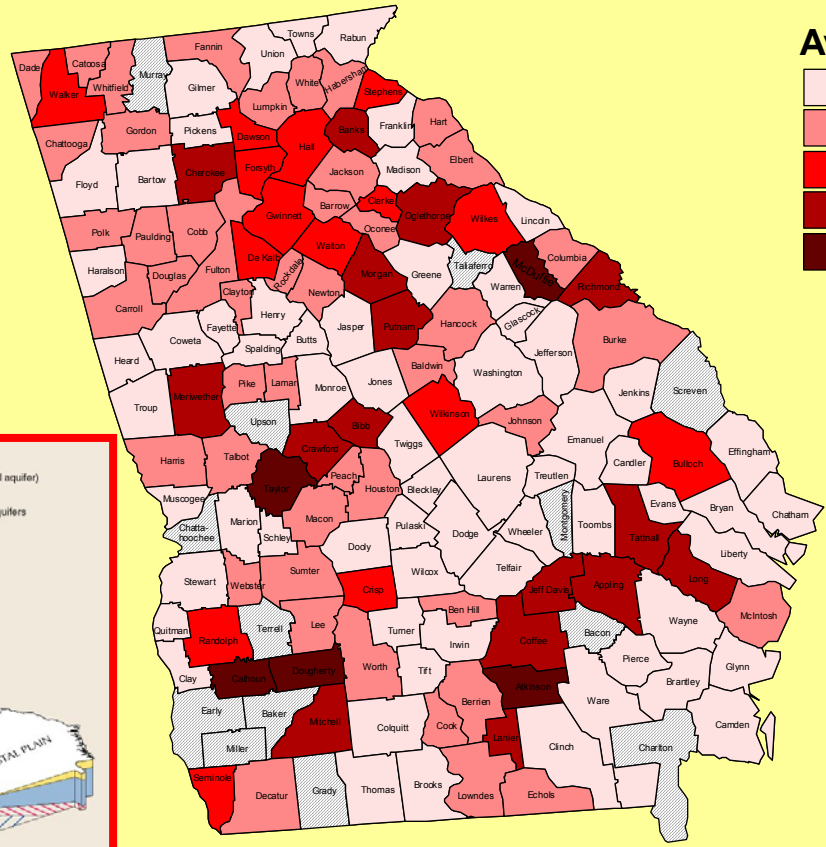
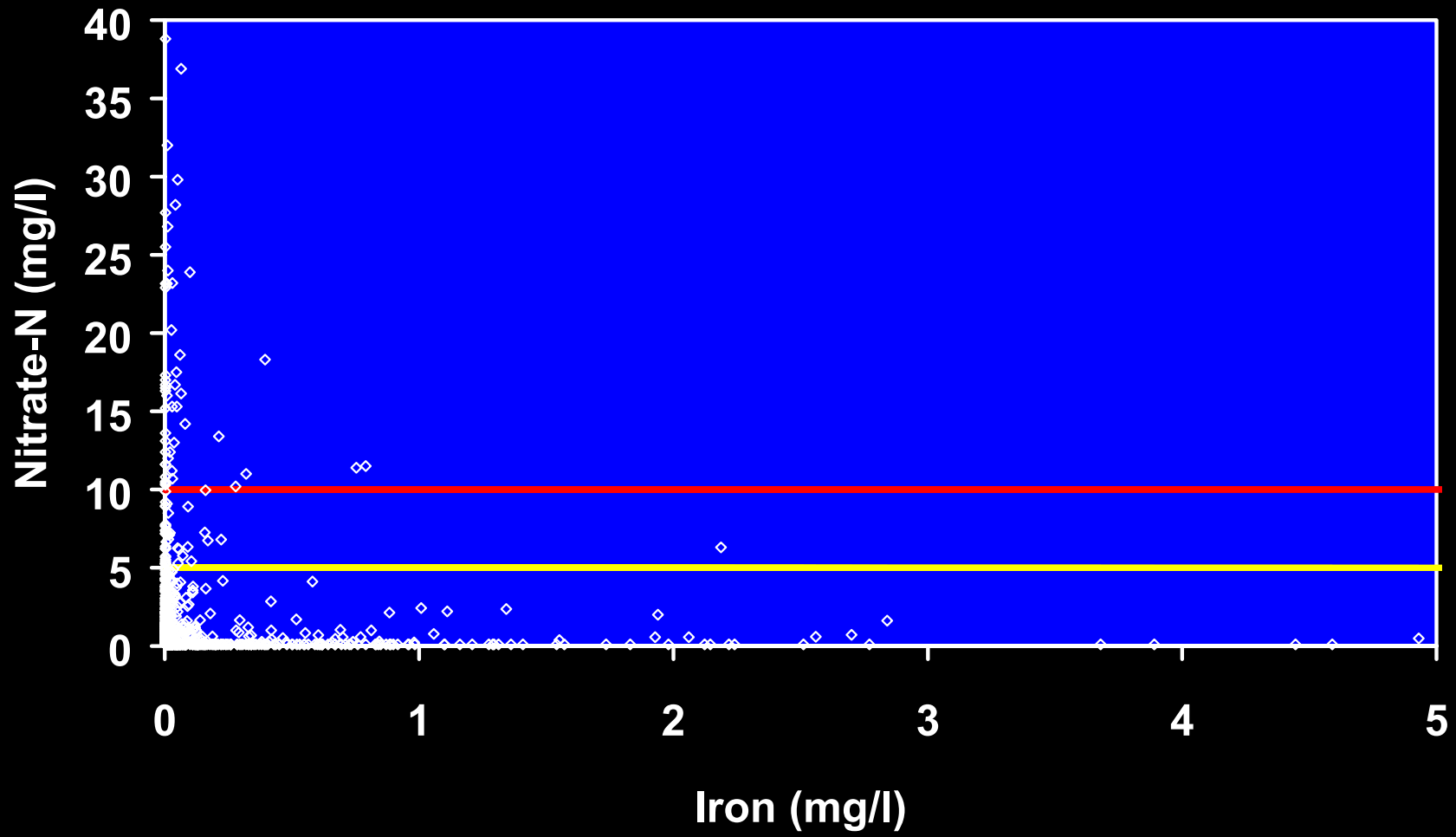

