Per- & polyfluorinated alkyl substances (PFAS) in Pennsylvania surface waters: a statewide assessment & associated sources

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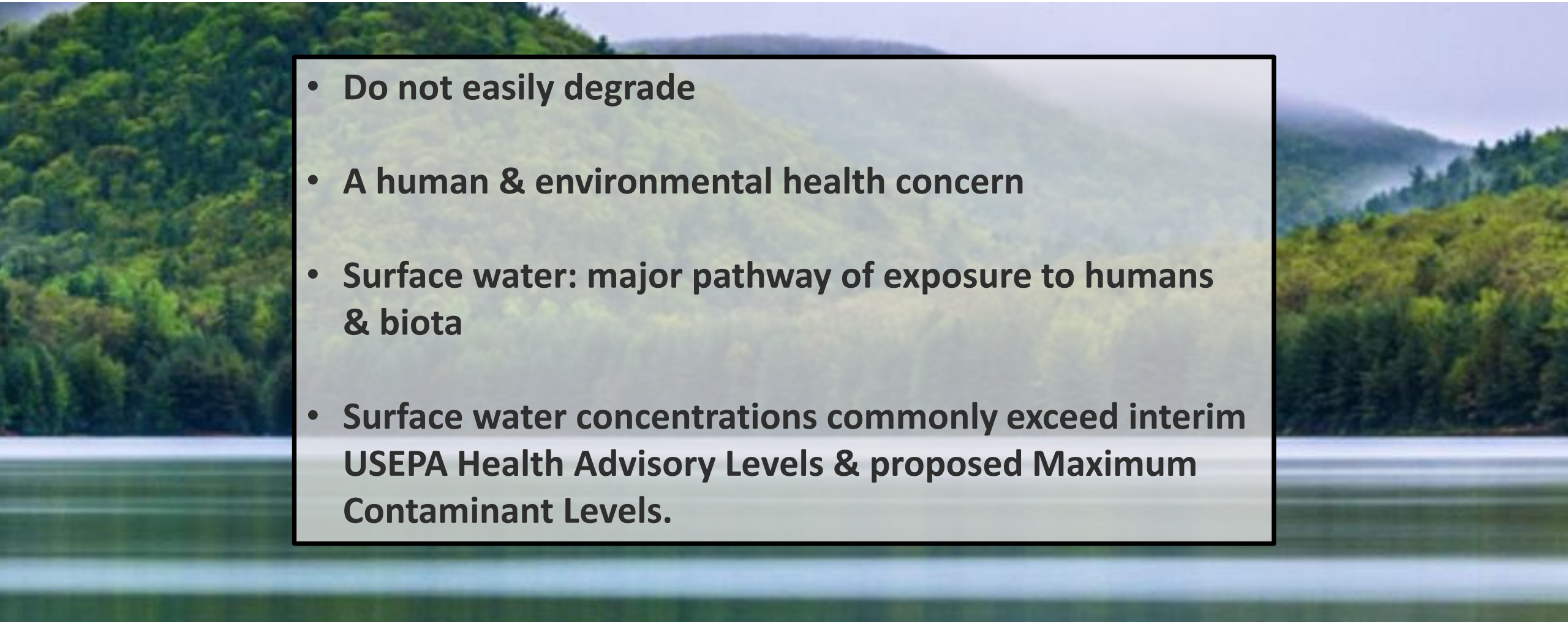
Per- & polyfluorinated alkyl substances (PFAS)



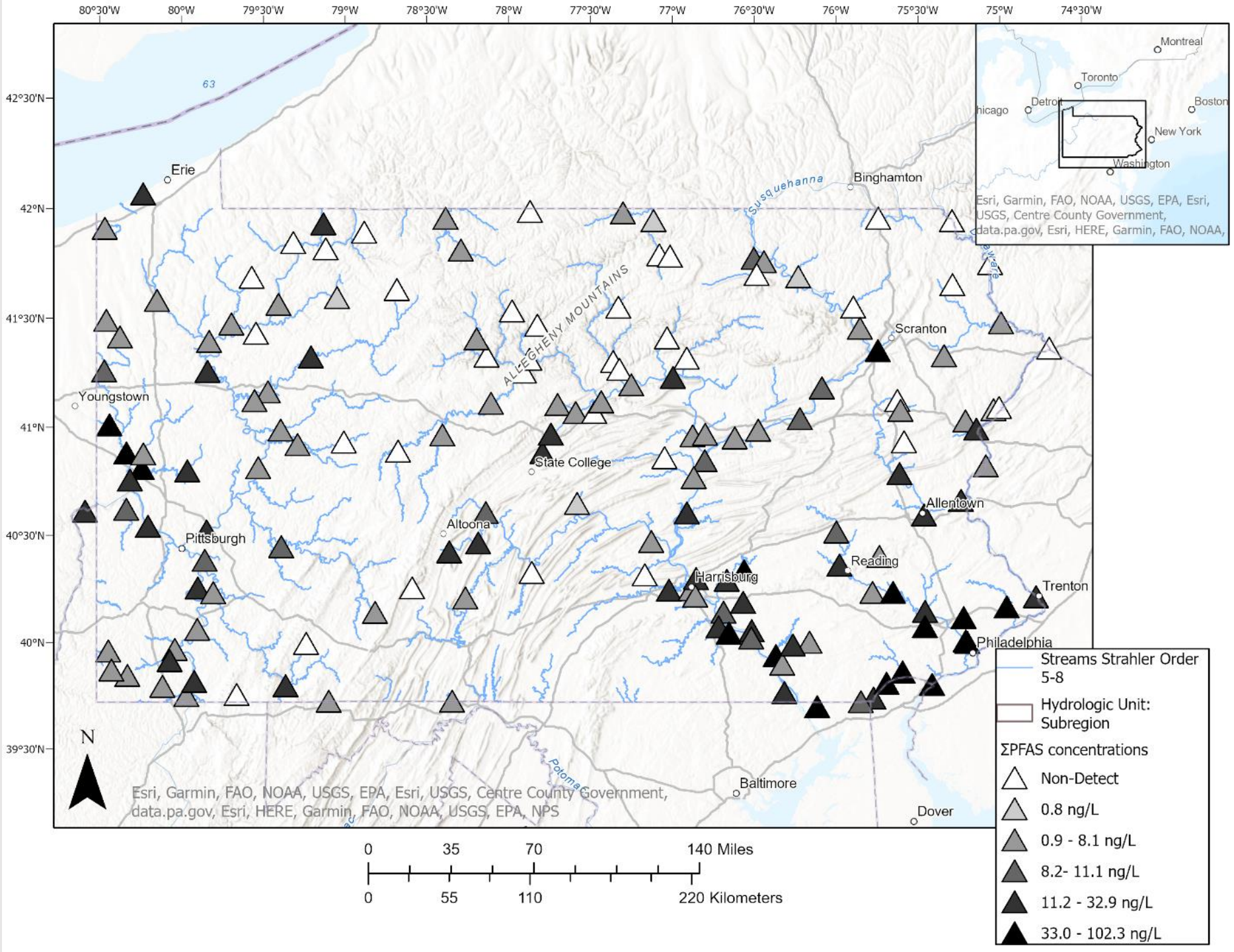
- Do not easily degrade
- A human & environmental health concern
- Surface water: major pathway of exposure to humans & biota
- Surface water concentrations commonly exceed interim USEPA Health Advisory Levels & proposed Maximum Contaminant Levels.

