NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Per- and Polyfluoroalkyl Substances (PFAS) in Groundwater

Presented by
Brandon Kernen, Manager of Hydrology and Conservation
Drinking Water and Groundwater Bureau

Connecticut Private Well Conference
April 11, 2018

NEW HAMPSHIRE DEPARTMENT OF Environmental Services




NH PFAS Investigation

New Hampshire Department of Environmental Services

https://www4.des.state.nh.us/nh-pfas-investigation/

PFAS IN DRINKING WATER | PFAS IN THE ENVIRONMENT | MAPS & DATA | COMMUNITY RESOURCES | FAQS

Welcome

Posted on September 1, 2017 by Jana Ford

Welcome. This website will be used to update interested parties on NHDES' current investigation into the presence of Per- and Polyfluoroalkyl Substances (PFASs) in New Hampshire. You can access our previous webpage for archived information: https://www.des.nh.gov/organization/commissioner/pfoa.htm .

Posted in Uncategorized

NHDES Extends Bottled Water Delivery Area

Posted on September 13, 2017 by Jim Martin

NHDES has extended bottled water delivery area to additional properties in Merrimack and Litchfield. The complete list of eligible properties can be found on the Bottled Water Delivery Area page.

https://www4.des.state.nh.us/nh-pfas-investigation/

Posted in General Information, Litchfield, Merrimack, St. Gobain

ADDITIONAL RESOURCES

Water Line Extension Projects
Investigation Documents
Be Well Informed Guide
Pease Tradeport Investigation Archive

EMAIL ALERTS

CONTACT INFORMATION

Jim Martin
(603) 271-3710
NHDES Public Information Officer

RECENT POSTS

NHDES Extends Bottled Water

PFAS Challenges

- Unique chemical properties
  - Expansive uses
  - Mobile and persistent
  - Challenging to remediate
- Health impacts
  - Bioaccumulative
  - Known or suspected toxicity at very low concentrations
  - Sensitive receptor endpoint
- Emerging understanding
  - Heightened public awareness
  - Stakeholder knowledge evolving
  - Analytical capabilities evolving

Check each box where the answer to any of the following questions is "YES"

Sampling Results

☐ During the most recent monitoring event, were any new compounds detected at any sampling point?
Well/Compound:

☒ Are there any detections of contamination in drinking water that is untreated prior to use?
Well/Compound: SW103/PFOAs
SW112S/PFOAs
SW104D/PFOAs
SW112D/PFOAs

☐ Do compounds detected exceed AGQS? At this time there is no AGQS for PFOAs only an EPA health advisory limit

☐ Was free product detected for the first time in any monitoring point?
Surface Water (*visible sheen*)
Groundwater (*1/8" or greater thickness*)

PFAS
Just Not Another New Contaminant

- Two sites in NH Contaminated by Air Emissions
  - Undermines traditional waste site investigation/source water protection
  - Has caused contamination over standard over 30-40 sq. miles
- Its presence in drinking water is measurable in our residents' blood – health implication is not known
- Currently have standards for two out of thousands PFAS
- Short-term exposure is considered a health risk
- Public in NH is demanding "0". Other states contemplating standards 3-5 times lower than EPA's recommended concentration

Magnitude of the Issue

- Over 40 million dollars has been allocated for addressing PFAS at a couple of sites in NH. A full state-wide assessment is just beginning……
- In the southern region of NH, groundwater/drinking water has been contaminated over a 30-40 square mile area
- Three significant water supply sources in NH contaminated over health standards
- Since March 2016 – NH has sampled over 3,000 sources of drinking water for PFAS
  - 600+ homes on private wells are being provided bottled water
  - Public water systems are being extended to these homes (20+ miles of pipe)

Concept of Regulating a Contaminant to "0"

- No state drinking water standard is set at 0 or non-detect.
- Detection limits keep getting lower. At some level there is no such thing as non-detect.
- Standards need necessary justification
  - Public health improvement
  - Consistent with public health protection approach for other contaminants
- NH provides information on how homeowners can treat to non-detect for $200-$3000.
- Standards must be based on real-world limitations
  - Treatment technologies/Analytical limitations
  - Simultaneous compliance with other drinking water regulations

General PFAS Timeline

1930s and 1940s

- PFAS research
- PTFE (Teflon®) patented by DuPont; production begins

1950s and 1960s

- Consumer products (e.g., Scotchguard, Zonyl)
- PFOS-based AFFF developed

1970s

- Company worker exposure studies
- AFFF expands beyond military activities

1980s and 1990s

- Detection in global environment
- Analytical capabilities
- Toxicological studies published
- PFOA found in drinking water in WV and OH

2000s

- PFOA Stewardship Program begins - C8 phase-out
- PFOS production phase-out in U.S.
- Replacement chemistries (shorter chain)
- Large scale PFAS production begins in China
- AFFF formulations modified
- EPA studies & Provisional Health Advisories
- Water system testing begins

2010s

- PFOS included as POP on Stockholm Convention
- C8 phase-out by 2015 (PFOA stewardship program)

New Hampshire Timeline

2013-2015	• UCMR3 • 18 systems - 80 samples • 3 systems with detections
April 2014	• Haven Well - 2,500 ng/L PFOS • Class B Use at Pease Tradeport
February - April 2016	• Private wells up to 1,600 ng/L PFOA • Public wells up to 140 ng/L PFOA • Industrial Air Emissions in Southern NH
April 2016 to present	• Statewide assessments

Uses & Sources of PFAS

PFAS are used in a wide variety of industries and commercial products for their valuable properties, including fire resistance, dust suppression, and oil, stain, grease, and water repellence. (Some examples of uses are on the following slides)

Fire fighting foams (AFFF) used in military and civilian airports as well as some other industrial facilities.

From: Hillary Thornton, USEPA Region 4

Uses & Sources of PFAS

- Polishes, waxes, paints
- Stain repellants (carpets, clothing and upholstered furniture)
- Cleaning products

From: Hillary Thornton, USEPA Region 4

Uses & Sources of PFAS

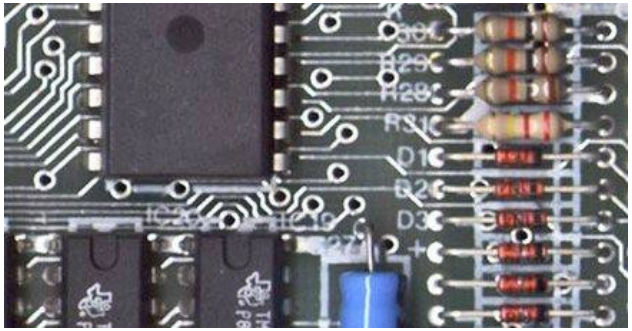
- Food surfaces (Teflon[1] pans, pizza boxes, popcorn bags, food wrappers)

[1] https://en.wikipedia.org/wiki/Polytetrafluoroethylene PFOA, which used to be a key ingredient in making Teflon, has been phased out, however there is little evidence that the chemicals that have replaced PFOA are much safer.

[2] Shaider, *Environ. Sci. Technol. Lett.*, Publication Date (Web): February 1, 2017 http://pubs.acs.org/doi/ipdf/10.1021/acs.estlett.6b00435

From: Hillary Thornton, USEPA Region 4

Uses & Sources of PFAS



- Dust suppression for chrome plating
- Electronics manufacturing
- Oil and mining for enhanced recovery
- Performance chemicals (hydraulic fluid, fuel)

From: Hillary Thornton, USEPA Region 4

Uses & Sources of PFAS

- Landfills
- Land where biosolids from wastewater treatment plants treating PFAS-containing wastewater was applied
- Direct release of PFAS products into the environment – such as use of AFFF in training and at crash sites

From: Hillary Thornton, USEPA Region 4

Expansive Use of PFAS

Commercial Products	Industrial Uses
• Nonstick Cookware • Fast Food Containers • Candy Wrappers • Microwave Popcorn Bags • Personal Care Products (Shampoo, Dental Floss) • Cosmetics (Nail Polish, Eye Makeup) • Paints and Varnishes • Stain Resistant Carpet • Stain Resistant Chemicals • Water Resistant Apparel • Cleaning Products • Electronics • Ski Wax • Soil amendments • Pesticides • Potting soils	• Photo Imaging • Metal Plating • Semiconductor Coatings • Aviation Hydraulic Fluids • Medical Devices • Class B Firefighting Foam (e.g., Aqueous Film Forming Foam) • Insect Baits • Printer and Copy Machine Parts • Chemically Driven Oil Production • Textiles, Upholstery, Apparel and Carpets • Paper and Packaging • Rubber and Plastics • Pesticides

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EPA/600/R-09/033
March 2009

Perfluorocarboxylic Acid Content in 116 Articles of Commerce

Zhishi Guo, Xiaoyu Liu, and Kenneth A. Krebs
U.S. Environmental Protection Agency, Office of Research and Development
National Risk Management Research Laboratory, Research Triangle Park, NC 27711

