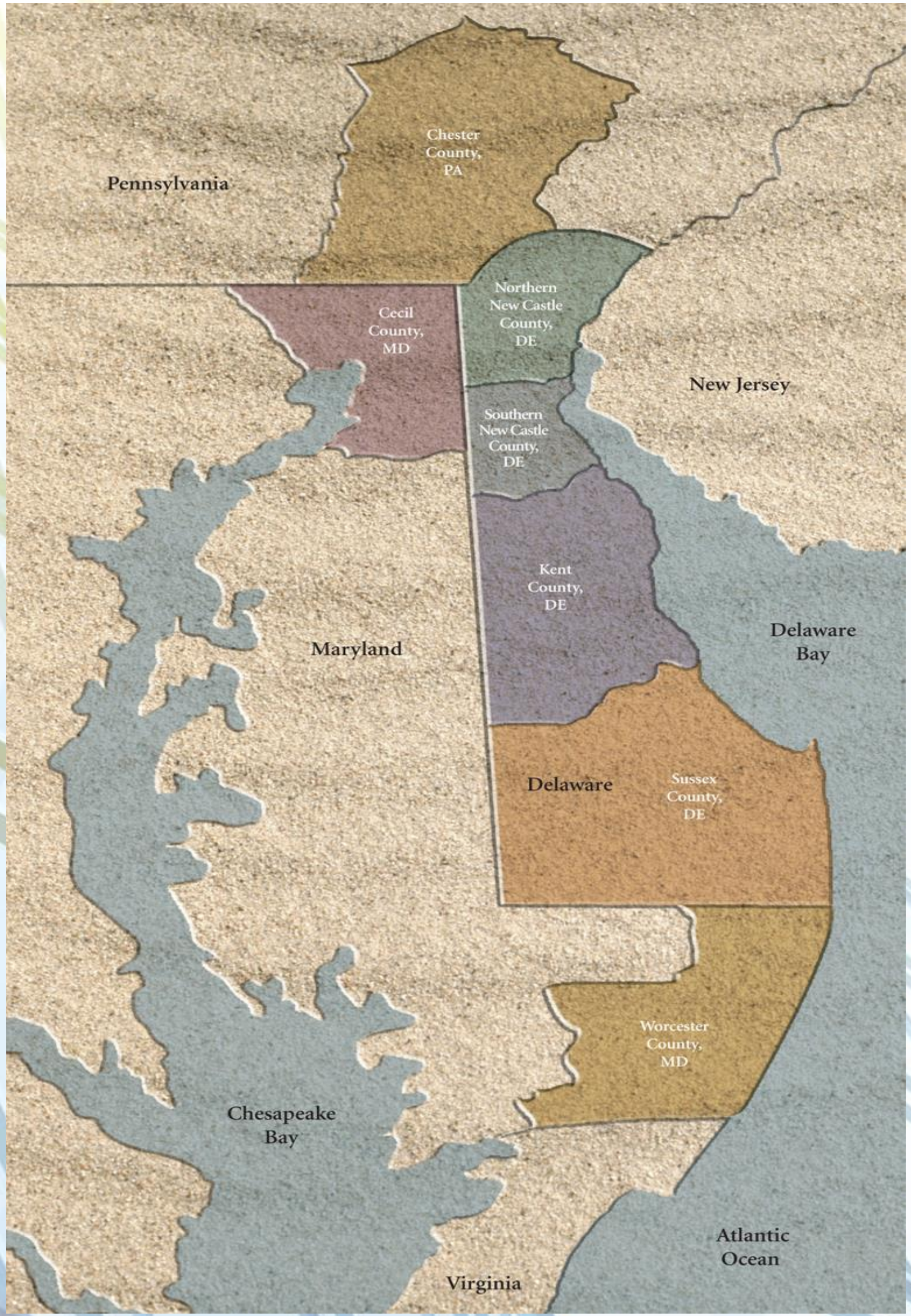
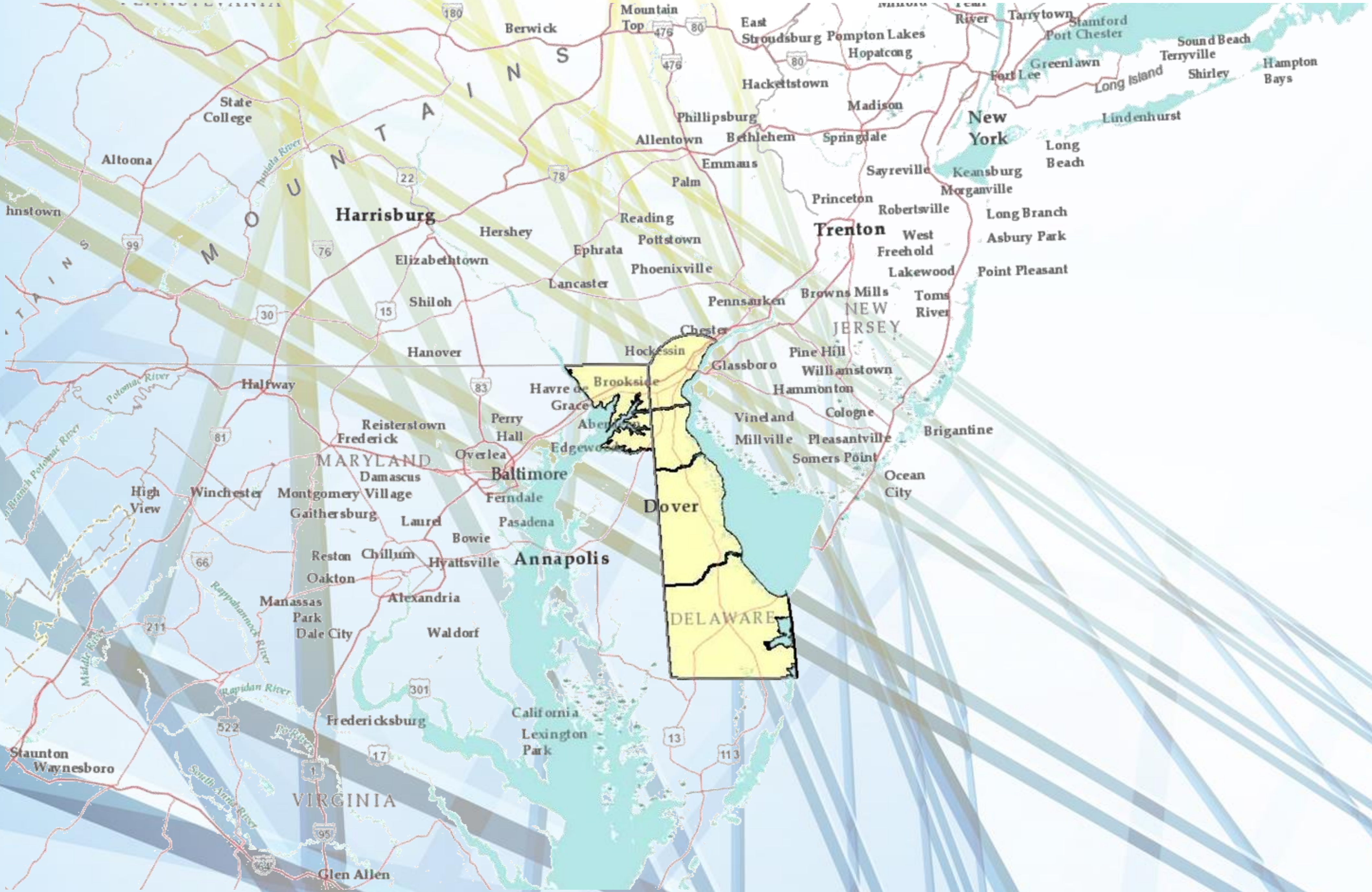
NARUC 2019 SUMMER POLICY SUMMIT

Artesian Water Company, Inc.