Pennsylvania Water Quality Network Streams (n=161)

- Sampled once- September 2019
- 33 target PFAS concentrations

(EPA draft method 1633)

- pH, alkalinity, total dissolved solids, total nitrogen (TN), ammonia, chloride, & sulfate



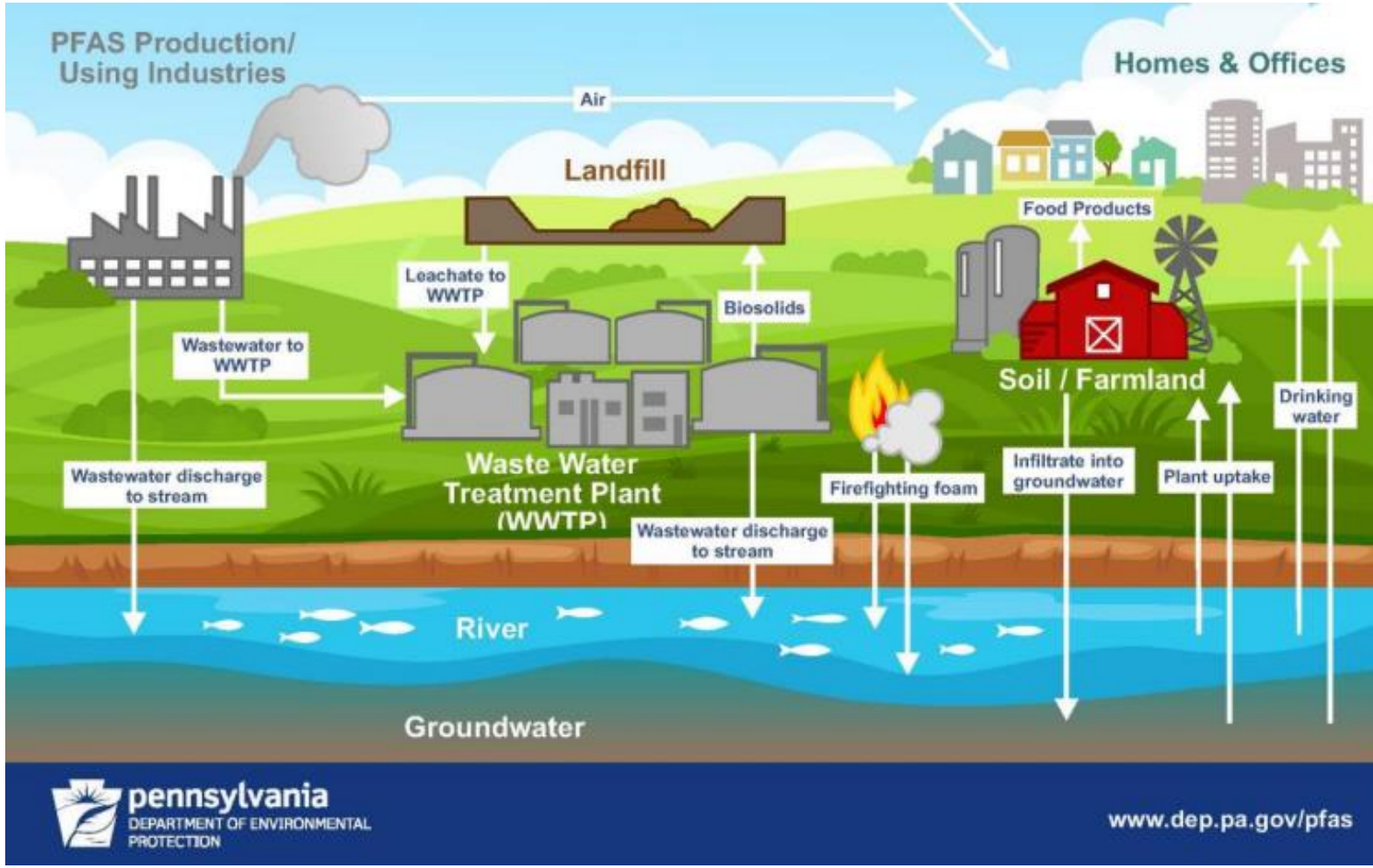
Geospatial Analysis

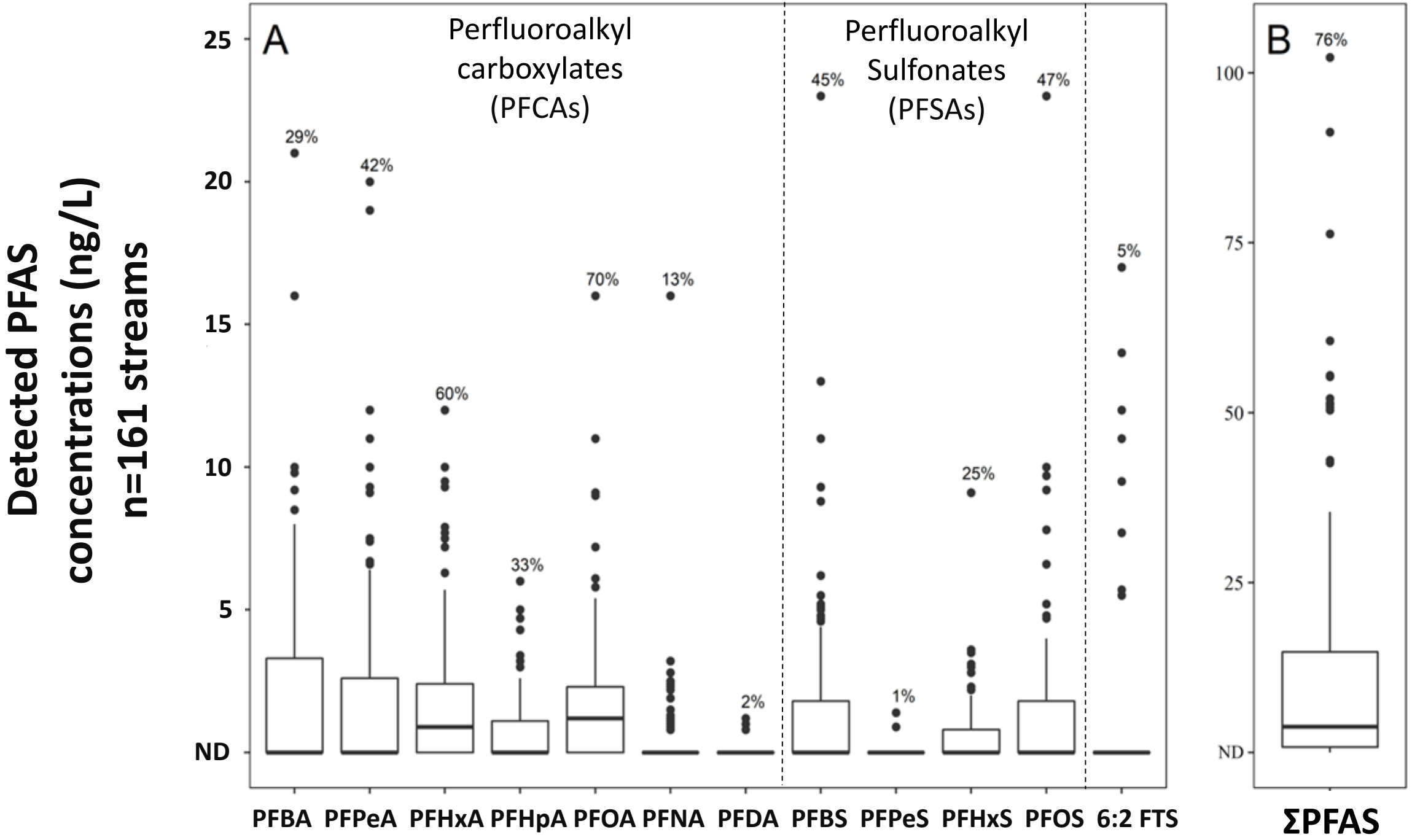
Land use (upstream catchment)

