An evaluation of naturally occurring contaminants under New Jersey's Private Well Testing Act

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Private Wells in New Jersey

- Why do we care about private wells?
- What have we learned from the PWTA about overall groundwater quality in NJ?
- Are there regions in the state with specific groundwater problems?
- What should a homeowner do if they have a private well?

Private Wells in New Jersey

- **NJ Population: 8.9 million (2013 est.)**
  - About 87% obtain water from highly regulated public water systems
  - The other 13% of the population (1,150,000 people) have private wells for their drinking water supply.

- **An estimated 400,000 private (domestic) wells in New Jersey.**
  - about 16% of (*sampled*) wells are in the Pinelands

- **No federal regulations cover private wells.**

- **Before 2002: state regulations applied only to newly-constructed wells.**

Why do we care about private wells?

- **Naturally occurring substances** in the ground can make you sick and result in an unpleasant taste, smell, and appearance of your well water, or stain clothes and plumbing.

- **Drinking water can be contaminated** by natural sources in the rock or soil, or from man-made sources like agricultural or industrial run-off.

- Contamination to regional groundwater, lakes, or rivers can impact well water.

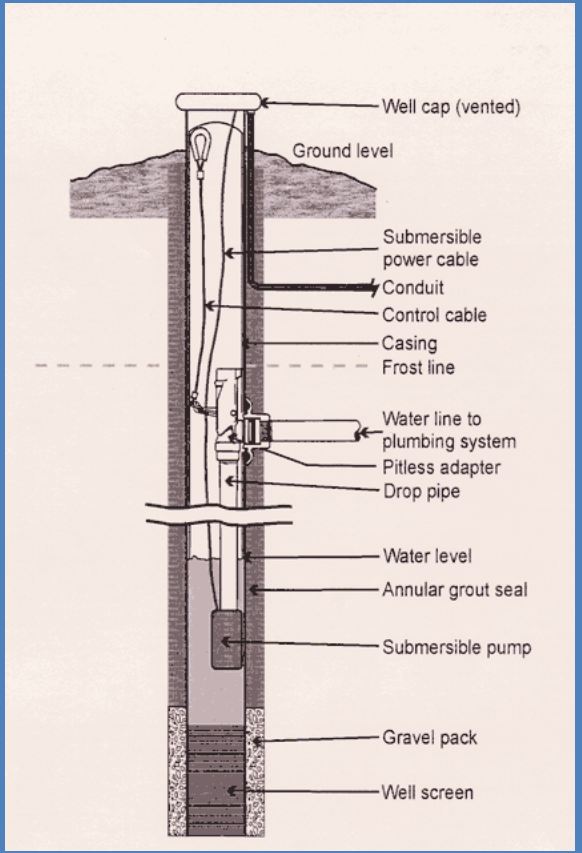
Why do we care about private wells?

- **Health concerns** vary depending on chemical and length of exposure.

- **Potential health concerns include**:
- fever, dysentery, hepatitis, diarrhea, stomach cramps (bacteria),
- neurological damage (Mn),
- kidney damage (Hg),
- liver and central nervous system damage (VOC) ,
- delays in mental and physical development (Pb),
- and cancer (Pb, As, Ur, Ra).

NJ Private Well Testing Act

- Became effective 9/16/2002.
- Real estate with wells. Untreated well water must be tested during real estate transactions for up to 35 parameters (county-dependent).
- Testing done by private, state-certified labs. Cost paid by seller or buyer (currently $450-600).
- Results provided to client and submitted electronically to the NJDEP.
- No action required if a parameter limit is “exceeded” (a right-to-know law).



What does New Jersey's PWTA Measure?

PRIMARY STANDARDS

Total Coliform (if positive, fecal or E. coli)

26 Volatile Organic Chemicals

Inorganics

- Arsenic (12 northern counties)
- Mercury (9 southern counties)
- Nitrates
- Lead

Radiological

- Gross Alpha (12 southern and central counties)

SECONDARD STANDARDS

Iron, Manganese & pH

Table 1. NJ Private Well Testing Act Test Parameters

Parameter	Recommended Limit (a)	RL Origin (b)
Primary		
	Bacteriological	
Total Coliform (c)	0 /100 ml (FC or E. coli)	S-RL
	Organic chemicals	
26 volatile organic chemicals	see Table 2	F&S-MCL
	Inorganic chemicals	
Nitrate/nitrite (as nitrogen)	10 mg/L	F-MCL
Lead	10 µg/L (to 11/6/05); 5 µg/L (after 11/6/05)	S-GWQS
Arsenic (d)	10 µg/L (to 1/22/06); 5 µg/L (after 1/22/06)	S-MCL
Mercury (e)	2 µg/L	F-MCL
	Radiological	
48-h gross alpha particle radioactivity (f)	15 pCi/L	S-MCL
Secondary		
pH	6.5 - 8.5	F-OP
Iron	0.3 mg/L	F-RL
Manganese	0.05 mg/L	F-RL

(a) Units: ml = milliliter; µg/L = microgram per liter (part per billion); mg/L = milligram per liter (part per million); pCi/L = picoCurie per liter.

(b) The NJDEP adopted a federal (F) standard or derived its own state (S) standard. RL = recommended limit; MCL = Maximum Contaminant Level; GWQS = Ground Water Quality Standard; OP = optimum range.

(c) If Total coliform test positive, sample tested for either fecal coliform (FC) or E. coli. The RL is exceeded if FC or E. coli are detected.

(d) Testing required in 12 northern and central counties only.

(e) Testing required in 9 southern counties only.

(f) Testing required in 12 southern and central counties only. 2 4-h test: if > 5 pCi/L, tested again at 48-h. If > 15 pCi/L, MCL exceedence.

Table 2. NJ Private Well Testing Act Test Parameters

Volatile Organic Compound	MCL (µg/l) (a)	MCL Origin (b)
Benzene	1	S
Carbon Tetrachloride	2	S
Chlorobenzene	50	S
1,2-Dichlorobenzene	600	S/F
1,3-Dichlorobenzene	600	S
1,4-Dichlorobenzene	75	F
1,1-Dichloroethane	50	S
1,2-Dichloroethane	2	S
1,1-Dichloroethylene	2	S
cis-1,2-Dichloroethylene	70	S/F
trans-1,2-Dichloroethylene	100	S/F
1,2-Dichloropropane	5	F
Ethylbenzene	700	F
Methyl-tertiary Butyl Ether	70	S
Methylene Chloride	3	S
Naphthalene	300	S
Styrene	100	F
1,1,2,2-Tetrachloroethane	1	S
Tetrachloroethylene	1	S
Toluene	1000	F
1,2,4-Trichlorobenzene	9	S
1,1,1-Trichloroethane	30	S
1,1,2-Trichloroethane	3	S
Trichloroethylene	1	S
Vinyl Chloride	2	F
Xylenes [total]	1000	S

(a) Maximum Contaminant Level. µg/L = micrograms per liter (parts per billion).

(b) The NJDEP adopted a federal (F) standard or derived its own state (S) standard. S/F = NJ-derived standard, but the same as the federal standard.

Data Limitations and Strengths

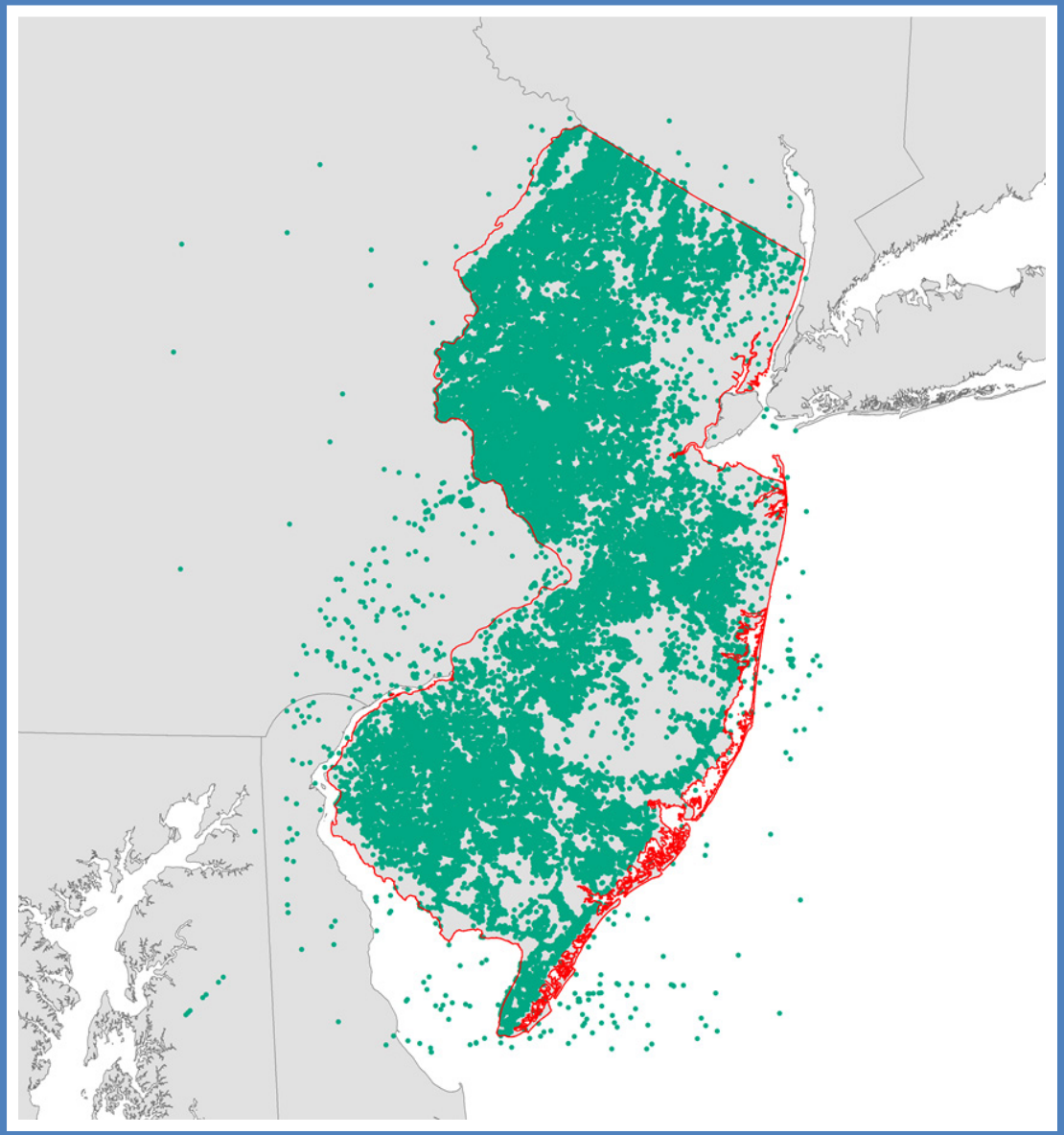
- **Limitations**
  - Sampling untreated water but many samples collected after holding/pressure tanks.
  - No well construction or detailed hydrogeological information (except pH), including well depth.
  - Laboratory capacity
  - Regulations were difficult to pass and difficult to update.
  - Water treatment in the State is completely unregulated.

Data Limitations and Strengths

- **Strengths**
  - Large database, data submitted by 35 labs (21 currently active).
    - From September 2002 through March 2014
      - 106,260 Samples
      - 86,634 Wells
      - about **22%** of the 400,000
  - Little or no sample/well selection bias.
  - Well location information corrected & reasonably accurate.

