

# Coliform Bacteria in Private Wells in NJ:

## Influence of Sample Number, Geology, Season, Laboratory and Method

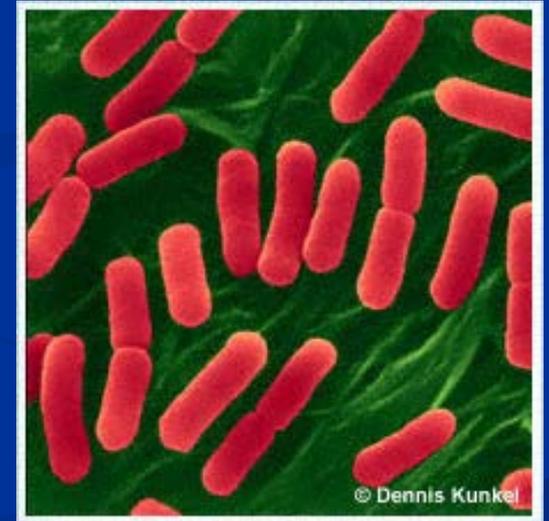
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NJDEP

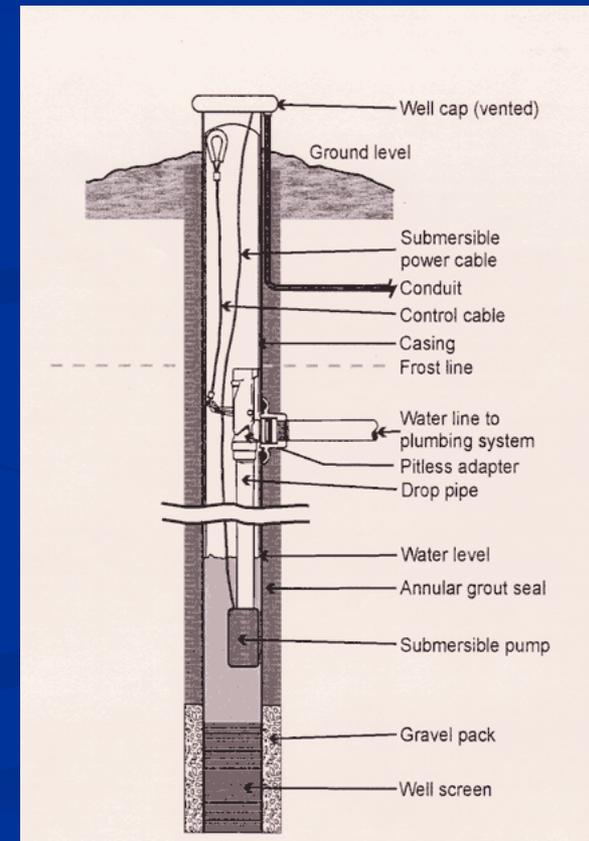




# Private Well Testing Act



- PWTA passed 2001. Effective **9/16/2002**.
- Real estate with wells. **Untreated** well water must be tested during real estate transactions for **34 or 35 parameters** (county dependent).
- Testing done by private, state-certified labs. Cost paid by seller or buyer.
- Results provided to client and **submitted electronically to the NJDEP**.
- No action required if any parameter is "exceeded" (a right-to-know law).



# PWTA: Test Parameters

- Primary (health-related)
  - Coliform bacteria
  - Arsenic
  - Mercury
  - Lead
  - Nitrate/nitrite
  - Volatile organic chemicals (26)
  - Radioactivity (48-hr gross alpha particle)
- Secondary (aesthetic or other)
  - pH
  - Iron
  - Manganese

# Coliform bacteria are "indicator" organisms

- Always present in high concentrations in **untreated** sewage and animal fecal wastes, but also have non-fecal sources (soils and sediments).
- Almost always present in **surface and storm waters** (Del R, 1996 medians: TC, 850; FC, 120; EC, 88 orgs per 100 ml).
- In **ground water**: not present or, if present, found intermittently and, when detected, at very low concentrations.
- If detected, "indicates" that disease-causing microbes **may** also be present (pathogenic bacteria, viruses, and/or protozoa).

# Coliform bacteria (acid & gas from lactose)



## ■ Total Coliforms (35°C)

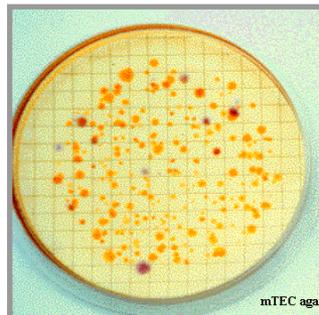
- Escherichia (not all strains)
- Enterobacter
- Klebsiella
- Citrobacter
- Serratia
- Leclercia
- Yersinia
- Others (Hafnia, Buttiauxella, Kluyvera, Pantoea, Rahnella)

## ■ Fecal Coliforms(44.5°C)

- Escherichia (not all strains)
- Klebsiella (15% of *K. pneumoniae* strains)
- Enterobacter (5% of *E. cloacae* and *E. aerogenes* strains)

# PWTA Coliform Testing

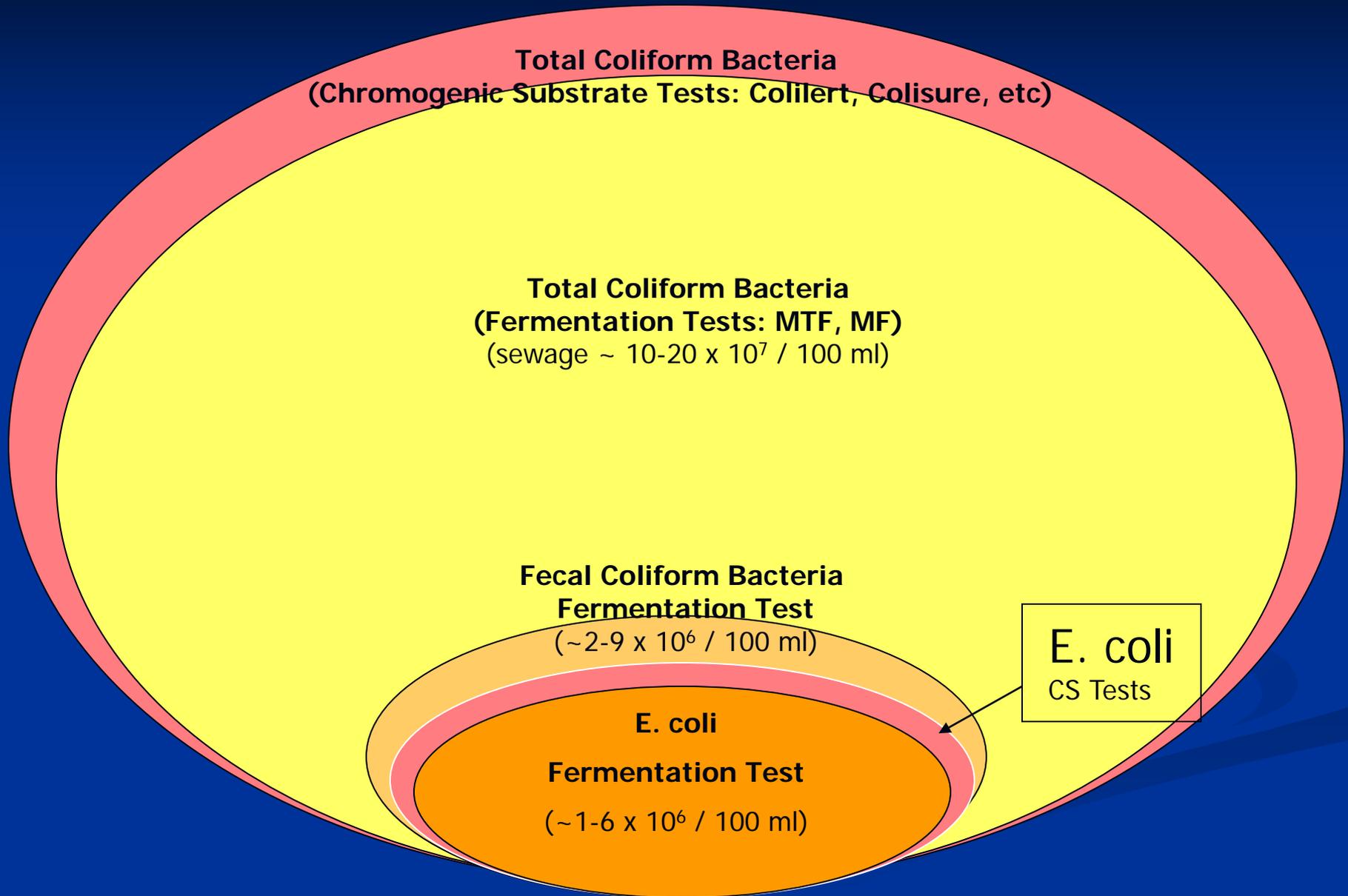
- Test 100 ml (~3.4 oz) untreated water for **Total Coliform (TC)** bacteria.
- If TC-positive, must test the TC-positive sample for **Fecal Coliform (FC)** or **E. coli (EC)** bacteria.
- If FC- or EC-positive, an "Exceedance."
  - The well may contain fecal contamination and hence may contain disease-causing microorganisms.
- Result **valid for 6 months.**



- *E. coli* colonies remain yellow after the urease test
- non-*E. coli* colonies turn from yellow to purple from the breakdown of urea