and

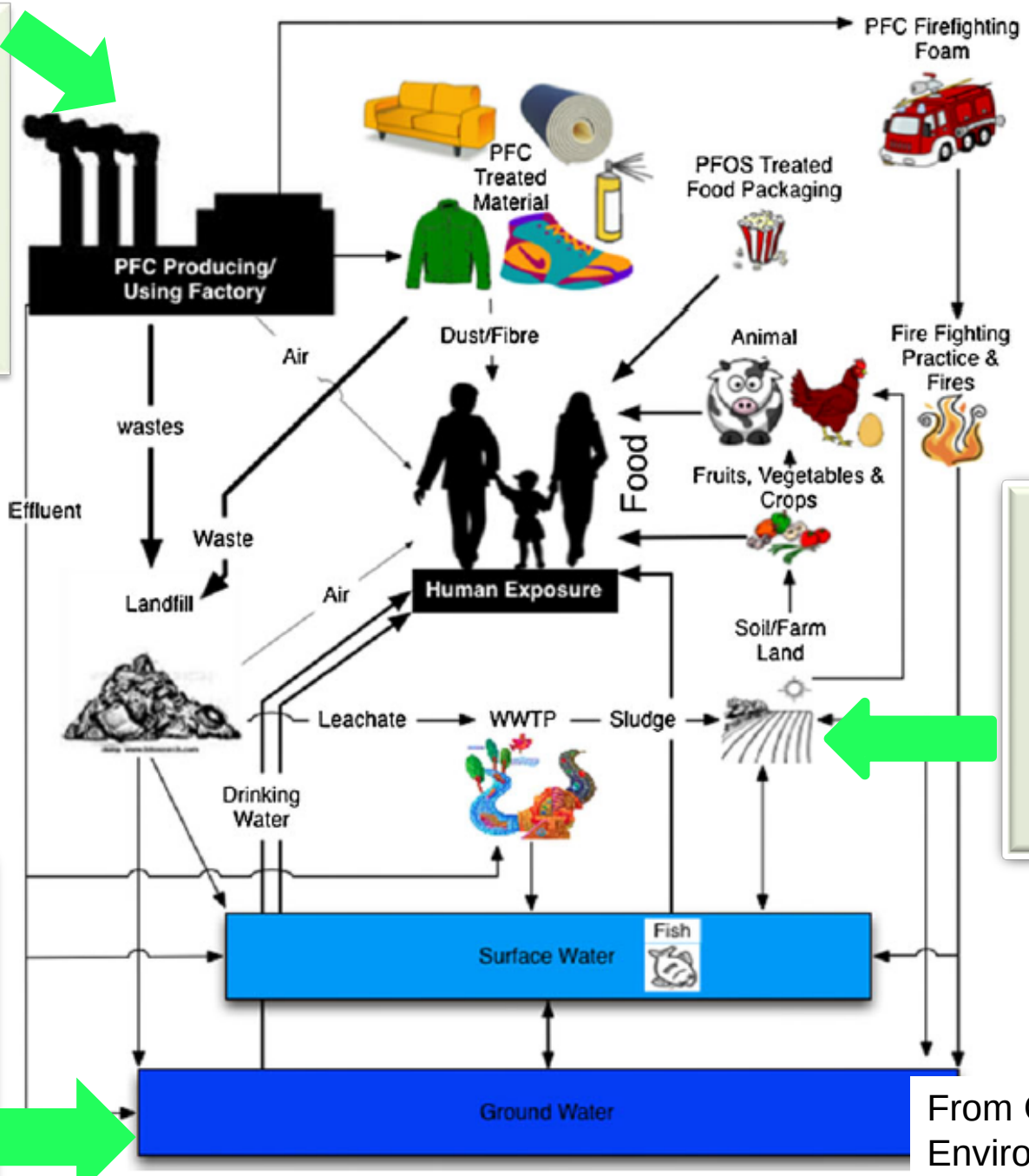
Nancy F. Roache

ARCADIS, 4915 Prospectus Dr., Suite F, Durham, NC 27713

Solar Panels??

- Teflon/PTFE are included in some solar panels
- Solar panels are often located near drinking water sources
- New Hampshire has not observed PFAS contamination near solar panels(3 known sites)
  - Have not specifically studied run-off near solar panel installations
  - Have not reviewed solar panel designs to date in NH to identify if PFAS was used

Ambient Air Limit (APFO)
(Inhalation)
0.050 µg/m³
(24-hr)
0.024 µg/m³
(annual)



Soil Guidance Levels for PFOA and PFOS
(Direct contact)
0.5 mg/kg
(500 ppb)

Ambient Groundwater Quality Standards for PFOA + PFOS
70 ng/L (ppt)

From Oliaei 2013, Environmental Science Pollution Research

Human Exposure Pathway

- Major[1,2]
  - Diet (bioaccumulation)
    - Fish and seafood
    - Produce
  - Drinking water
  - Incidental soil/dust ingestion
- Usually insignificant or minor
  - Dermal absorption
  - Inhalation

1 Oliaei et al., 2013. Environ. Sci. Pollut. Res. Manag. 20:1977-1992
2 Domingo, 2012. Environment International 40:187-195

From: Hillary Thornton, USEPA Region 4

PFOA/PFOS Exposure Decreasing

- Most people have been exposed to PFOA/PFOS through everyday commercial products
- In 2006, PFOA/PFOS manufacturers joined an EPA global stewardship program:
  - Phased out by the end of 2015
- Materials imported not really addressed
- PFAS chemistry is complex and PFOA and PFOS still show up in processes using other types of PFAS
- PFOA and PFOS being replaced by other PFAS with no health information

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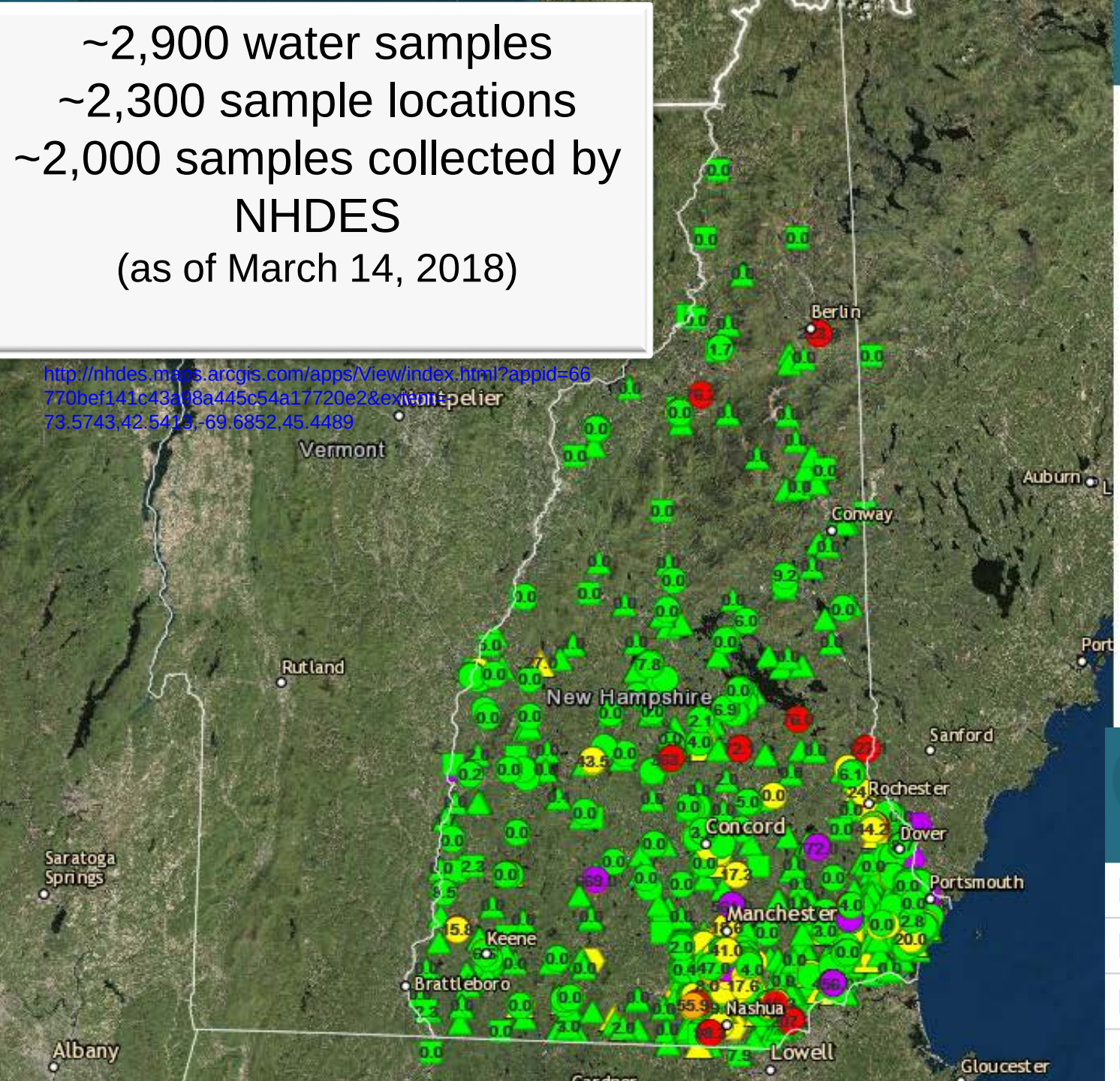
~2,900 water samples
~2,300 sample locations
~2,000 samples collected by NHDES
(as of March 14, 2018)

http://nhdes.maps.arcgis.com/apps/View/index.html?appid=66770bef141c43a08a445c54a17720e2&extent=-73.5743,42.5415,-69.6852,45.4489



Legend

PFASResults_GroundWater

PFOA+PFOS (ppt)

- 400+ ppt
- 70 ppt - <399 ppt
- 45 ppt - <70 ppt
- 10 ppt - <45 ppt
- <10 ppt

PFASResults_SurfaceWater

PFOA+PFOS (ppt)

- 400+ ppt
- 70 ppt - <399 ppt
- 45 ppt - <70 ppt
- 10 ppt - <45 ppt

Layers

- [x] PFASResults GroundWater
- [x] PFASResults SurfaceWater
- [x] PFASResults PublicSupply
- [x] PFASResults OtherSamples