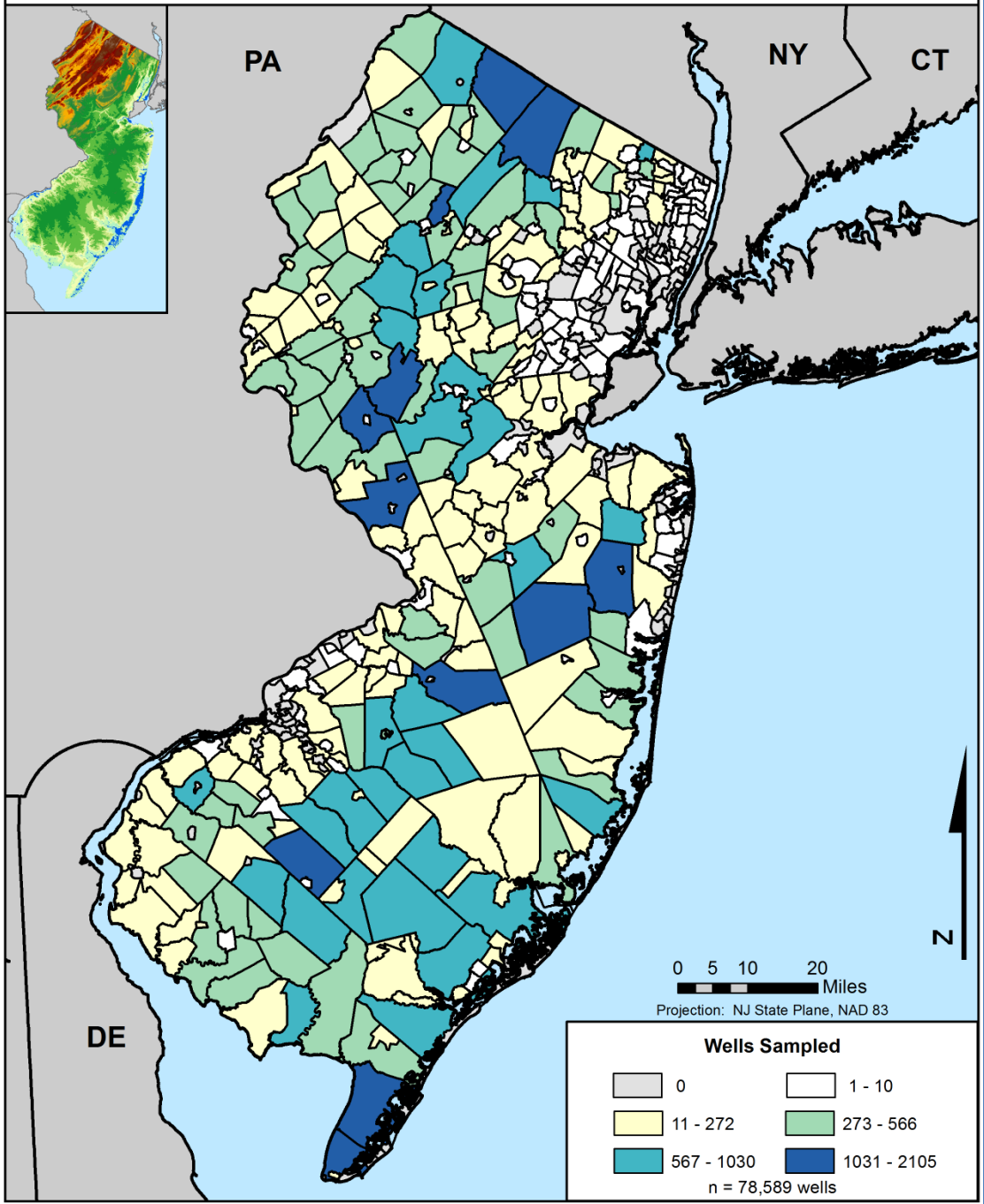
Uncorrected Well Locations

Several People, Several Years To Correct Well Location Information



- **Sources of errors:**
  - Reversed block and lots.
  - Entry errors. Lot is 2.05, but entered as 2, or 2-5, or 2.5.
  - Reversed X & Y coordinates, or made up out of thin air.
  - Several towns changed their block and/or lot numbering systems.
  - Failure to correct the coordinates using appropriate reference (base) stations.
  - Spelling is important, you wouldn't buy a shirt without the r.
  - Wrong road category, i.e. Maple Road rather than Maple Drive.
- **Finally:**
  - Would you buy a house on "Shades of Death" road?

Number of Wells Sampled



Most Frequently Sampled:

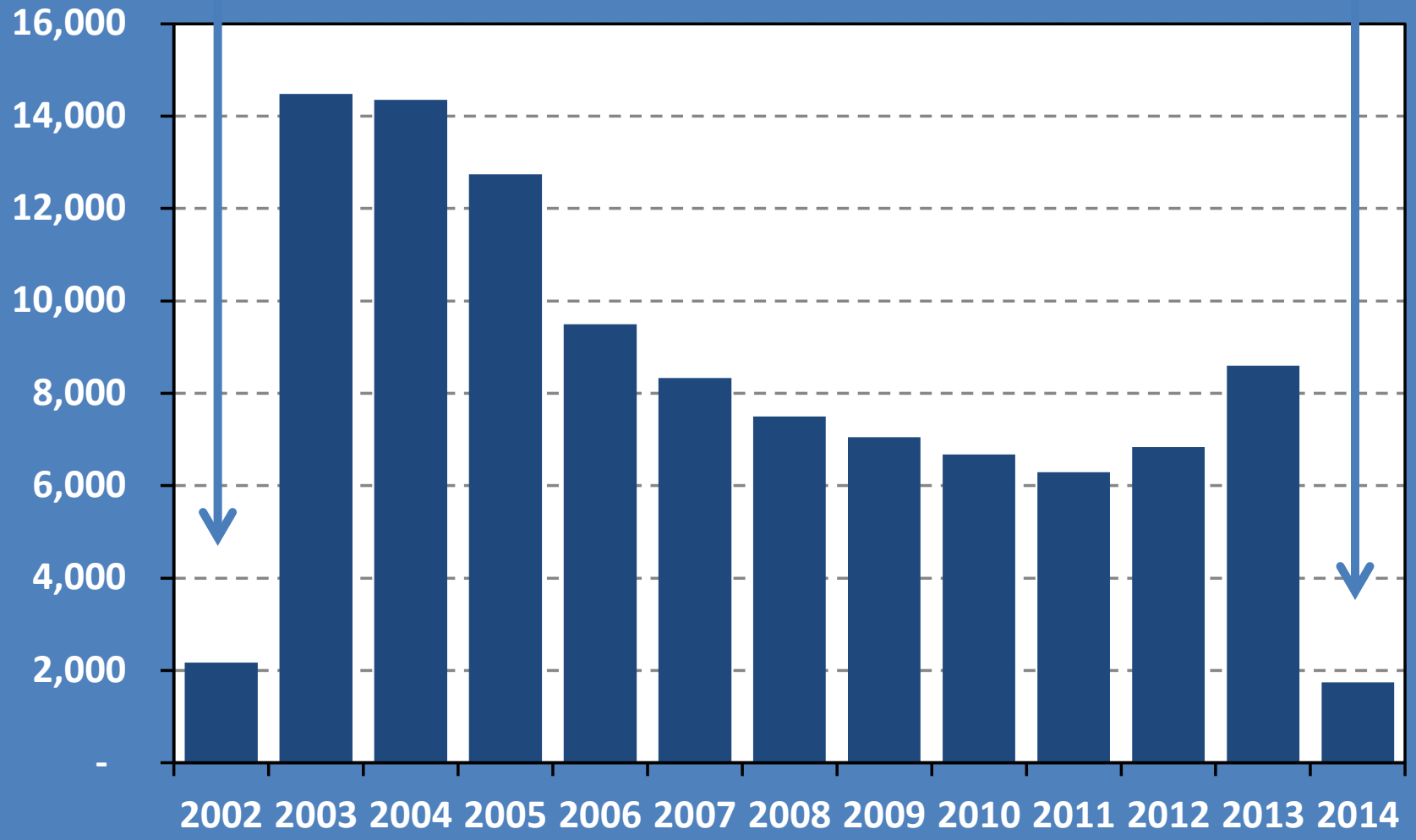
Municipality	County	Wells
West Milford Twp	Passaic	2,105
Franklin Twp	Gloucester	1,759
Vernon Twp	Sussex	1,719
Lower Twp	Cape May	1,683
Jackson Twp	Ocean	1,528
Raritan Twp	Hunterdon	1,340
Middle Twp	Cape May	1,302
Hopewell Twp	Mercer	1,277
Hopatcong Boro	Sussex	1,206
Pemberton Twp	Burlington	1,178

County	Wells
Sussex	8,176
Hunterdon	7,714
Morris	7,139
Burlington	6,866
Gloucester	5,217
Ocean	5,131
Cape May	4,617
Atlantic	4,543
Cumberland	4,448
Somerset	4,324
Monmouth	4,080
Warren	3,798
Passaic	3,226
Salem	2,522
Mercer	2,141
Camden	2,037
Bergen	1,764
Middlesex	687
Essex	104
Union	53
Hudson	2

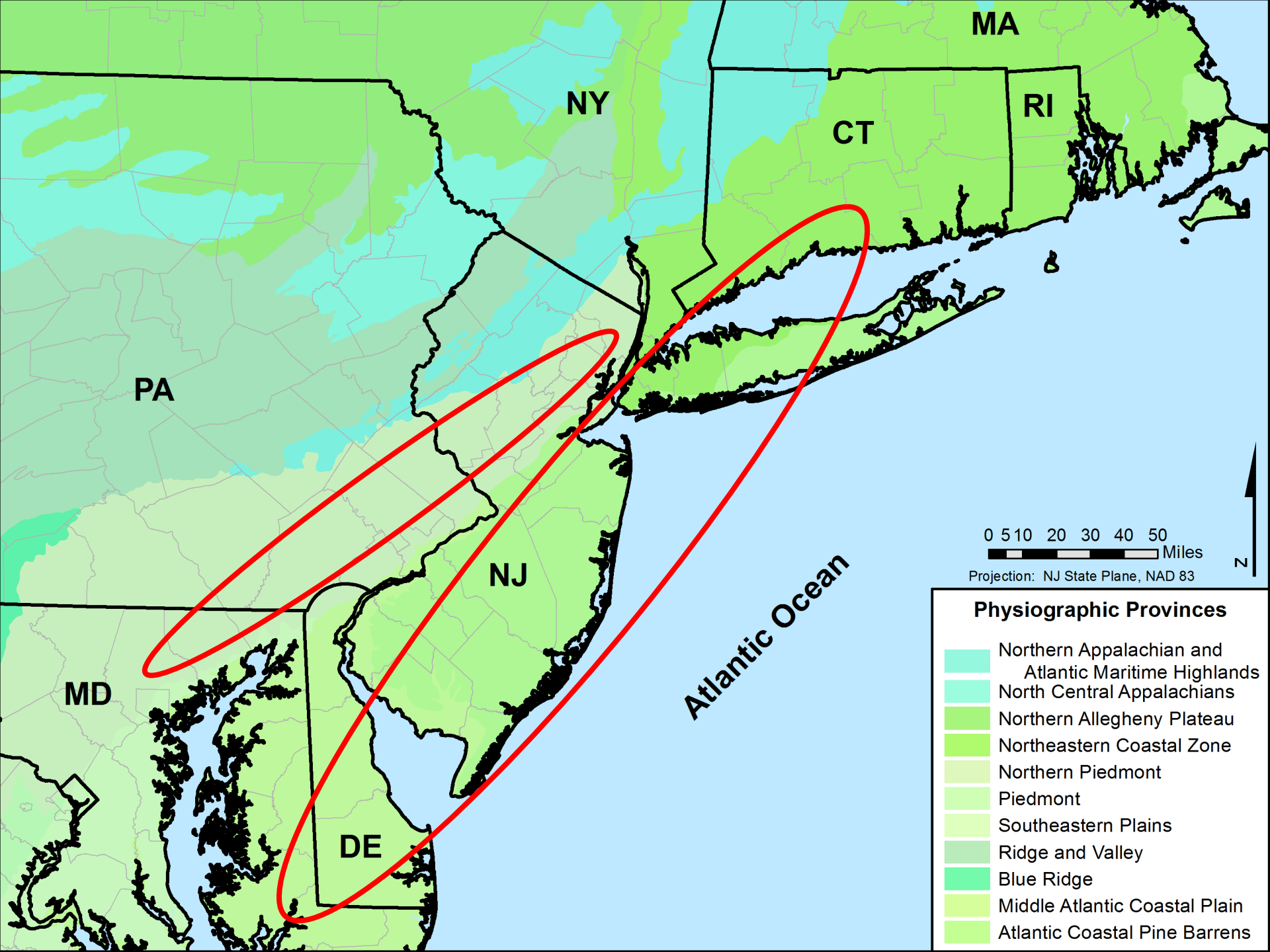
Number of Wells Sampled per Year

Program Commenced
Sep 2002

Program Ongoing
- Data through Mar 2014



What have we learned from the PWTA about overall ground-water quality in NJ?


MA
NY
CT
RI
PA
NJ
MD
DE
Atlantic Ocean
0 5 10 20 30 40 50
Miles
Projection: NJ State Plane, NAD 83
N
Physiographic Provinces
Northern Appalachian and Atlantic Maritime Highlands
North Central Appalachians
Northern Allegheny Plateau
Northeastern Coastal Zone
Northern Piedmont
Piedmont
Southeastern Plains
Ridge and Valley
Blue Ridge
Middle Atlantic Coastal Plain
Atlantic Coastal Pine Barrens

What the data tell us…

- Lends to the development of vulnerability maps.
  - Identification of “hot spots”
- Helps public outreach efforts.
  - Inform the public about the quality of their drinking water.
  - Test, test, test!

Regional Data Analyses

- As part of the Act any analysis must protect confidentiality of the homeowner

- Data were summarized regionally by:
  - Municipality and County
  - a 2 mile x 2 mile grid
    - It was desired to evaluate data at a non-political boundary level.
    - A minimum sample size of 10 wells per grid was deemed acceptable for analysis.
    - A 2x2 mile grid provided for the retention of 98% of all wells sampled for statewide parameters.
    - In other words, 2.0% of wells were in grids with less than 10 wells.

Statistical Analyses

- Data were summarized to determine:
  - The number of wells sampled
    - Arsenic – +31,000
    - Mercury – +39,000
    - Radionuclides – +45,000
    - Nitrate and other inorganics & VOC – +78,500
  - The percentage of wells that exceeded:
    - for arsenic, 5 *u*g/L (***NJ DWS***) and 10 *u*g/L
    - for nitrate, 2 mg/L, 5 mg/L, and 10 mg/L (***NJ DWS***)
    - Established primary or secondary standards or optimal range for other inorganics and radionuclides and VOCs.
  - The 95th percentile

- R statistical software with the NADA package was used for analysis using the Kaplan-Meier procedures to account for data below multiple detection limits.