Average Lead
1 - 1.9
1.9 - 3.7
3.7 - 5.9
5.9 - 10.9
10.9 - 22.5
100 0 100 200 Miles
N
W
E
S

Nitrate-N (mg/l)

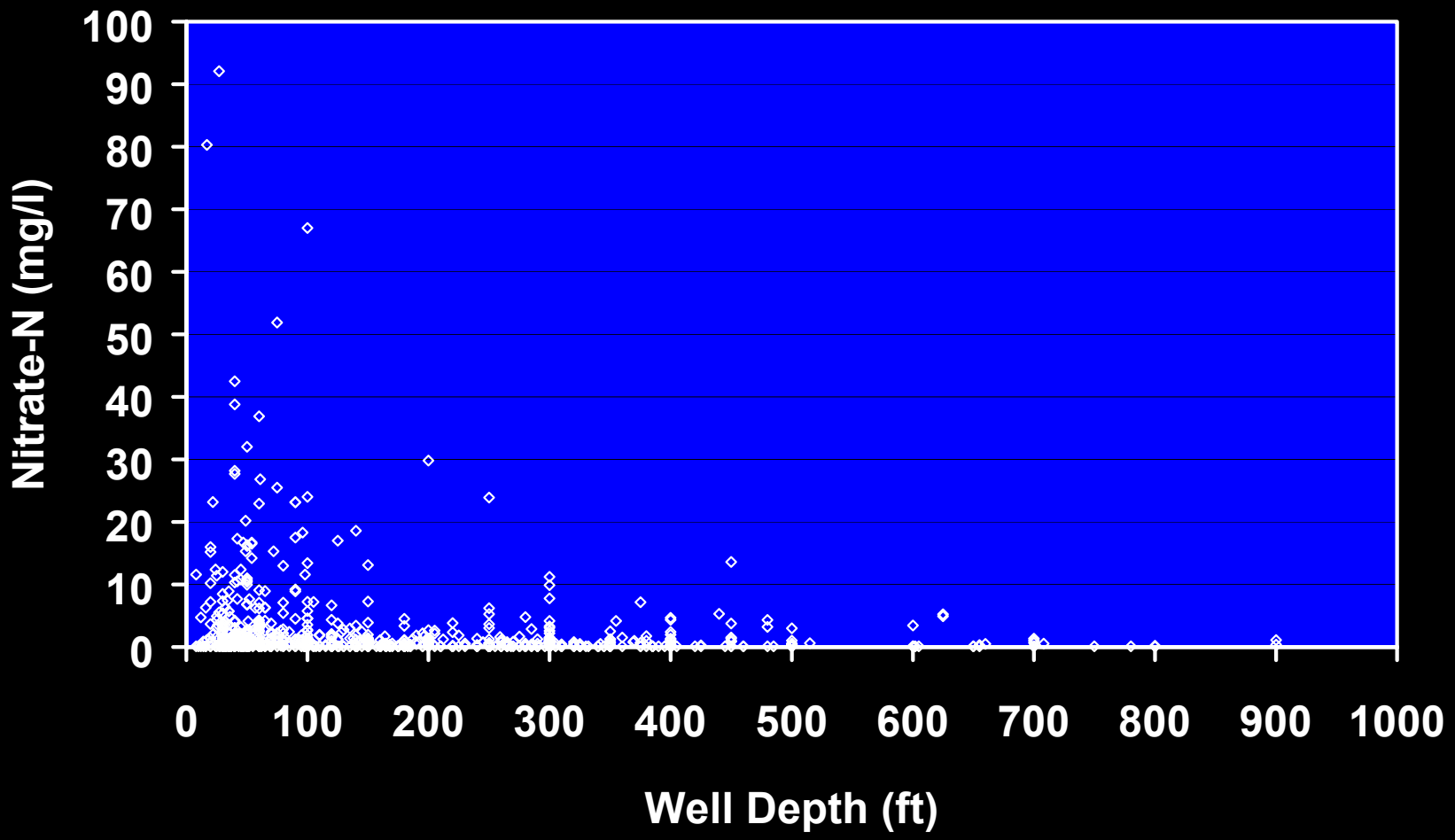




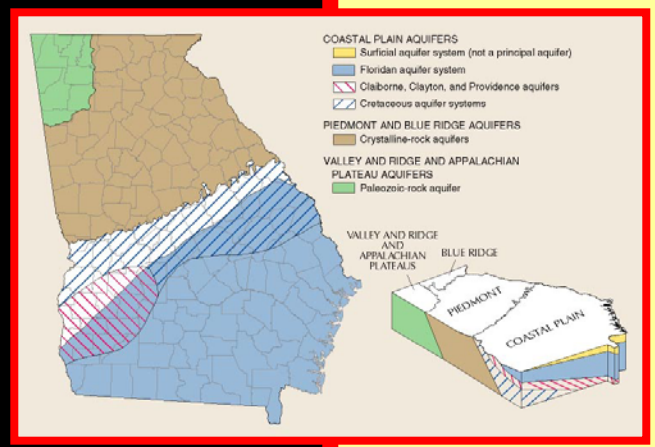
Nitrate and Iron……Mutual Exclusion