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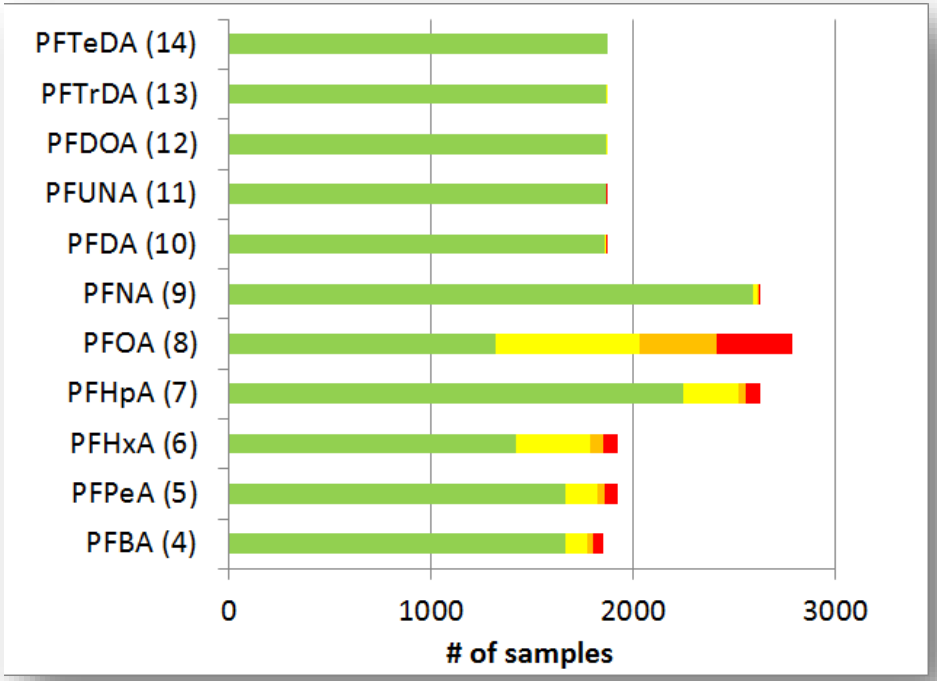
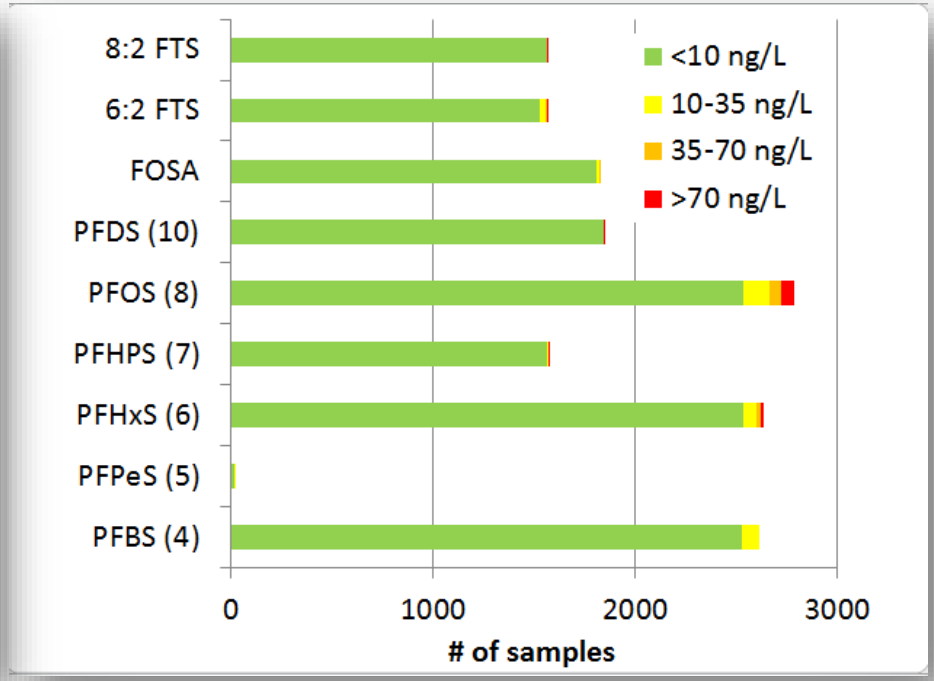
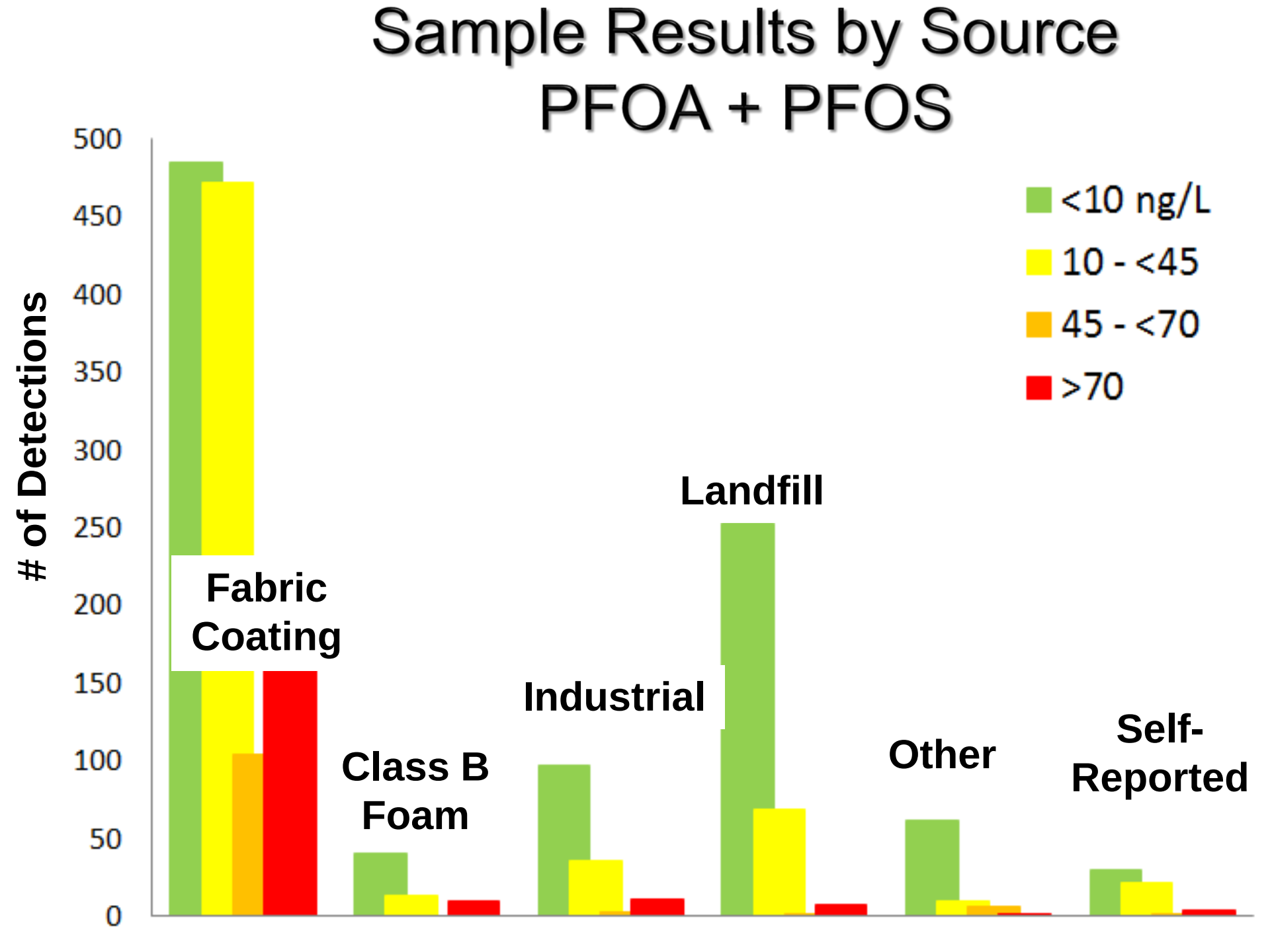
Detection Frequency





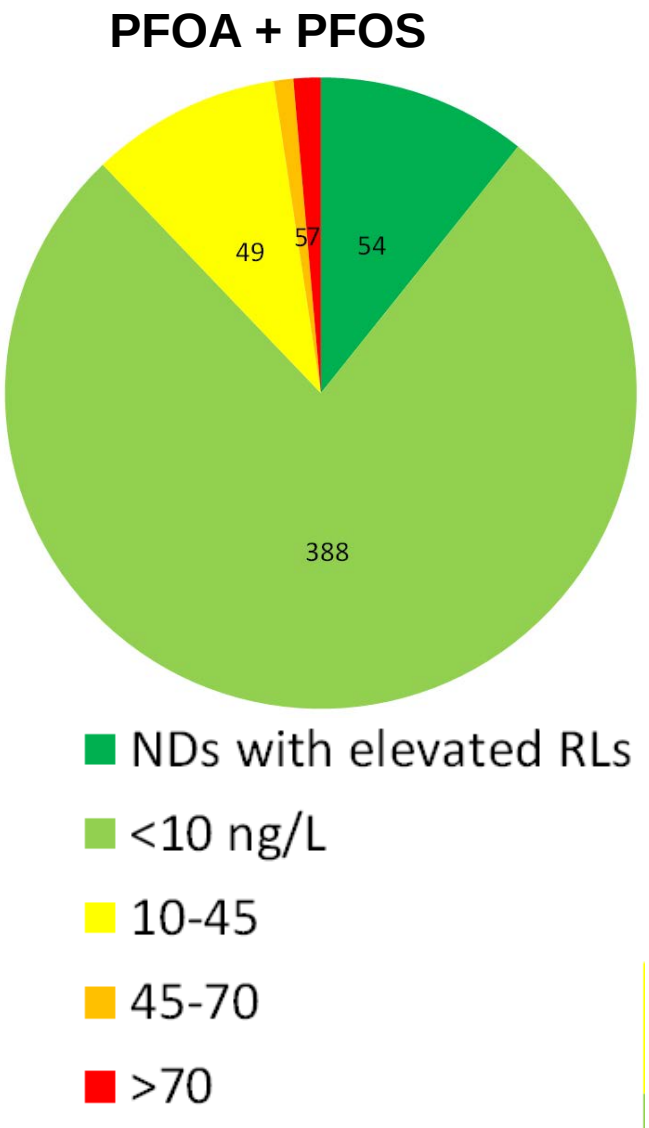
- Compounds detected in one or more samples (as of October 2017)
- Results biased by targeted sampling near southern NH fabric coating sources

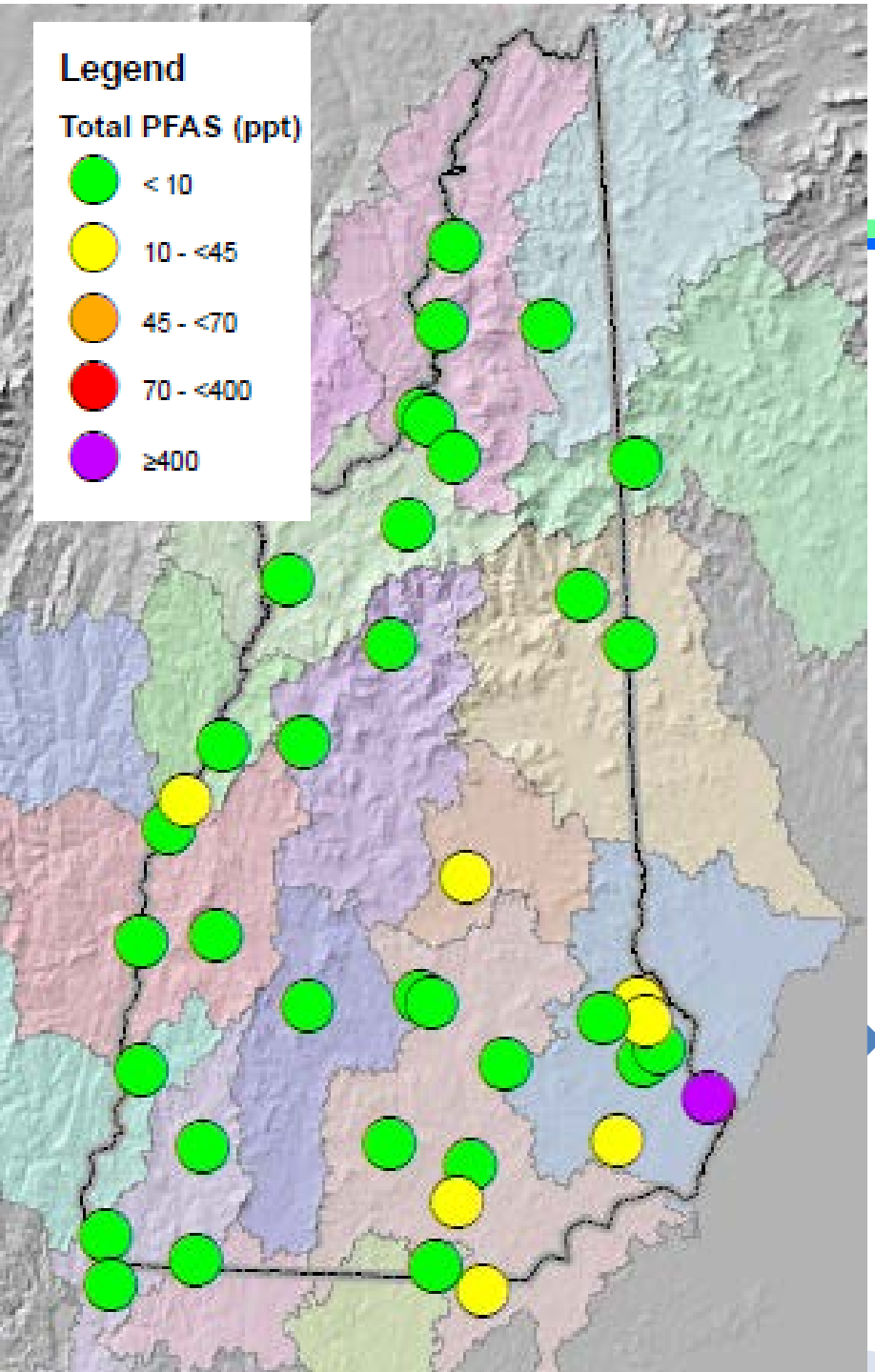
Sample Results by Source
PFOA + PFOS



Water Supply Testing

- Public Water Supplies
  - UCMR 3
  - Voluntary sampling request (>4,000 sources)
  - ~500 samples from ~400 sources
- Targeted private supply well sampling around potential sources