# Relationship of Coliform Groups

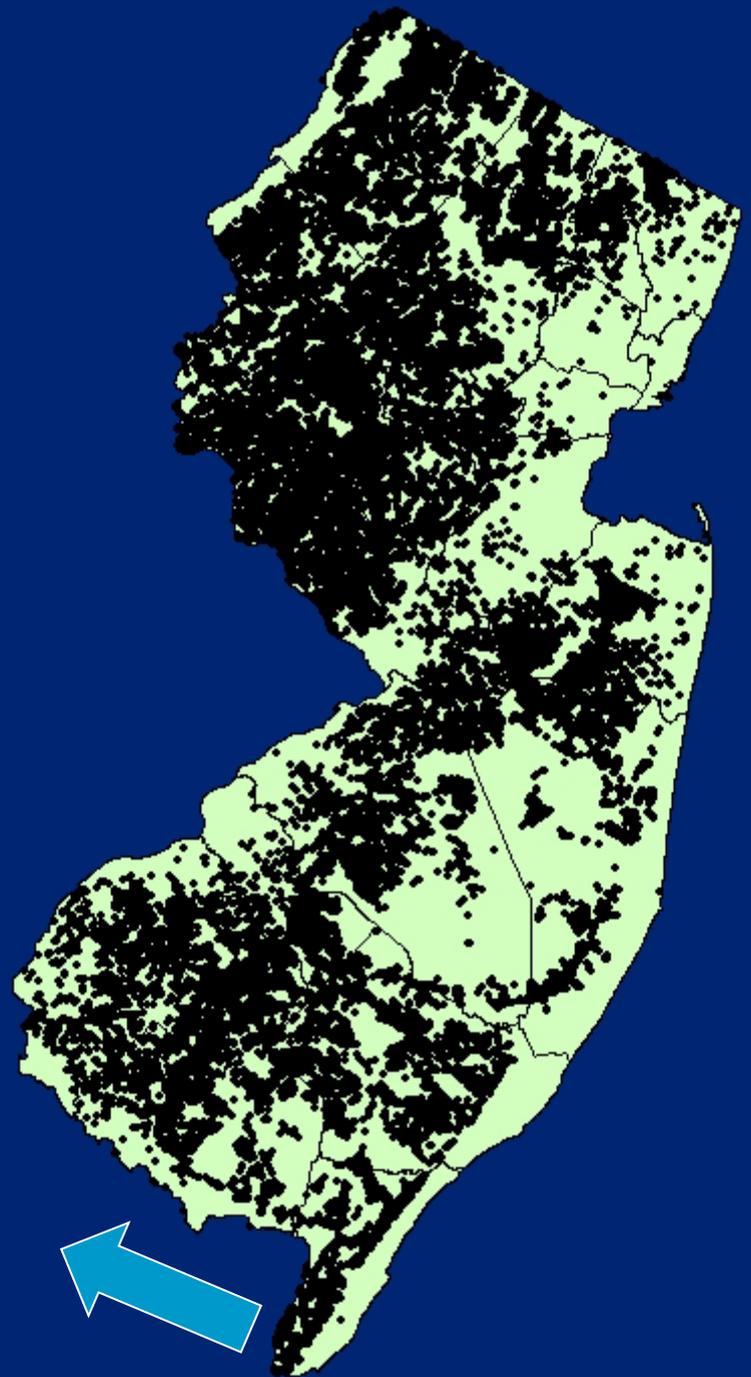
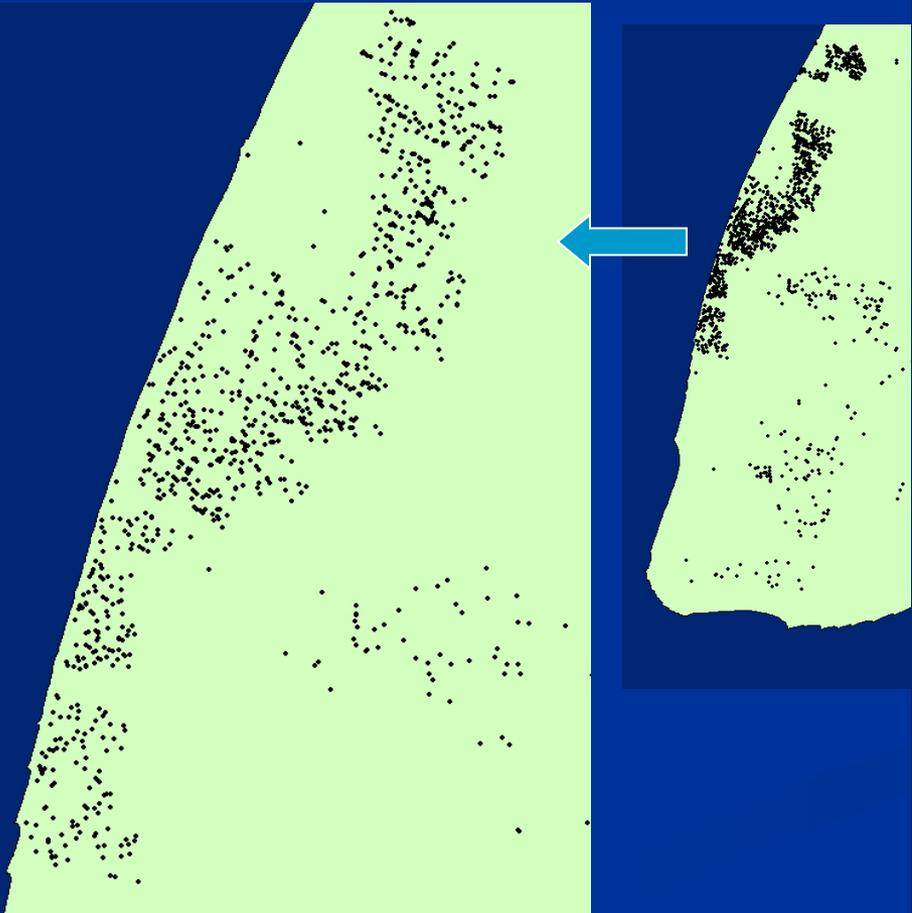


# Meaning of Positive Indicator Tests

Test	Does a positive test indicate fecal contamination? [a]	Notes
Total coliform	suggestive	High concentrations in intestinal wastes but non-intestinal sources also.
Fecal coliform	likely	Minor non-intestinal component in many but not all waters.
E. coli	likely	Considered intestine-specific but also recent evidence of persistence (and growth?) in warm waters and sediments.
[a] Suggestive = confirmatory testing necessary. Likely = more definitive than TC test but may contain non-intestinal sources.		

# Data from:

- 50,801 Wells
- 55,740 Samples
- 9/16/2002 – 4/5/2007



# Uncorrected Well Locations

2 People, 2 Years To Correct Well Location Information



# Data Limitations and Strengths

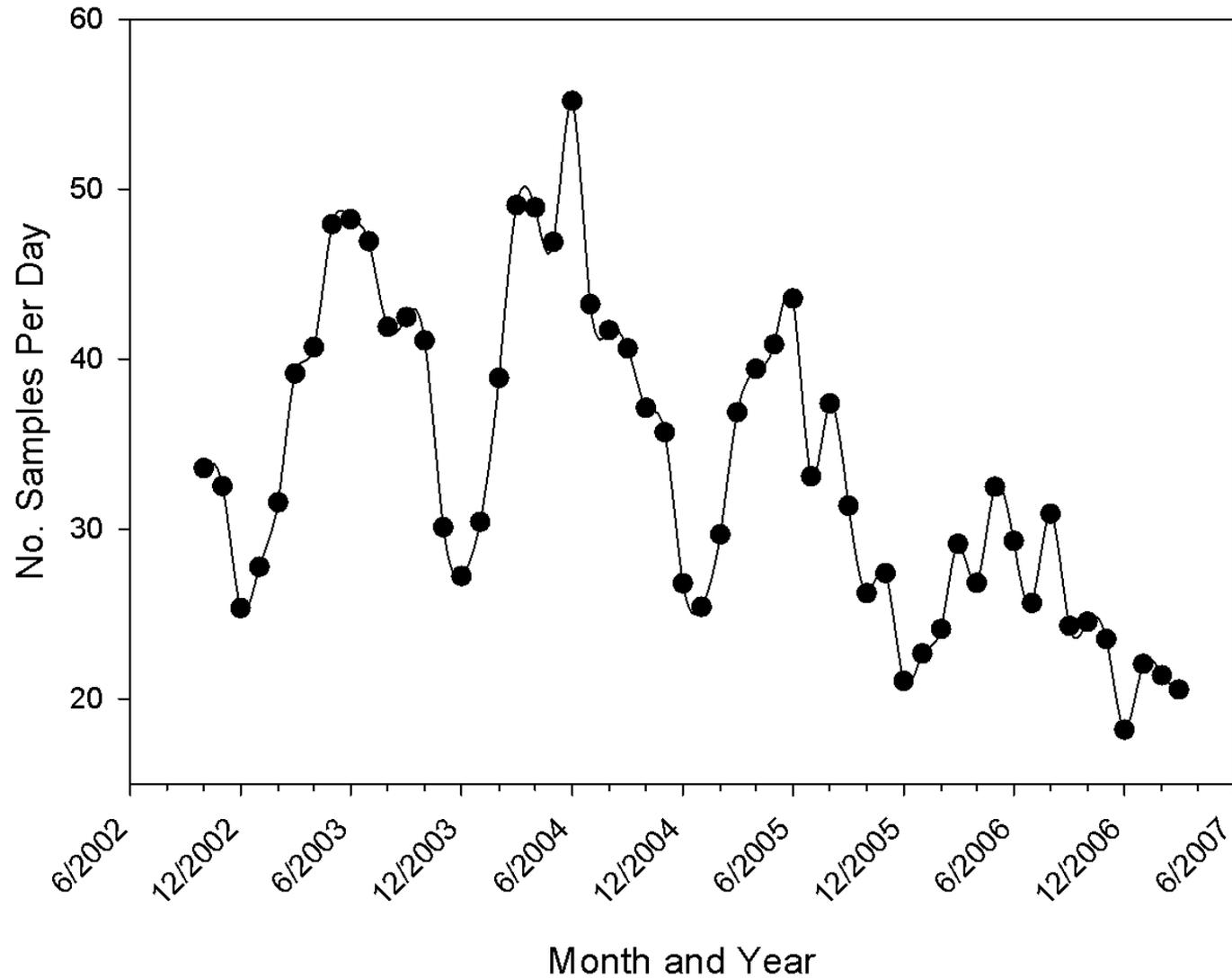
## ■ Limitations

- Sampling untreated water but usually collected after pressure tanks.
- Some data missing.
- **Number of data errors unknown.**
- No hydrological information (*e.g.*, well depth, depth to water table, hydraulic conductivity, etc.).
- Data software issues.