Nitrate and Depth



Iron (mg/l)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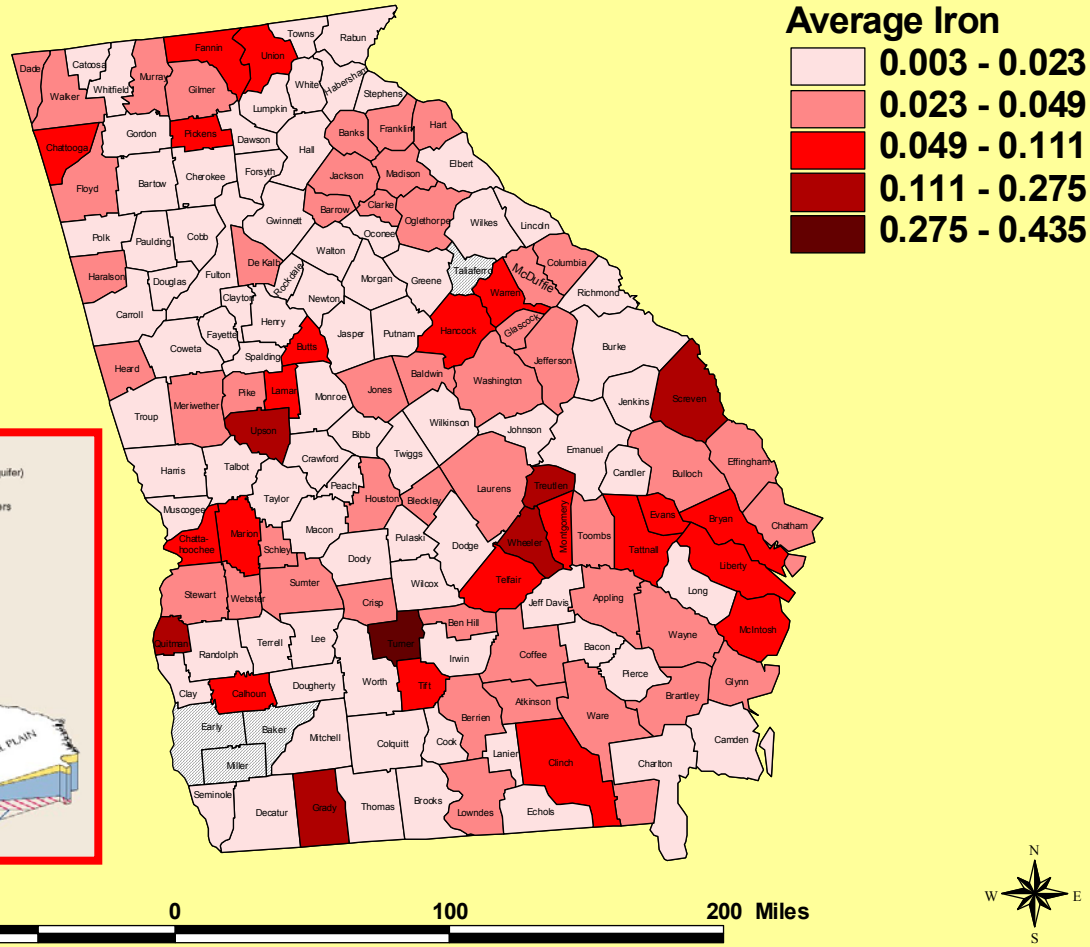