Surface Water

Site	PFOA (ng/L)	PFOS (ng/L)
Pond Near Landfill #1	10	<4
Stream Near Landfill #2	850	400
Pond at Fire Training Area	270	3,000
Me, MI, MN Standards	*50 - 12,000*	*6 - 12*

- No NH Surface Water Standard
  - *Site-specific screening level for Coakley Landfill*
    - *760 ng/L PFOA*
    - *760 ng/L PFOS*

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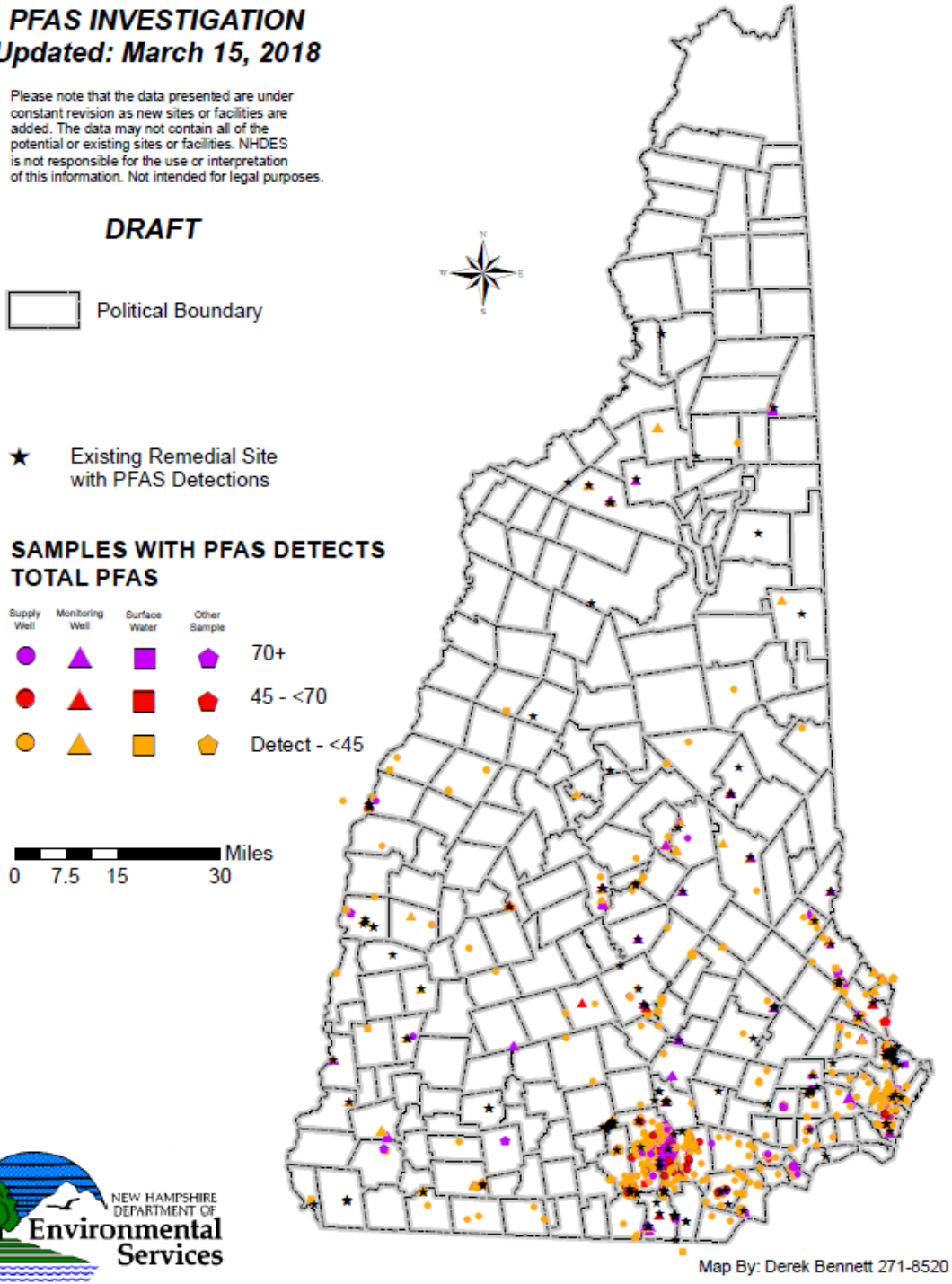
As of March 8, 2018

~100 sites with detections



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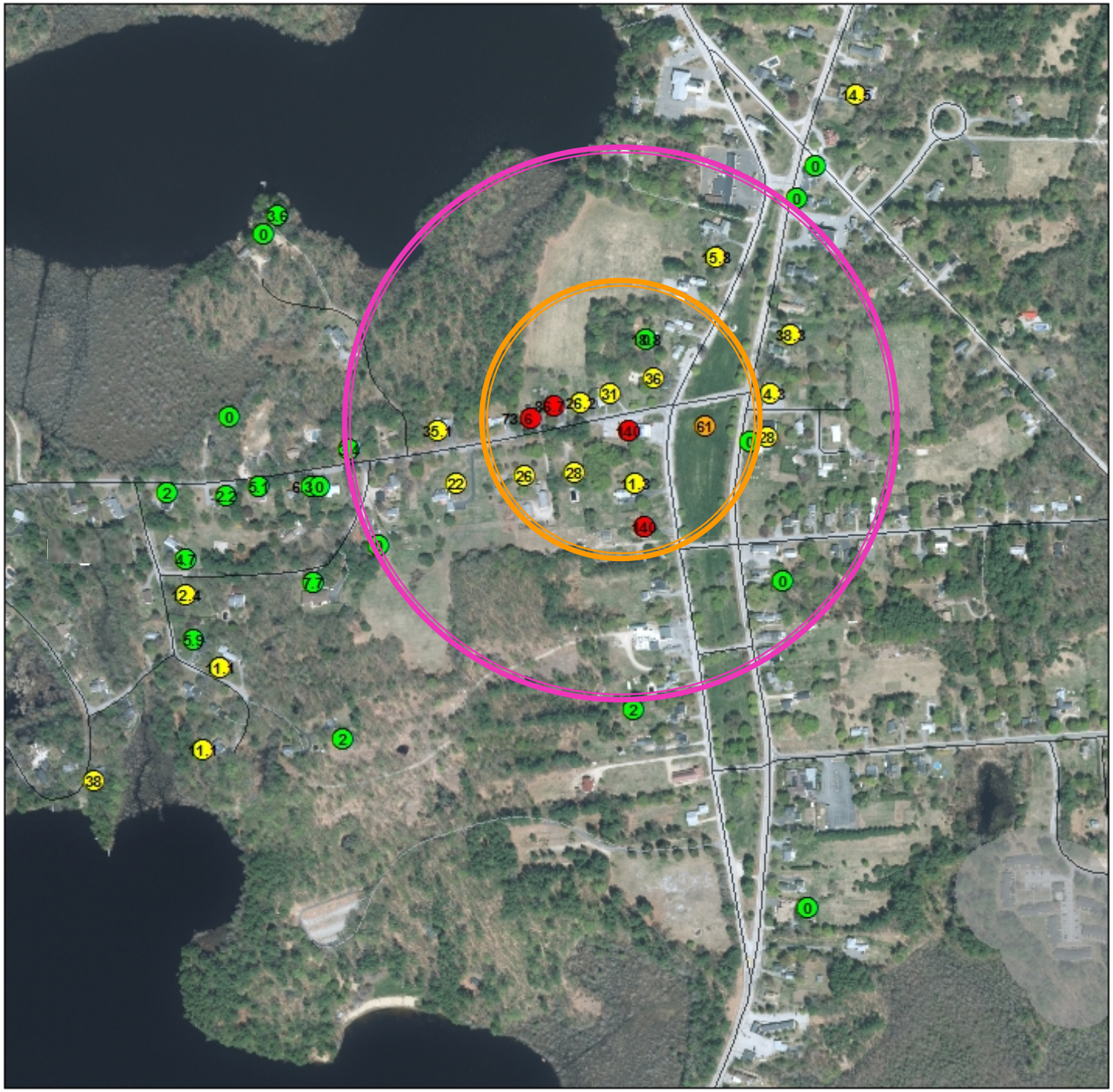

FIRE DEPARTMENT
PFAS INVESTIGATION
May 5, 2017

PFOA + PFOS (PPT)