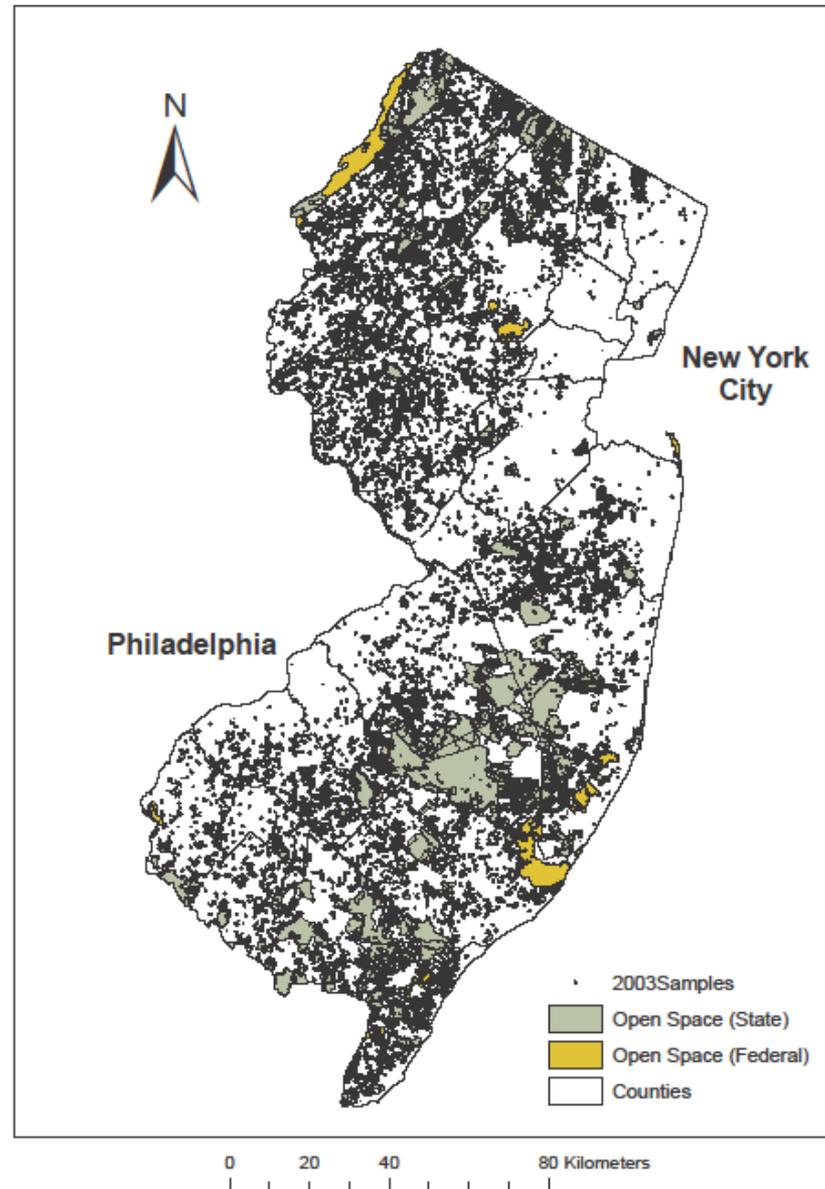
## ■ Strengths

- Large database, data submitted by 39 labs (99.8% by 28 labs).
- **Little or no selection bias** (but lots of data from new homes)
  - water quality = none; spatial = minimal; temporal = minimal.
- **Well location and test method information was corrected & is reasonably accurate.**

Figure S16  
Number of Samples Collected Per Day  
for Each Month Analyzed



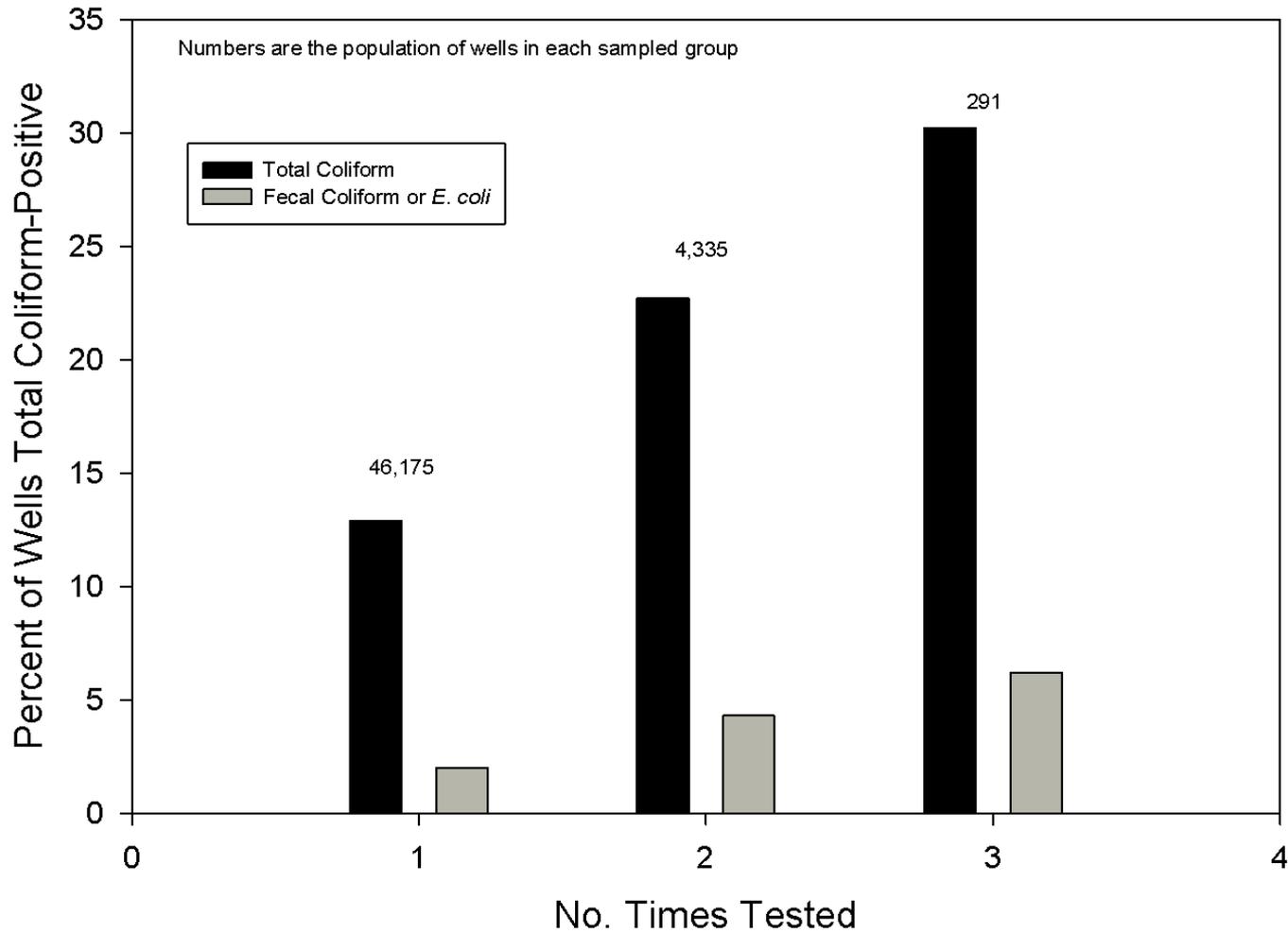
**Figure S17**  
**Wells Sampled in 2003**