Emerging Contaminants and Secondary Water Standards in the Mid-Atlantic Region

Artesian Water Company, Inc on the Delmarva Peninsula





Mountain Top
Berwick
East Stroudsburg
Pompton Lakes
Hopatcong
River
Tarrytown
Stamford
Port Chester
Sound Beach
Terryville
Hampton Bays
Greenlawn
Fort Lee
Long Island
Shirley
Hackettstown
Madison
New York
Lindenhurst
State College
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Allentown
Bethlehem
Springdale
Long Beach
Altoona
Emmaus
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Robertsville
Long Branch
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Harrisburg
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Hershey
Pottstown
West Freehold
Asbury Park
MOUNTAINS
Elizabethtown
Ephrata
Phoenixville
Lakewood
Point Pleasant
Lancaster
Shiloh
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Potomac River
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Cologne
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Pleasantville
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Laurel
Pasadena
Bowie
Reston
Chillum
Hyattsville
Annapolis
Oakton
Alexandria
Manassas Park
Dale City
Waldorf
DELAWARE
California
Lexington Park
Fredericksburg
Staunton
Waynesboro
VIRGINIA
Glen Allen

WATER SERVICE FACTS

Population Served – approximately 301,000
Metered Customers – 88,300
Annual Production – 7.9 billion gallons
Miles of main – 1,311
Active Wells- 191
Treatment Facilities – 66
Storage Capacity – 174 million gallons
Water Service Territory – 285 square miles
Wastewater Service Territory – 26 square miles
Average Cost Per Day - $1.68

EPA United States Environmental Protection Agency

The Fourth Unregulated Contaminant Monitoring Rule (UCMR 4)

General Information

What is the Unregulated Contaminant Monitoring Rule?

The 1996 amendments to the Safe Drinking Water Act (SDWA) require that once every five years, the U.S. Environmental Protection Agency (EPA) issue a new list of no more than 30 unregulated contaminants to be monitored by public water systems (PWSs). The Unregulated Contaminant Monitoring Rule (UCMR) provides EPA and other interested parties with scientifically valid data on the occurrence of contaminants in drinking water. This national survey is one of the primary sources of information on occurrence and levels of exposure that the Agency uses to develop regulatory decisions for contaminants in the public drinking water supply.

The "Revisions to the Unregulated Contaminant Monitoring Rule (UCMR 4) for Public Water Systems and Announcement of Public Meeting" was published in the *Federal Register* on December 20, 2016 (81 FR 92666). UCMR 4 monitoring will occur from 2018-2020 and includes monitoring for a total of 30 chemical contaminants: 10 cyanotoxins (nine cyanotoxins and one cyanotoxin group) and 20 additional contaminants (two metals, eight pesticides plus one pesticide manufacturing byproduct, three brominated haloacetic acid [HAA] disinfection byproducts groups, three alcohols, and three semivolatile organic chemicals [SVOCs]).

What contaminants are systems monitoring for under UCMR 4?

Under UCMR 4, PWSs will conduct sampling for Assessment Monitoring ("List 1") contaminants as shown in the table below. For additional information on these contaminants, please review the contaminant-specific UCMR 4 Fact Sheets.

10 Cyanotoxins (Nine Cyanotoxins and One Cyanotoxin Group)

total microcystins	microcystin-LA	microcystin-RR	microcystin-LF	microcystin-YR
microcystin-LR	microcystin-LY	nodularin	cylindrospermopsin	anatoxin-a

20 Additional Contaminants

germanium	manganese	alpha-hexachlorocyclohexane	profenofos	chlorpyrifos
tebuconazole	dimethipin	total permethrin (cis- & trans-)	ethoprop	tribufos
oxyfluorfen	HAA5[1]	HAA6Br[1]	HAA9[1]	1-butanol
2-propen-1-ol	2-methoxyethanol	butylated hydroxyanisole	o-toluidine	quinoline

1. HAA5 (dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, monochloroacetic acid, trichloroacetic acid); HAA6Br (bromochloroacetic acid, bromodichloroacetic acid, dibromoacetic acid, chlorodibromoacetic acid, monobromoacetic acid, tribromoacetic acid); HAA9 (bromochloroacetic acid, bromodichloroacetic acid, chlorodibromoacetic acid, dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, monochloroacetic acid, tribromoacetic acid, and trichloroacetic acid).

Which water systems will participate in UCMR 4?

Approximately 6,000 PWSs will participate in UCMR 4. All community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) serving more than 10,000 people (i.e., large systems) are required to monitor:

- All large surface water (SW) and ground water under the direct influence of surface water (GWUDI) systems will monitor for cyanotoxins and the 20 additional contaminants.
- All large ground water systems will monitor for the 20 additional contaminants.

- Fourth Unregulated Contaminant Monitoring Rule (UCMR4)
- Testing 2018 – 2020
- Includes Herbicides, Pesticides, Fungicides and Plant Growth Regulators

Llangollen

$4.7 million invested to enhance capability in New Castle County

ASDWA
Association of State Drinking Water Administrators

Per- and Polyfluoroalkyl Substances (PFAS) and State Drinking Water Program Challenges

Who is ASDWA: The Association of State Drinking Water Administrators (ASDWA) represents the drinking water program administrators in the 50 states, the five territories, the Navajo Nation, and the District of Columbia. ASDWA's members regulate and provide technical assistance and funding for the nation's 160,000 public water systems, and coordinate with multiple partners to ensure safe drinking water. ASDWA works with its PFAS workgroup (comprised of drinking water program representatives from 27 states across the country) and other partners to discuss ASDWA member needs and challenges for assessing and addressing PFAS in drinking water.

PFAS Background: The understanding of potential drinking water impacts from PFAS has significantly increased over the past decade. This class of chemicals started to get publicity in 2001-2002 due to water contamination from the Washington Works Plant in West Virginia. In 2006, DuPont and other manufacturers agreed to principally phase out production of PFOA and PFOS.

Third Unregulated Contaminant Monitoring Rule (UCMR3): Six PFAS compounds were included in EPA's final UCMR3. UCMR3 monitoring occurred between January 2013 and December 2015 and included two to four quarterly samples at mostly large water systems throughout the country. The table here includes information on EPA actions related to seven PFAS compounds, including the PFAS on UCMR3.

Name	UCMR3	2009 EPA HAs (for UCMR3)	2016 Revised HAs	2019 EPA Action Plan
PFOA	Perfluorooctanoic acid	400 ppt	70 ppt (individual and combined sum of PFOA and PFOS)	EPA committed to making regulatory determinations
PFOS	Perfluorooctanesulfonic acid	200 ppt		
PFNA	Perfluoroonanoic acid	On UCMR3, No EPA HAs	No EPA HAs	EPA committed to developing toxicity assessments
PFHxS	Perfluorohexanesulfonic acid			
PFHpA	Perfluoroheptanoic acid			
PFBS	Perfluorobutanesulfonic acid		No EPA HAs, EPA developed draft toxicity assessments for PFBS and GenX in 2018, to be finalized in 2019	
GenX	Hexafluoropropylene oxide dimer acid (NOT on UCMR3)	No actions		

EPA's 2009 Provisional and 2016 Revised Health Advisories (HAs): In 2009, EPA established provisional health advisories (HAs) for PFOA at 400 parts per trillion (ppt) and for PFOS at 200 ppt; those two numbers were the benchmark at that time, even though an EPA health effects review was underway. Based on the provisional health advisories, national occurrence in UCMR3 for PFOA and PFOS, at the time appeared to be relatively low. In May 2016, EPA released revised HAs for the sum of PFOA and PFOS at 70 ppt. This numerical reduction significantly increased the number of water systems impacted.