Summaries of naturally occurring contaminants

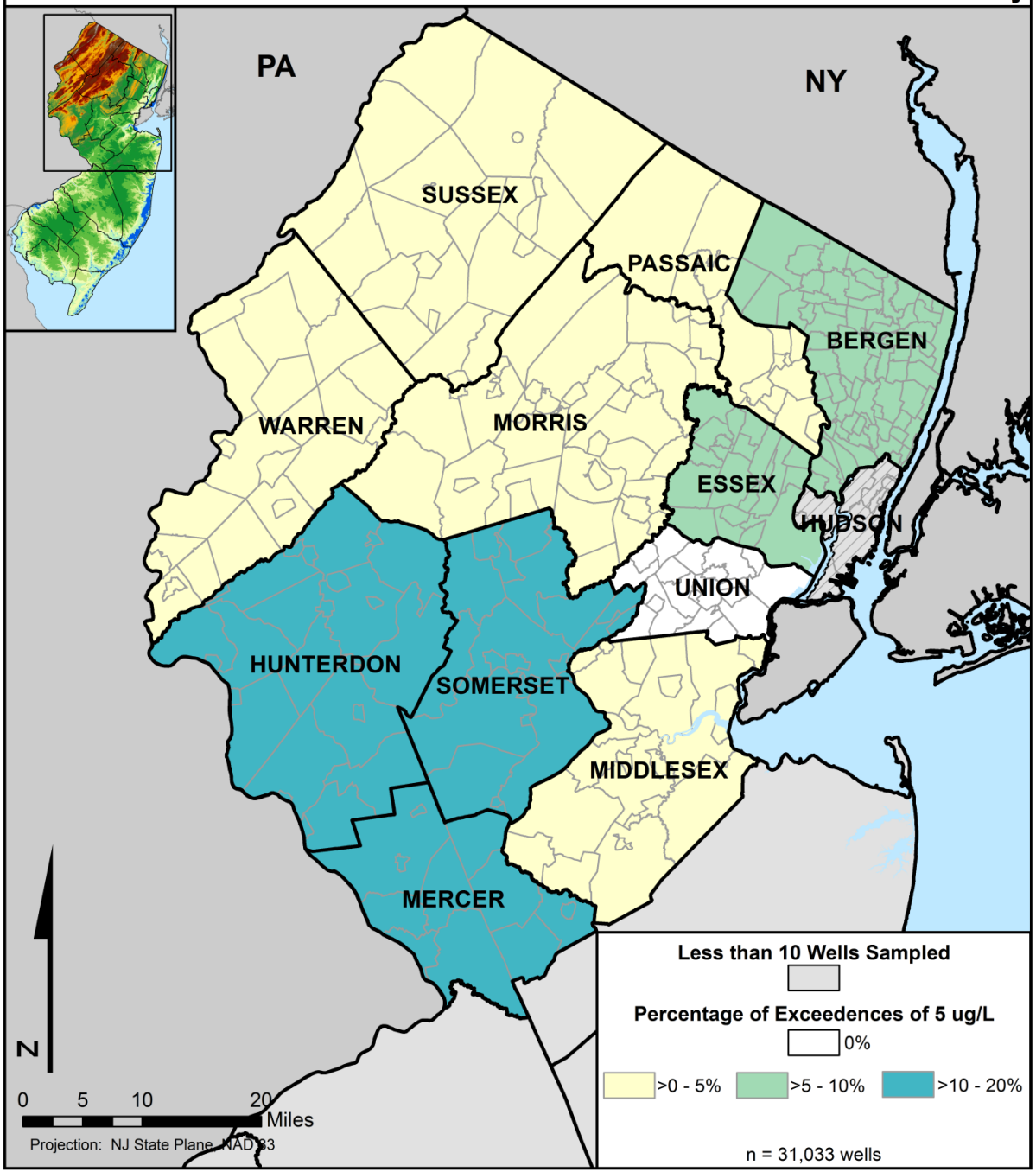
Percentage of wells exceeding a primary or secondary MCL or optimal ranges

Arsenic

- Sources:
  - Arsenical pesticides
    - Used extensively between late 1800's to mid-late 1900's
    - Considered not very mobile
  - Natural minerals
    - Pyrite-rich formations
    - Hematite, glauconite, and clays

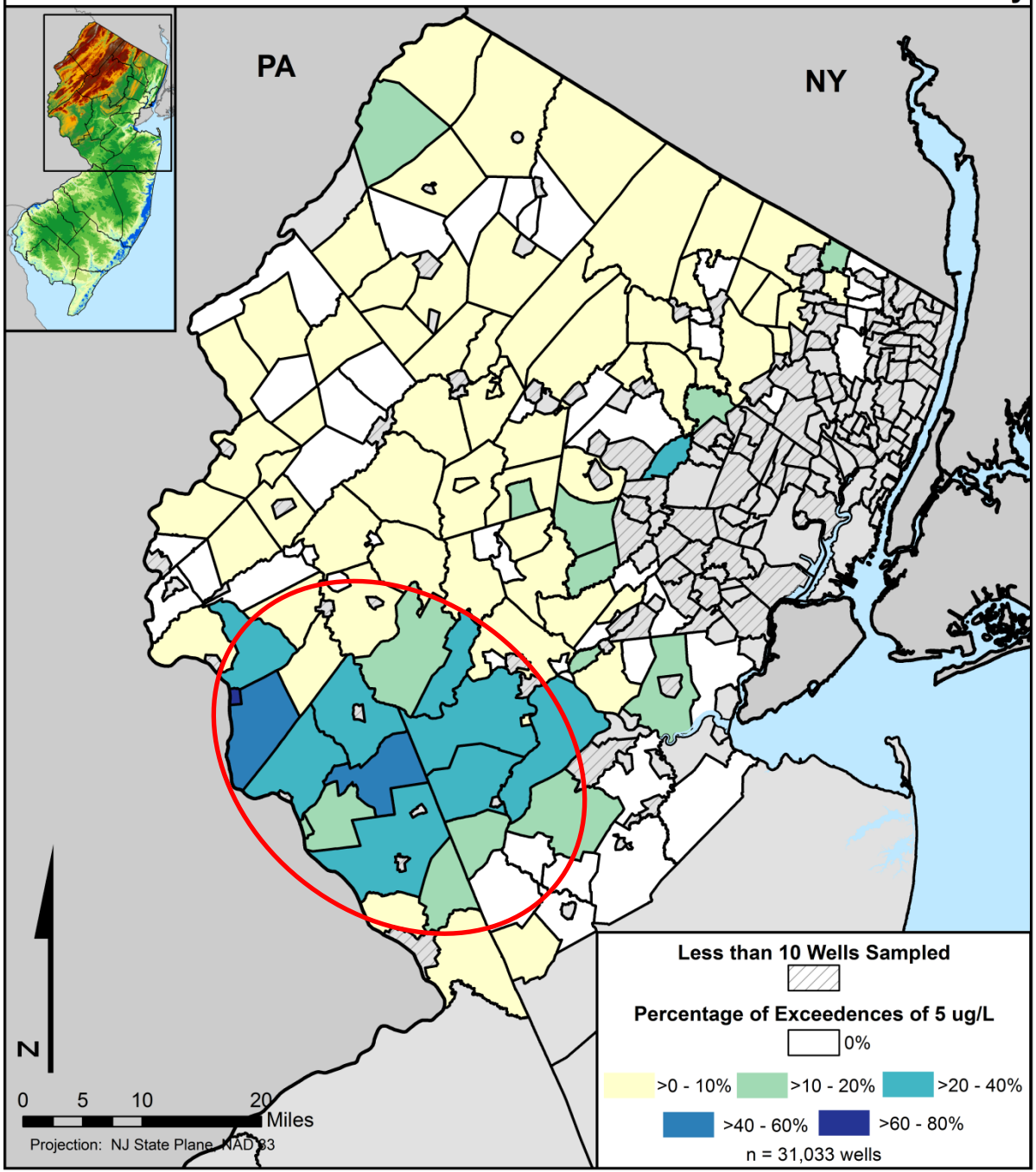
Arsenic - Percentage of Wells Exceeding 5 ug/L

Northern New Jersey



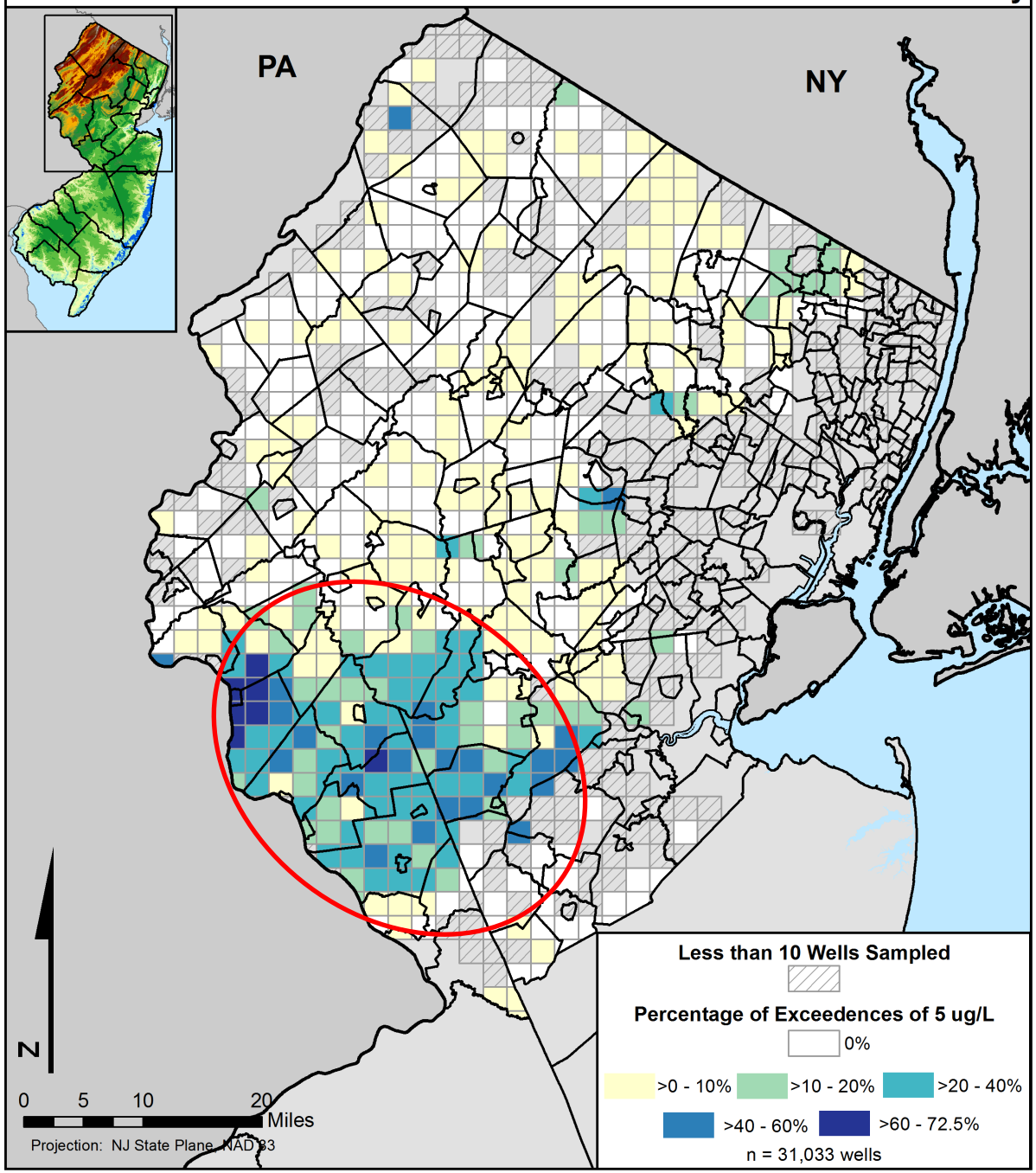
Arsenic - Percentage of Wells Exceeding 5 ug/L

Northern New Jersey



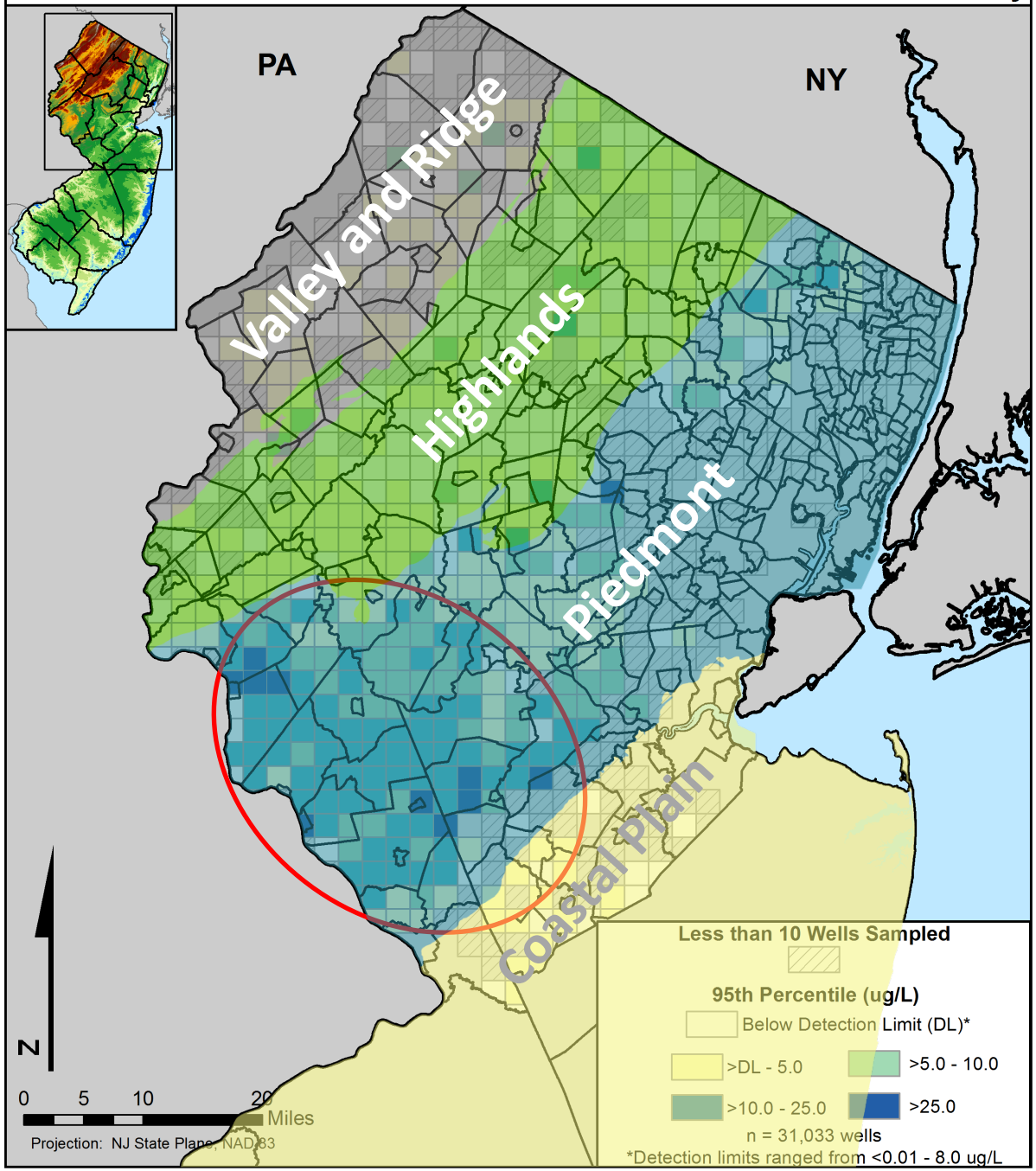
Arsenic - Percentage of Wells Exceeding 5 ug/L