# Coliform Data Analysis Summary: The Probability of Detecting Coliform Bacteria in Well Water Depends on:

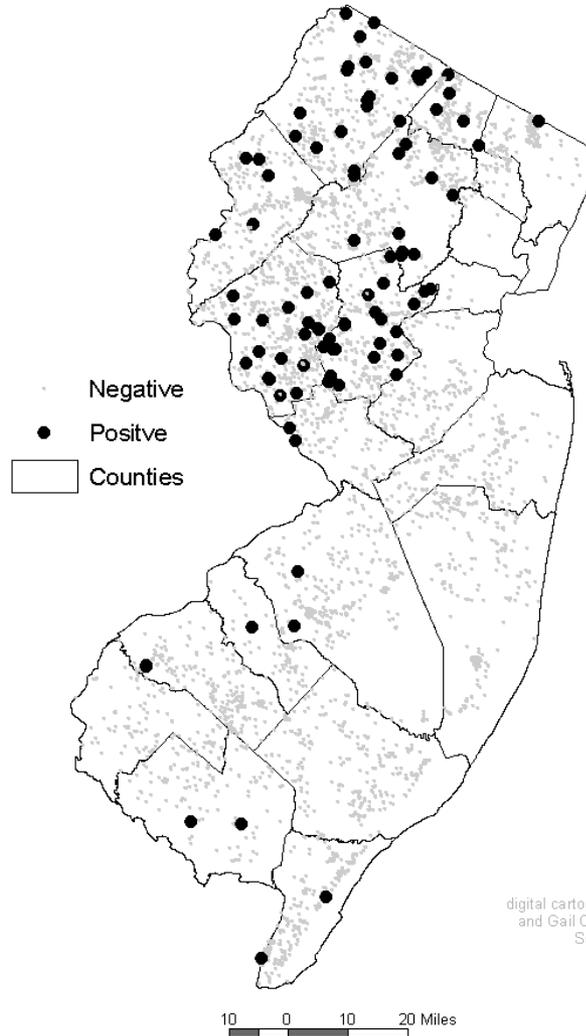
- Number of times a well is sampled.
- The laboratory and the method used.
- Proper construction, including disinf. & flushing of new wells.
- Geology, including past glacial activity (if any), and aquifer pH.
- The time of year the well is sampled.
- In bedrock: surface water & precipitation.

## Percentage of Coliform-Positive Wells Following the Indicated Number of Times the Wells Were Tested

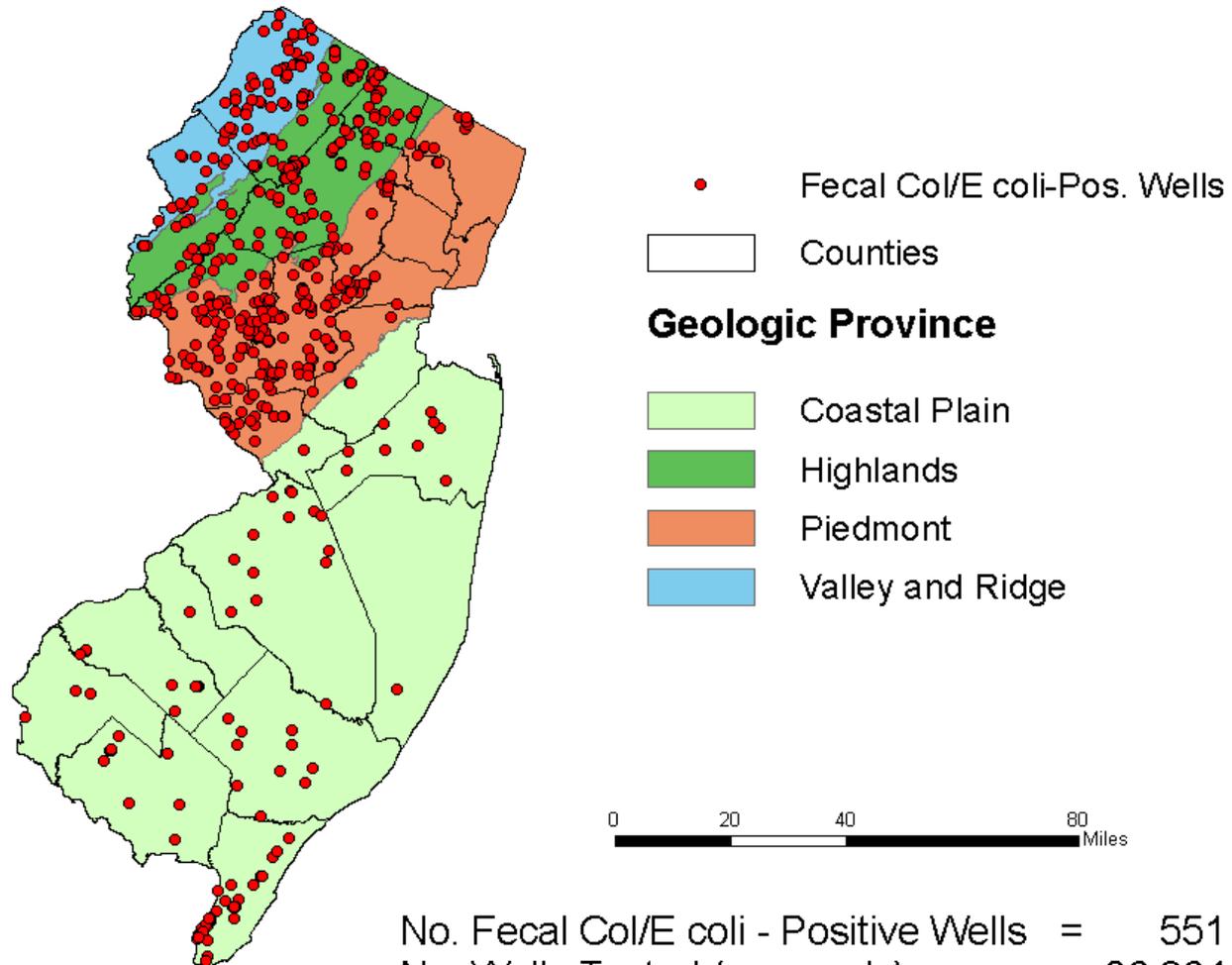


# Data after 6 Months

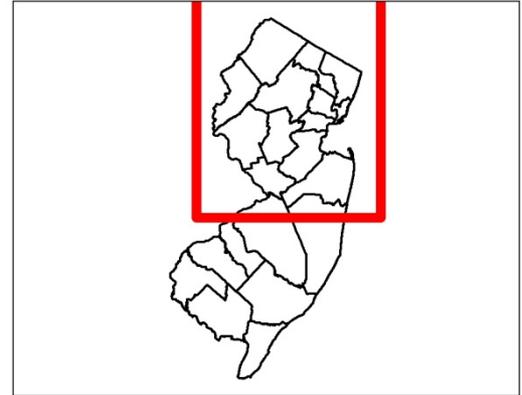
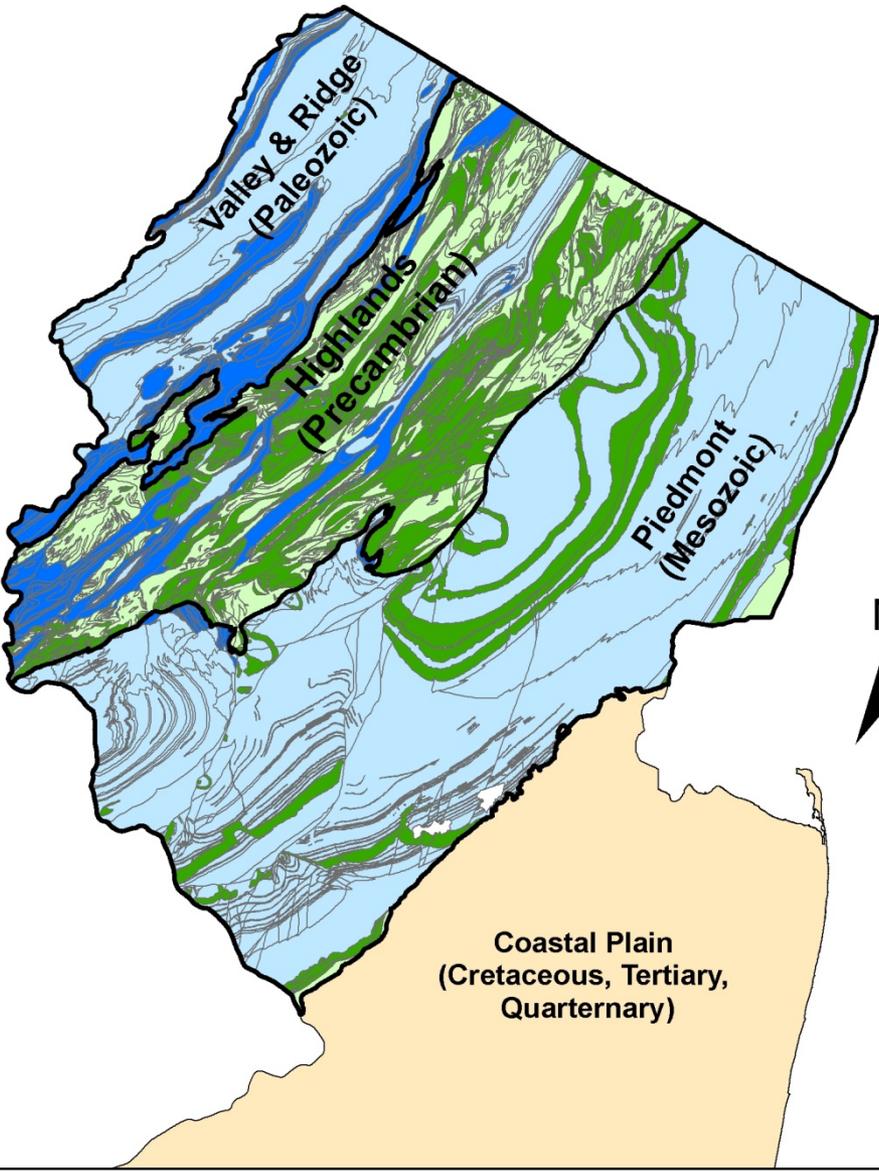
## Private Well Testing Act Results from September 2002 - March 2003 Fecal Coliform/E. coli Results



