



# DSCA PFAS Pilot Study

April 2026

*Dry-Cleaning Solvent Cleanup Act (DSCA)*  
*Division of Waste Management*  
*Department of Environmental Quality*



# *DSCA PFAS Pilot Study Overview*



- Background
- Groundwater Sampling
- Process Sampling
- Next Steps

## Background – History of PFAS & Dry-Cleaning Operations

Per- and polyfluoroalkyl substances (PFAS) use in the textile industry:

- Began in the 1950s and became more prominent in the late 1960s
- Waterproofing membranes and coatings
- Surface finishes to impart water, oil, and stain resistance
- Dye and bleach processing and defoaming agents
- Phase out of select PFAS began around 2000 but remains incomplete

PFAS are not known constituents of typical chlorinated and petroleum-based dry-cleaning solvents.

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# Background – Prior Studies

## FLORIDA STATEWIDE PFAS PILOT STUDY AT DRYCLEANING SITES

Sponsored By:



Florida Department of Environmental Protection  
Waste Site Cleanup Program  
2600 Blair Stone Road, MS 4520, Tallahassee, FL 32399-2400

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May 2021

### 2021 Florida Department of Environmental Protection (FDEP) Study

- Groundwater and dry-cleaning process samples at 15 sites
- Concluded dry-cleaning and wet laundry activities contributed to PFAS concentrations in the environment
- Primary source appeared to be PFAS leaching from fabrics

### Wisconsin Department of Natural Resources (WDNR)

- WDNR began requesting dry-cleaner sites with open contamination related to discharges of spent solvent to sample for PFAS beginning in 2020
- There is no published study
- The data has not been compiled for evaluation
- Per WDNR staff\*, “Overall, while some PFAS have been detected, it’s been relatively minimal and vapor intrusion remains the driving factor at open dry cleaner sites.”

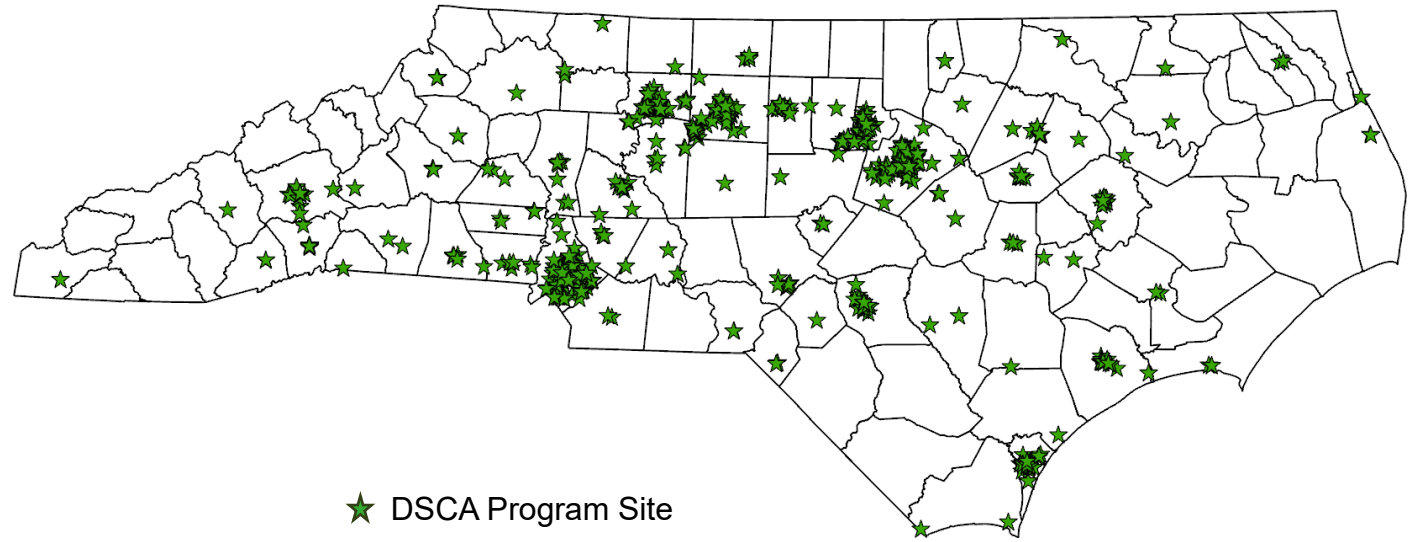
\* Information collectively provided by Alyssa Sellwood, P.E., Complex Sites Project Manager & Jennifer Borski, Vapor Intrusion Team Leader, March 2026.