Northern New Jersey



Arsenic - 95th percentile

Northern New Jersey

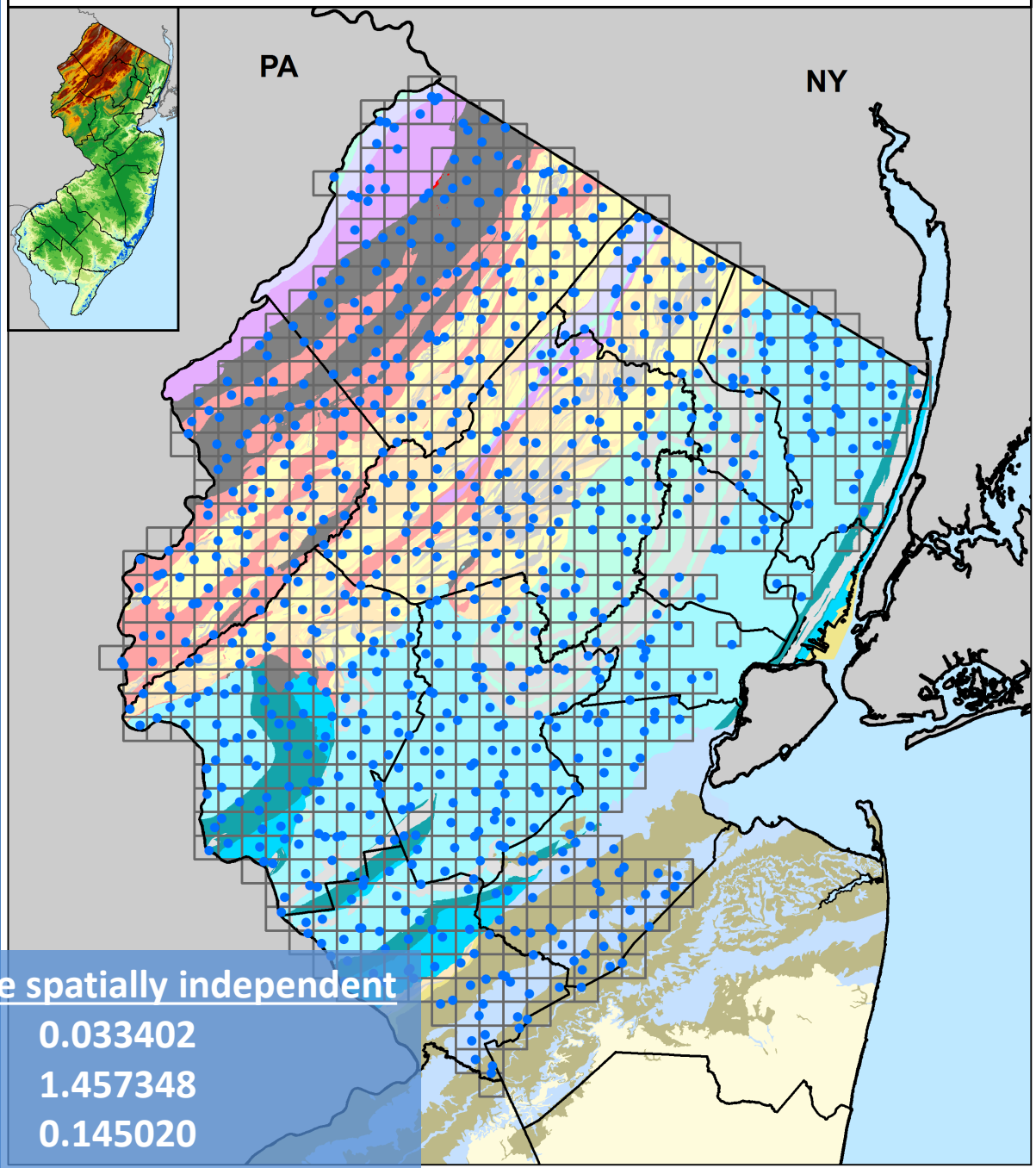


Arsenic Exceedances

Overall 9.1% of wells exceeded the NJ MCL and 3.1% exceed the Federal MCL

Province	Exceedance of NJ Standard (5 ug/l)	Exceedance of Federal Standard (10 ug/l)
Valley and Ridge	2.1%	0.5%
Highlands	1.2%	0.5%
Piedmont	17.3%	5.8%
Coastal Plain	0.9%	0.6%

772 Stratified Random Wells and Geologic Units



Arsenic values are spatially independent

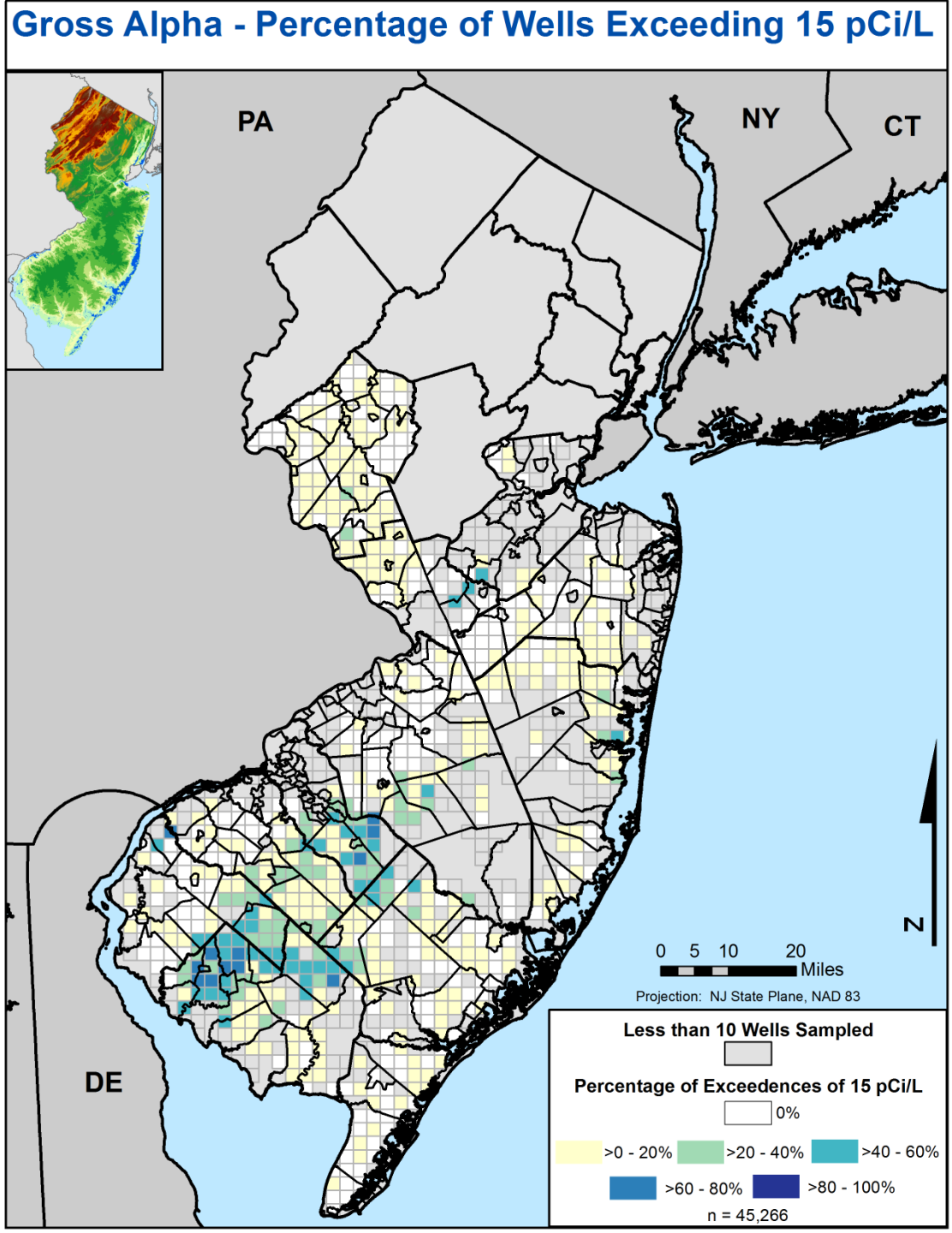
Moran's Index:	0.033402
z-score:	1.457348
p-value:	0.145020

Geologic Units	Number of wells	Percent of wells	Percent Exceed 5 ug/L	Percent Exceed 10 ug/L
Cambrian-Ordovician carbonate rocks and quartzite	77	10.0	1.3	0.0
Cretaceous-Paleogene clay and silt	21	2.7	0.0	0.0
Cretaceous-Paleogene sand, gravel, and silt	36	4.7	0.0	0.0
Devonian black shale	9	1.2	0.0	0.0
Devonian clastic and carbonate rocks	11	1.4	0.0	0.0
Jurassic clastic rocks	41	5.3	9.8	7.3
Jurassic diabase and basalt	49	6.3	6.1	2.0
Ordovician shale, slate, and sandstone	64	8.3	1.6	0.0
Precambrian diorite and amphibolite	24	3.1	0.0	0.0
Precambrian gneiss	96	12.4	3.1	3.1
Precambrian granite	73	9.5	2.7	1.4
Precambrian to Ordovician schist and metaclastics	1	0.1	0.0	0.0
Silurian quartzite, clastic and carbonate rocks	15	1.9	6.7	0.0
Triassic argillite	29	3.8	13.8	3.4
Triassic mudstone, siltstone, and shale	199	25.8	19.1	5.5
Triassic sandstone	27	3.5	3.7	3.7

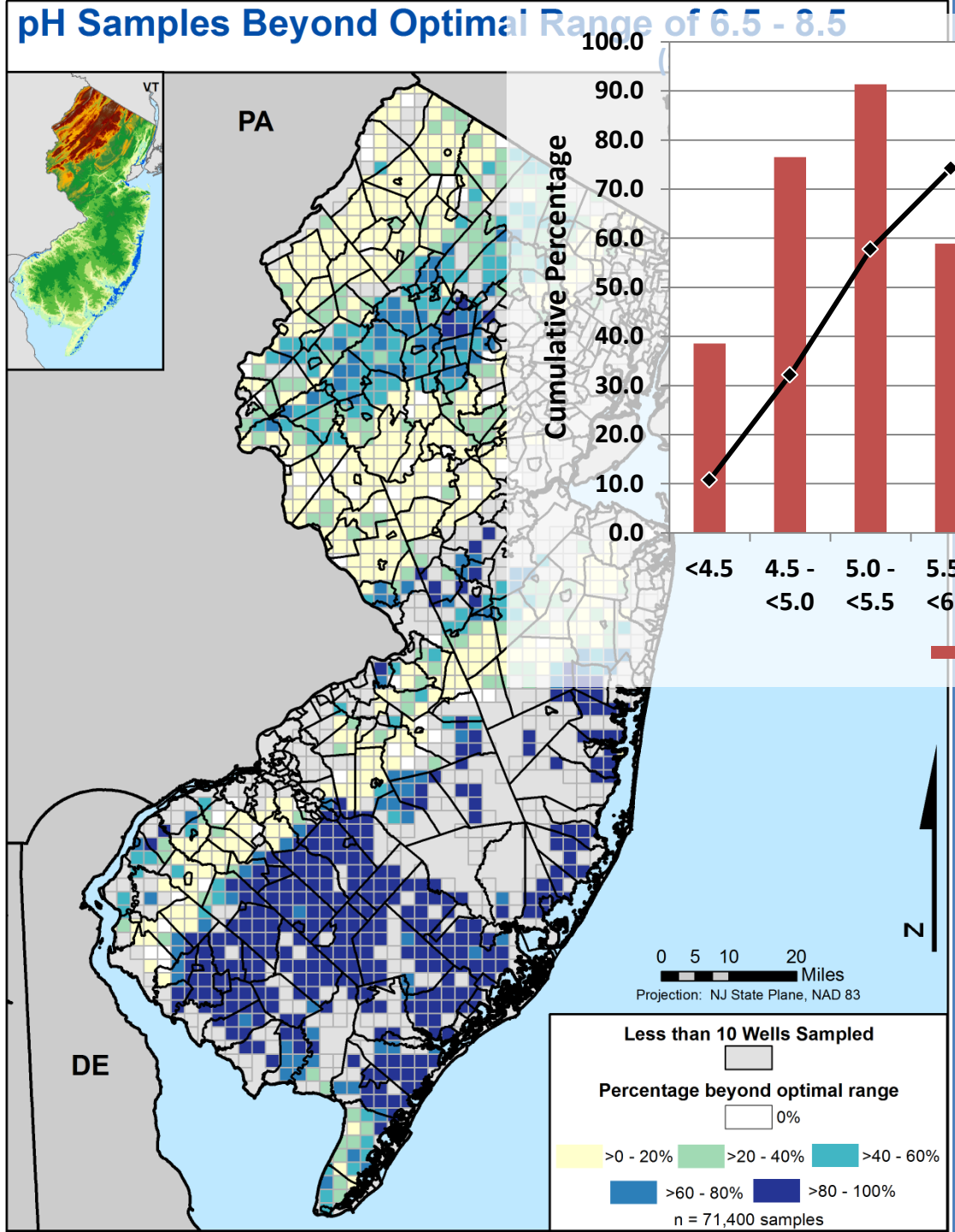
Alpha radiation is emitted from both short-lived and long-lived radionuclides.