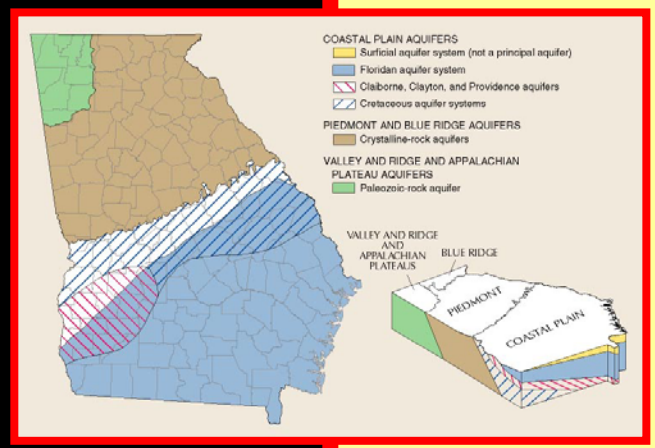
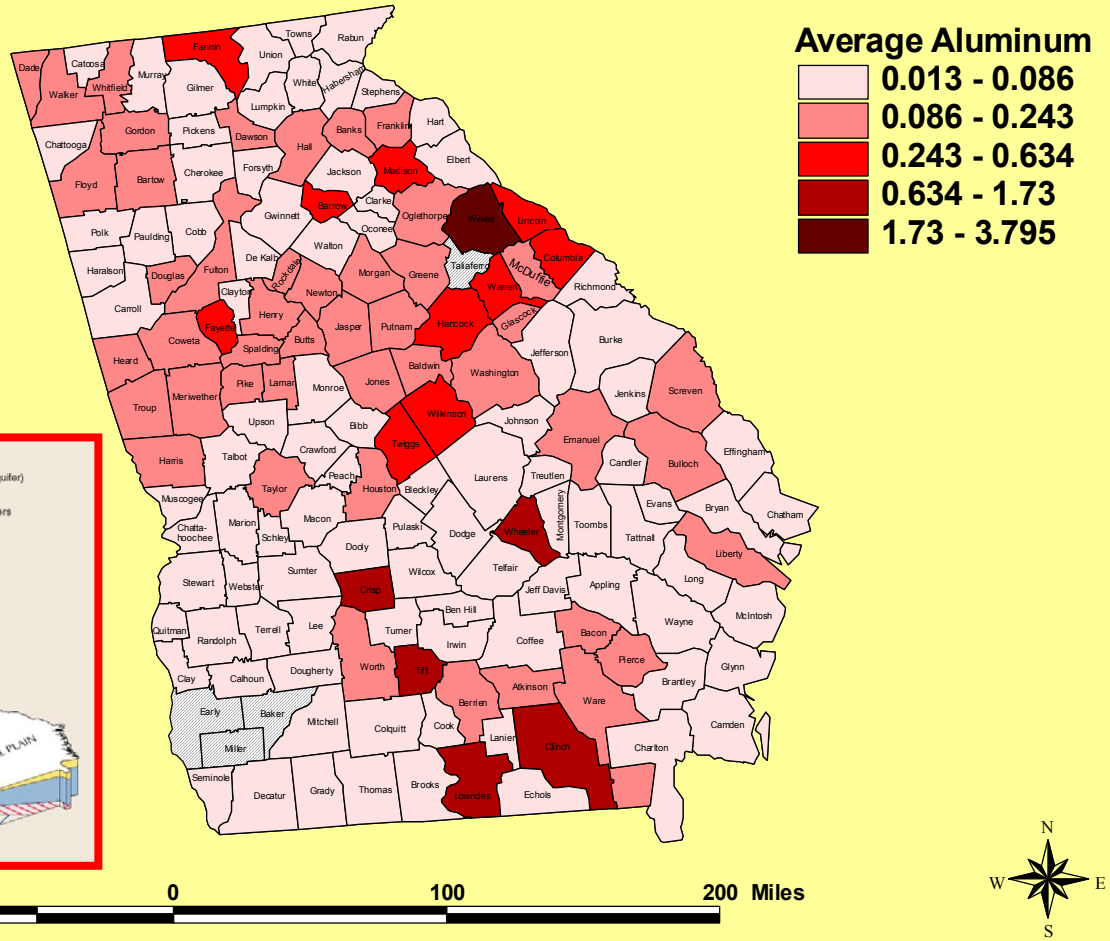
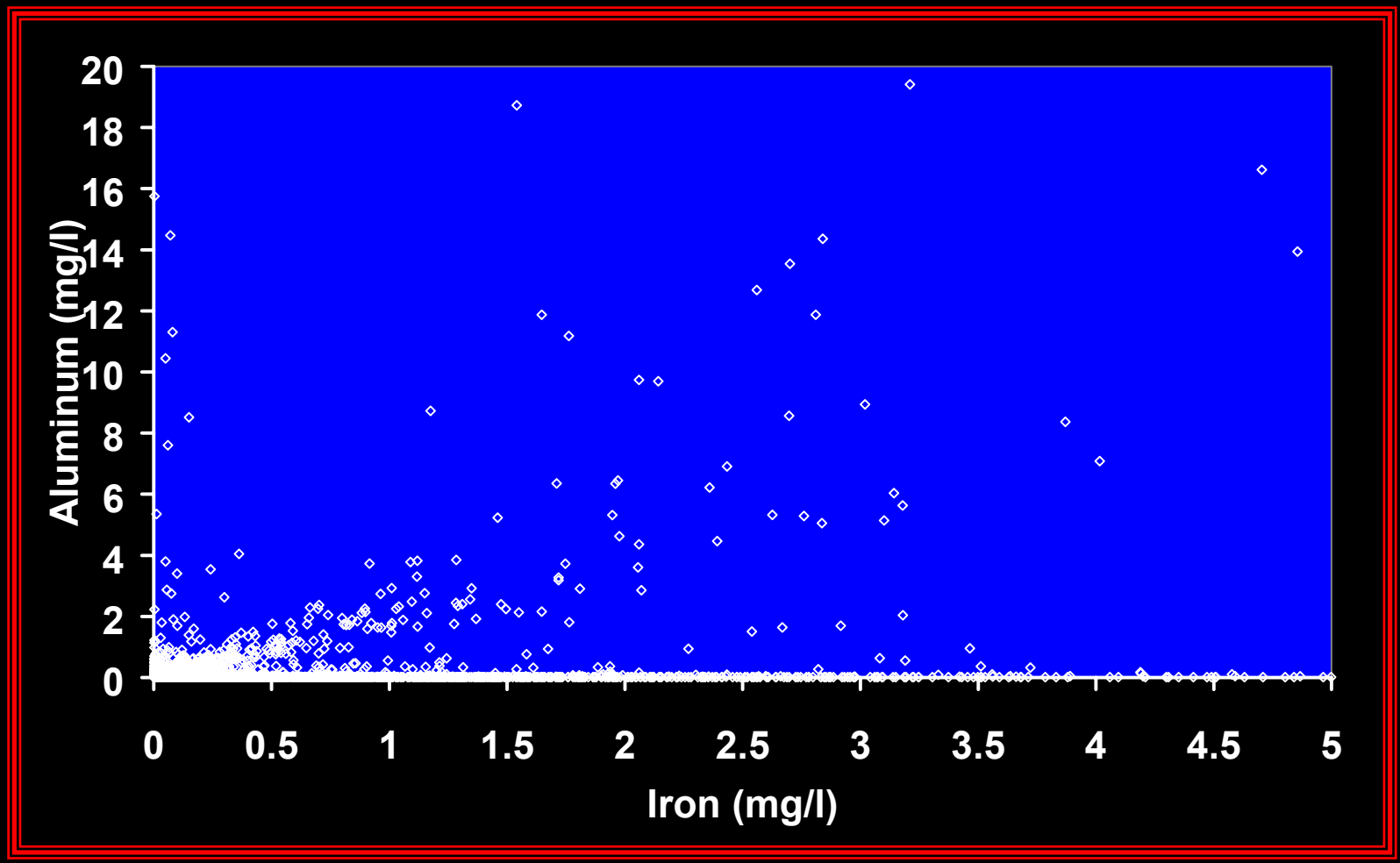