## *Background – DSCA PFAS Pilot Study Purpose*

### Objectives of NC DSCA Program pilot study:

- Determine whether PFAS pose a concern at dry-cleaning sites in NC
- Identify possible sources
- Provide a technical foundation for future programmatic decision-making



# Groundwater Sampling



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# Groundwater Sampling – Site Selection

## Location

- Mountain
- Piedmont
- Triassic Basin
- Coastal Plain

## Operations

- Chlorinated solvent use
- Petroleum solvent use
- 1 distribution facility

## Operational Dates

- 2 sites 1950s-1960s
- Multiple sites 1970s to 2010s
- No sites after 2010s

## Dry-Cleaning Solvent Concentrations

- Wide range of tetrachloroethylene (PCE)
- 1 site with primarily petroleum impacts

## Excluded Sites

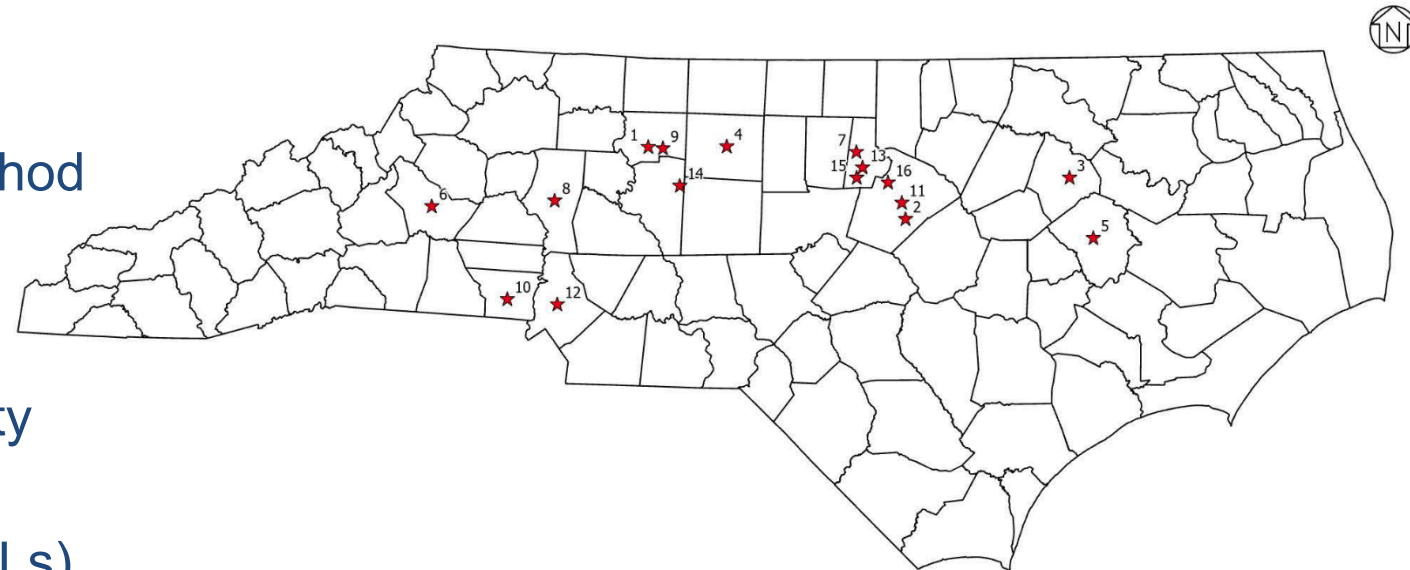
- Previous remediation activities
- No clear upgradient well
- Potential regional PFAS impacts associated with Chemours facility
- Septic systems

# Groundwater Sampling – Study Design

- 14 sites
- 1 upgradient well and 1 source well
- Quality assurance/quality control (QA/QC) samples indicated no significant concerns
- Environmental Protection Agency (EPA) Method 1633A analysis
- Concentrations compared to:
  - 15A NCAC 2L .0202 Groundwater Quality Standards (NC 2L Standards)\*
  - EPA Maximum Contaminant Levels (MCLs)
  - Background (upgradient) concentrations

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★ Pilot Study Groundwater Sampling Site



\* = NC 2L Standards for perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) are 0.001 and 0.7 nanograms per liter (ng/L) or parts per trillion (ppt), respectively, but current standard is equivalent to EPA Practical Quantitation Limit (PQL) of 4 ng/L.