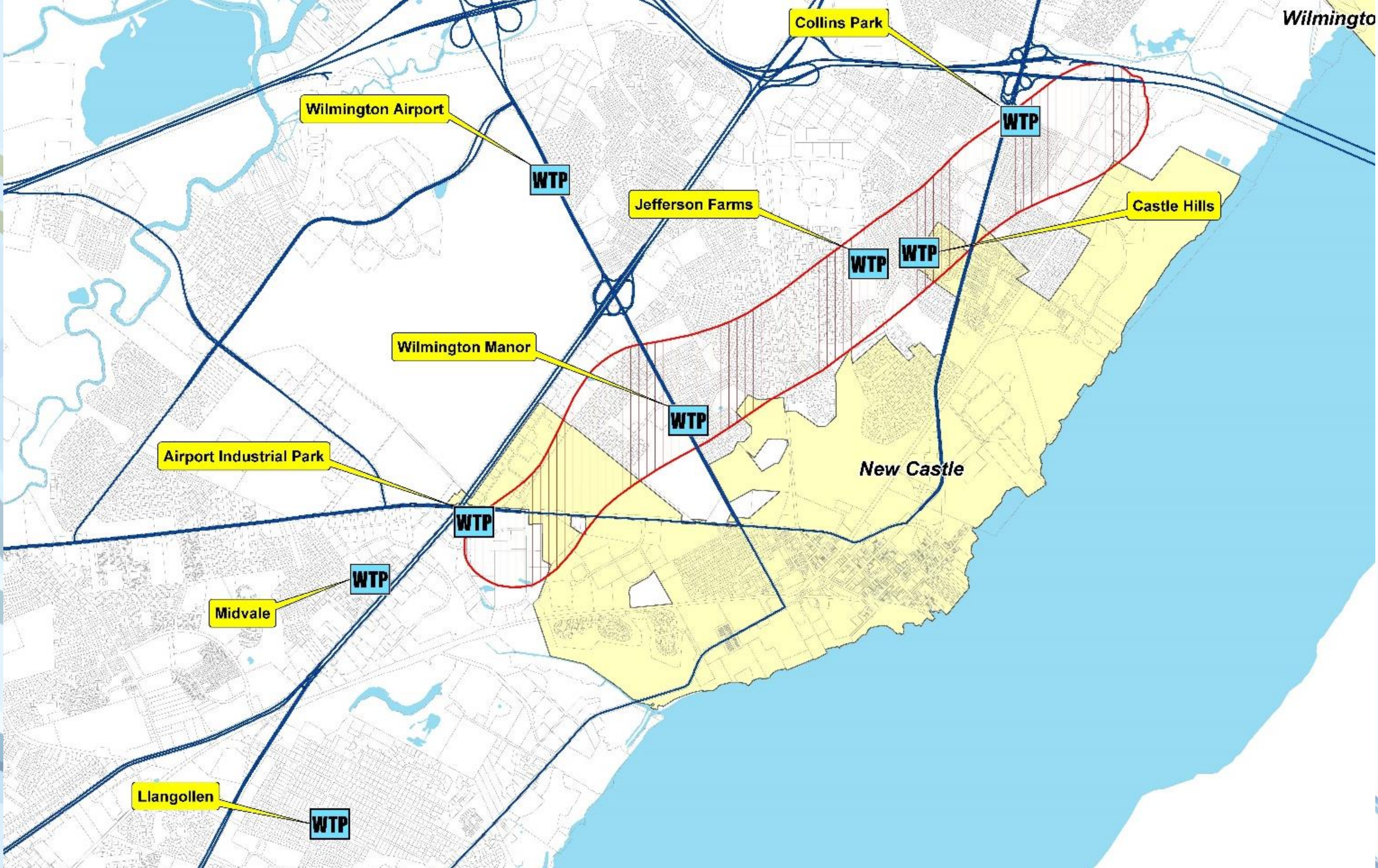
2019 EPA PFAS Action Plan: Commitments by EPA in the action plan included: making a regulatory determination for PFOA and PFOS; determining if a SDWA regulation is appropriate for a broader class of PFAS; including a larger group of PFAS in UCMR5; working through its regulatory development process for listing PFOA and PFOS as CERCLA hazardous substances; continuing to use its authority under TSCA to review new PFAS and issuing supplemental proposed Significant New Use Rules on PFAS; and developing new tools to characterize PFAS in the environment and materials to communicate about PFAS.

More PFAS Contamination Sites are Being Found: The number of PFAS contaminated sites continues to grow. Over the past decade, PFAS contamination was found in many more locations than where the UCMR3 required water systems to conduct monitoring. Initially, contamination was thought to be somewhat limited to the chemical manufacturing facilities but has now expanded to include military bases, fire-fighting foam

www.asdwa.org/PFAS

- Proposed UCMR5
- PFOS, PFOA and PFCs first on list
- Already setting Health Advisory Limits
- Still found in products

UBIQUITOUS


Collins Park
Wilmingto
Wilmington Airport
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Jefferson Farms
Castle Hills
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Wilmington Manor
WTP
Airport Industrial Park
New Castle
WTP
WTP
Midvale
Llangollen
WTP