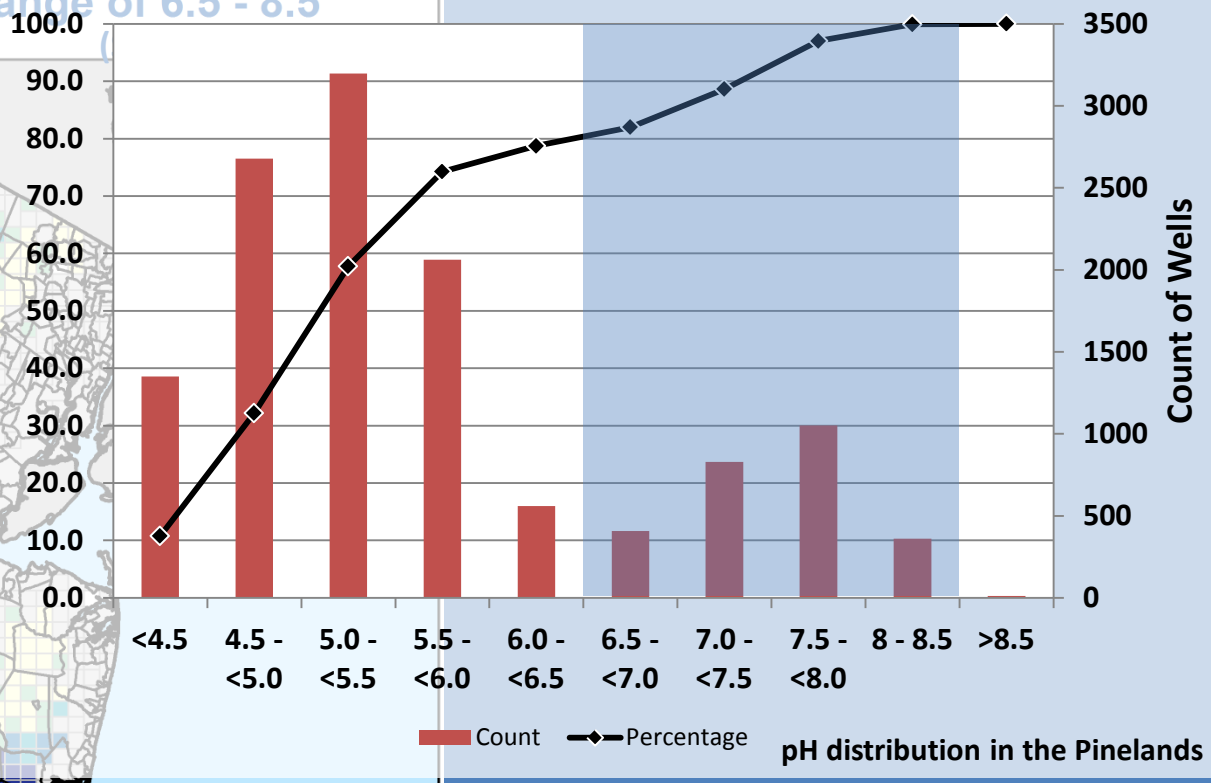
Source - Erosion of natural deposits of certain minerals that are radioactive may emit alpha radiation.

In the Southern part of the state, it is likely the decay of radium and its isomers, while in the northern counties uranium may be implicated.



pH Samples Beyond Optimal Range of 6.5 - 8.5

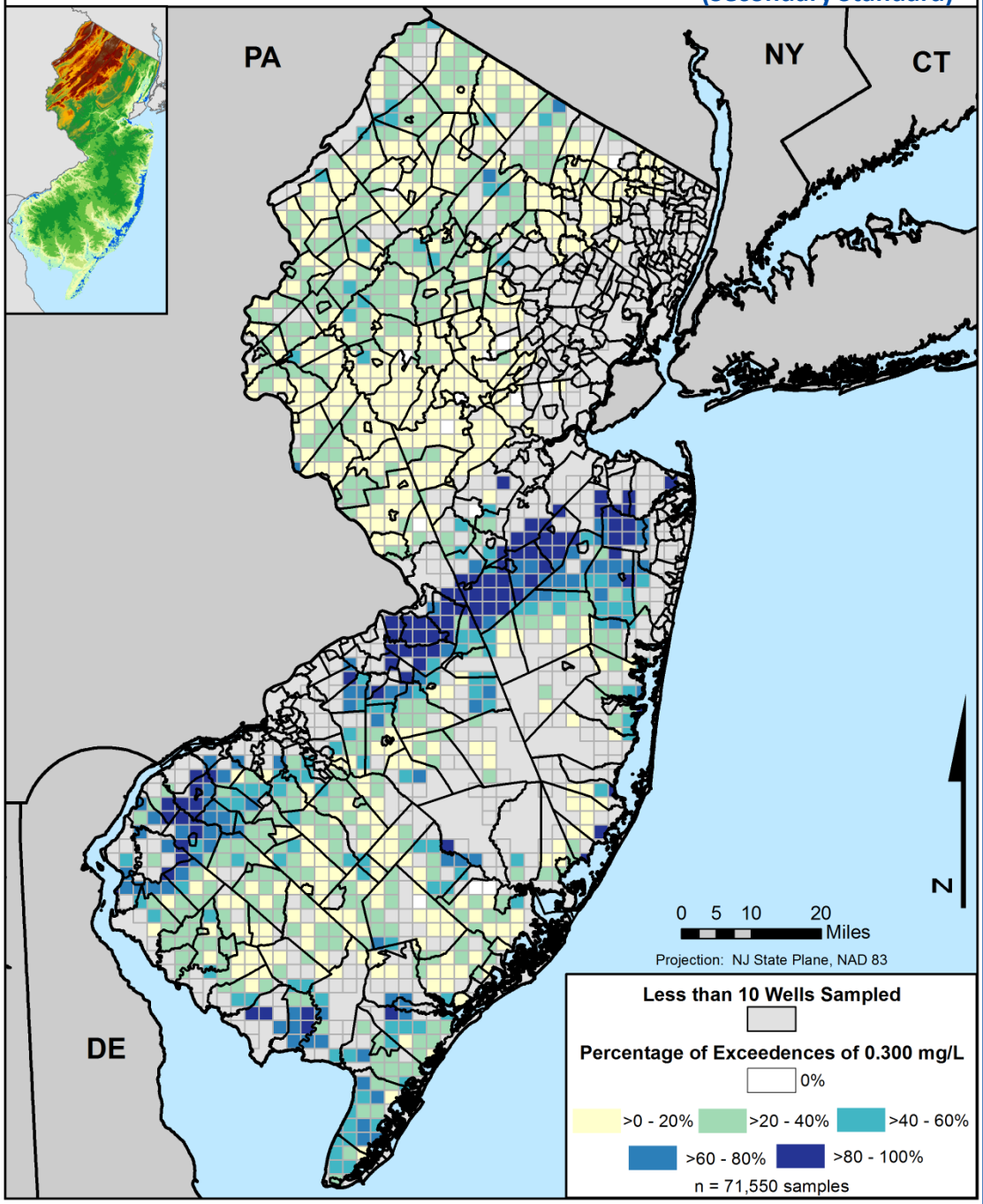




pH distribution in the Pinelands		
Number of Wells	Range	Percentage of Wells
1,349	<4.5	10.8
4,028	<5	32.2
7,226	<5.5	57.8
9,288	<6	74.3
9,848	<6.5	78.7
2,649	6.5 – 8.5	21.2
12	>8.5	0.1

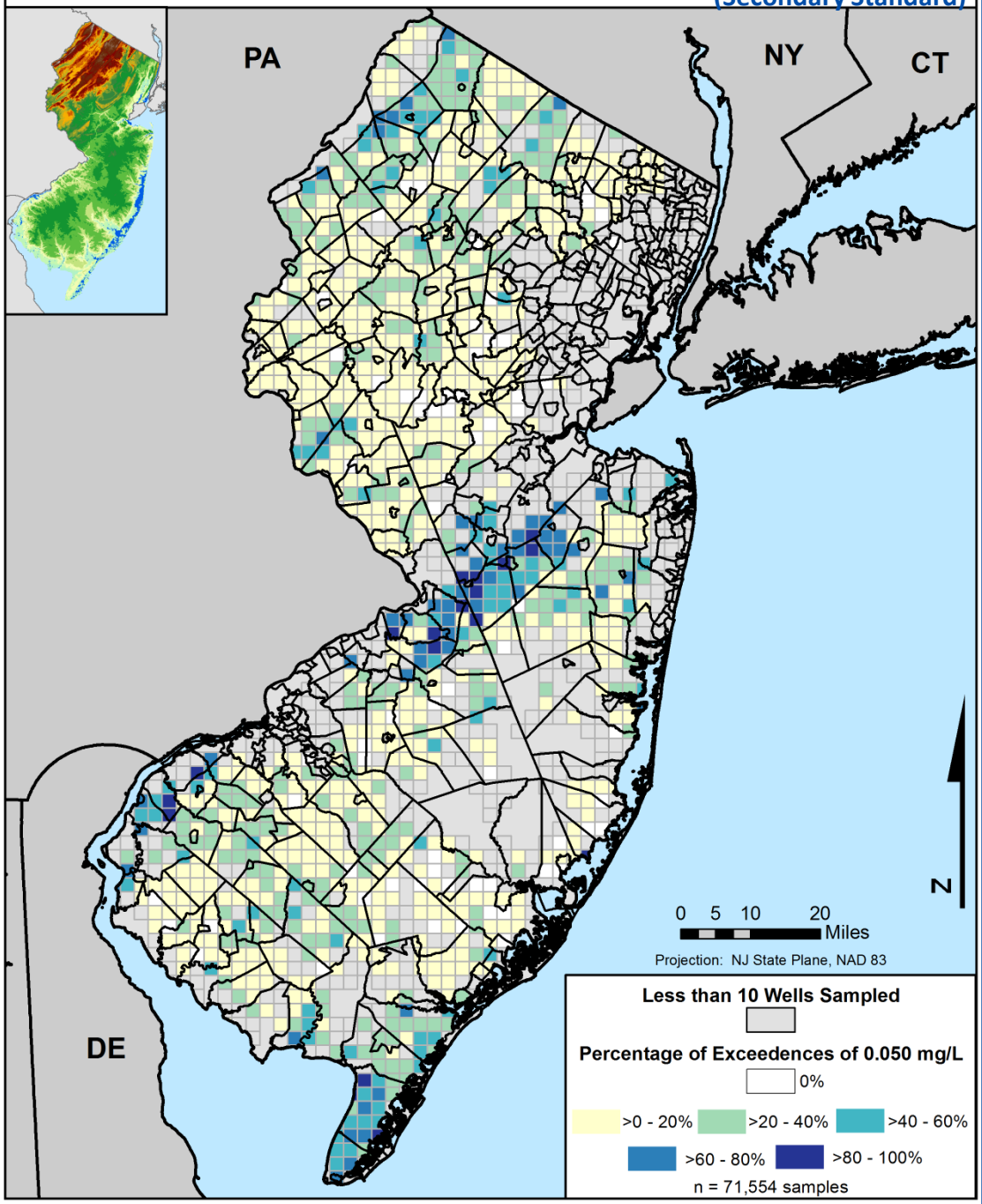
Iron - Percentage of Wells Exceeding 0.30 mg/L

(Secondary Standard)



Manganese - Percentage of Wells Exceeding 0.05 mg/L

(Secondary Standard)