Supply Well

- ≥400
- 70 - <400
- 45 - <70
- 10 - <45
- < 10

Political Boundary

Feet
0 300 600 1,200

1 inch = 600 feet

N
W E
S

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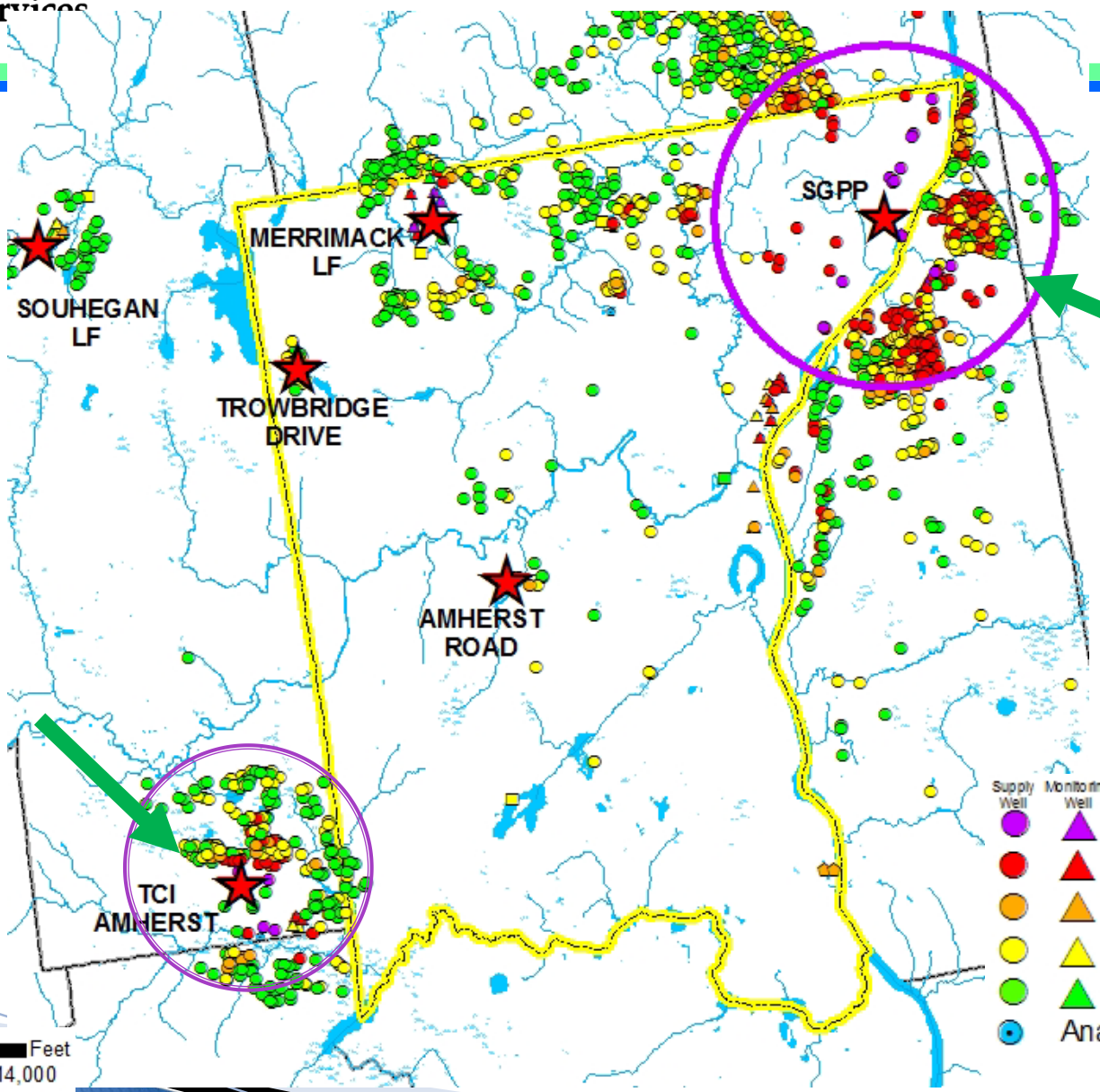
Fabric Coating / Air Emissions



POUs, ~400+ public water service connections

POEs, ~100 public water service connections

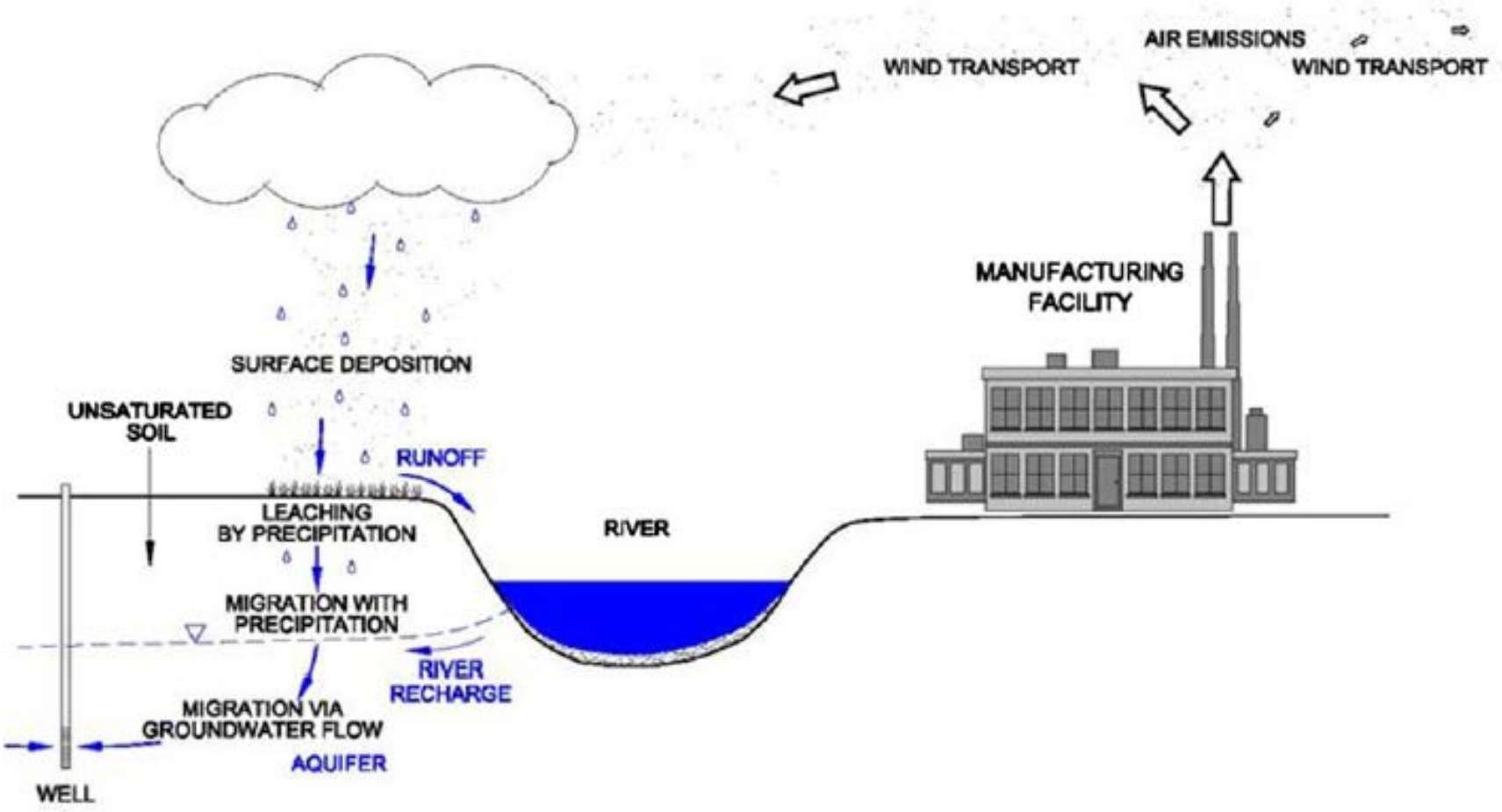
Investigation Around Saint-Gobain Performance Plastics

1.5 Mile Radius

PFOA + PFOS (PPT)

Supply Well	Monitoring Well	Surface Water	Other Sample	
●	▲	■	⬟	≥400
●	▲	■	⬟	70 - <400
●	▲	■	⬟	45 - <70
●	▲	■	⬟	10 - <45
●	▲	■	⬟	<10

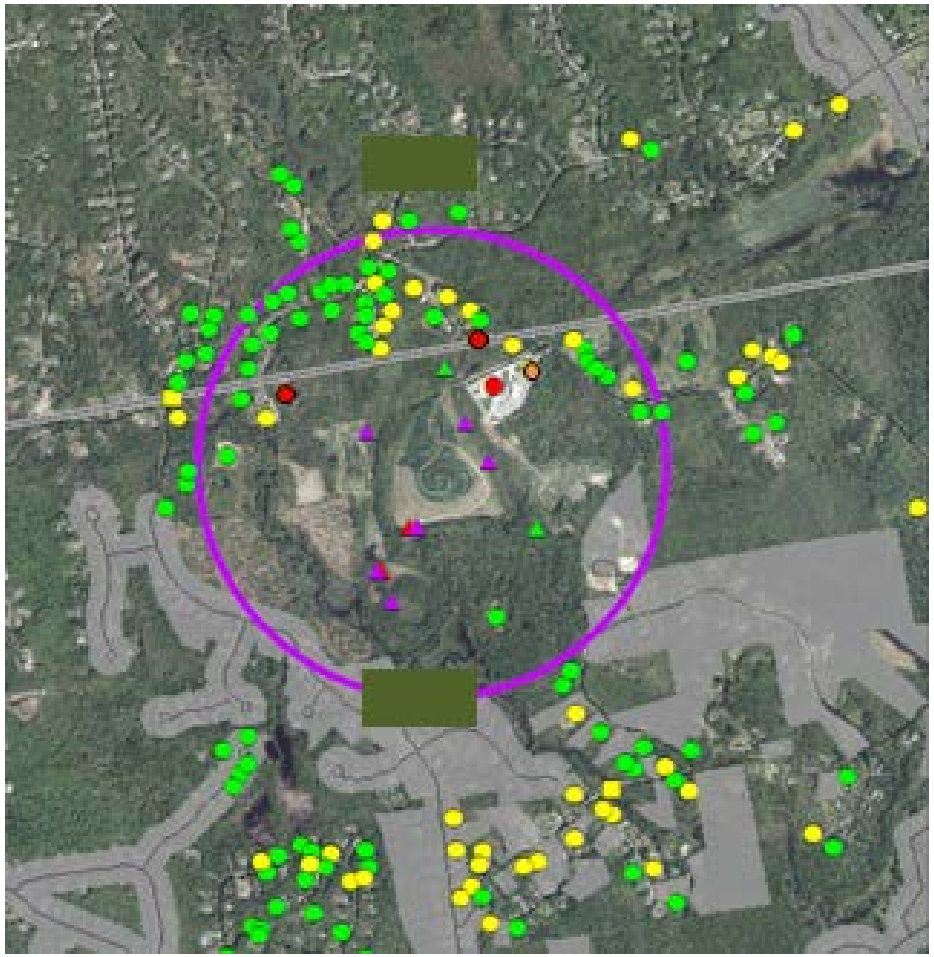
● Analytical Result Pending



Davis et al., 2007, *Chemoshpere*

Landfills

- PFOA + PFOS up to ~3,700 ng/L
  - Exceedances at ~60% of unlined
  - Exceedances at ~40% of lined
- Total PFAS up to ~6,600 ng/L
  - (9 compounds)
- Groundwater impacts fairly localized
- No typical “fingerprint”