June 12, 2014 Public Notice

ARTESIAN RESOURCES

OVER 100 YEARS OF SUPERIOR SERVICE

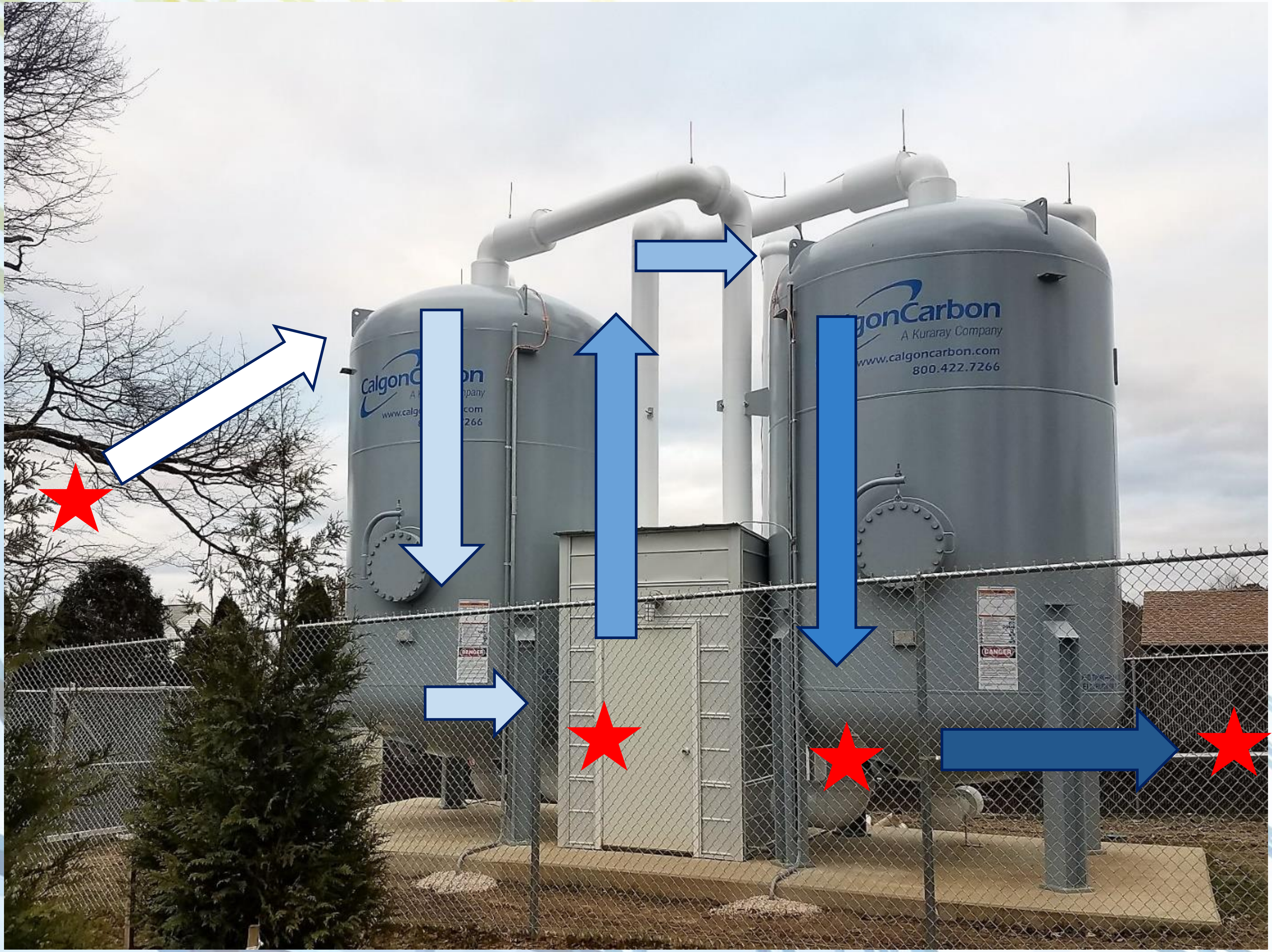
Artesian Water Company ▲ Artesian Wastewater Management ▲ Artesian Utility Development ▲ Artesian Water Pennsylvania ▲ Artesian Water Maryland ▲ Artesian Wastewater Maryland

DRINKING WATER NOTICE

Artesian's Wilmington Manor 3 Treatment Plant detected levels of Perfluorooctane Sulfonate (PFOS) Above Provisional Health Advisory

Our water system recently exceeded a provisional health advisory. As our customers, you have a right to know what happened, what you should do, and what we are doing to correct the situation.

As part of the federal Unregulated Contaminant Monitoring Rule 3 (UCMR3), we monitored for the presence of an EPA selected group of 28 unregulated drinking water contaminants. On June 2, 2014, we received notice that the samples collected on July 17, 2013 and January 28, 2014 showed at our Wilmington Manor 3 Treatment Plant that we exceeded the Federal provisional health advisory for PFOS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NARUC 2019 SUMMER POLICY SUMMIT

Artesian Water Company, Inc.

Emerging Contaminants and Secondary Water Standards in the Mid-Atlantic Region

Emerging Contaminants
Poly and Perfluoroalkyl Substances

July 23, 2019

Robert R. Scott, Commissioner

New Hampshire Department of Environmental Services

Emerging Contaminants

- USEPA tests for select unregulated contaminants every 5 years
- Often originate from everyday consumer products (pharmaceuticals, personal care products, coatings, fabrics, paint, pesticides etc.)
- Perceived, potential, or real threat to human health or the environment
- Lack of published health standards
- New source or new pathway to humans has been discovered
- New detection method or treatment technology has been developed

The Brewing Public Crisis Created by Emerging Contaminants – *in the words of a NH Water System*

- What was “0” just years ago is now detectable. Better lab equipment is fueling public concern.
- Emerging Contaminants are not regulated and generally health effects are not well understood.
- Wide range of data on emerging contaminants, some backed by science and some by fake news.
- Utilities are expected to provide water that meets regulatory standard which is often different than the public’s demands for water with “0” levels of contamination.
- Contrary to public opinion the cost of treating all water to a Maximum Contaminant Level Goal Of Zero is more than the public can afford.
- The “vocal” public believes no risk is acceptable.
- The public believes the cost of treatment should be borne by the Utility.

Poly and Perfluoroalkyl Substances

- A class of chemicals that are ubiquitous due to
  - Wide variety of uses
  - Persistence
  - High Mobility
- They are a concern due to:
  - Known or suspected toxicity, especially for PFOS, PFOA, PFNA and PFHxS
  - Bioaccumulation (ppt in water = ppb in blood)
- Information on PFAS is rapidly evolving
  - EPA Health Advisory Levels for PFOA/PFOS were substantially lowered in 2016
  - NH has recently adopted new standards that are 6-7 times lower

NHDES

Uses & Sources of PFAS

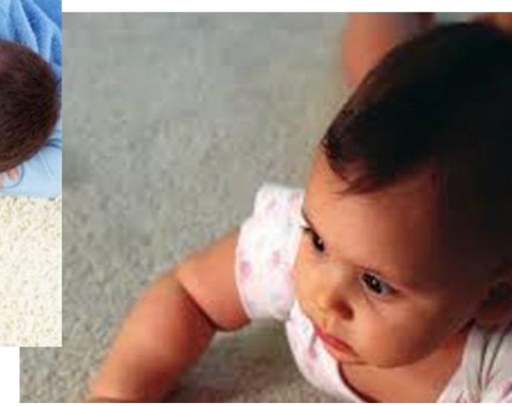
PFAS are used in a wide variety of industries and commercial products for their valuable properties, including fire resistance, dust suppression, and oil, stain, grease, and water repellence. (Some examples of uses are on the following slides)

- 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

NHDES

Uses & Sources of PFAS

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

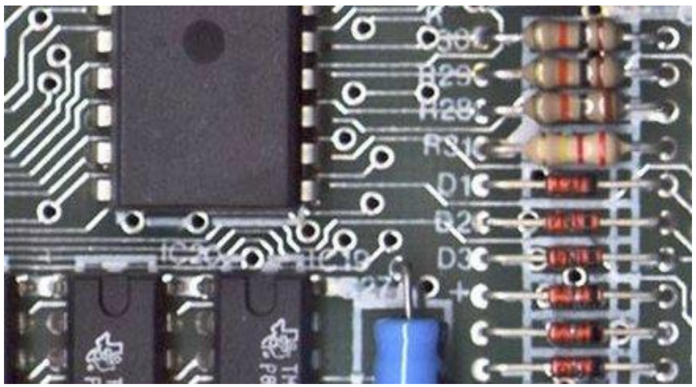
[1] https://en.wikipedia.org/wiki/Polytetrafluoroethylene PFOA, which used to be a key ingredient in making Teflon, has been phased out, however there is little evidence that the chemicals that have replaced PFOA are much safer.