- Wetland
- Cropland
- Development

Potential PFAS sources (local catchment)

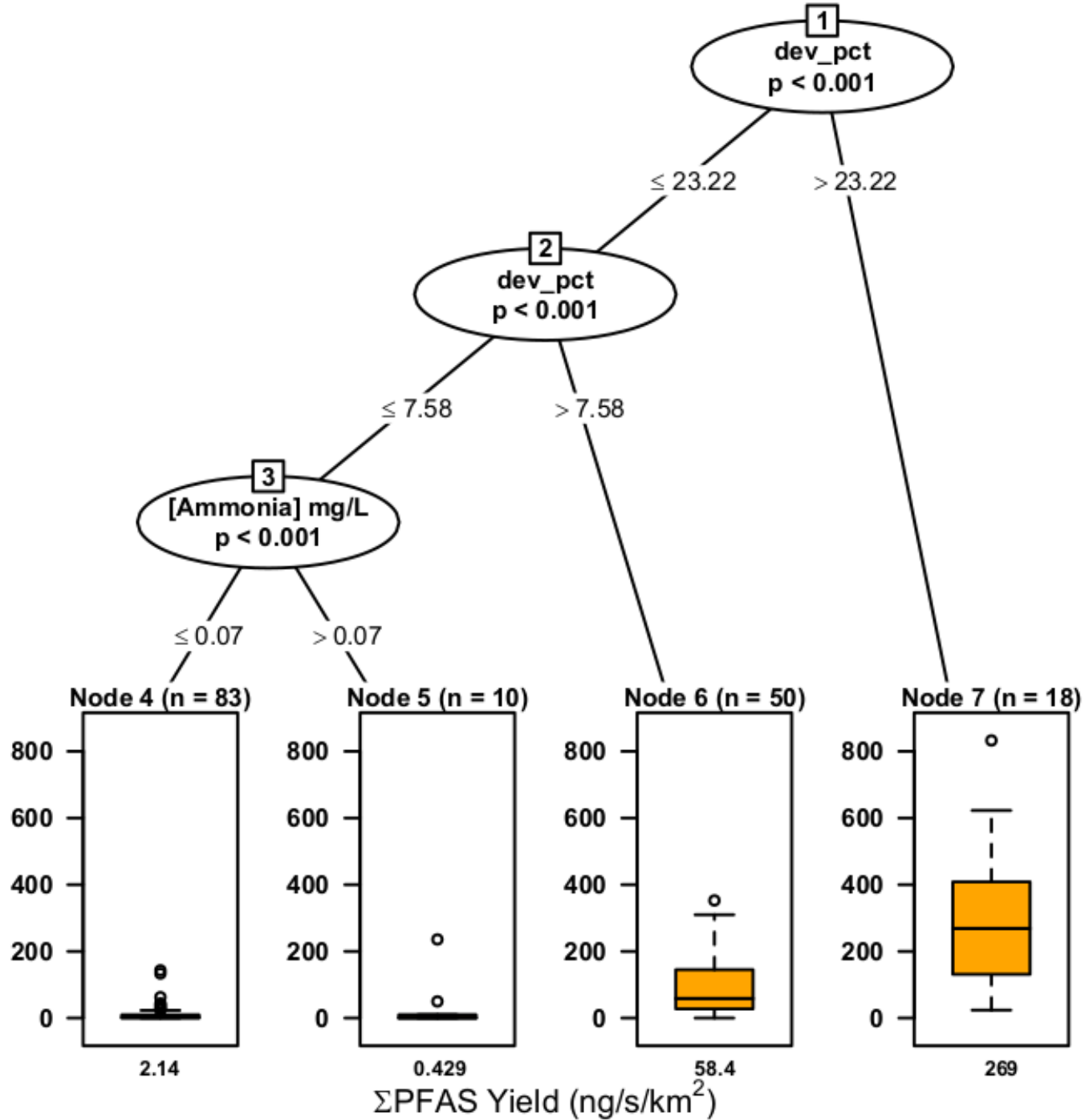
- Sinkholes
- Water pollution control facilities
- Military installations
- Airports
- Fire training schools
- Combined sewer overflow outfalls
- Oil & gas wells
- Land recycling cleanup locations
- Superfund sites
- Major groups of EnviroFACTS industries (manufacturing/service facilities w/ permitted discharges)