Chrome Plating

PFOA: 1,070
PFOS: 90
Total PFAS (12): 3,461

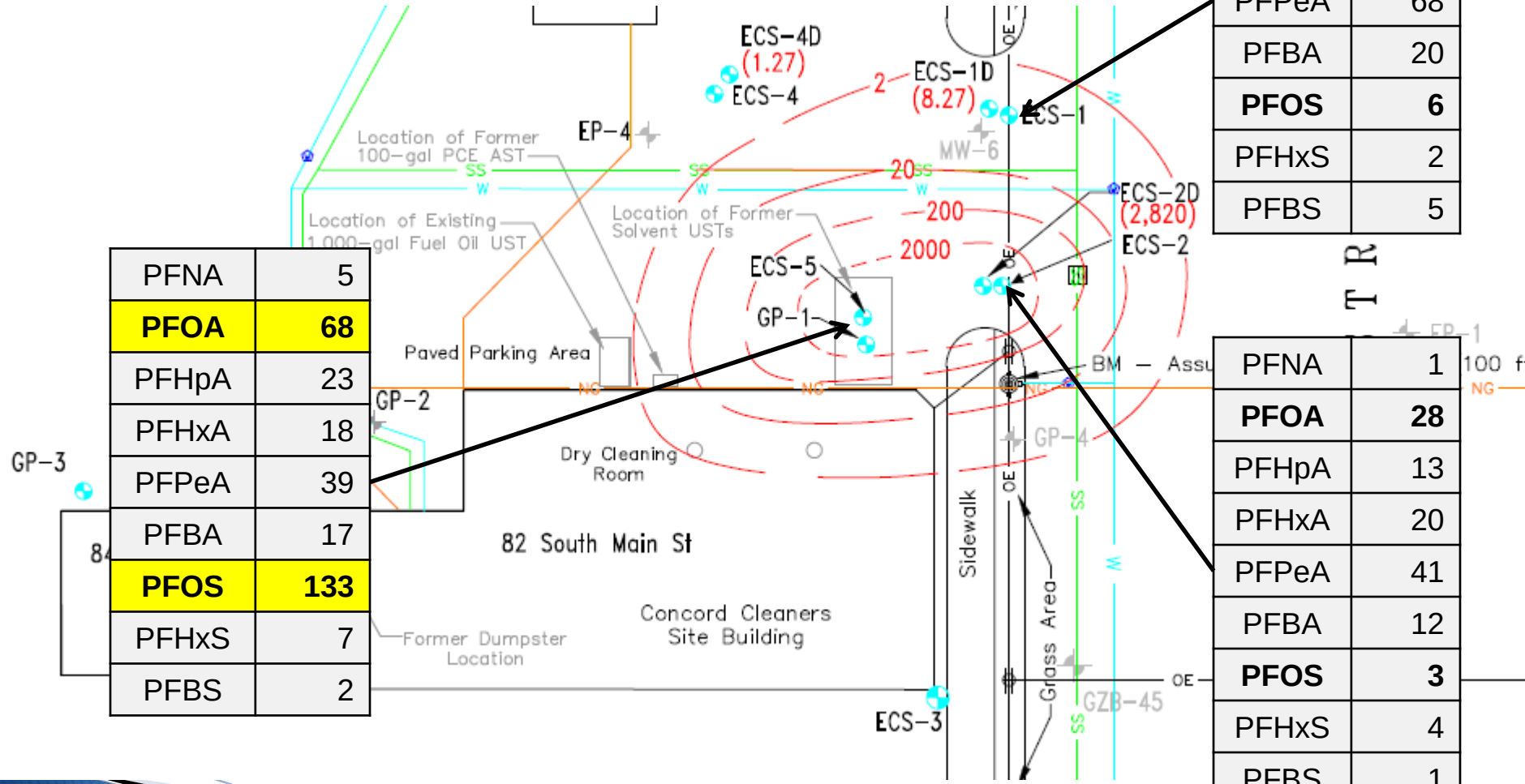
PFOA: 44
PFOS: 3,130
Total PFAS (12): 3,437

Results in ng/L (ppt)

Adapted from Ransom, August 2017 and Sanborn Head, October 2017

Dry Cleaning

PFNA	16
PFOA	**15**
PFHpA	18
PFHxA	38
PFPeA	68
PFBA	20
PFOS	**6**
PFHxS	2
PFBS	5



PFNA	5
PFOA	**68**
PFHpA	23
PFHxA	18
PFPeA	39
PFBA	17
PFOS	**133**
PFHxS	7
PFBS	2

PFNA	1
PFOA	**28**
PFHpA	13
PFHxA	20
PFPeA	41
PFBA	12
PFOS	**3**
PFHxS	4
PFBS	1

AUTO SHINE CAR WASH SYSTEMS OF NEW ENGLAND

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SIMONIZ

Simoniz Shield Special Teflon Formulation Lemon

Product ID: ASCWS-T37760

Choose One:

Quantity:

Add To Cart

A clear coat sealer containing Teflon¨ that will provide gloss and protection. It should be followed by a final rinse.

This product is listed in these Categories...

Polishes & Sealants

previous | next

Client:	New Hampshire Department of Environmental Services	**Service Request:**	K1610470
Project:	Regulated Car Wash	**Date Collected:**	09/01/16 11:40
Sample Matrix:	Water	**Date Received:**	09/07/16 09:30
Sample Name:		**Units:**	ng/L
Lab Code:	K1610470-002	**Basis:**	NA

Perfluorinated Sulfonic Acids and Perfluorinated Carboxylic Acids by HPLC/MS

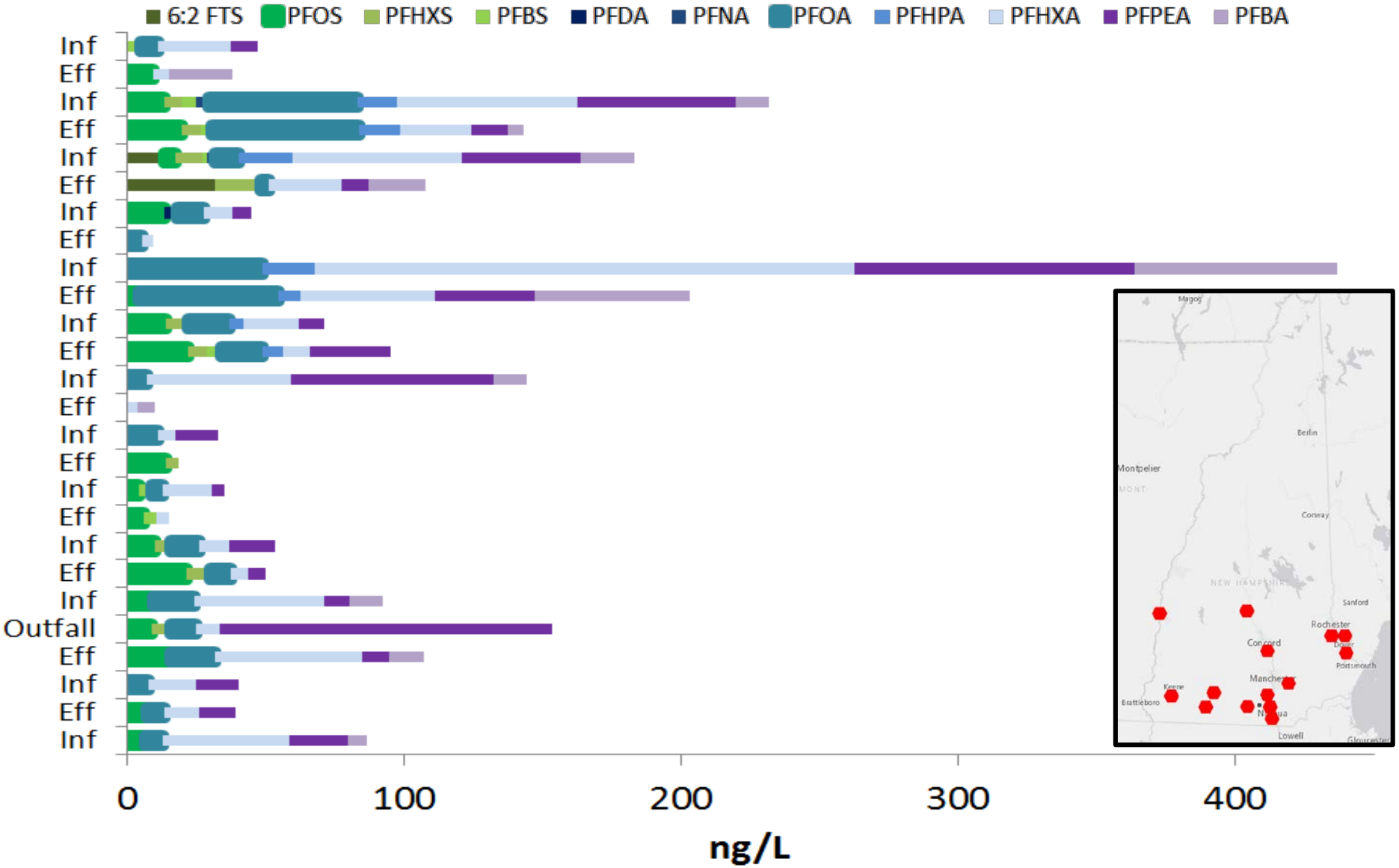
Analysis Method: PFC/537M
Prep Method: EPA 3535A

+9000 PPT PFAS in groundwater at a car wash

Analyte Name	Result	MRL	Dil.	Date Analyzed	Date Extracted	Q
HFPO-DA	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorobutanoic Acid	640	93	10	09/30/16 04:30	9/26/16	*
Perfluoropentanoic Acid	3400	46	10	09/30/16 04:30	9/26/16	*
Perfluorobutane Sulfonate	5.3	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorohexanoic Acid	3500	46	10	09/30/16 04:30	9/26/16	*
Perfluoroheptanoic Acid	1200	46	10	09/30/16 04:30	9/26/16	*
Perfluorohexane Sulfonate	4.9	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorooctanoic Acid	33	1.9	1	09/28/16 03:35	9/26/16	*
Perfluorononanoic Acid	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorooctane Sulfonate	19	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorodecanoic Acid	350	4.6	1	09/28/16 03:35	9/26/16	*
Perfluoroundecanoic Acid	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorodecane Sulfonate	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorododecanoic Acid	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluorooctylsulfonamide	ND U	4.6	1	09/28/16 03:35	9/26/16	**
Perfluoro-n-tridecanoic acid	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluoro-n-tetradecanoic acid	ND U	4.6	1	09/28/16 03:35	9/26/16	*
Perfluoroheptane sulfonate	ND U	4.6	1	09/28/16 03:35	9/26/16	*
N-ethylperfluoro-1-octanesulfonamide	ND U	4.6	1	09/28/16 03:35	9/26/16	*
N-methylperfluoro-1-octanesulfonamide	ND U	4.6	1	09/28/16 03:35	9/26/16	*
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	ND U	4.6	1	09/28/16 03:35	9/26/16	*
2-(N-methylperfluoro-1-octanesulfonamido)	ND U	4.6	1	09/28/16 03:35	9/26/16	*

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Wastewater Assessments



WWTF Effluent Sampling in NH (ppt)

WWTF	PFBS	PFBA	PFHPA	PFHXS	PFHXA	PFOA	PFOS	PFPEA	Total PFAS
A	C4-S	C4	C7	C6-S	C6	C8	C8	C5	
B	<4	7	<4	<4	46	6	7	21	86
C	<4	<4	<4	<4	17	8	<4	16	41
D	<5	12	<5	<5	47	15	9	9	92
E	<4	<4	<4	6	11	11	10	16	53
F	4	<4	<4	<4	18	4	4	5	35
G	<4	<4	<4	<4	6	11	<4	16	33
H	<4	12	<4	<4	52	7	<4	73	144
I	<4.8	<9.6	5	8	20	15	14	9	71
J	<4	73	19	<4	195	49	<4	101	437
K	<4	<4	<4	<4	10	10	14	7	40
L	5	12	14	6	65	54	14	57	227
M	5	<4	<4	<4	26	7	<4	10	47