## *Groundwater Sampling Conclusions – Site Categories*

Sites categorized with respect to evidence of PFAS impacts from dry-cleaning operations:

**Little Evidence**

Upgradient well concentrations higher than or similar to source well

**Moderate Evidence**

Source well concentrations higher than upgradient well by less than order of magnitude for most constituents

**Strong Evidence**

Source well concentrations higher than upgradient well by more than order of magnitude for multiple constituents

**Inconclusive Evidence**

Variability in higher concentrations between source and upgradient wells

# Groundwater Sampling Conclusions – Site Categories

Location	Long-Chain						Short-Chain						Precursors			Total PFAS	
	PFOA	PFOS	PFHxS	PFHpS	PFNA	PFDA	PFBA	PFBS	PFPeA	PFPeS	PFHxA	PFHpA	PFOSA	NEtFOSAA	NMeFOSAA		6:2 FTS
2L Standard	4	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA MCL	4	4	10	NS	10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>Little Evidence</b>																	
DC320014																	
Upgradient	<u>15</u>	<u>10</u>	3.2	<1.5	3.6	<1.5	9.1	15	19	0.81 J	15	8.6	<1.5	<1.5	<1.5	<3.0	99
Source	<u>14</u>	<u>8.2</u>	1.8	<1.8	2.2	<1.8	4.5	6.3	6.3	<1.8	6.5	6.0	<1.8	<1.8	<1.8	<3.6	56
DC490007																	
Upgradient	1.7	<1.5	3.3	<1.5	<1.5	<1.5	3.2	3.1	5.5	1.4 J	5.3	1.4 J	<1.5	<1.5	<1.5	<3.0	24.9
Source	<1.5	<1.5	1.6	<1.5	<1.5	<1.5	1.0 J	0.96 J	2.1	<1.5	1.7	<1.5	<1.5	<1.5	<1.5	<3.1	7.4
DC290002																	
Upgradient	<u>34</u>	<u>32</u>	5.9	0.72 J	3.2	0.50 J	8.8	19	13	0.88 J	11	9.4	<1.6	<1.6	<1.6	<3.2	138
Source	<u>6.5</u>	<u>5.8</u>	1.9	<1.6	0.48 J	<1.6	1.6 J	1.2 J	2.9	0.57 J	3.1	1.5 J	<1.6	<1.6	<1.6	<3.1	25.55
DC340039																	
Upgradient	2.3	<1.2	1.7	<1.7	<1.7	<1.7	1.6 J	1.2 J	1.9	<1.7	2.2	0.90 J	<1.7	<1.7	<1.7	<3.3	11.8
Source	2.5	2.2	1.9	<1.7	<1.7	<1.7	1.8 J	1.2 J	1.6 J	<1.7	1.9	1.1 J	<1.7	<1.7	<1.7	<3.3	14.2
DC920056																	
Upgradient	<u>4.4</u>	<1.7	7.3	<1.7	<1.7	<1.7	6.2	22	3.0	5.6	3.3	1.7	<1.7	<1.7	<1.7	<3.3	54
Source	<u>4.1</u>	<1.8	9.8	<1.8	<1.8	<1.8	3.2 J	5.0	4.0	<1.8	4.4	3.0	<1.8	<1.8	<1.8	<3.5	33.5

**Little Evidence  
5 Sites**

**Exceeds EPA MCL**

Exceeds NC 2L Standard

Upgradient ≥ Source

Source > Upgradient by less than order of magnitude

Source > Upgradient by order of magnitude or more

Notes:  
 Concentrations in ng/L or ppt  
 J = estimated concentration  
 \* = NC 2L Standards shown for PFOS and PFOA is equivalent to current EPA PQL



# Groundwater Sampling Conclusions – Site Categories

Location	Long-Chain						Short-Chain						Precursors			Total PFAS	
	PFOA	PFOS	PFHxS	PFHpS	PFNA	PFDA	PFBA	PFBS	PFPeA	PFPeS	PFHxA	PFHpA	PFOSA	NEtFOSAA	NMeFOSAA		6:2 FTS
2L Standard	4	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA MCL	4	4	10	NS	10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>Moderate Evidence</b>																	
DC340005																	
Upgradient	<u>6.5</u>	<u>14</u>	6.4	0.50 J	0.57 J	<1.6	1.6 J	6.2	1.7	1.4 J	2.8	1.8	<1.6	<1.6	<1.6	<3.1	43
Source	<u>14</u>	<u>21</u>	4.3	0.67 J	<1.5	<1.5	5.6	13	9.9	1.5	7.0	5.3	<1.5	<1.5	<1.5	<3.0	82
DC410009																	
Upgradient	<u>13</u>	<u>16</u>	5.5	<1.8	<1.6	<1.8	3.9	2.8	4.1	<1.8	5.5	5.6	<1.8	<1.8	<1.8	<3.6	56
Source	<u>73</u>	<u>140</u>	11	3.2	8.4	4.1	16	6.1	26	2.6	28	19	<1.8	<1.8	<1.8	<3.5	340
DC600093																	
Upgradient	<u>7.3</u>	3.0	6.1	<2.0	<2.0	<2.0	3.4 J	5.9	11	1.2 J	9.6	2.5	<2.0	<2.0	<2.0	<3.9	50
Source	<u>31</u>	<u>16</u>	7.9	<1.7	0.98 J	<1.7	7.4	9.5	21	<1.7	18	9.6	<1.7	<1.7	<1.7	<3.4	121