[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

NHDES

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

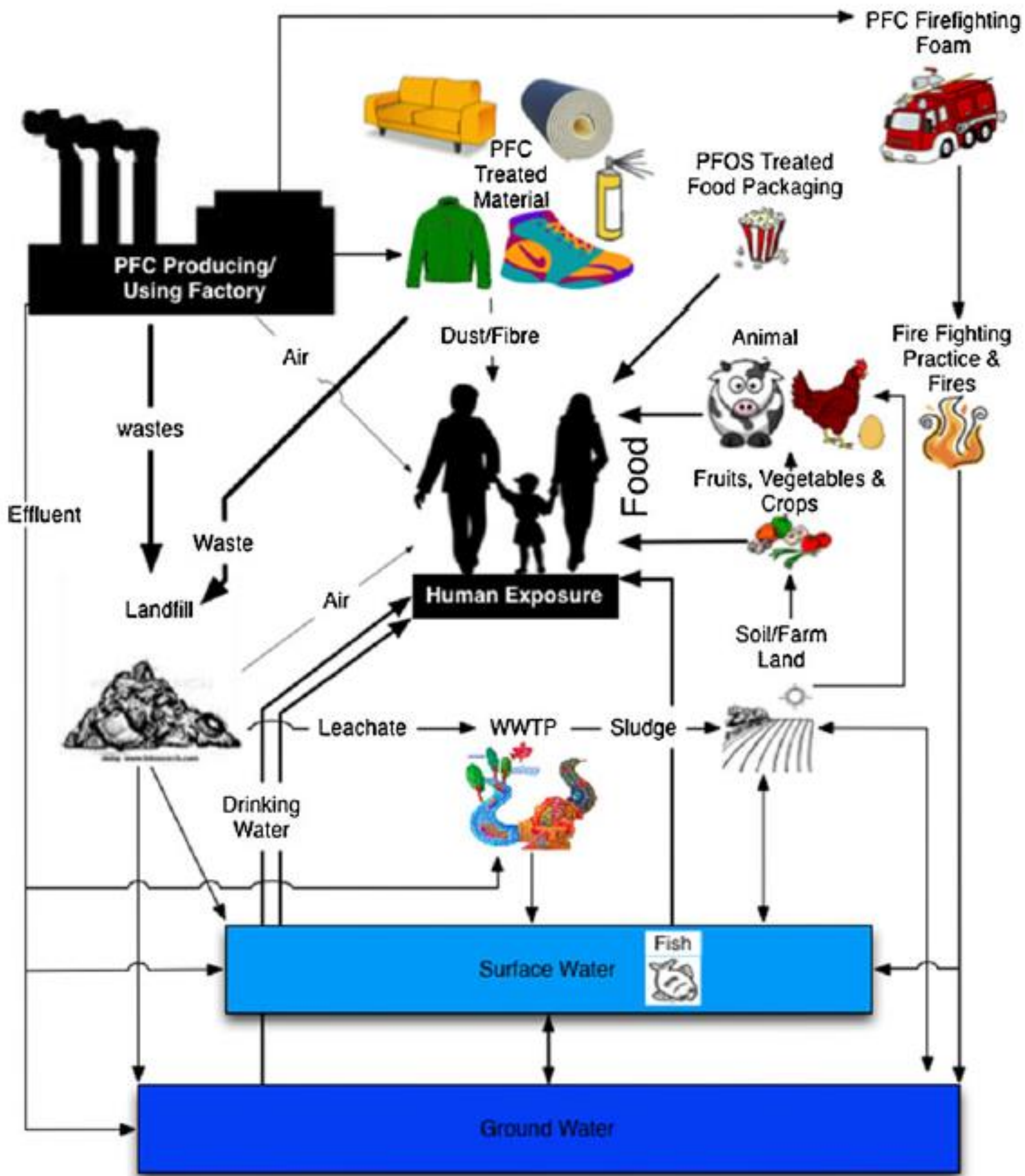
NHDES

Uses & Sources of PFAS

1) Paints.
2) Sealants, including products used on grout, countertops and floor treatments.
3) House cleaners and stain removers.
4) Floor wax removers.
5) Stain-resistant textiles (or chemicals used to treat textiles in homes and businesses) including, but not limited to, carpets, shoes and clothing.
6) Furniture with stain-resistant fabric.
7) Water proof textiles.
8) Food cooking ware and utensils.
9) Ski and boat waxes.
10) Dental floss, cosmetics, sunscreen and other personal care products.
11) Construction materials, including caulk sealants and plumbing sealants.
12) Pesticides.
13) Treated paper.
14) Chemical coatings for metal roofing.
15) Solar panels.
16) Purchased garden soils.
17) Automotive supplies, including waxes, cleaners, windshield wipers and additives to fluids used in automobiles.
18) Camping and other outdoor gear.
19) Spray- and grease-based lubricants.
20) Inks.

NHDES

PFAS Lifecycle/Recycling In the Environment



From Oliaei 2013, Environmental Science Pollution Research

PFAS Sampling Timeline in NH

2013-2015 UCMR 3

(21 water systems / 80 sources)

2014 – DoD / Superfund Sampling

(3 major water supply wells)

2016 – Sampling of wells around two air emissions sites

(1000+ wells)

Present – Statewide sampling (3000+ multi-media samples)

PFAS INVESTIGATION
Updated: July 9, 2019

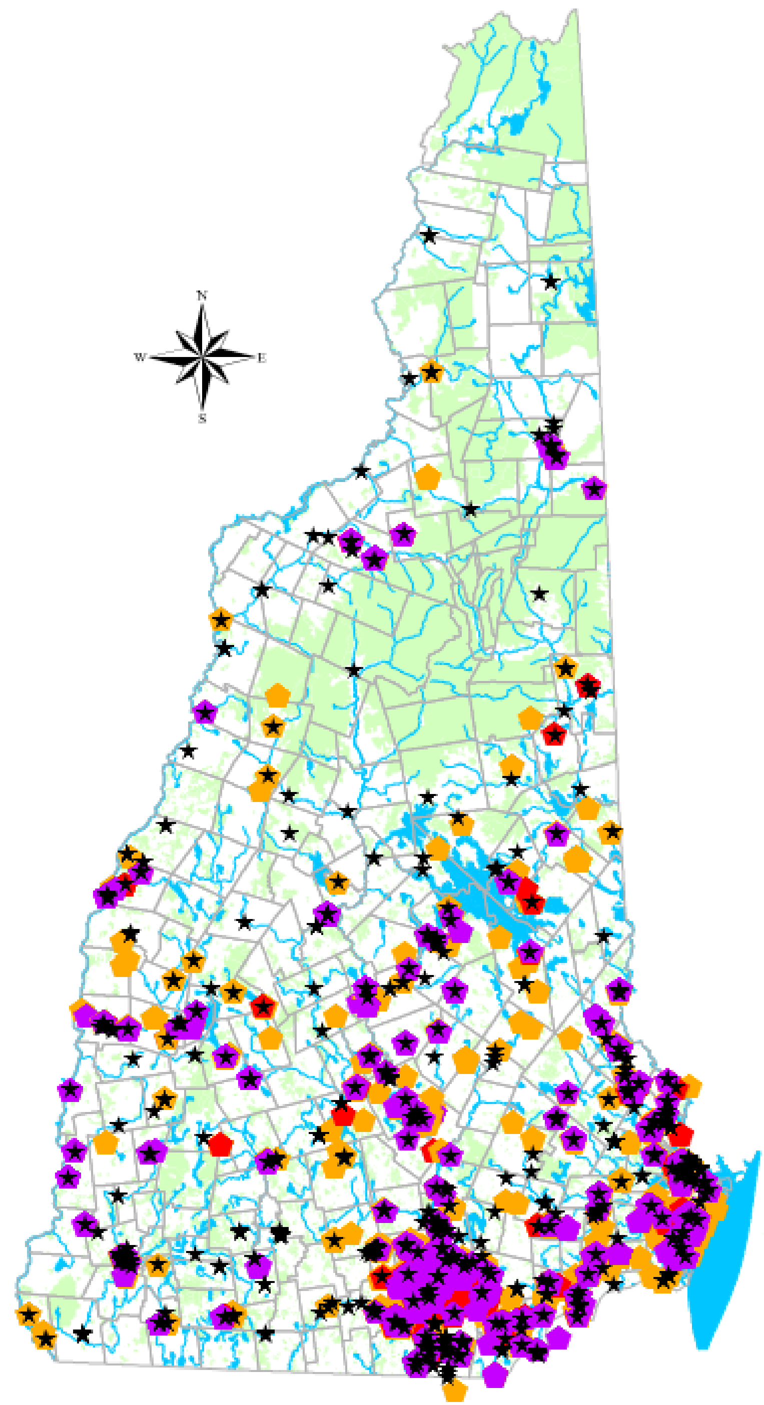
SAMPLES WITH PFAS DETECTS
TOTAL PFAS (ppt)