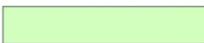
# Data after 2 Years



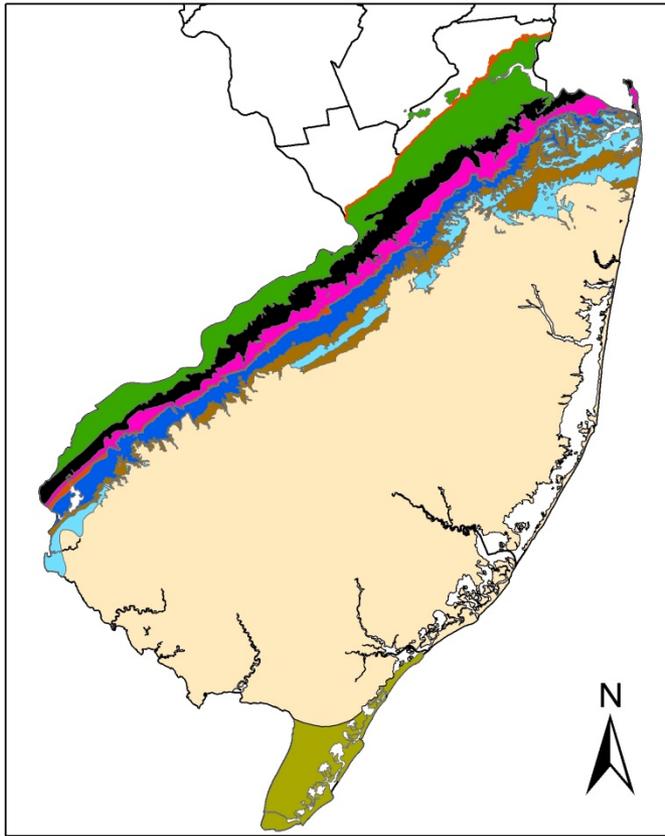
No. Fecal Col/E coli - Positive Wells = 551  
No. Wells Tested (once only) = 26,064



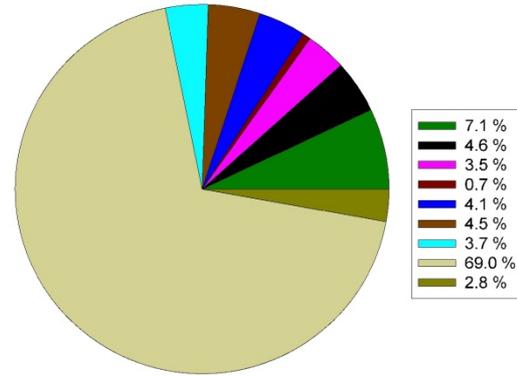
**Legend**

-  Piedmont
-  Highlands
-  Valley&Ridge
-  Coastal Plain
-  Non-Carb Sedimentary
-  Carb Sedimentary
-  Igneous
-  Metamorphic