Summaries of anthropogenic contaminants

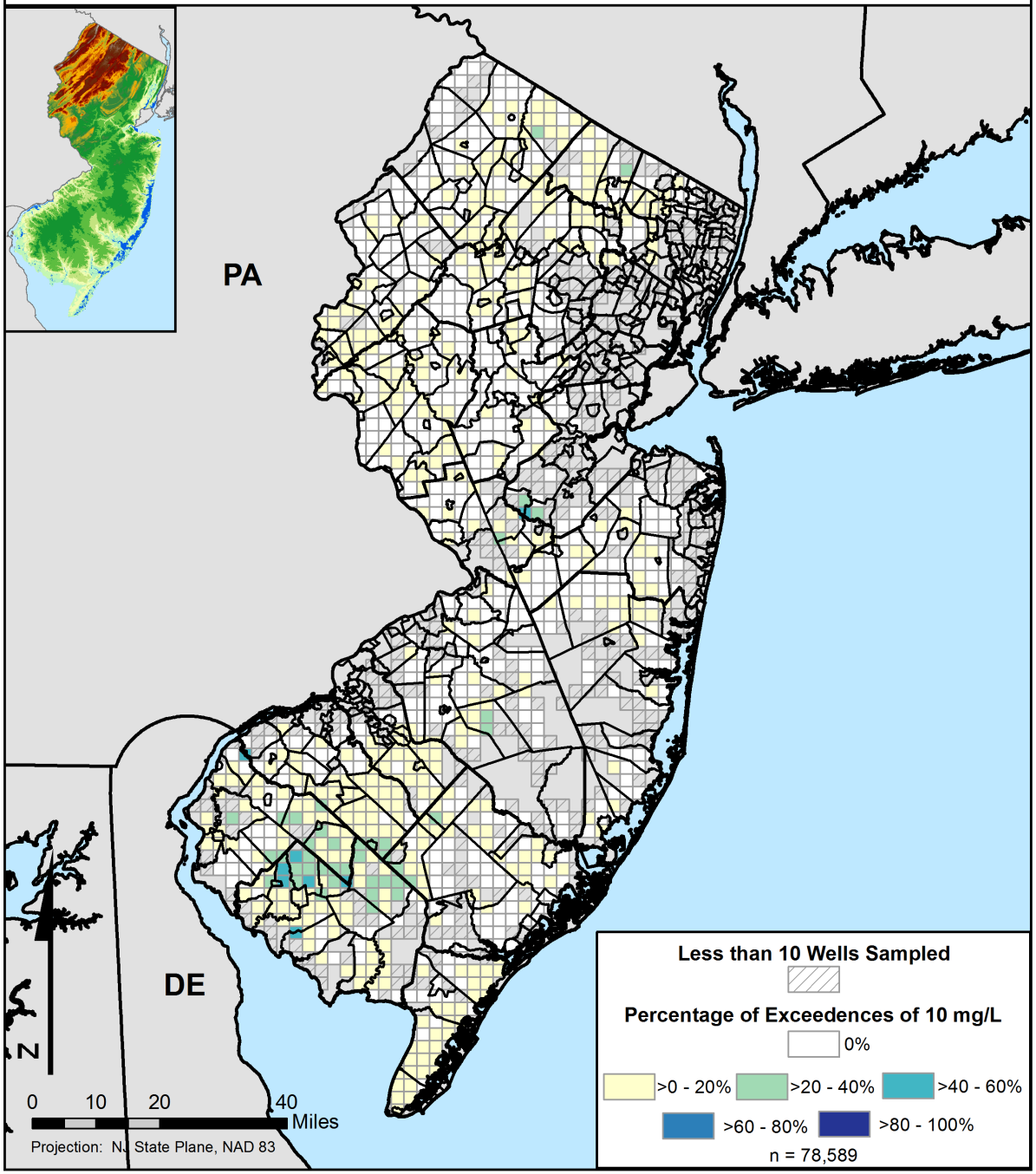
Nitrate and its reduced form nitrite are found in ground water due to a number of factors including natural deposition, runoff from fertilizer use, leaching from septic tanks, and from sewage.

Total Coliform – Sources include contaminated surface waters including lakes, streams, wetlands, and detention/infiltration basins; runoff from agricultural lands, feedlots, stockyards, land-applied sludge or manure, manure storage areas, and landfills; septic tanks, and cracked sewer lines.

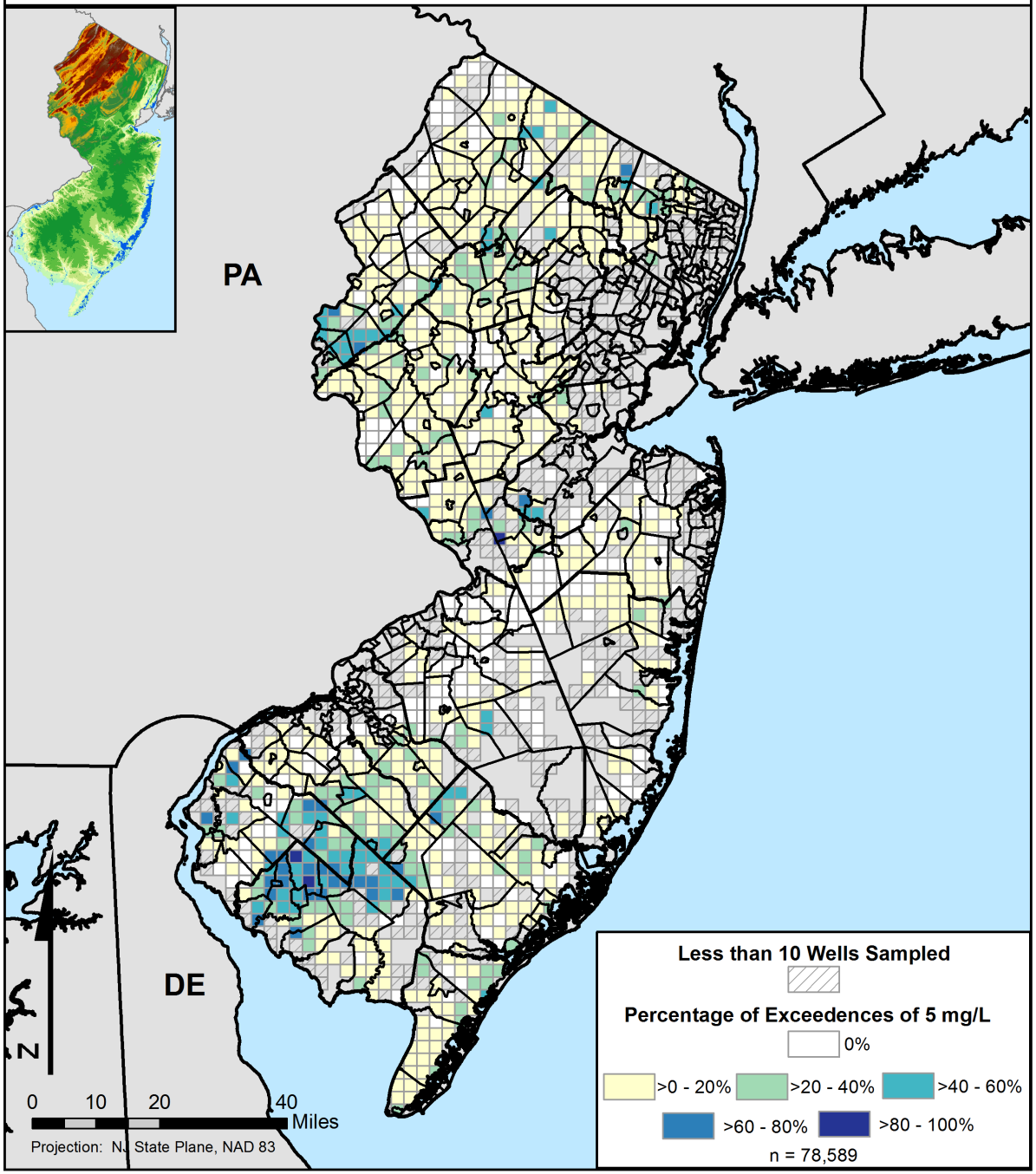
VOCs – Sources include solvents, degreasers, and components of gasoline.

Mercury – Sources include air deposition, past pesticide use, and discharges from industrial facilities.

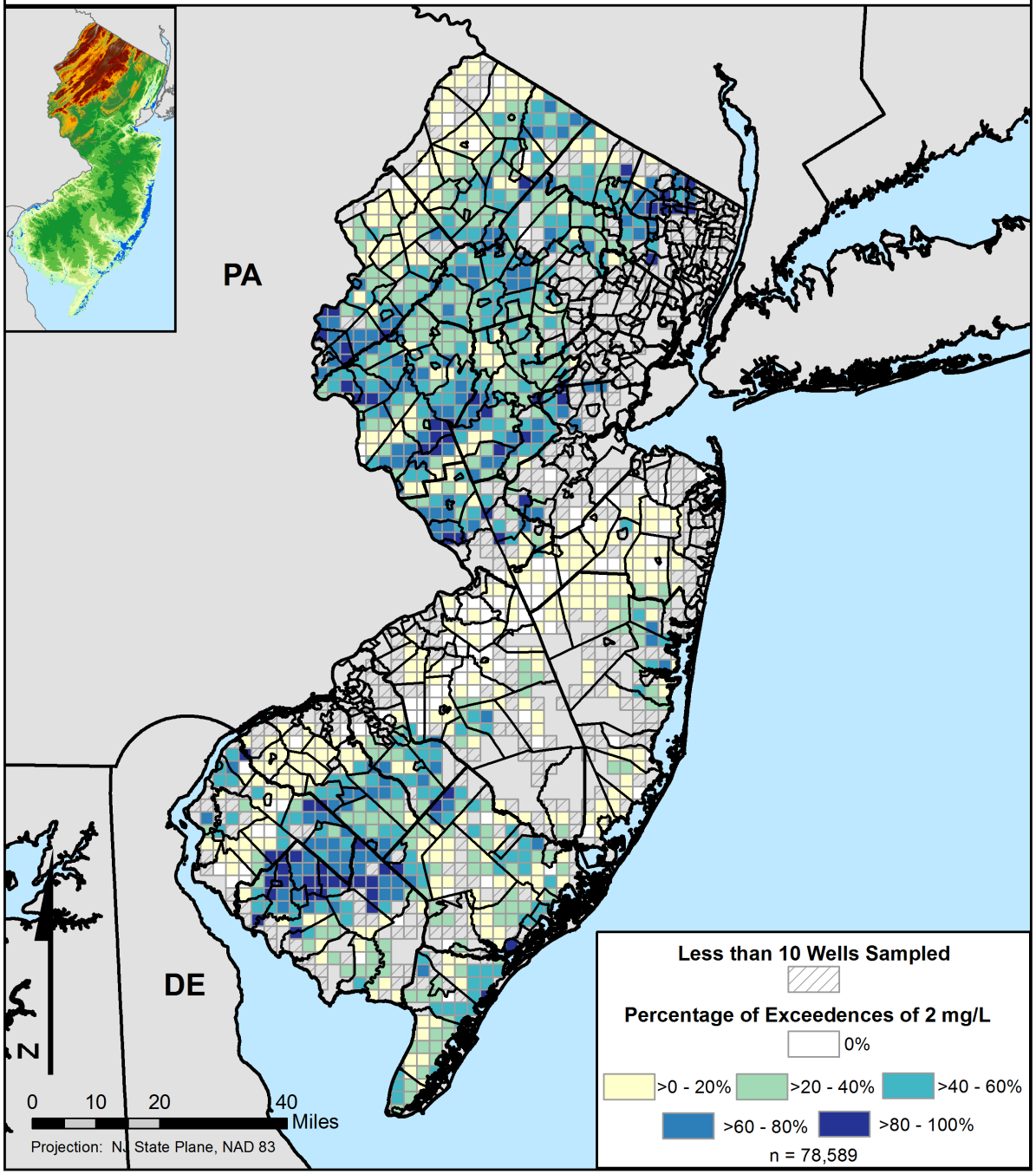
Nitrate Samples and Exceedences of 10 mg/L



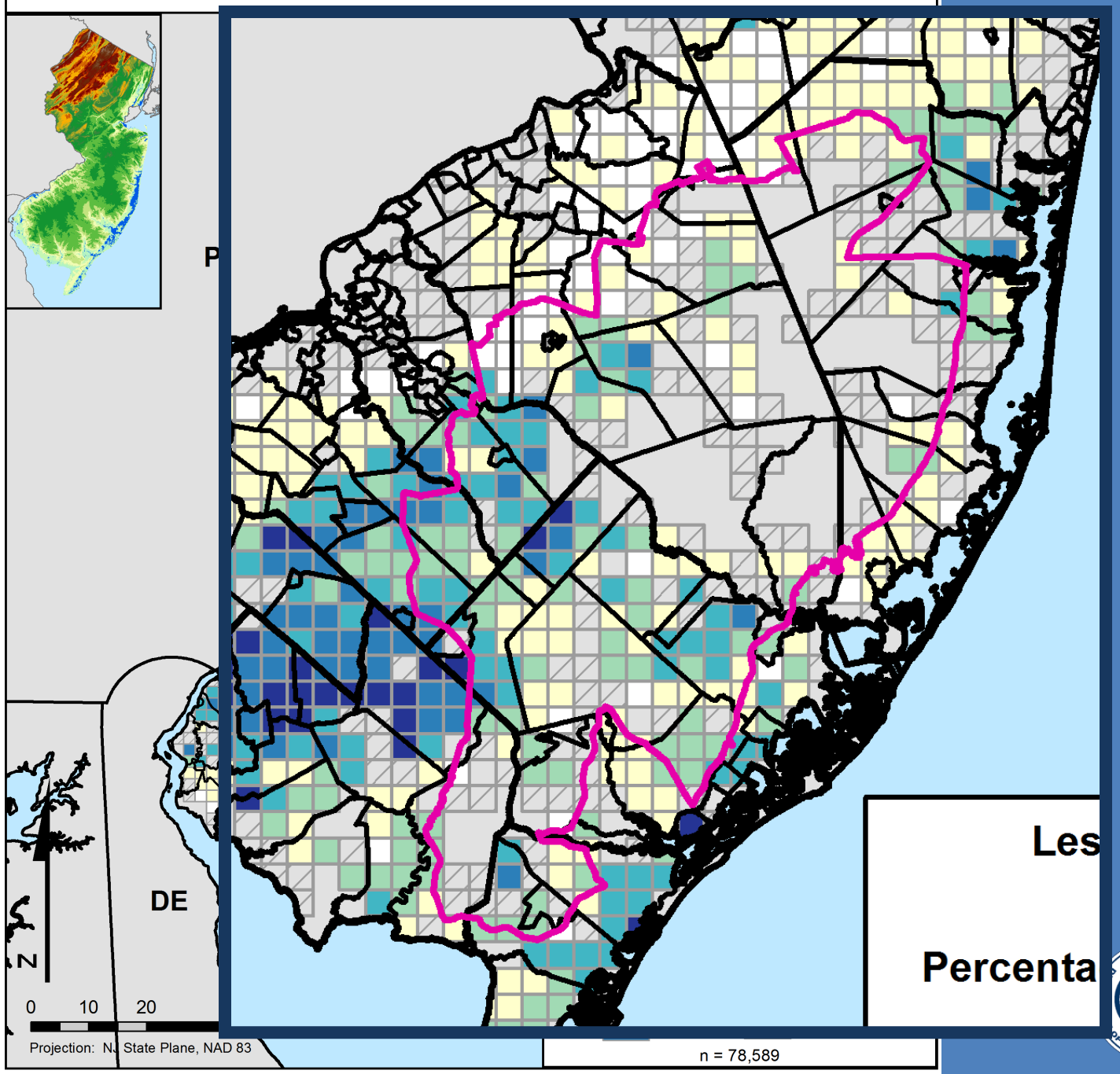
Nitrate Samples and Exceedences of 5 mg/L