- 70+
- 45 - <70
- Detect - <45

- Existing Remedial Site with PFAS Detections

- Political Boundary
- Major Waterbody
- Conservation Land

Miles
0 12.5 25 50



NEW HAMPSHIRE DEPARTMENT OF
Environmental Services

Public Water System Sampling in NH

Combined PFOA & PFOS Result	Number of Public Water System Sources	Percentage
Greater than 70 ppt	**18**	**4%**
Greater than 60 ppt	**20**	**4%**
Greater than 50 ppt	**21**	**4%**
Greater than 40 ppt	**22**	**5%**
Greater than 30 ppt	**30**	**6%**
Greater than 20 ppt	**47**	**10%**
Greater than 10 ppt	**74**	**16%**
Greater than 5 ppt	**102**	**22%**
Greater than ND	**179**	**40%**
Non-detect	**277**	**62%**

Number of Sources Tested = 471

PFAS Detected in Public Water Systems

	Number of Detections	Maximum Concentration Detected (ppt)
PFOA/PFOS	179	279
PFOA	170	106
PFOS	83	173
PFHPA*	69	22.8
PFHXS	62	159
PFHXA	52	79.1
PFBS	50	49
PFPEA	41	76
PFBA	34	19.7
PFNA	17	73
PFHPS	4	2.66
N_ETFOSA	2	5.81
PFDS	1	1
PFTRDA	1	4.28
FOSA	1	4.6

*PFHPA has been identified as a common lab contaminant.

NH Adopted MCLs

Health-Based Risk Assessment Process based on non-cancer endpoints

Specific PFAS	NHDES Revised MCLs	Health Outcome
PFOA	**12 ng/L**	**Liver toxicity & altered lipid metabolism**
PFOS	**15 ng/L**	**Suppressed immune response to vaccines**
PFHxS	**18 ng/L**	**Reduced female fertility**
PFNA	**11 ng/L**	**Liver toxicity & altered lipid metabolism**

NHDES

Drinking Water / Groundwater

(Select Locations – Established or Proposed Standards and Guidance Values)

Location	Concentration (ng/L) (* also includes sum of indicated analytes)							
	PFOA	PFOS	PFNA	PFHxS	PFHpA	PFDA	PFBS	PFBA
USEPA	70	70						
	40	40						
Alaska*	70	70	70	70	70		2,000	
Rhode Island	*70	*70						
Maine	*70	*70					400,000	
Connecticut	*70	*70	*70	*70	*70			
Vermont	*20	*20	*20	*20	*20			
Massachusetts	*20	*20	*20	*20	*20	*20	2,000	
Minnesota	35	15		47			2,000	7,000
California	10	13						
New Jersey	14	13	13					
New York	10	10						
New Hampshire								
	12	15	11	18				

* - Indicates standard is based on the sum of multiple PFAS compounds

Sources: State webpages and ITRC PFAS Fact Sheets (https://pfas-1.itrcweb.org/fact-sheets/)

Survey of States Adopting PFAS MCLs

- 7 states have or are in the process of establishing MCLs
- 3 states may establish MCLs
- 15 states can establish MCLs but currently do not intend to
- 12 states have laws or policies prohibiting them from making any standard that is more stringent that Federal requirements

13 states did not respond to the survey

Source: Association of State Drinking Water Administrators – June 2019

PFAS – BREAKING NEWS IN NEW HAMPSHIRE

N.H. Sues Makers of PFAS Chemicals for Drinking Water Contamination

By ANNIE ROPEIK • MAY 29, 2019

Share Tweet Email

Governor Chris Sununu announced the lawsuits at a press conference Wednesday with leaders from the Attorney General's office and Department of Environmental Services.

CREDIT ANNIE ROPEIK / NHPR

New Hampshire is suing the original makers of toxic PFAS chemicals for allegedly contaminating the state's drinking water.

At a press conference Wednesday, Gov. Chris Sununu joined officials from the Departments of Justice and Environmental Services to announce two statewide lawsuits against eight companies – including 3M, DuPont and its spinoff, Chemours.

"New Hampshire is taking, again, a preeminent position not just for ourselves and our citizens, but in the country ... in making a stand against the introduction of the PFAS compounds into our drinking water," Sununu says.

You can read the complaints at:

https://www.courts.state.nh.us/caseinfo/index.htm

PFAS Presents Unique Challenges

- Two sites in NH Contaminated by Air Emissions
- Its presence in drinking water is measurable in our residents' blood – health implication is not known
- Currently have standards for four out of thousands PFAS
- Public exposed to PFAS in drinking water are demanding regulations be set at "0" or "non-detect"
  - Feel no level is safe
  - Remediate their bodies

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 safe drinking water regulations

Challenge to Water Utilites

- Public confidence
  - Waiting on the science
- Cost to treat
  - Carbon/resin
  - Blending
  - Well closures
  - Higher O&M costs
- Regulatory Uncertainty
  - What's next?

Approaches to PFAS removal

Mark Vannoy, P.E.

ECT2

USEPA PFAS treatment assessment –Fayetteville Regional Summit

Drinking Water Treatment for PFOS

Ineffective Treatments

Conventional Treatment
Low Pressure Membranes
Biological Treatment (including slow sand filtration)
Disinfection
Oxidation
Advanced oxidation

PAC Dose to Achieve

50% Removal	16 mg/l
90% Removal	>50 mg/L

Dudley et al., 2015

Effective Treatments

Effective Treatments	Percent Removal	
Anion Exchange Resin (IEX)	90 to 99	- Effective
High Pressure Membranes	93 to 99	- Effective
Powdered Activated Carbon (PAC)	10 to 97	- Effective for only select applications
Granular Activated Carbon (GAC)		
Extended Run Time	0 to 26	- Ineffective
Designed for PFAS Removal	> 89 to > 98	- Effective