Average Iron
0.003 - 0.023
0.023 - 0.049
0.049 - 0.111
0.111 - 0.275
0.275 - 0.435
100 0 100 200 Miles
N
W
E
S

Aluminum (mg/l)

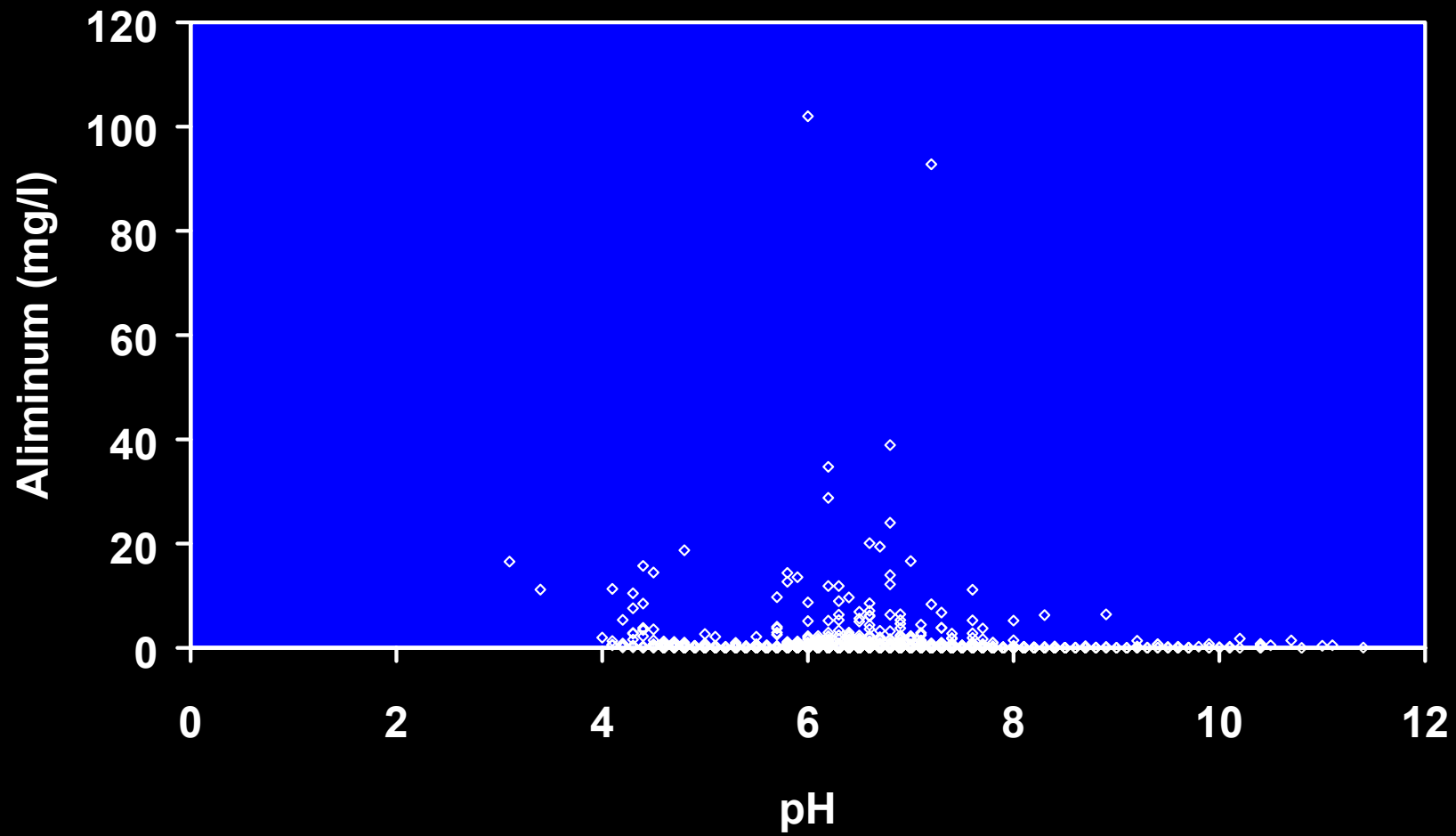




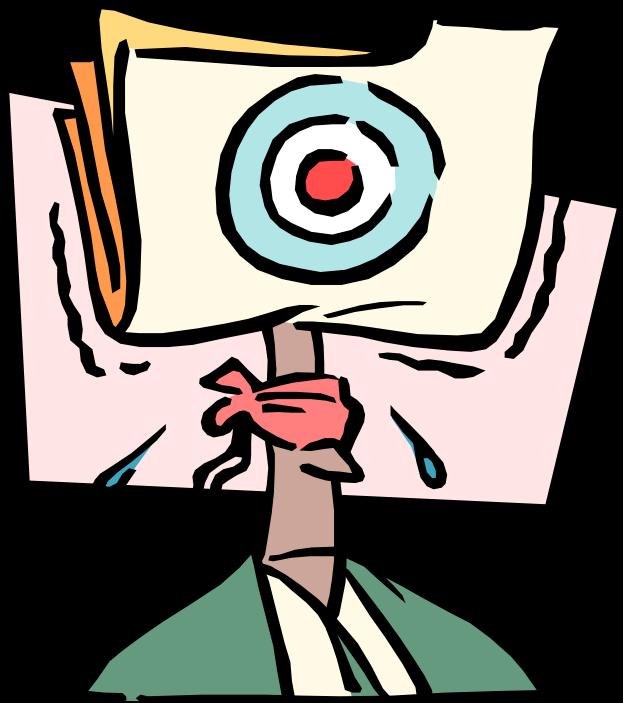
Aluminum and Iron



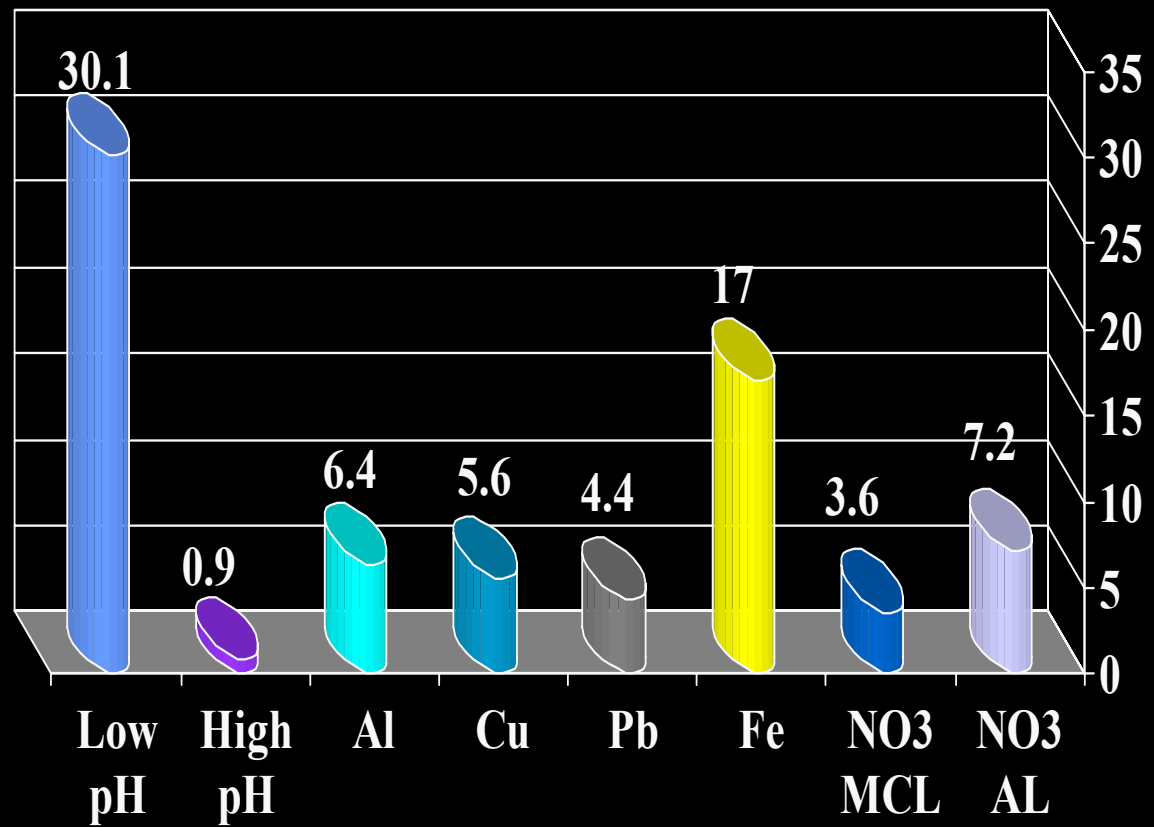
Aluminum and pH



Summary and Conclusions



% Above Maximum Levels



pH

- 30% of the wells tested had pH below 6.5
- The fall line is an area of shallow wells with low pH
- Low pH water can be corrosive and cause elevated copper and lead.
- However, water hardness seems to be better related to elevated copper and lead.