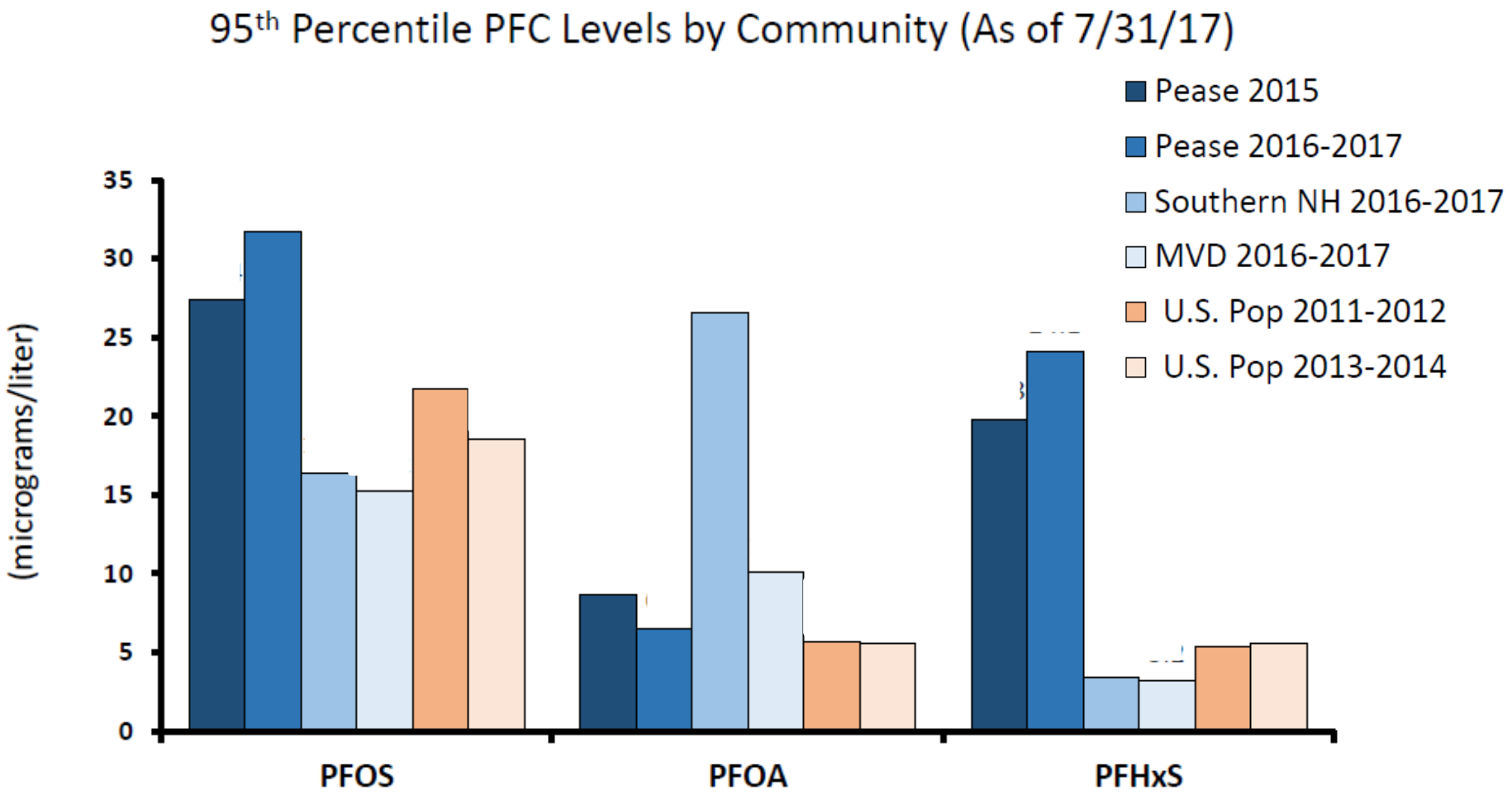
Wastewater Sludge/Biosolids

		A	B	C	D	E	F	G	H
		Sludge	Sludge	Sludge	Sludge	Compost	Sludge	Sludge	Ash
PFBS	C4-S	<1.1	<0.81	0.54	<8.8	5.20	Not Detected	<9.8	<0.98
PFBA	C4	Not Tested	Not Tested	Not Tested	<8.8	12.00	1.20	<9.8	<0.98
PFDS	C10	Not Tested	Not Tested	Not Tested	6.70	Not Tested	Not Tested	Not Tested	<0.98
PFDA	C10	Not Tested	Not Tested	Not Tested	2.60	Not Tested	Not Tested	Not Tested	<0.98
PFDOA	C12	Not Tested	Not Tested	Not Tested	5.60	Not Tested	Not Tested	Not Tested	<0.98
PFHPA	C7	<1.1	1.00	<1	<8.8	2.80	0.52	4.60	<0.98
PFHXS	C6-S	3.20	73.00	2.30	<8.8	0.48	3.50	<9.8	<0.98
PFHXA	C6	Not Tested	Not Tested	3.30	4.90	73.00	10.00	1.30	<0.98
PFNA	C9	1.90	3.60	<1	<8.8	3.40	1.50	<9.8	<0.98
PFOA	C8	4.40	6.50	1.10	<8.8	13.00	3.40	<9.8	<0.98
PFOS	C8	46.00	390.00	7.20	17.00	8.70	15.00	17.00	<0.98
PFPEA	C5	Not Tested	Not Tested	<1.0	<8.8	27.00	1.70	3.80	<0.98
Total PFAS		56	474	14	37	146	37	27	0

Units in parts-per-billion

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Human Blood Testing in NH

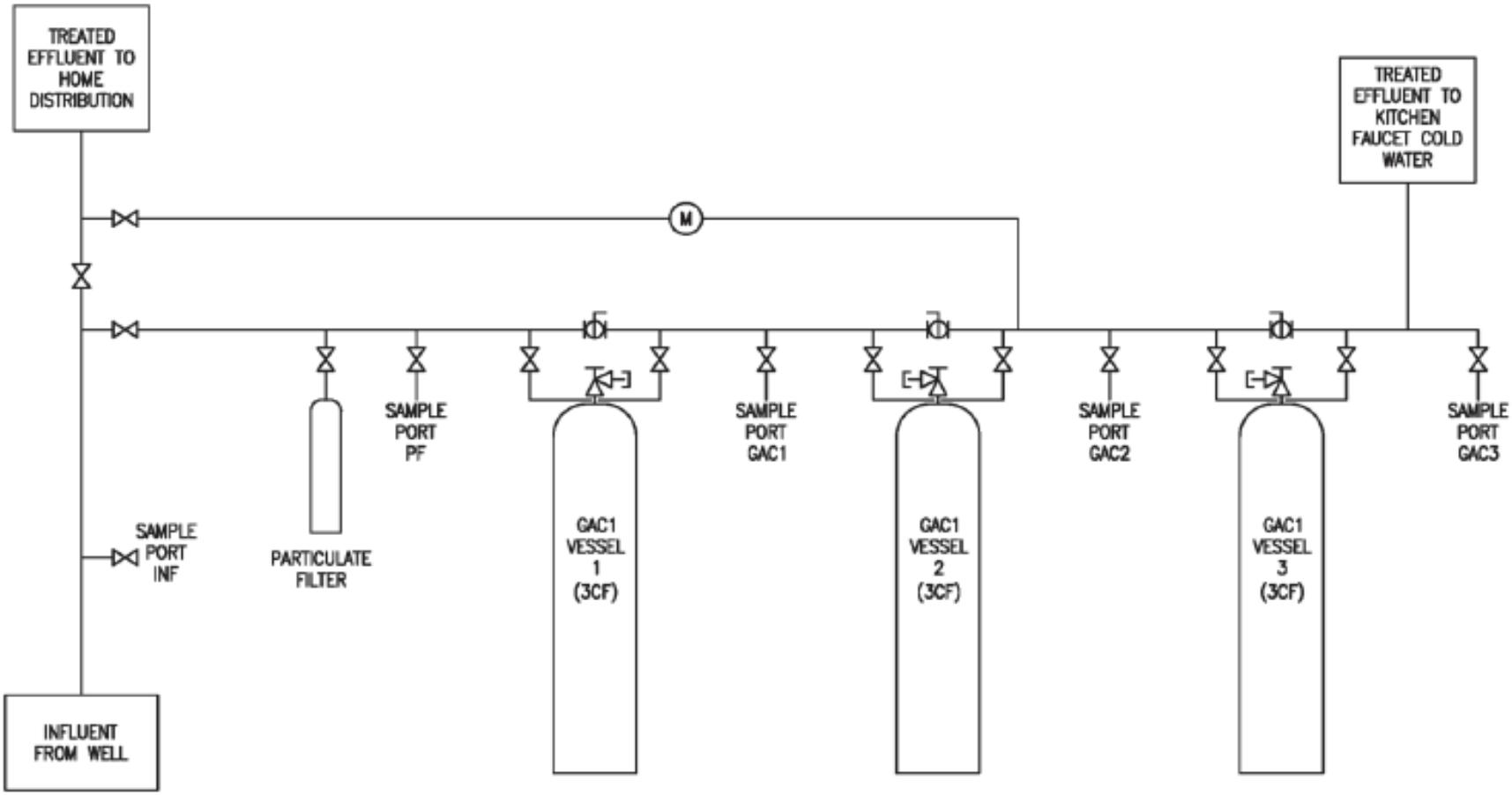


https://www.dhhs.nh.gov/media/pr/2017/10102017-pfc-findings.htm

Residential Scale Water Treatment

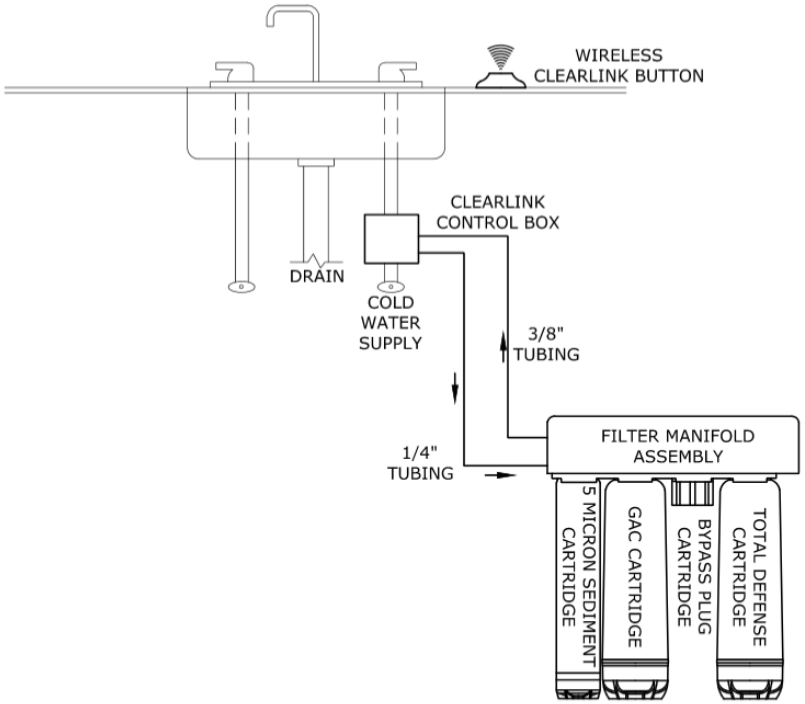
- NHDES developed a PFAS Treatment Factsheet
- Need to pay attention to “traditional contaminants”
- Point of Entry (whole house) Treatment Options
  - Granular activated carbon
  - Engineered resins may be an option in the future
- Point of Use (treatment for a single fixture) Treatment Options
  - Granular activated carbon (only addresses PFAS and a few other contaminants)
  - Reverse osmosis (addresses PFAS and most other contaminants)