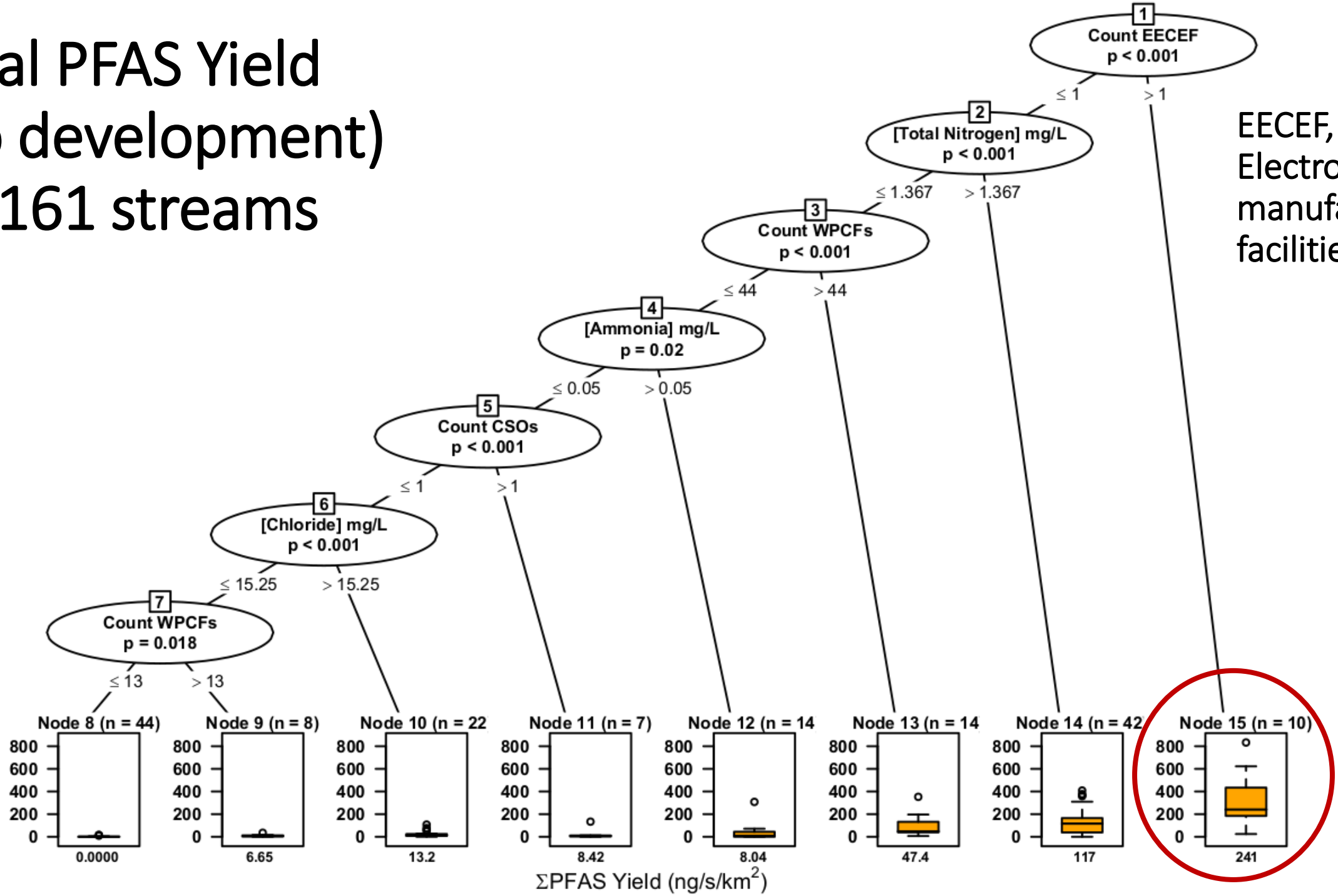

Detected PFAS concentrations (ng/L)
n=161 streams
A
Perfluoroalkyl carboxylates (PFCAs)
Perfluoroalkyl Sulfonates (PFSAs)
25
20
15
10
5
ND
29%
42%
60%
33%
70%
13%
2%
45%
1%
25%
47%
5%
PFBA
PFPeA
PFHxA
PFHpA
PFOA
PFNA
PFDA
PFBS
PFPeS
PFHxS
PFOS
6:2 FTS
B
76%
100
75
50
25
ND
ΣPFAS

Urbanization & PFAS

- n=161 streams
- 38 total input features
- Total PFAS yield (median)= $11.9\ \frac{\mathrm{ng}}{\mathrm{s}}/\mathrm{km}^2$
- dev_pct,
  % development



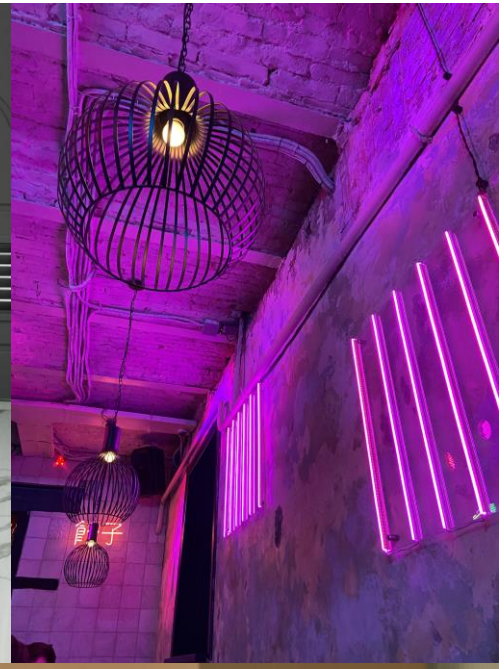
Total PFAS Yield (no development) n= 161 streams

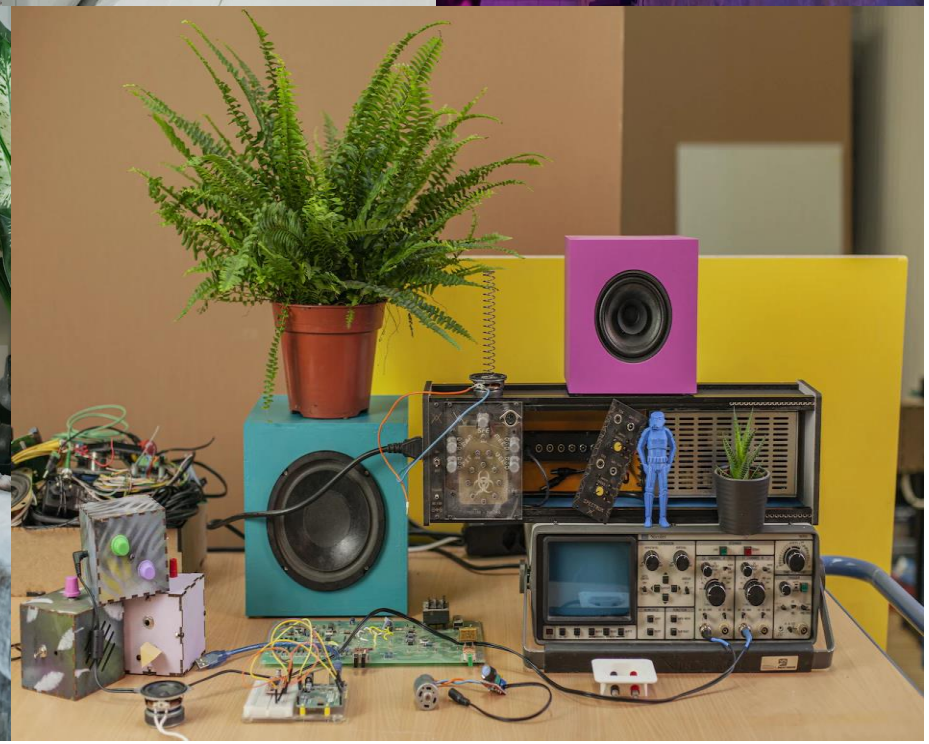


EECEF, Electronics manufacturing facilities

Electronic & Other Electrical Equipment & Components (Except Computer Equipment):

- Electrical industrial apparatus
- Household appliances
- Electrical lighting & wiring
- Radio & television
- Phones
- Electronic components & accessories