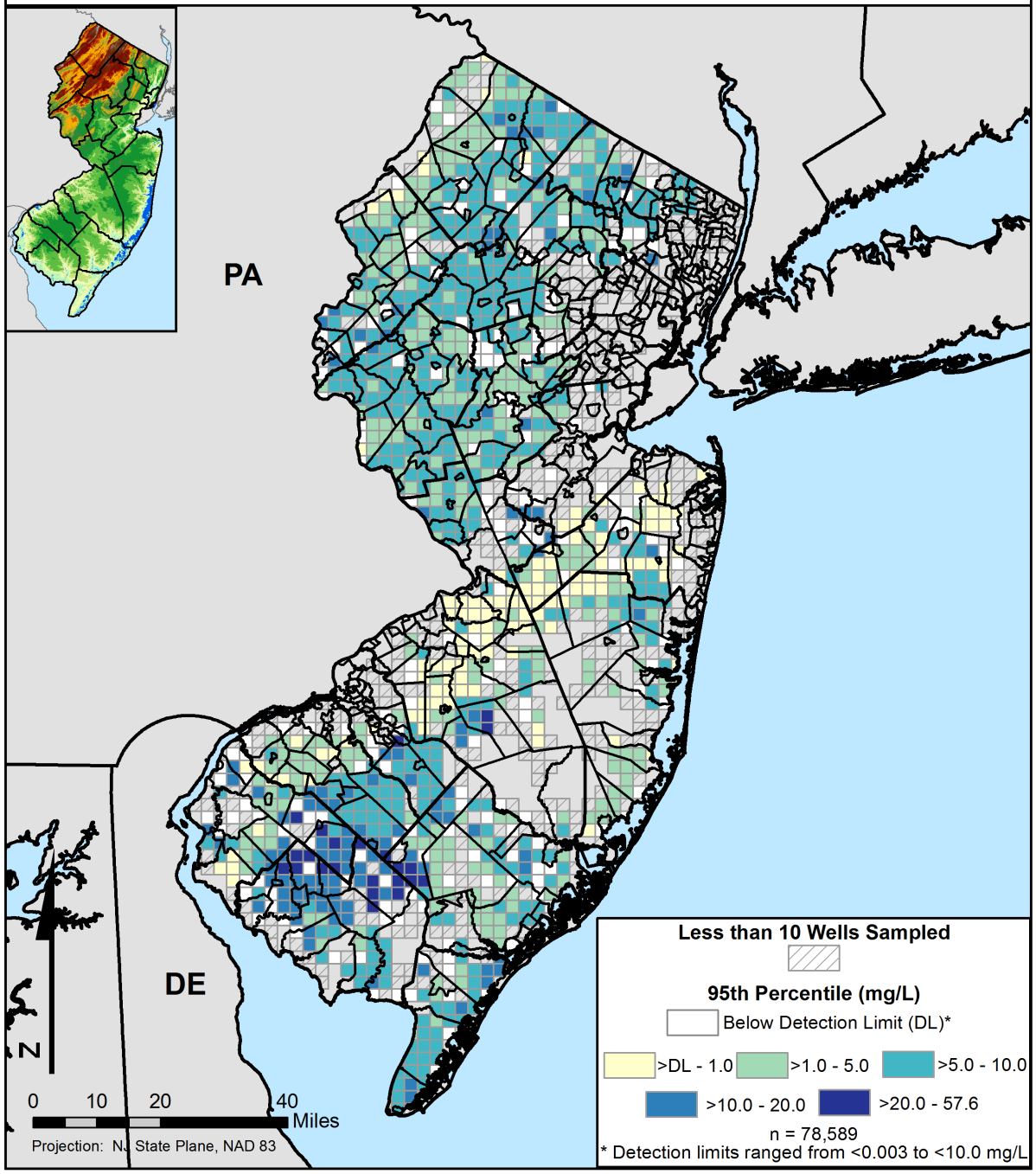
Nitrate Samples and Exceedences of 2 mg/L



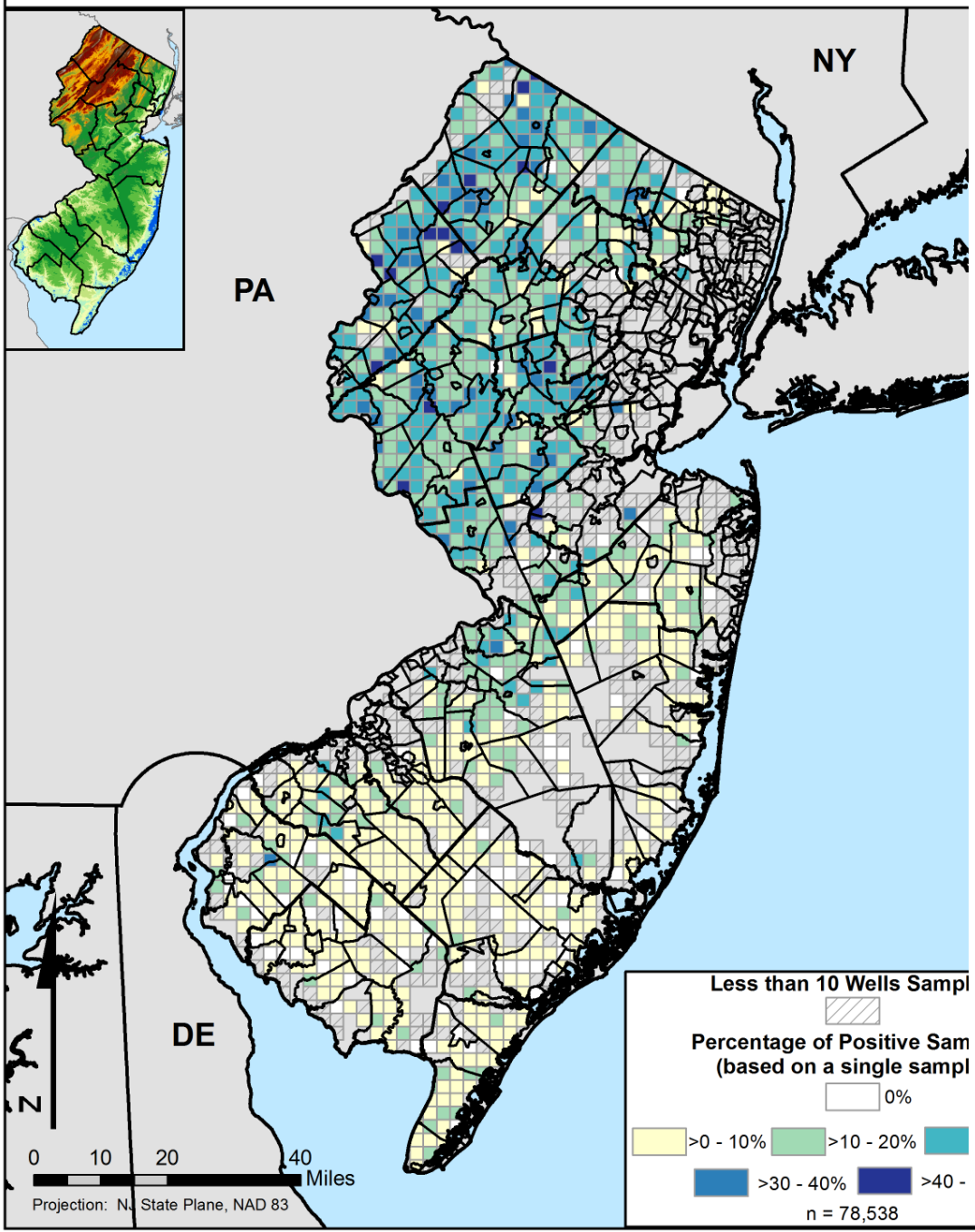
Nitrate Samples and Exceedences of 2 mg/L



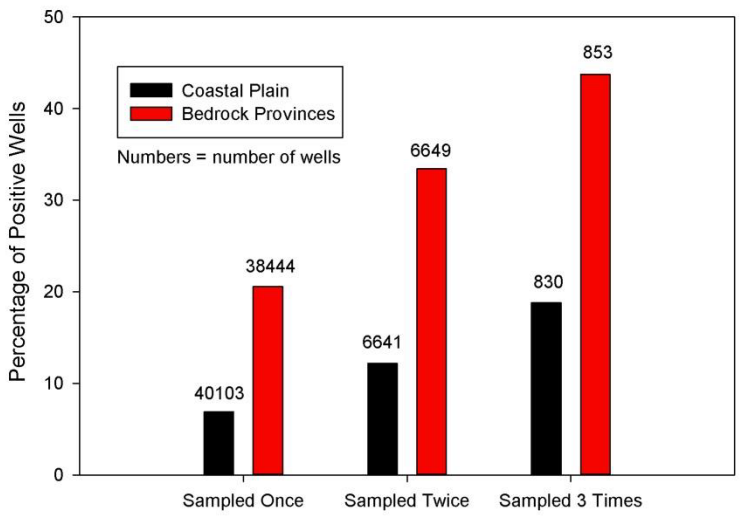
Nitrate - 95th Percentile

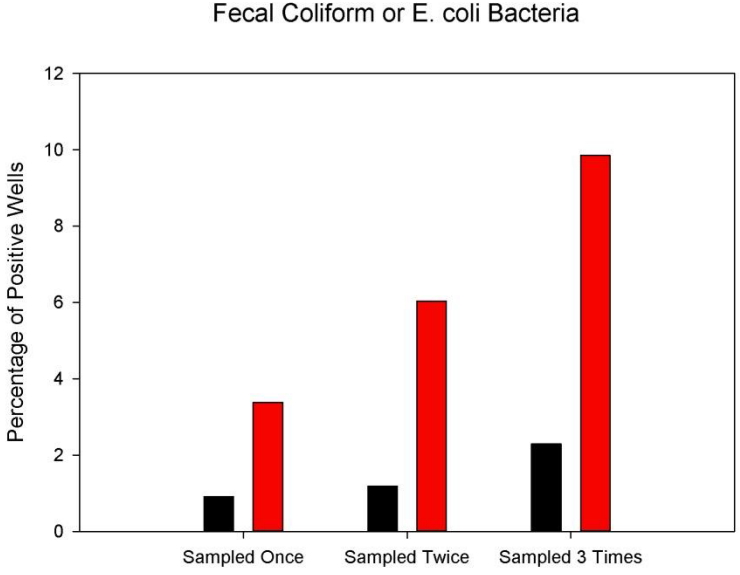


Total Coliform Detections

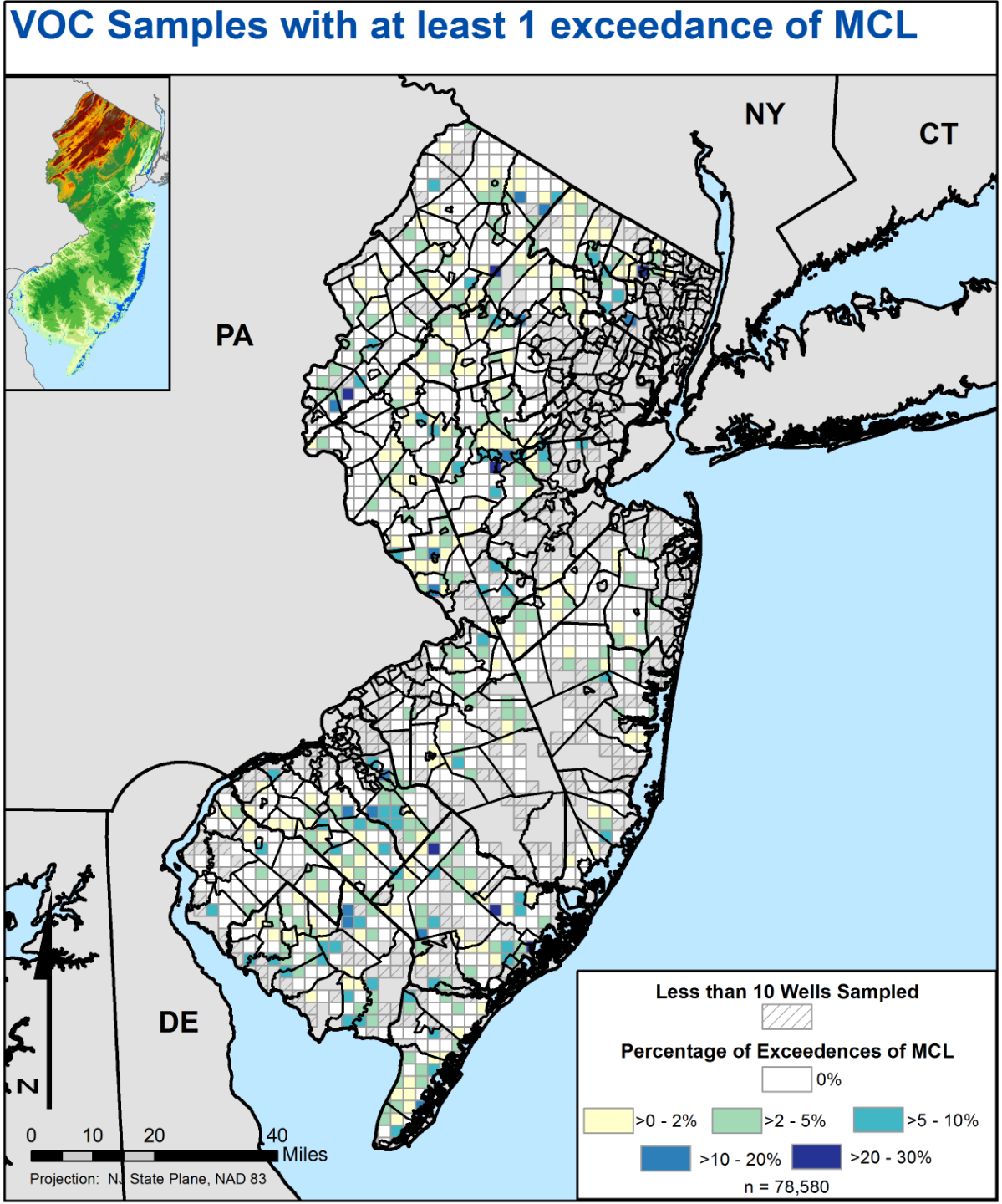


Percentage of Wells Positive for Coliform Bacteria Following the Indicated Number of Samplings