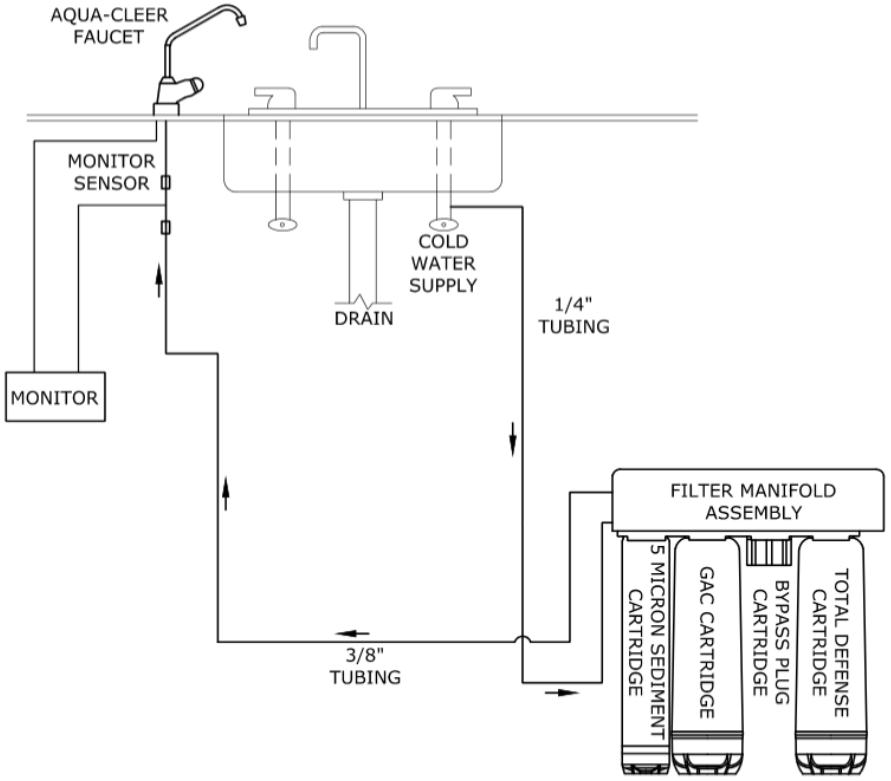
Typical Design of a Point of Entry Carbon Treatment for a Home



Available information suggests treatment systems with two (2 cubic foot) granular activated carbon vessels may be adequate.

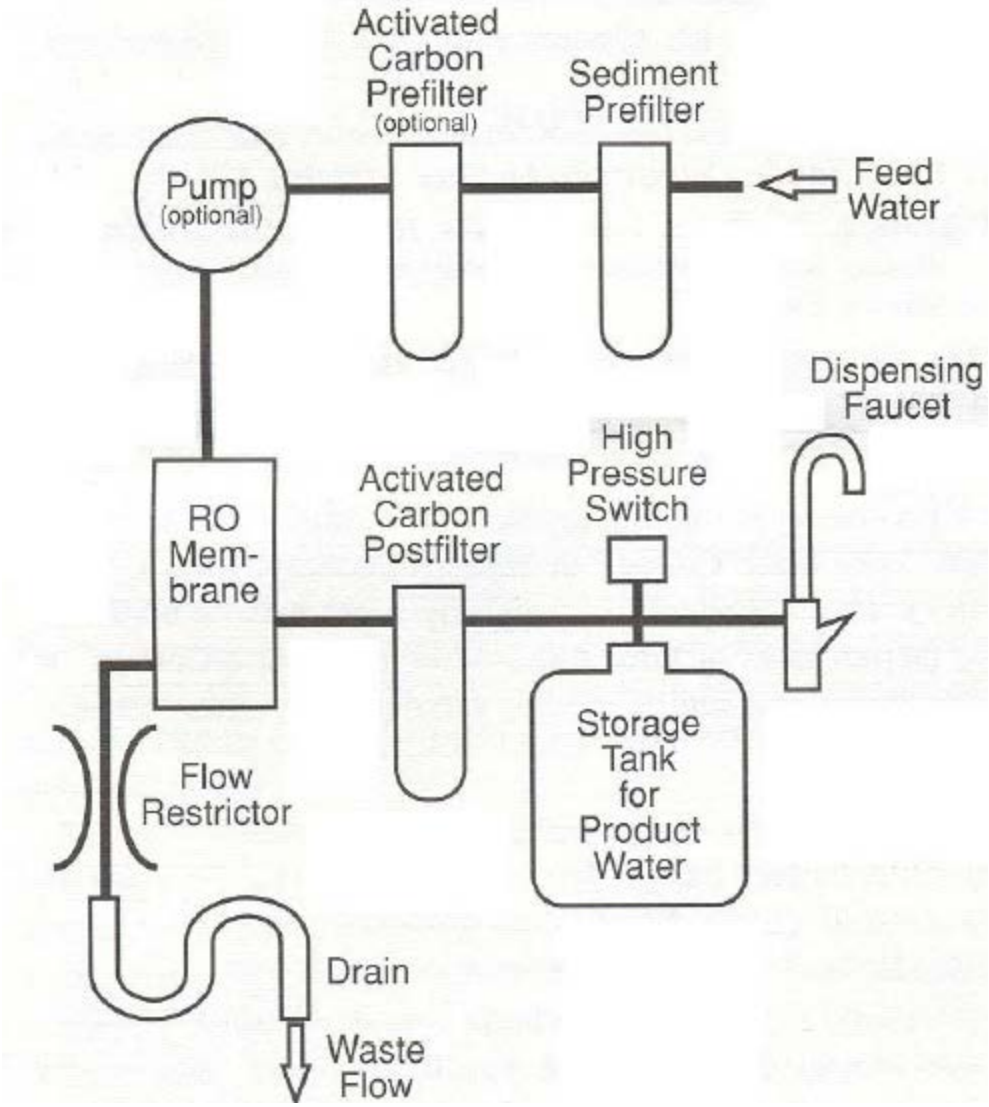
Point of Use Carbon Treatment





FROM POINT OF USE (POU) TREATMENT SYSTEMS WORK PLAN – 11/30/16 (NHDES SITE # 1997 12005)

Point of Use Reverse Osmosis

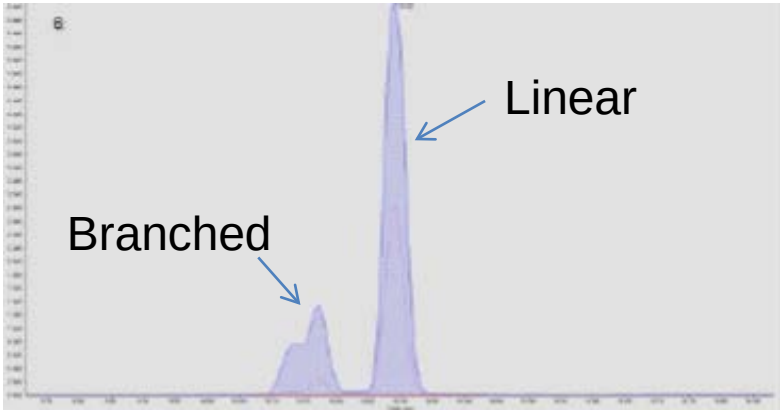


http://waterquality.cce.cornell.edu/publications/CCEWQ-04-ReverseOsmosisWtrTrt.pdf

Analytical Guidance

http://des.nh.gov/organization/commissioner/documents/pfoa-testing-labs.pdf

- Lab capabilities growing
- Only standard method is for drinking water – labs develop own methods
  - EPA 537 Rev 1.1 (6 to 14 compounds)
  - New EPA methods… soon?
  - **Recommend Modified 537 with isotope dilution**



- Accuracy of +/- 50% is considered acceptable
  - NHDES QA/QC testing shows +/-25% accuracy is typical but that results for PFOA/PFOS/PFHxS are typically underreported
- Analytical process evolving
  - One lab study identified 20 to 30% variability between certified standards

Discrepancies and Inconsistencies with Lab Reports

Lab reports and electronic data deliverables are problematic

- Different labs are reporting different forms of PFAS compounds – same acronym but different properties
- Form of compound can affect the concentration reported
- Lab reports/electronic data deliverables contain mismatching CAS #s and chemical names/forms
- **EPA's health advisory & NHDES standards reference the acid form**

Table 3-1. Basic naming structure and shorthand for perfluoroalkyl acids (PFAAs)

X	Y	Acronym	Name	Formula	CAS No.
O = octa (8 carbon)	A = Carboxylate or carboxylic acid	PFOA	Perfluorooctanoate	$C_7F_{15}CO_2^-$	45285-51-6
			Perfluorooctanoic acid	$C_7F_{15}COOH$	335-67-1
	S = Sulfonate or sulfonic acid	PFOS	Perfluorooctane sulfonate	$C_8F_{17}SO_3^-$	45298-90-6
			Perfluorooctane sulfonic acid	$C_8F_{17}SO_3H$	1763-23-1

Current PFAS/PFAS Related Compounds in Use

- GenX is receiving a lot of national attention as a replacement to PFOA
  - Not a chemical – it is a process using two chemicals to make fluoropolymers without PFOA
  - Chemicals associated with GenX not detected in hundreds of samples collected in NH
  - Unlikely to be detected unless sampling near facilities producing PFAS chemicals
- PFHxA is detected frequently and is a replacement for PFOA
- EPA Office of Research and Development is assisting with identifying highly fluorinated compounds currently in use.

What's next?

- Legislative activity in NH
- More information needed:
  - Drinking, ground, and surface water quality guidance for other PFAS
  - Soil leaching guidance
  - Air emission information
  - Additional toxicological studies
  - Standardized analytical methods
  - Reporting use of PFAS (TRI, SDS)?

USEPA's PFAS National Leadership Summit will be in Washington, D.C. on May 22-23, 2018.

Questions??

- Media coverage on PFAS see PFASproject.com
- Technical resources of PFAS see https://pfas-1.itrcweb.org/
- NHDES's website des.nh.gov