PFAS treatment options

Biological Treatment

Air Stripping

GAC

Foam Fractionation

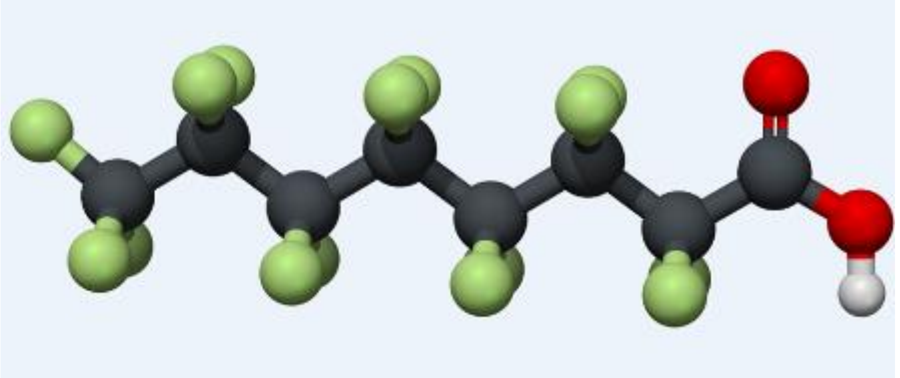
Ion Exchange (IEX) Resin

Reverse Osmosis

Advanced Oxidation

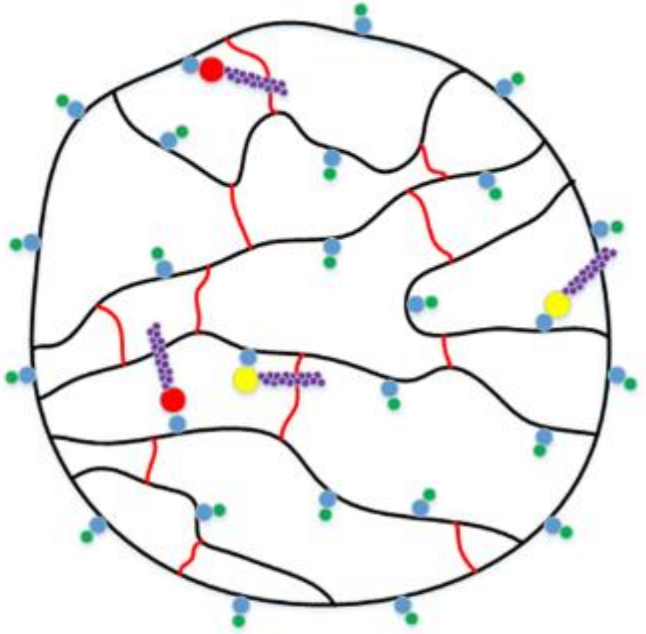
How does IEX resin remove PFAS?

Dual mechanism of removal: IEX and adsorption



PFOS Molecule

By Manuel Almagro Rivas - Own work using: Avogadro, Discovery Studio, GIMP, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=47567609



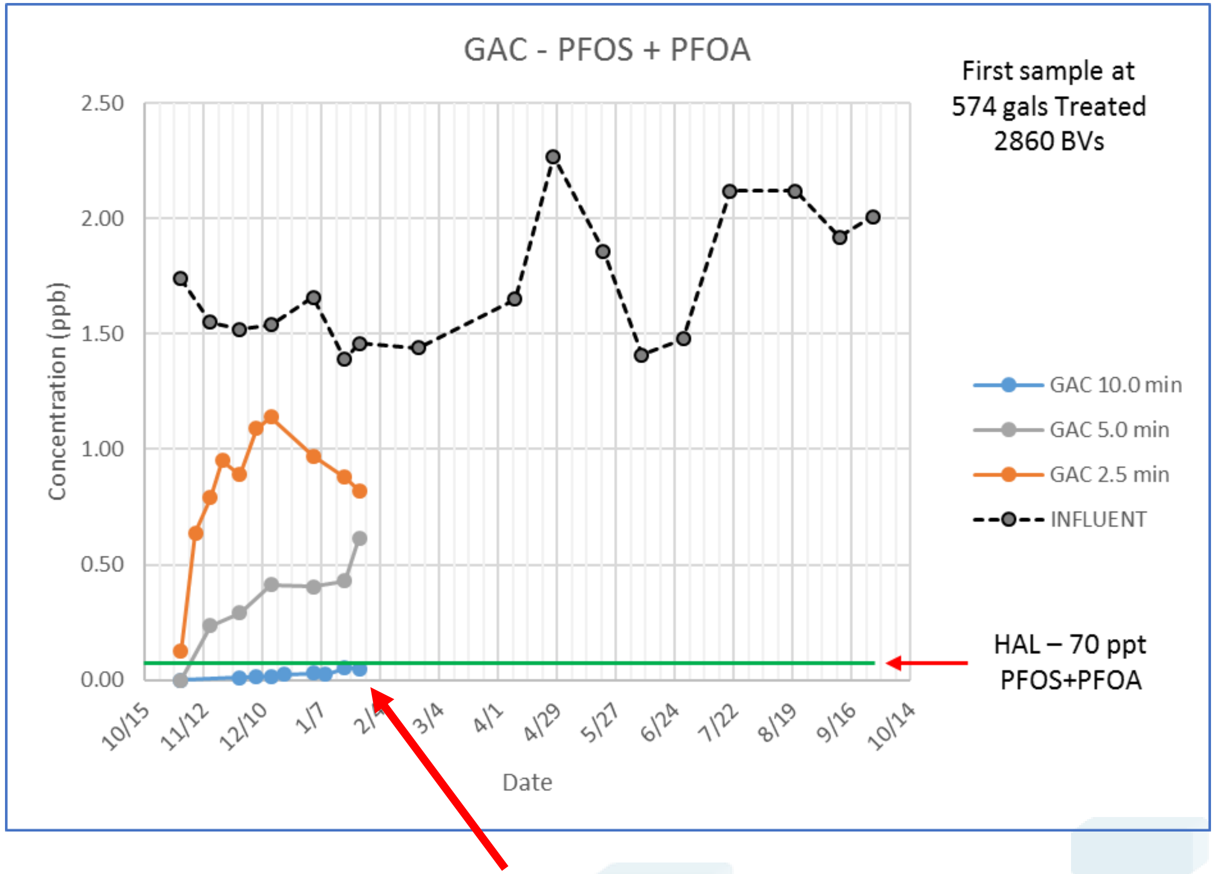
Simplified Resin Bead

- Polystyrene polymer chain
- Divinylbenzene crosslink
- Fixed ion exchange group, e.g., quartenary ammonium, $-\equiv N^{+}$, for anion IEX
- Exchangeable counter ion, e.g., chloride ion, Cl-, for anion IEX
- Sulfonate group, $-SO_3^{-}$, of PFAS (e.g., PFOS), replacing exchangeable counter ion
- Carboxylate group, $-CO_2^{-}$, of PFAS (e.g., PFOA), replacing exchangeable counter ion
- PFAS carbon-fluorine tail adsorbing to polystyrene polymer chain or divinylbenzene crosslink via Van der Waals forces