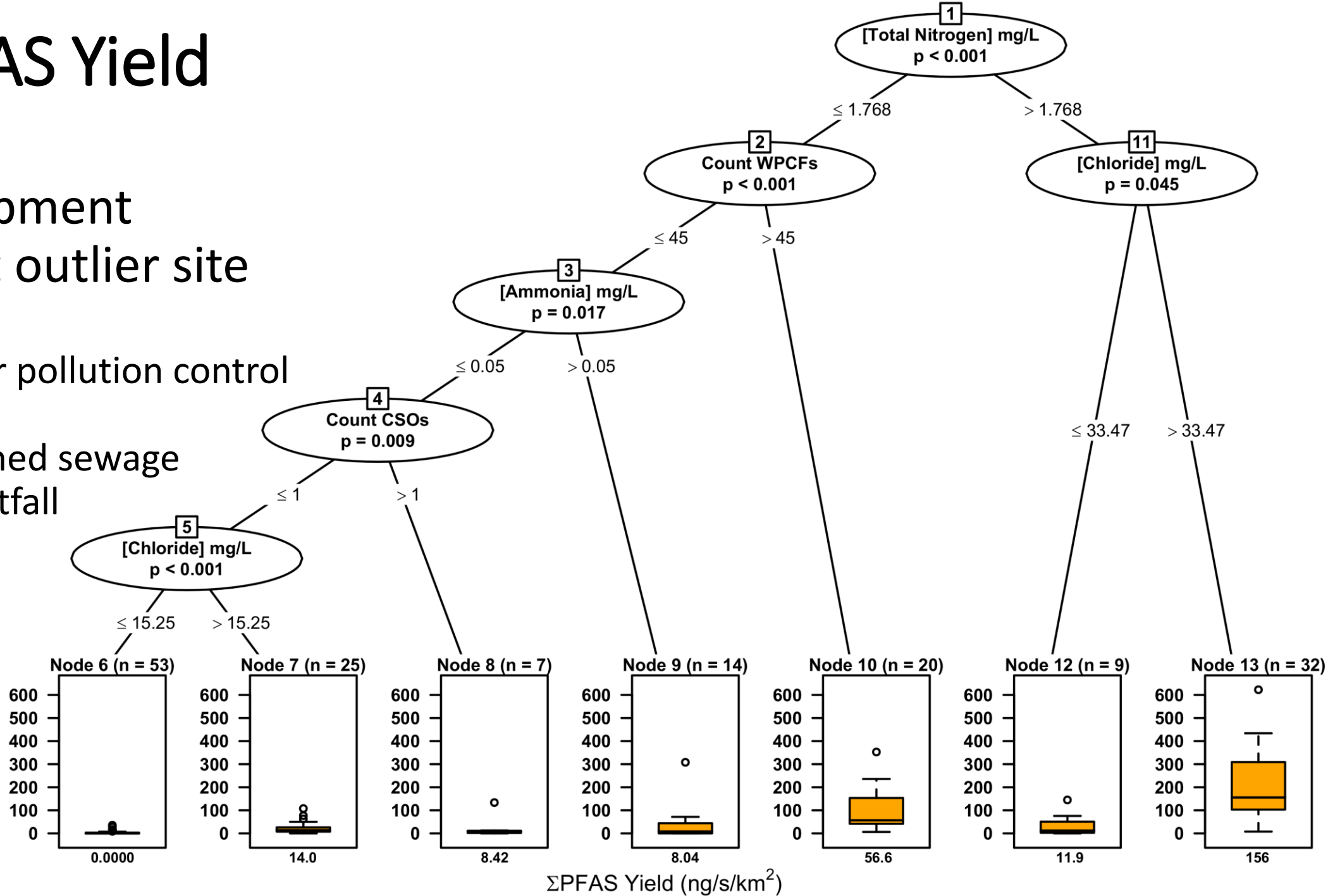


Total PFAS Yield

Excluded:

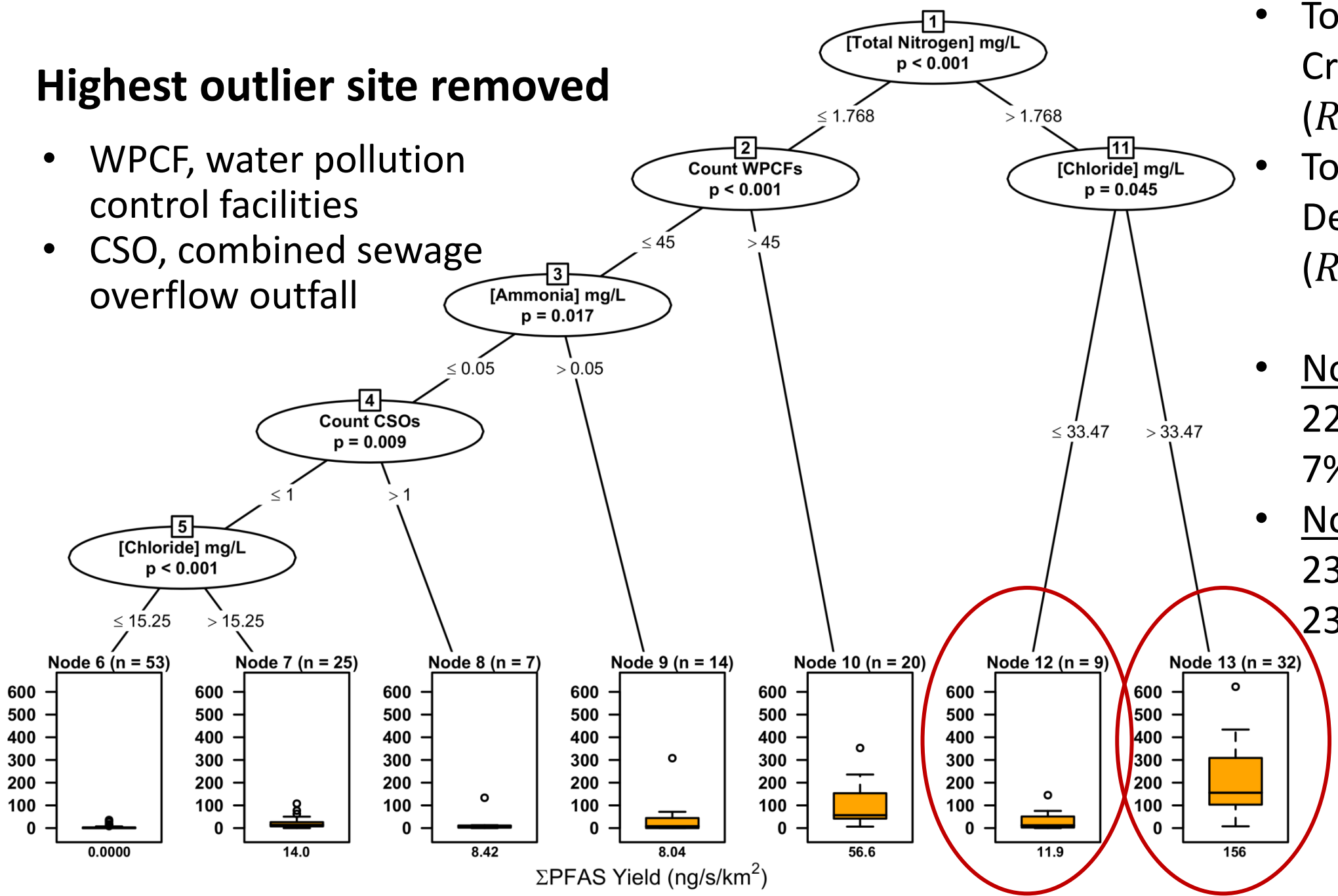
- Development
- Highest outlier site

WPCF, water pollution control facilities
CSO, combined sewage overflow outfall



Highest outlier site removed

- WPCF, water pollution control facilities
- CSO, combined sewage overflow outfall