26 different compounds

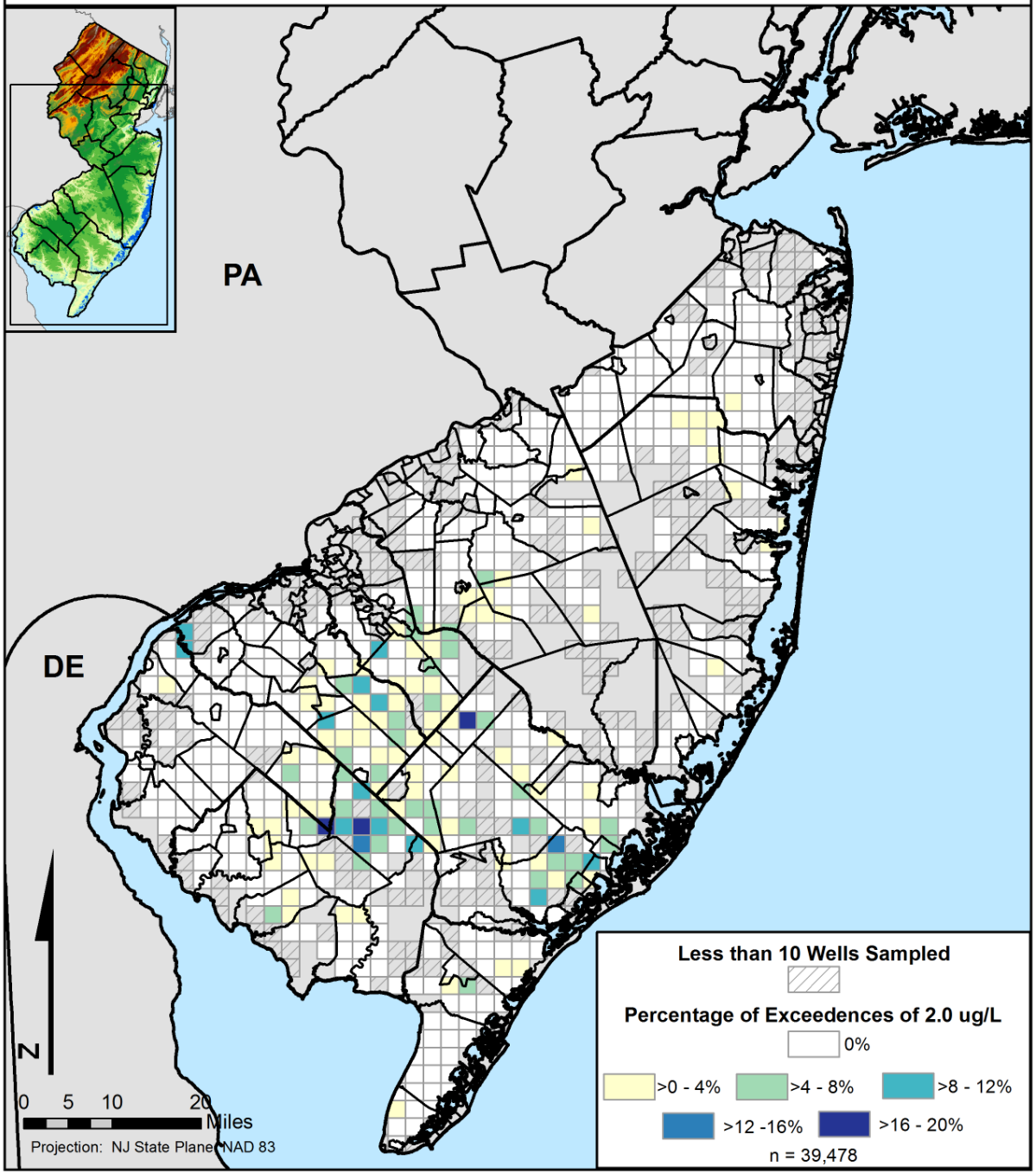


VOC exceedences in 12,510 private wells in the Pinelands

VOC	Number of Wells with Detections (over 0.5 ppb)	Percentage of Wells with Detections	Applicable MCL (ppb)	Number of Wells Above MCL	Percentage of Wells Above MCL
Benzene	34	0.27	1	16	0.13
Carbon Tetrachloride	37	0.30	2	15	0.12
Chlorobenzene	9	0.07	50	0	0.00
1,2-Dichlorobenzene	7	0.06	600	0	0.00
1,3-Dichlorobenzene	6	0.05	600	0	0.00
1,4-Dichlorobenzene	18	0.14	75	0	0.00
1,1-Dichloroethane	30	0.24	50	0	0.00
1,2-Dichloroethane	22	0.18	2	11	0.09
1,1-Dichloroethylene	16	0.13	2	1	0.01
cis-1,2-Dichlorothylene	30	0.24	70	0	0.00
trans-1,2-Dichlorothylene	2	0.02	100	0	0.00
1,2-Dichloropropane	39	0.31	5	6	0.05
Ethylbenzene	8	0.06	700	0	0.00
Methylene Chloride	51	0.41	3	9	0.07
MTBE	1,338	10.70	70	9	0.07
Naphthalene	47	0.38	300	0	0.00
Styrene	23	0.18	100	0	0.00
1,1,2,2-Tetrachloroethane	4	0.03	1	1	0.01
Tetrachloroethylene	96	0.77	1	70	0.56
Toluene	503	4.02	1000	0	0.00
1,2,4-Trichlorobenzene	6	0.05	9	1	0.01
1,1,1-Trichloroethane	26	0.21	30	0	0.00
1,1,2-Trichloroethane	3	0.02	3	1	0.01
Trichloroethylene	90	0.72	1	56	0.45
Vinyl Chloride	11	0.09	2	4	0.03
Xylenes (Total)	578	4.62	1000	0	0.00

Of the private wells tested in the Pinelands, 1.4 percent (179) contained at least one VOC in concentrations above the corresponding drinking water MCL. (1.2% statewide)

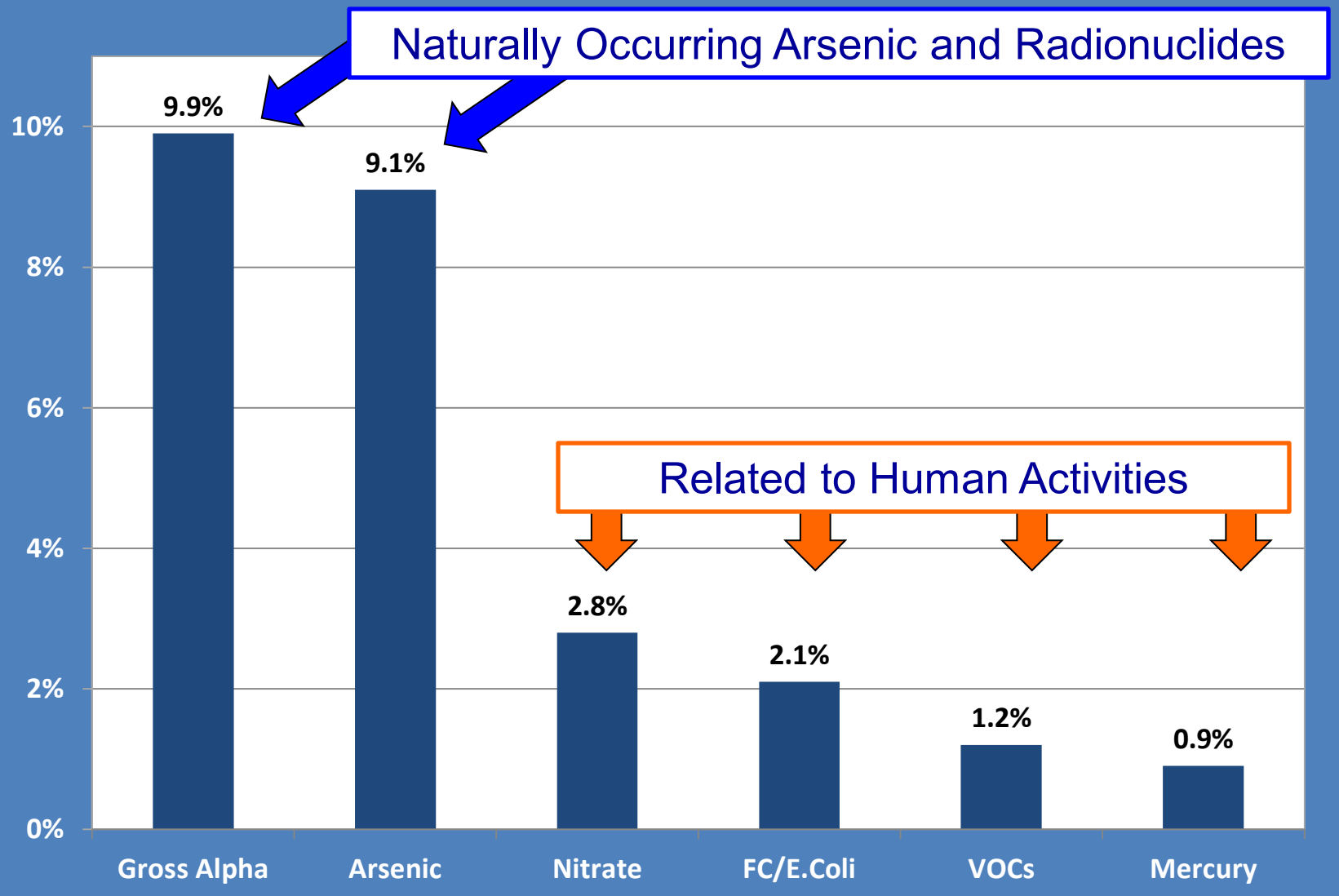
Mercury Samples and Exceedences of 2.0 ug/L



Summary of exceedences for wells in the Pinelands

Parameter	Level	Number of Wells	# of Wells Exceeding Std.	% Exceed Std. (Pinelands)
Naturally occurring parameters				
As	Testing not required in the Pinelands			
Gross Alpha	>15 pCi/l	11,366	1,640	14.4
pH	6.5 to 8.5	12,510	9,848	78.7
Fe	>0.3 mg/l	12,510	3,081	24.6
Mn	>0.05 mg/l	12,510	1,625	13.0
Mn	>HA of 0.30 mg/l	12,510	71	0.57
Anthropogenic parameters				
N	>10 mg/l	12,510	263	2.1
N	>5 mg/l	12,510	1,147	9.2
N	>2 mg/l	12,510	3,418	27.3
Hg	>2 *u*g/l	12,510	182	1.5
TC	TC Positive	15,030	814	5.4
TC	FC/EC Positive	15,030	86	0.57
VOC	>MCL (level varies)	12,510	200	1.6

Percent of Tested Wells that Exceed Specific MCLs in NJ



So what to do…?

- **Test, Test, Test!**

So what to do…?
How often should you test?

- Test annually for bacteria and nitrates.

- Test periodically for other chemicals including iron, manganese, arsenic, radionuclides (gross alpha), mercury, lead, and total dissolved solids, as well as pesticides and VOC.

http://www.nj.gov/dep/watersupply/pw_pwta.html
For list of certified labs

So what to do…?

Treatment options are available and include:

- Point-of-use (in line with a faucet) and point-of-entry (whole house) treatment systems

- Each uses filtration, distillation, disinfection, and/or reverse osmosis techniques.

Is there funding available?

- The State offers a loan program to assist with the costs of installation of a treatment system if your potable water does not meet the State's standards.

NJ Housing and Mortgage Finance Agency

- http://www.state.nj.us/dca/hmfa/homeownership/owners/potable/

The Bottom Line…

If your drinking water comes from a private well take the simple step to protect you and your family's health.

Test that well!

Contact Information

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- **PWTA websites:**
  http://www.nj.gov/dep/dsr/pwta

- **PWTA NJDEP:**
  - Kristin Hansen (general calls)
  - Tom Atherholt (database maintenance and analysis)
  - Sandra Goodrow (database maintenance and analysis)
  - Debra Waller (laboratory/method issues)
  - Rich Gunoskey (database/software issues)
  - Steve Spayd (treatment advice)

- **Health Effects Information:**
  - NJDOH: Jessie Gleason, Rebecca Greeley (Environ & Occup Health Surveil Program)
  - NJDEP: Gloria Post, Alan Stern (Office of Science)

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