GAC only has Adsorption

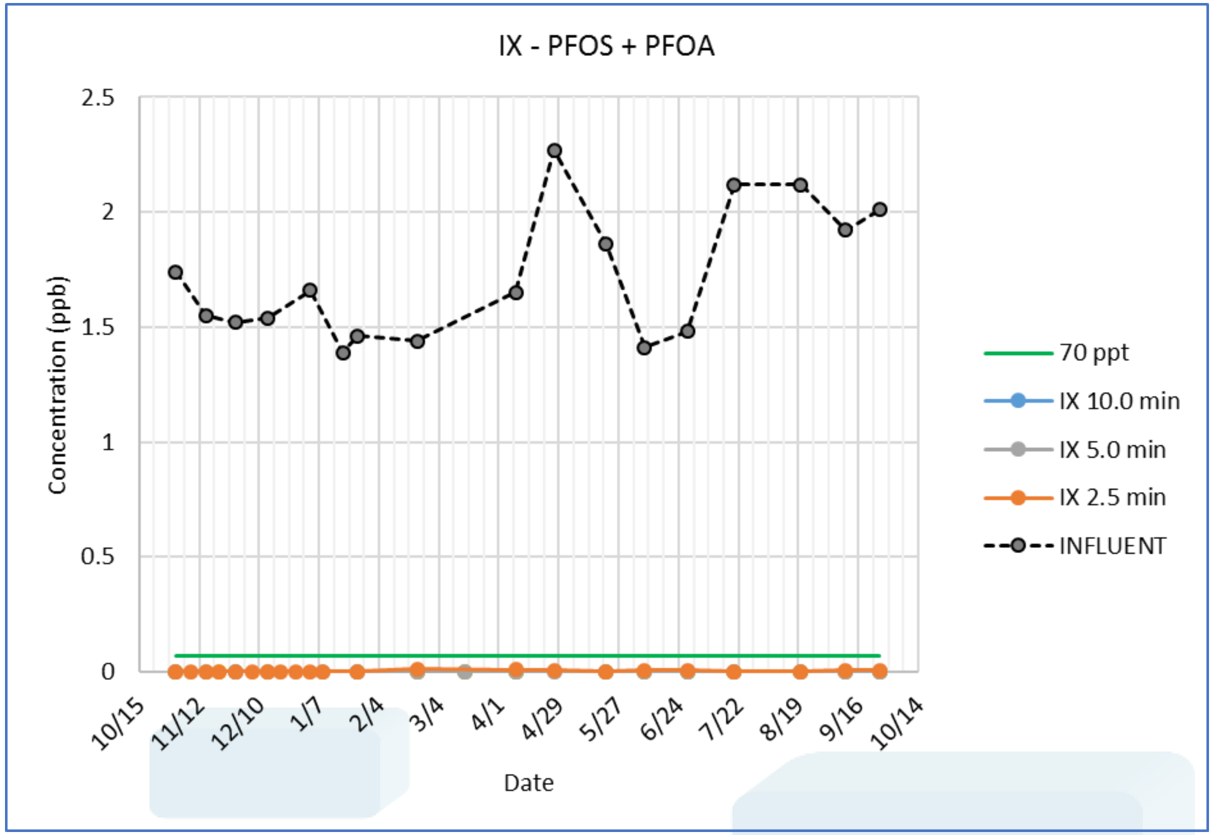
Removal comparison – PFOS + PFOA

GAC



City Stopped GAC at 10,400 gal Treated

IX Resin



IX Resin is ND after 171,000 BV's or 34,300 gals Treated (2.5 min EBCT)

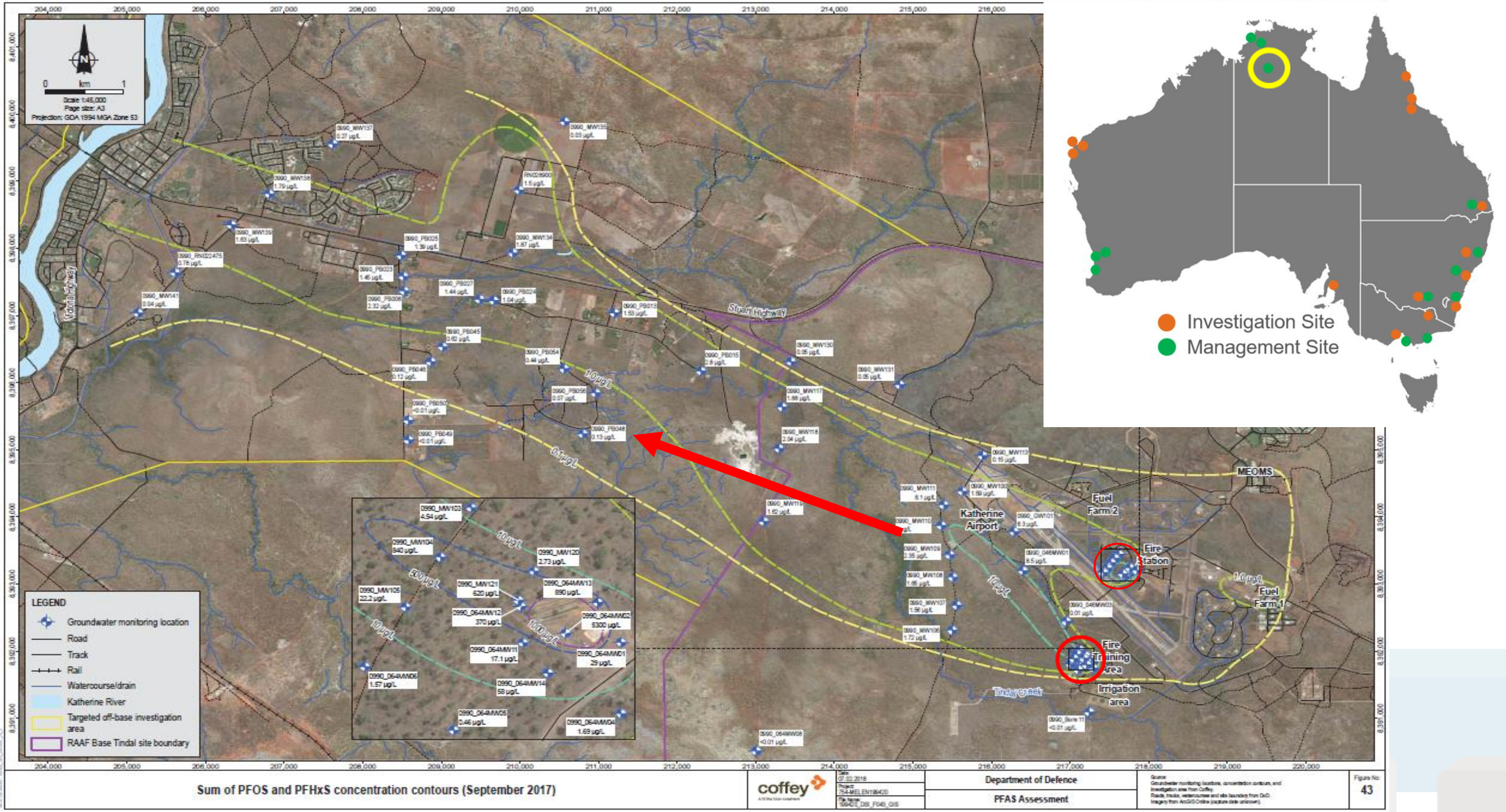
Weston & Sampson's (independent consultant) lifecycle cost analysis

ect2

Twenty-Year Present Worth Analysis (USD)

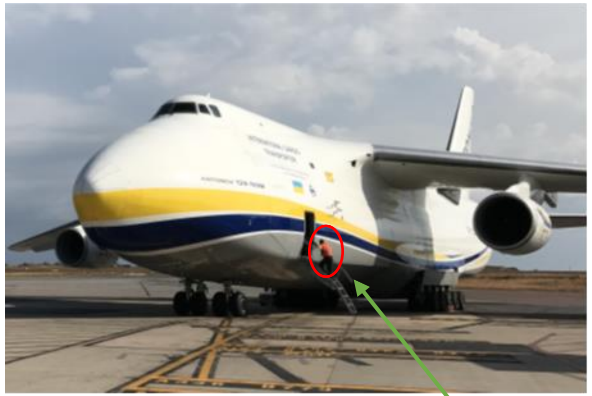
Treatment Option	Capital Cost	Annual Operating Cost	Present Worth Cost
GAC	$2,140,000	$304,000	$6,271,000
Resin	$1,090,500	$99,300	$3,173,000

PFAS contamination at RAAF Base Tindal



Public outcry is driving action

Town of Katherine water supply IX resin system: expedited overseas transport in Antonov AN-225 Mriya



Human

Treatment system being loaded onto Antonov in the US

Plug and play installation

Questions?

Mark Vannoy
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