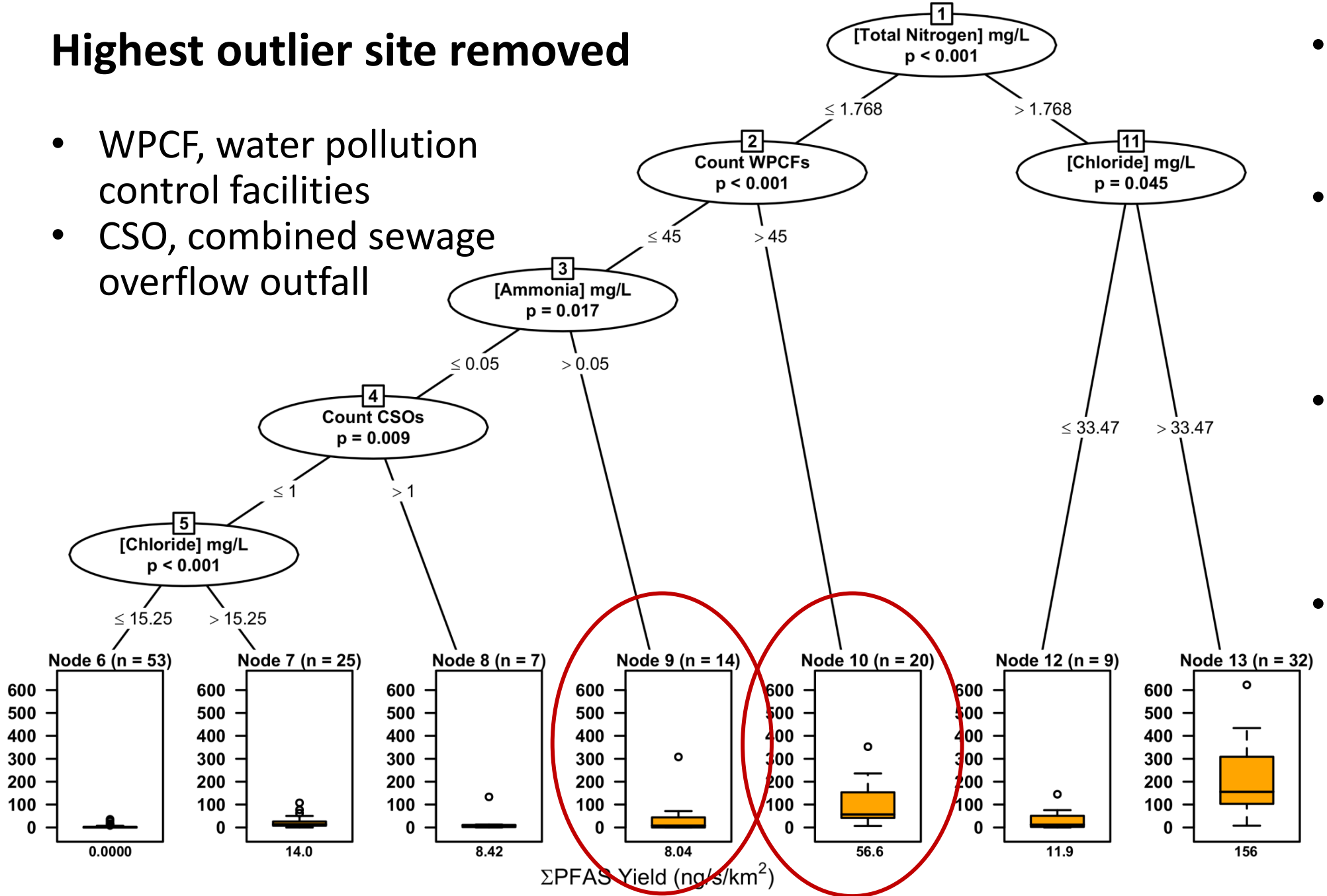


- Total PFAS & Cropland (R^2=0.35, p<0.001)
- Total PFAS & Development (R^2=0.77, p<0.001)

- <u>Node 12:</u>
  22% Cropland
  7% Developed
- <u>Node 13:</u>
  23% Cropland
  23% Developed

Highest outlier site removed

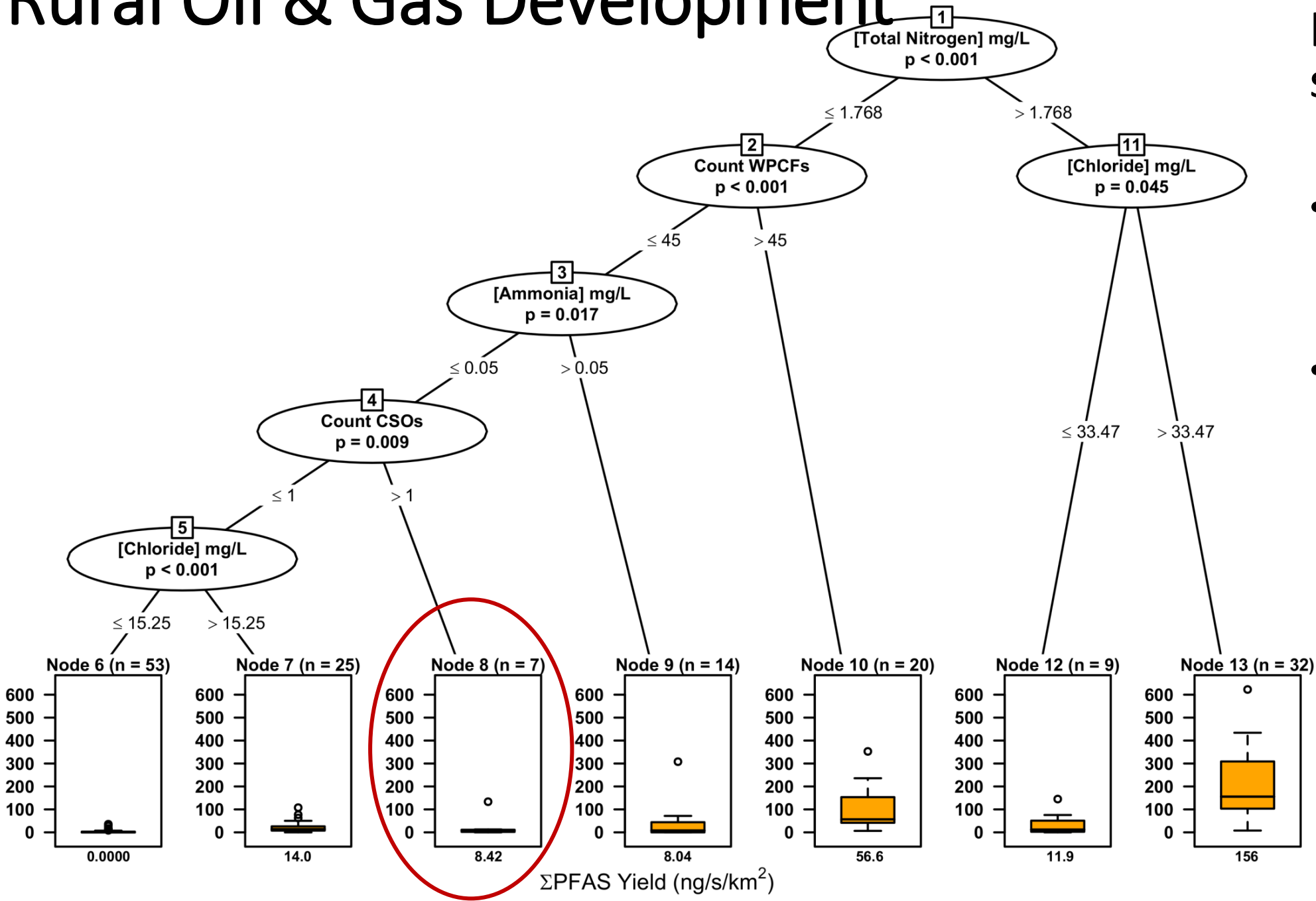
- WPCF, water pollution control facilities
- CSO, combined sewage overflow outfall