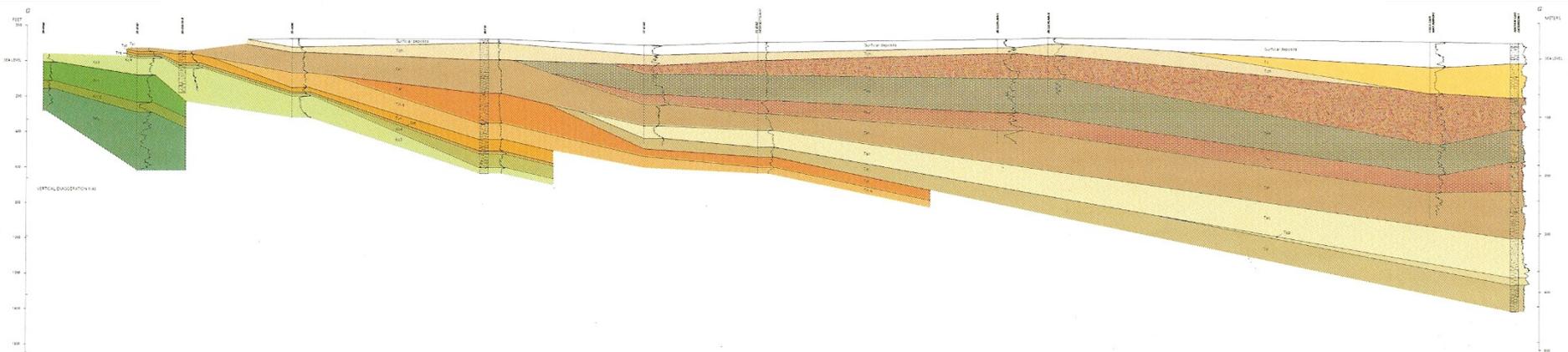


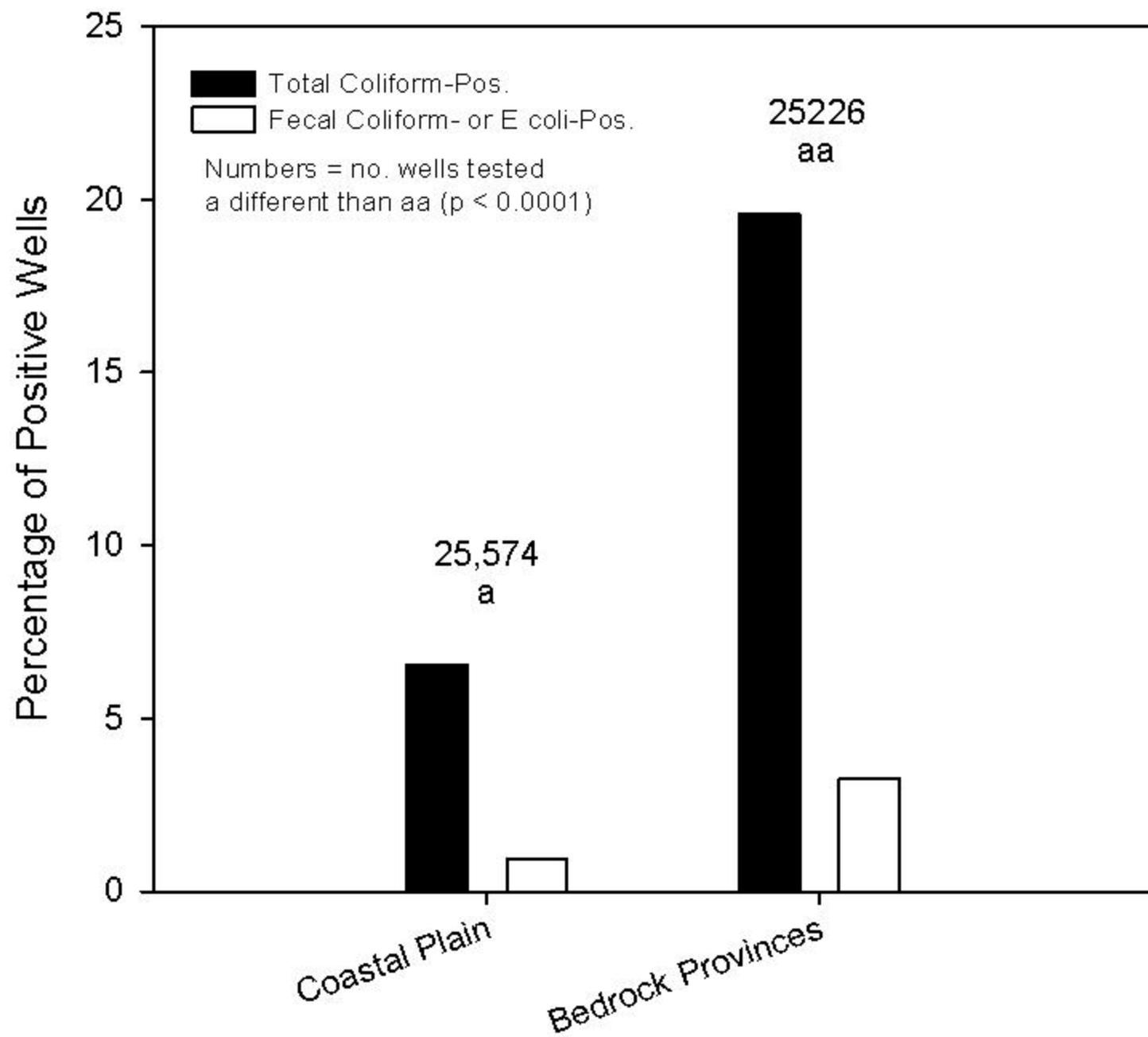
11,523 Square Kilometers

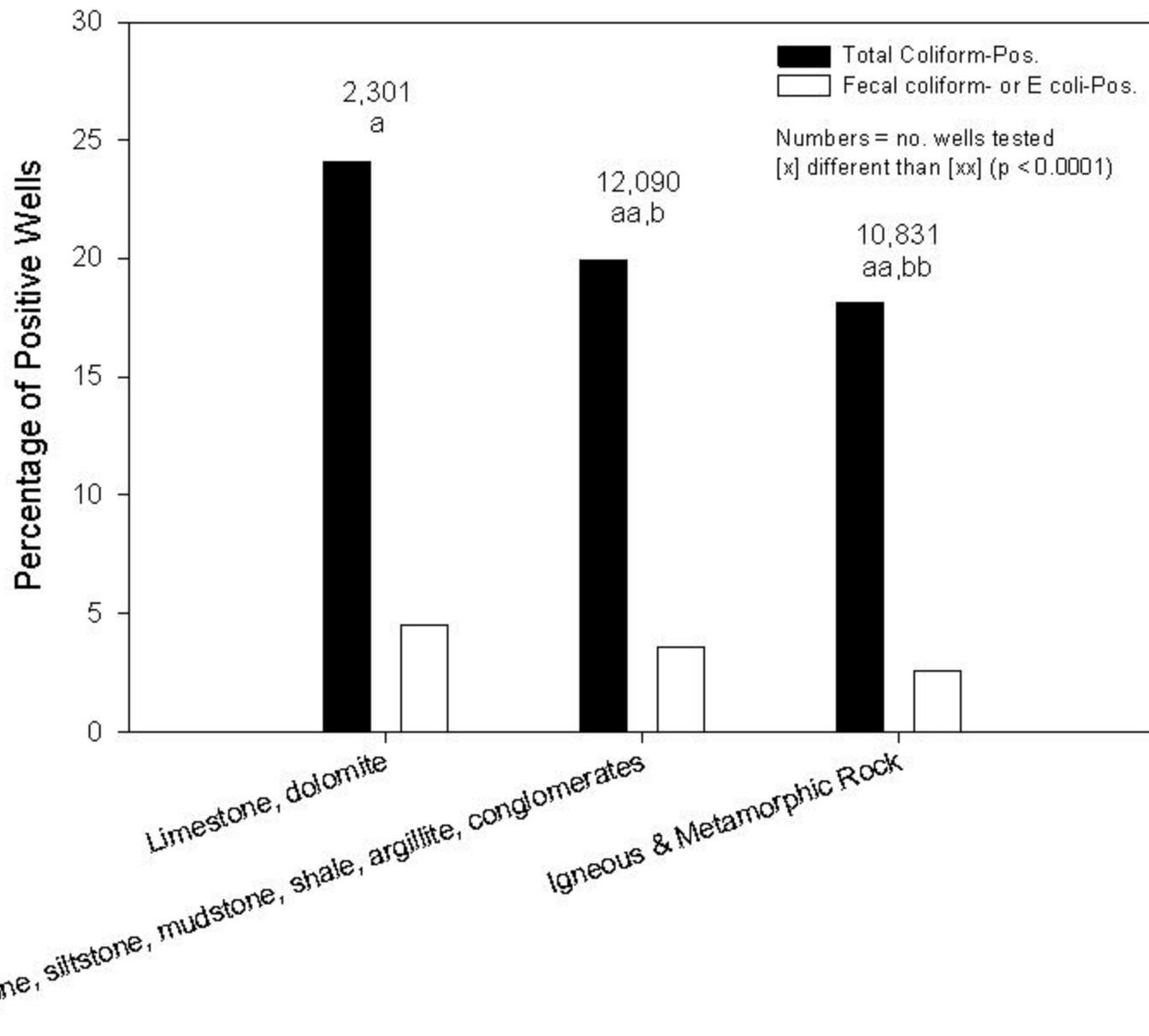


- Fall Line
- Potomac-Raritan-Magothy outcrop area
- Merchantville-Woodbury Confining Unit outcrop
- Englishtown outcrop
- Marshalltown-Wenonah Confining Unit outcrop
- Mt Laurel-Wenonah outcrop
- Composite Confining Unit outcrop
- Composite Confining Unit Aquifer outcrop
- Kirkwood-Cohansey
- Holly Beach
- Counties