Lead and Copper

- 5.6% of the samples tested had high copper levels
- 4.4% had high lead
- These elevated levels are in large due to corrosion of plumbing by low alkalinity and pH
- pH neutralization using calcium bases would help prevent high copper and lead or encourage the use of non-metallic plumbing

Iron

- 17% of wells tested had problem levels of iron
- High iron is a statewide problem
- However, high iron water may be protecting Georgia's groundwater from nitrate contamination
- Iron is a treatable problem using chlorination or other oxidation process.

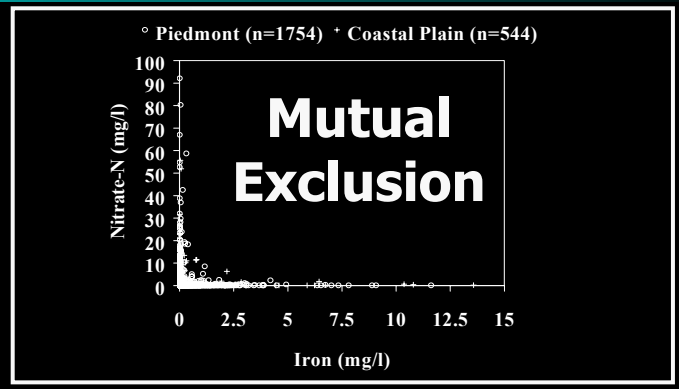
Aluminum

- 6% of the wells tested had high levels of aluminum
- Wells high in aluminum seem to be related to high iron and in some cases low pH
- The same reduction process that caused high iron may also cause high aluminum
- Iron removal will also reduce aluminum levels
- Some of these high aluminum levels may result from suspended clay particles and the method of analysis

Hardness

- Hard water is primarily in northwest and southeast Georgia.
- Groundwater in the Piedmont and along the fall line is relatively soft.
- Low hardness water tends to have higher copper and lead along with low pH

Nitrate-N



- Approximately 7% of wells tested were above the action level for nitrate and 4% were above the maximum contaminant level.
- High nitrate levels are generally found in shallow wells that have low levels of iron
- The environmental process that add iron to water remove nitrate

Corrosive, Scaling or Balanced?

Corrosive

- Reduces the lifetime of the pump and plumbing
- Leaks
- Toxic metals can be leached from plumbing
- Stains on fixtures
- Metallic taste

Scaling

- Fills hot water heaters with solids
- Causes blockages in plumbing
- Reduces flow
- Spots on glassware, utensils, and dishes

1785

Causes for Corrosion (oxidation and dissolution)

- Low pH
- High carbon dioxide
- Low alkalinity
- Low dissolved solids
- High dissolved oxygen
- High velocity
- High dissolved solids and Electrical cells (dissimilar metals)
- High temperature
- Hydrogen Sulfide
- Particles (sand)

Saturation Index
(predicts corrosion or scaling)

- SI = $pH - pH_S$
- pH_S is the pH of the water if it were in equilibrium with $CaCO_3$ at the existing calcium and bicarbonate concentrations

Water test Needed for the Saturation Index (SI)

- pH
- Temperature (estimated by region from statewide data)
- Calcium concentration
- Bicarbonate concentration (from total alkalinity)
- Total dissolved solids (estimated from specific conductance)

Using the Saturation Index

Index	Interpretation
-5.00	**Severe Corrosion**-corrosion control is recommended
-2.00	**Moderate Corrosion**-corrosion control should be considered
0.00	**Balanced**-no treatment is recommended
2.00	**Moderate Scale**-softening will decrease hardness and reduce scaling
5.00	**Severe Scale**-scale build-up in hot water heaters will be excessive

Expanded Water Test Package

Basic + more

Added to the Basic Test

- Total Alkalinity
- Specific Conductance
- Saturation Index
- Cation:Anion Balance
- Silica
- Nitrate-N
- Chloride
- Fluoride
- Sulfate

Basic Water Test

- pH
- Total Hardness
- Aluminum
- Calcium
- Iron
- Potassium
- Magnesium
- Manganese
- Copper
- Zinc
- Cadmium
- Chromium

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UGA Cooperative Extension Service

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- Coliform Bacteria
- Corrosive or Scaling
- Lead and Copper
- Iron and Manganese
- Hydrogen Sulfide and Sulfate
- Nitrate
- Pesticides, Solvents, and Petroleum Products
- Shock Chlorination
- Wellhead Protection
- Water Treatment
- Testing Water Quality