- Total PFAS & Cropland (R^2=0.35, p<0.001)
- Total PFAS & Development (R^2=0.77, p<0.001)

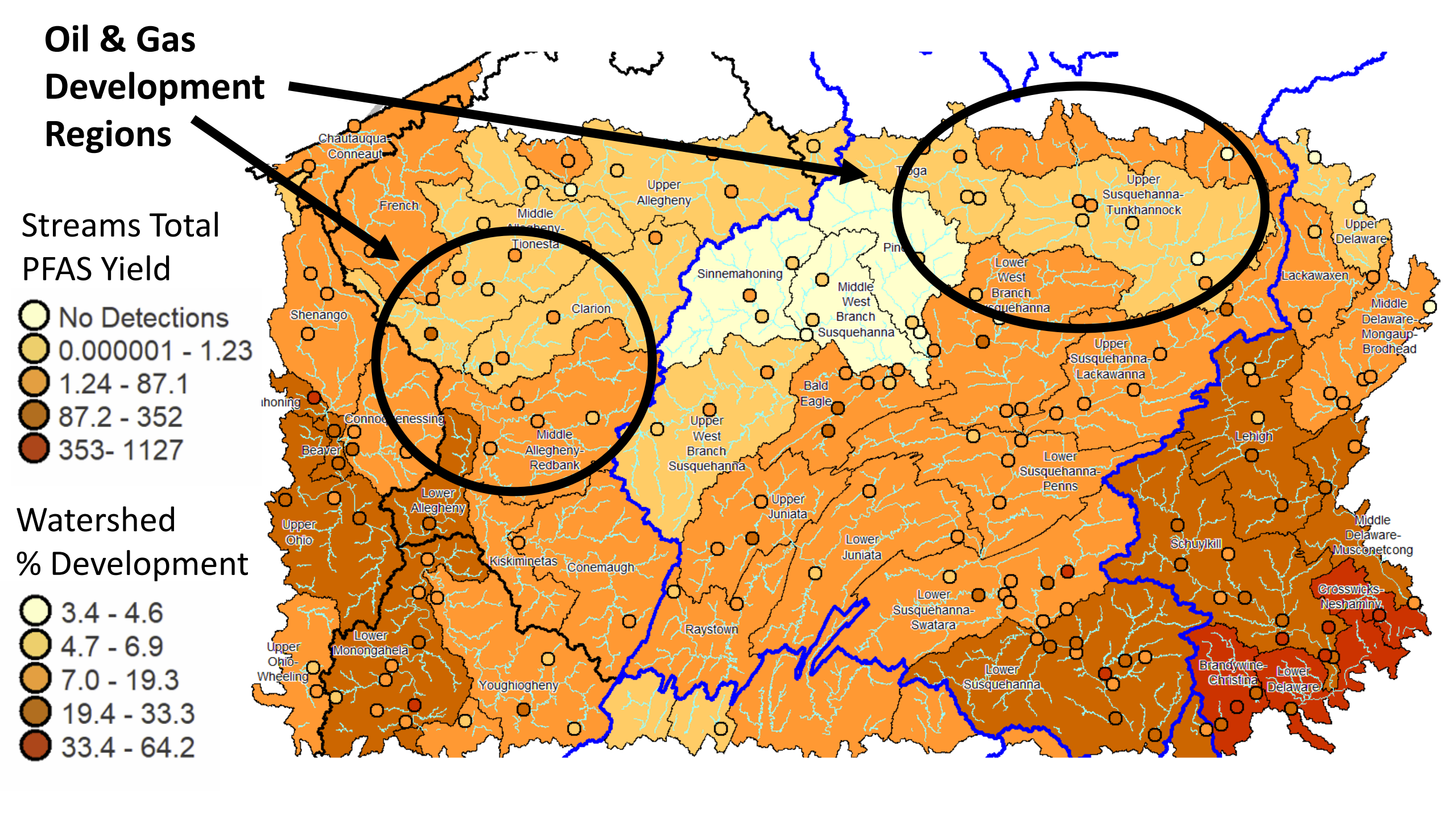
- <u>Node 9:</u>
  8% Cropland
  7% Developed
  (86% Open Space)
- <u>Node 10:</u>
  12% Cropland
  9% Developed

Rural Oil & Gas Development



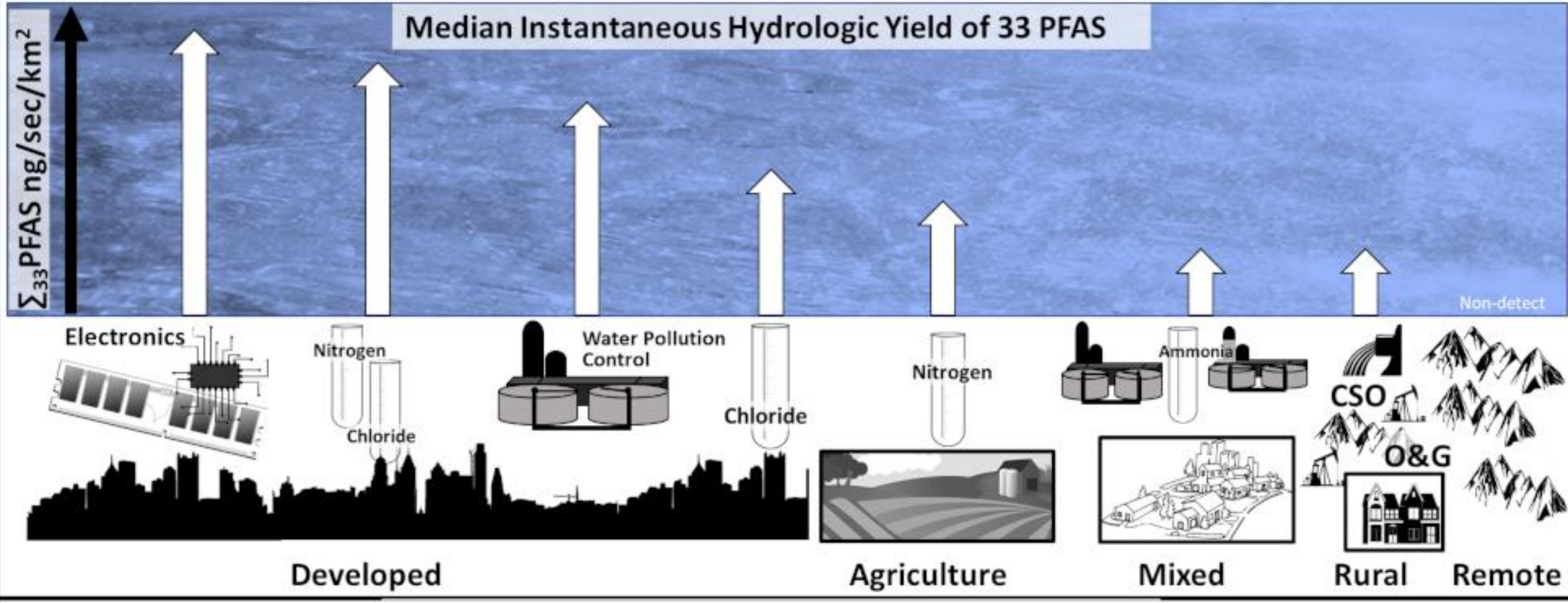
Highest outlier site removed

- WPCF, water pollution control facilities
- CSO, combined sewage overflow outfall