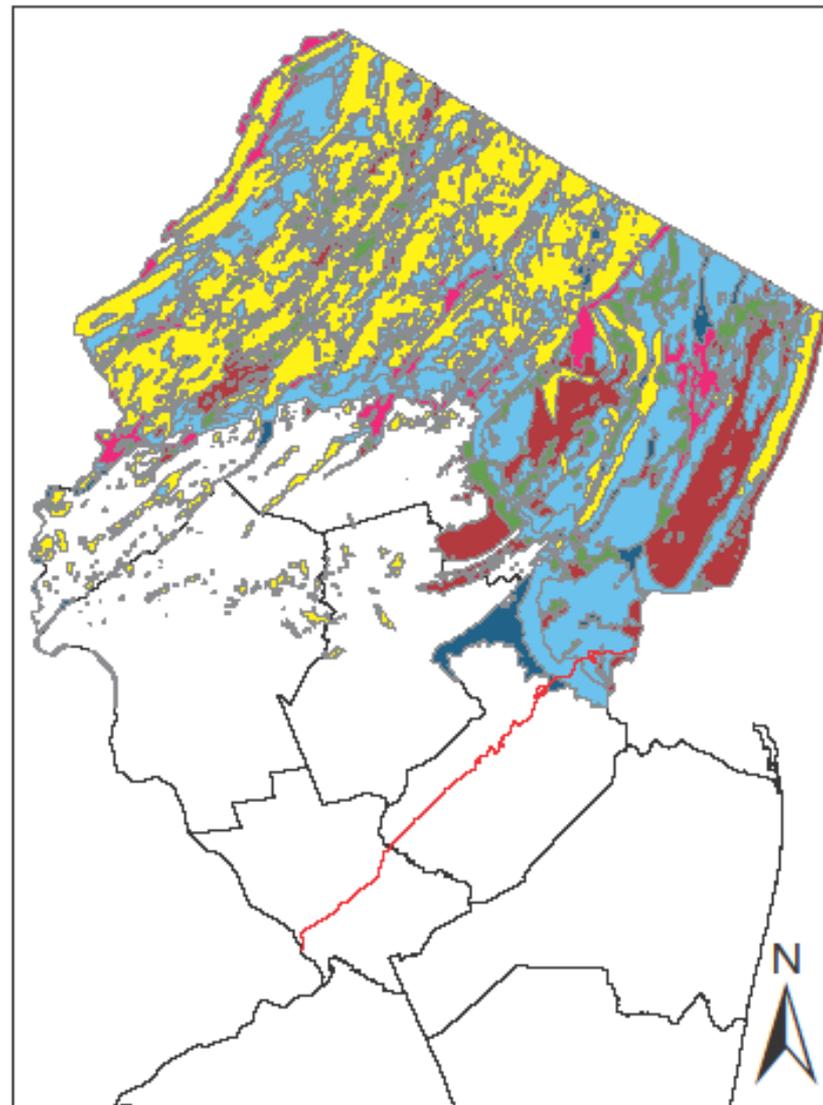
0 12.5 25 50 Kilometers



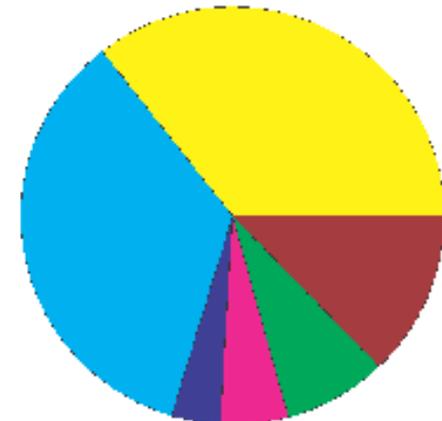




# Figure S5. Glacial Deposits in New Jersey



3059 square kilometers

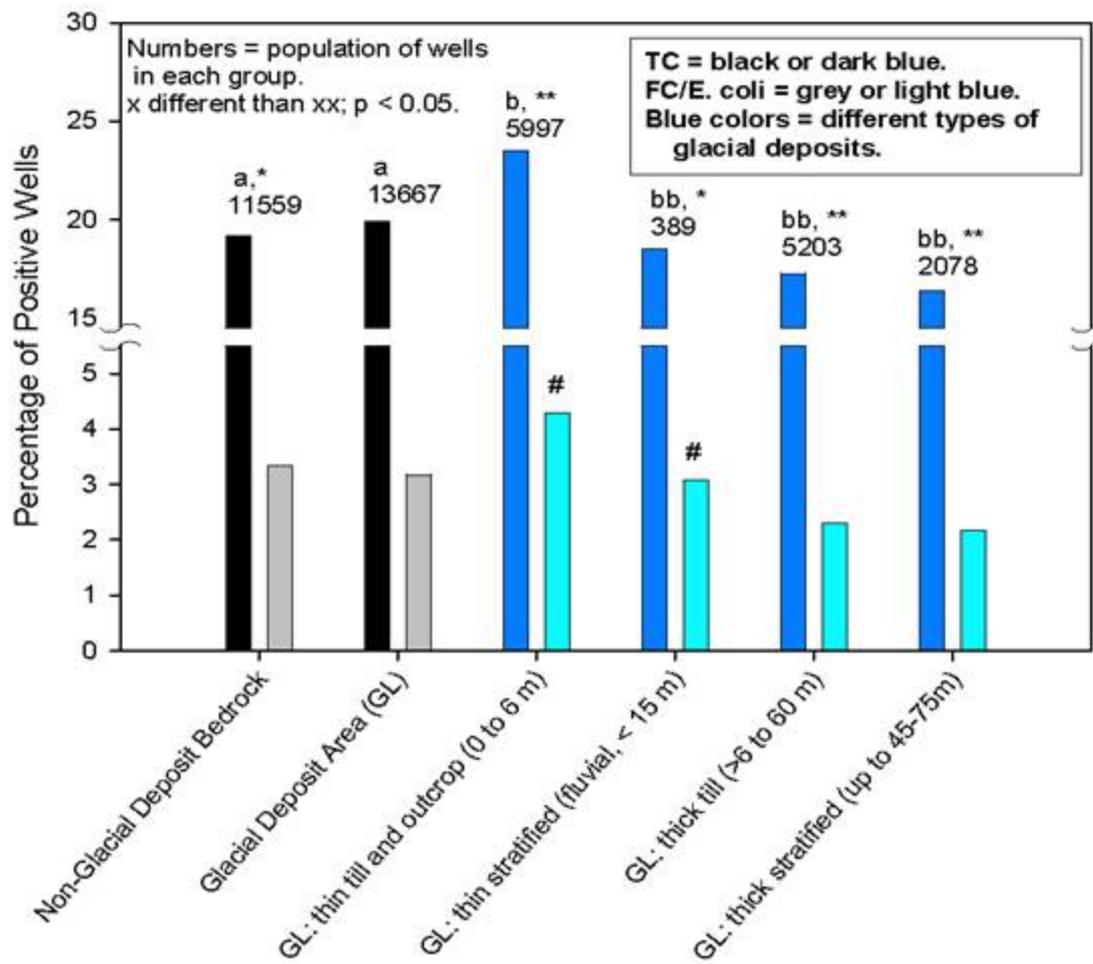


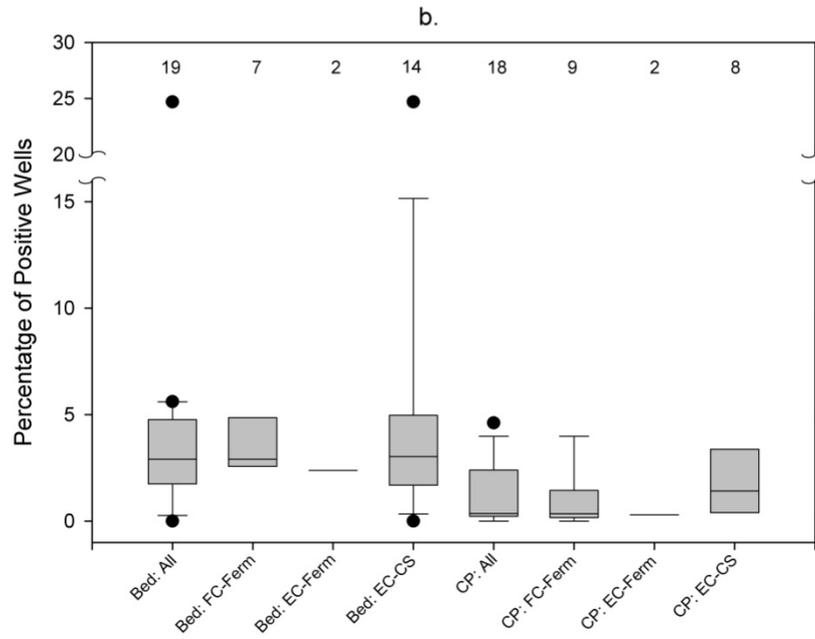
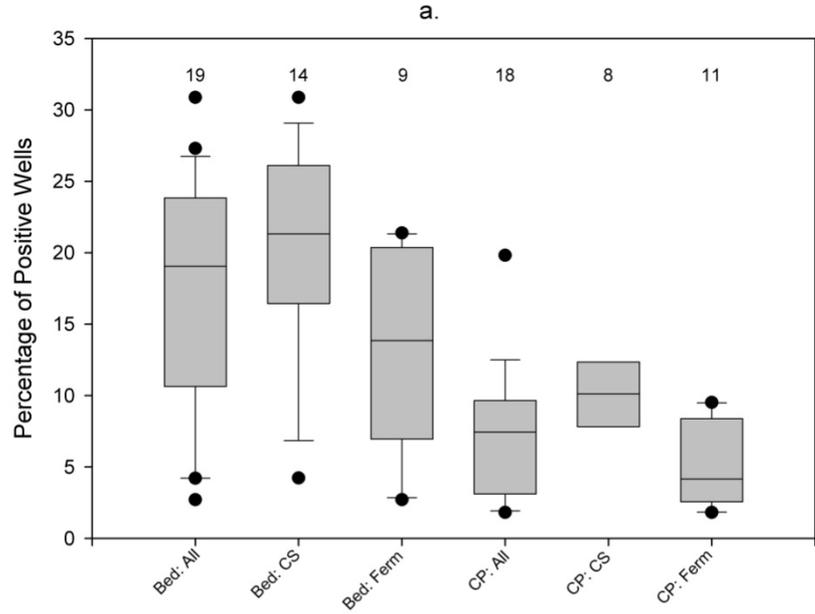
- Thin till (35.5%)
- Thick, moraine & ice-contact till (34.8%)
- Fluvial (stream) deposits (3.7%)
- Fluvial over lacustrine deposits (5.2%)
- Deltaic & lacustrine fan deposits (7.9%)
- Lake-bottom deposits (12.8%)

### Legend

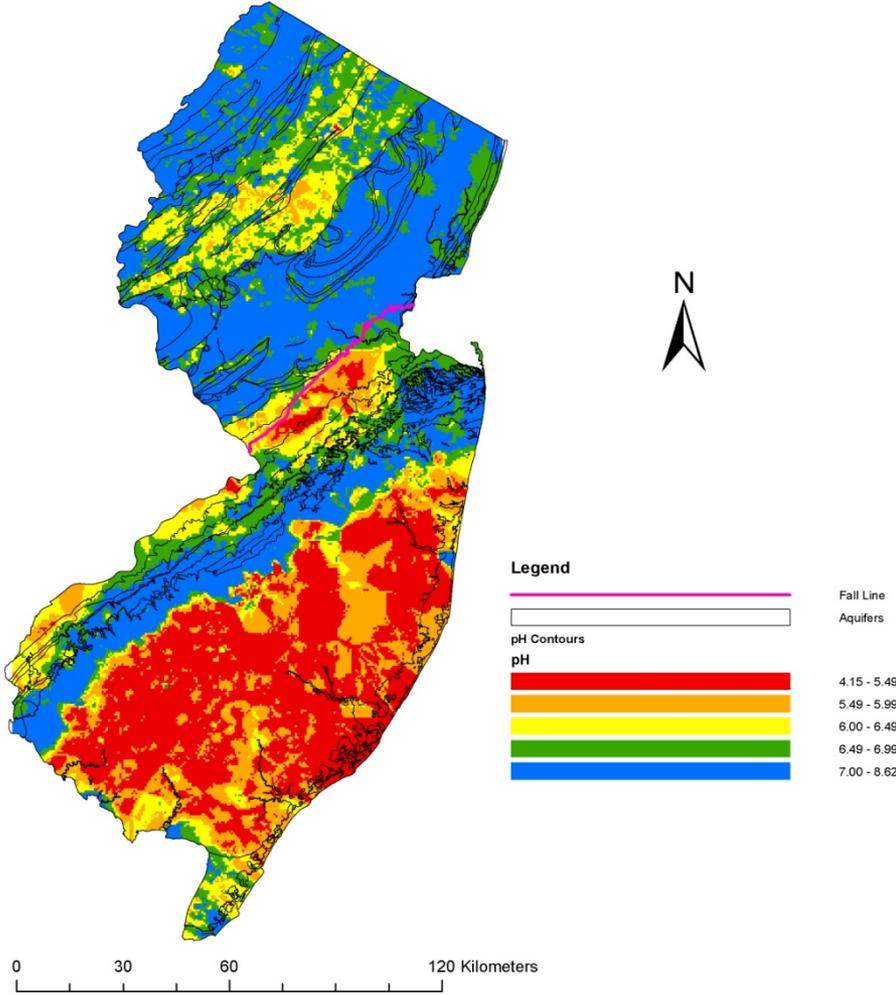
- Fall Line
- Thin Till
- Thick Till
- Fluvial Deposits
- Fluvial Over Lacustrine Deposits
- Deltaic Sediment
- Lake-Bottom Sediment
- Non-glacial area (county boundaries)