Oil & Gas Development Regions
Streams Total PFAS Yield
No Detections
0.000001 - 1.23
1.24 - 87.1
87.2 - 352
353- 1127
Watershed % Development
3.4 - 4.6
4.7 - 6.9
7.0 - 19.3
19.4 - 33.3
33.4 - 64.2
Chautauqua-Conneaut
French
Upper Allegheny
Middle Allegheny-Tionesta
Upper Susquehanna-Tunkhannock
Upper Delaware
Sinnemahoning
Lower West Branch Susquehanna
Lackawaxen
Middle West Branch Susquehanna
Middle Delaware-Mongaup-Brodhead
Shenango
Clarion
Upper Susquehanna-Lackawanna
Bald Eagle
Middle Allegheny-Redbank
Upper West Branch Susquehanna
Lehigh
Beaver
Lower Susquehanna-Penns
Lower Allegheny
Upper Juniata
Upper Ohio
Middle Delaware-Musconetcong
Schuylkill
Kiskiminetas
Conemaugh
Lower Juniata
Crosswicks-Neshaminy
Lower Susquehanna-Swatara
Raystown
Upper Ohio-Wheeling
Lower Monongahela
Lower Susquehanna
Brandywine-Christina
Lower Delaware
Youghiogheny

USEPA Drinking Water Human Health Criteria (ng/L)		
	Interim Health Advisory Level (HAL)	**Proposed Maximum Contaminant Level (MCL)**
PFOA	0.04	4.0
PFOS	0.02	4.0
PFNA	--	1.0 (unitless) Hazard Index
PFHxS	--	
PFBS	2000	
Gen-X	10	

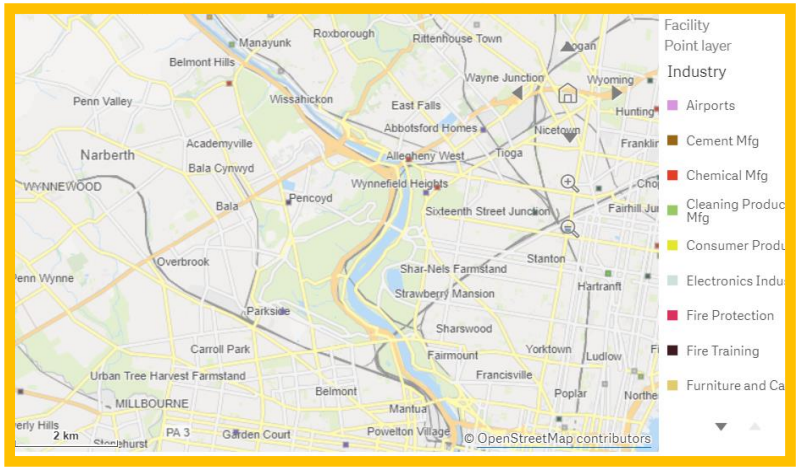
$$\text{Hazard Index} = \left(\frac{[\text{GenX}_{\text{water}}]}{[10\ \text{ppt}]}\right) + \left(\frac{[\text{PFBS}_{\text{water}}]}{[2000\ \text{ppt}]}\right) + \left(\frac{[\text{PFNA}_{\text{water}}]}{[10\ \text{ppt}]}\right) + \left(\frac{[\text{PFHxS}_{\text{water}}]}{[9.0\ \text{ppt}]}\right)$$

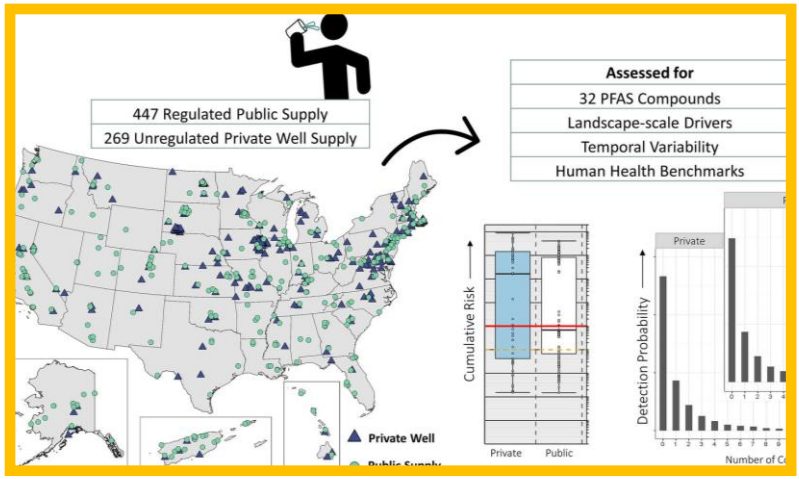


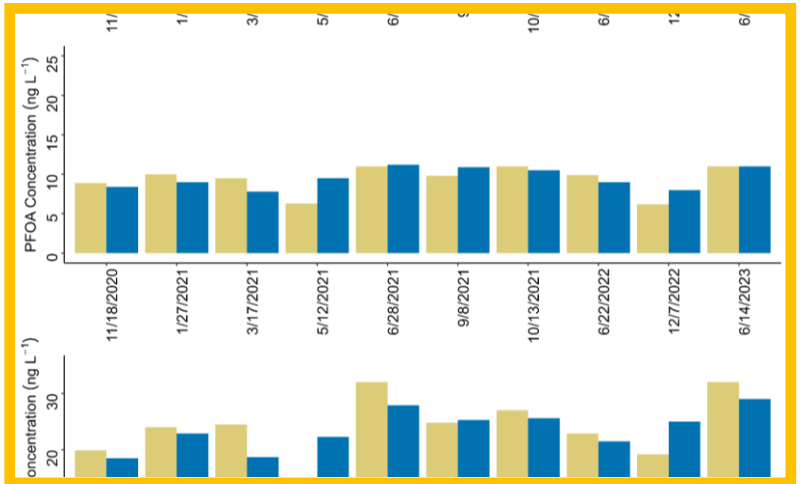
Factors explaining PFAS yield in Pennsylvania streams

Future PFAS Research Interests

- Predict aquatic exposure effects in PA stream reaches
- PFAS source relation to detections of PFAS in public water supplies (PWS)
- Determine relation between detections in SW, GW, and PWS
- Evaluate concurrent trends in source water and PWS
- Test for differences between PFAS in PWS with GW vs SW as sources
- Model potential toxicity from existing PWS PFAS detections
- Evaluate domestic supplies for PFAS and elucidate sources







Thank You

Contact information
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QUESTIONS?