0 15 30 60 Kilometers

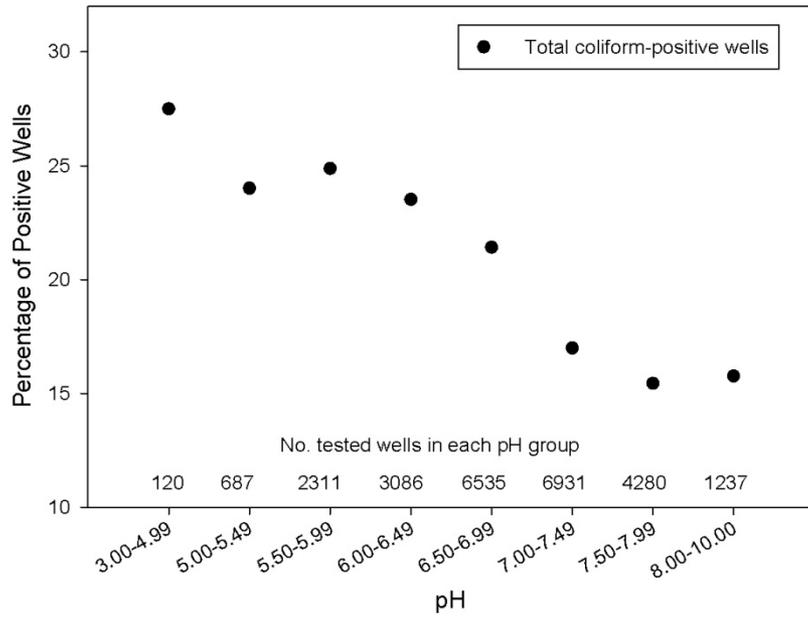




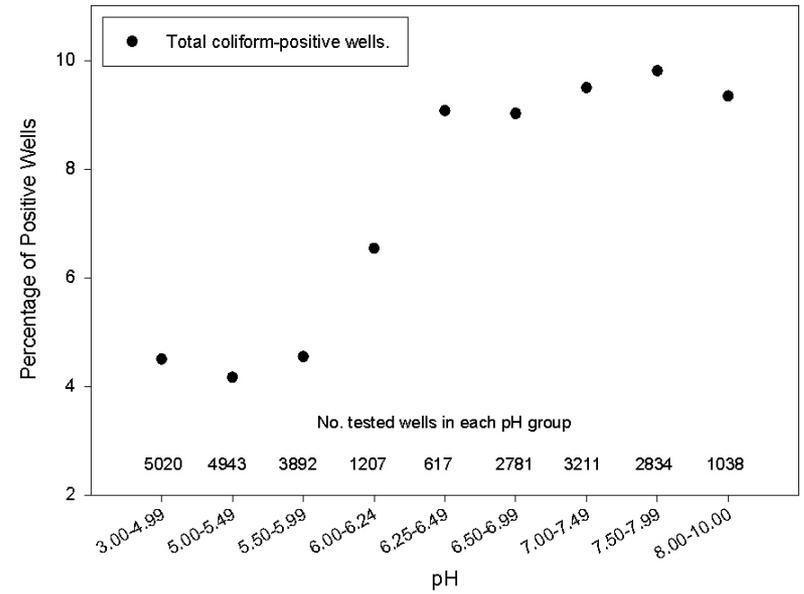
# NJ Ground Water pH Contours



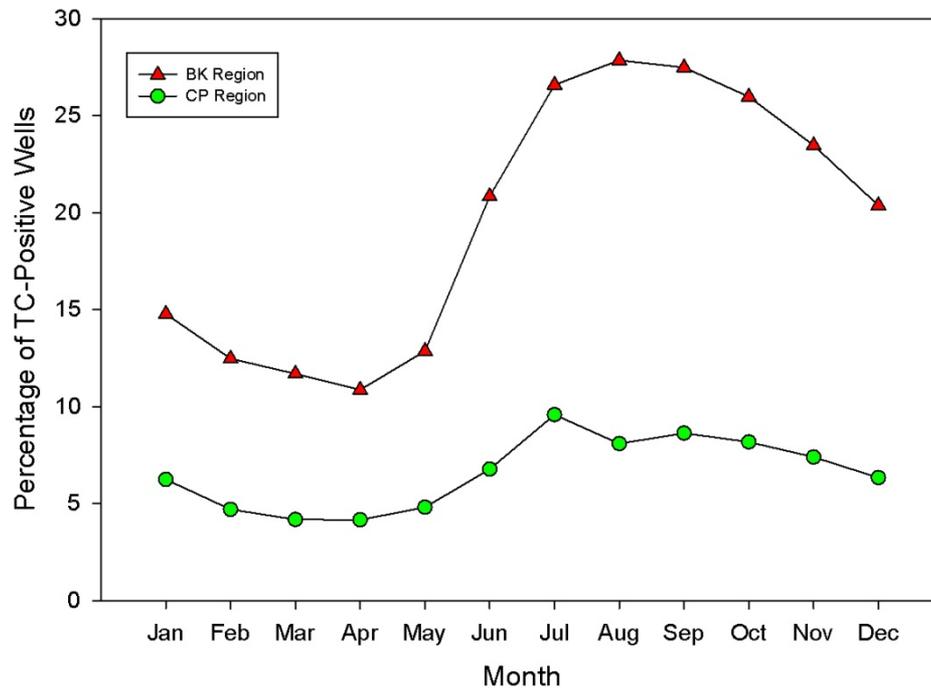
## Bedrock



## Coastal Plain



# Seasonality



# Bedrock Region

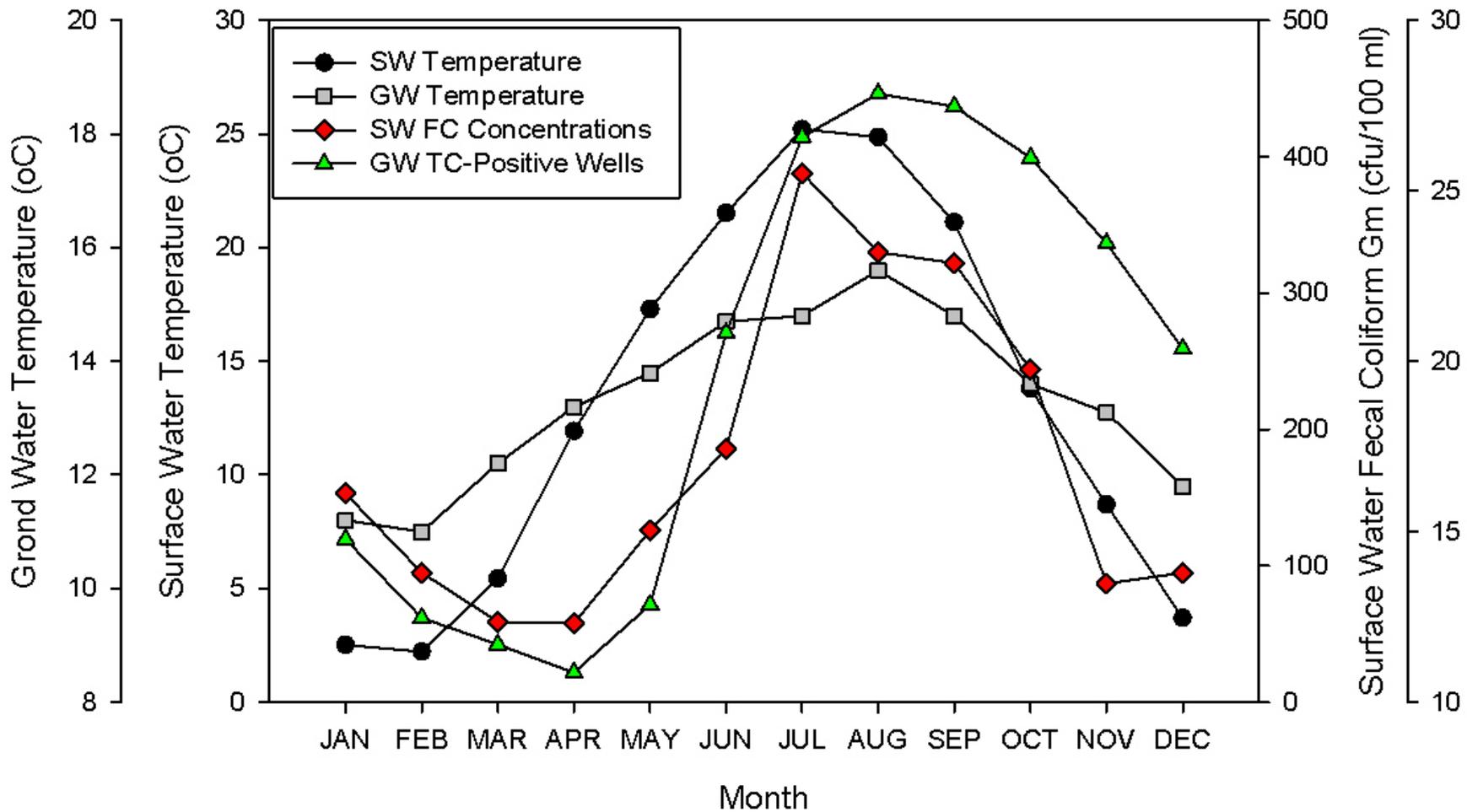


Figure 9a. Bedrock Provinces  
 Rainfall Total on the Sample Day and the  
 Percentage of Wells With Fecal Coliform or E. coli Bacteria  
 April - November

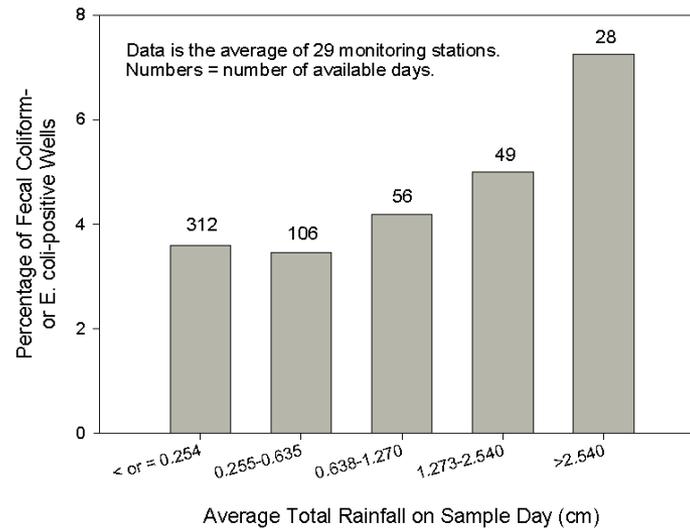


Figure 9b. Bedrock Provinces  
 Number of Dry Days Preceding a Dry Sample Day\*  
 and the Percentage of Wells  
 With Either Fecal Coliform or E. coli Bacteria  
 April - November