Notes:  
 Concentrations in ng/L or ppt  
 J = estimated concentration  
 \* = NC 2L Standards shown for PFOS and PFOA is equivalent to current EPA PQL

**Moderate Evidence**  
**3 Sites**

**Exceeds EPA MCL**

Exceeds NC 2L Standard

Upgradient ≥ Source

Source > Upgradient by less than order of magnitude

Source > Upgradient by order of magnitude or more



# Groundwater Sampling Conclusions – Site Categories

Location	Long-Chain						Short-Chain						Precursors			Total PFAS	
	PFOA	PFOS	PFHxS	PFHpS	PFNA	PFDA	PFBA	PFBS	PFPeA	PFPeS	PFHxA	PFHpA	PFOSA	NEtFOSAA	NMeFOSAA		6:2 FTS
2L Standard	4	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA MCL	4	4	10	NS	10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>Strong Evidence</b>																	
DC120001																	
Upgradient	<1.0	2.8	<1.4	<1.4	<0.43	<1.4	1.2 J	<1.4	<1.4	<1.4	<0.52	<1.4	<1.4	<1.4	<1.4	<2.9	4.5
Source	<b>86</b>	<b>47</b>	<b>14</b>	10	2.8	<1.5	9.8	6.4	44	3.7	24	9.1	<1.5	<1.5	<1.5	<3.0	257
DC360006																	
Upgradient	2.5	<1.6	3.7	<1.6	<1.6	<1.6	3.3	<1.6	3.4	<1.6	3.4	5.5	<1.6	<1.6	<1.6	<3.1	21.8
Source	<b>33</b>	<1.7	9.1	<1.7	<1.7	<1.7	140	280	710	2.9	390	83	<1.7	<1.7	<1.7	<3.3	1650
DC320038																	
Upgradient	<b>7.8</b>	<b>12</b>	1.5 J	<1.7	1.1 J	<1.7	17	6.5	26	<1.7	29	4.3	<1.7	<1.7	<1.7	<3.4	105
Source	<b>150</b>	<b>87</b>	9.7	2.1	<b>21</b>	2.9	140	26	100	3.2	93	61	<1.7	<1.7	<1.7	<3.3	700
DC920051																	
Upgradient	1.9	<1.7	4.5	<1.7	<1.7	<1.7	3.6	13	5.8	<1.7	6.2	5.4	<1.7	<1.7	<1.7	<3.5	40
Source	<b>110</b>	<b>6.3</b>	<b>17</b>	1.6 J	1.5 J	<1.7	35	44	96	2.0	82	89	<1.7	<1.7	<1.7	<3.4	480

Notes:

Concentrations in ng/L or ppt

J = estimated concentration

\* = NC 2L Standards shown for PFOS and PFOA is equivalent to current EPA PQL

**Strong Evidence**  
**4 Sites**

**Exceeds EPA MCL**

Exceeds NC 2L Standard

Upgradient ≥ Source

Source > Upgradient by less than order of magnitude

Source > Upgradient by order of magnitude or more

# Groundwater Sampling Conclusions – Site Categories

Location	Long-Chain						Short-Chain						Precursors			Total PFAS	
	PFOA	PFOS	PFHxS	PFHpS	PFNA	PFDA	PFBA	PFBS	PFPeA	PFPeS	PFHxA	PFHpA	PFOSA	NEtFOSAA	NMeFOSAA		6:2 FTS
2L Standard	4	4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
EPA MCL	4	4	10	NS	10	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>Inconclusive Evidence</b>																	
DC330005																	
Upgradient	<b>320</b>	<b>110</b>	<b>170</b>	7.2	4.1	<1.8	44	29	76	30	120	82	<1.8	<1.8	<1.8	5.1	1000
Source	<b>270</b>	<b>550</b>	<b>25</b>	6.1	<b>26</b>	8.0	38	10	47	6.0	62	78	8.6	9.9	13	<3.5	1160
DC740014																	
Upgradient	<b>15</b>	<b>76</b>	<b>40</b>	<1.2	<b>&lt;0.51</b>	<1.7	<3.4	3.2	9.1	1.5 J	10	5.8	<1.7	<1.7	<1.7	<3.4	161
Source	<b>45</b>	<b>24</b>	5.9	2.0	<b>5.1</b>	<1.6	2.5 J	1.7	11	1.2 J	10	13	<1.6	<1.6	<1.6	<3.2	121

Notes:  
 Concentrations in ng/L or ppt  
 J = estimated concentration  
 \* = NC 2L Standards shown for PFOS and PFOA is equivalent to current EPA PQL

**Inconclusive Evidence**  
**2 Sites**

**Exceeds EPA MCL**

Exceeds NC 2L Standard

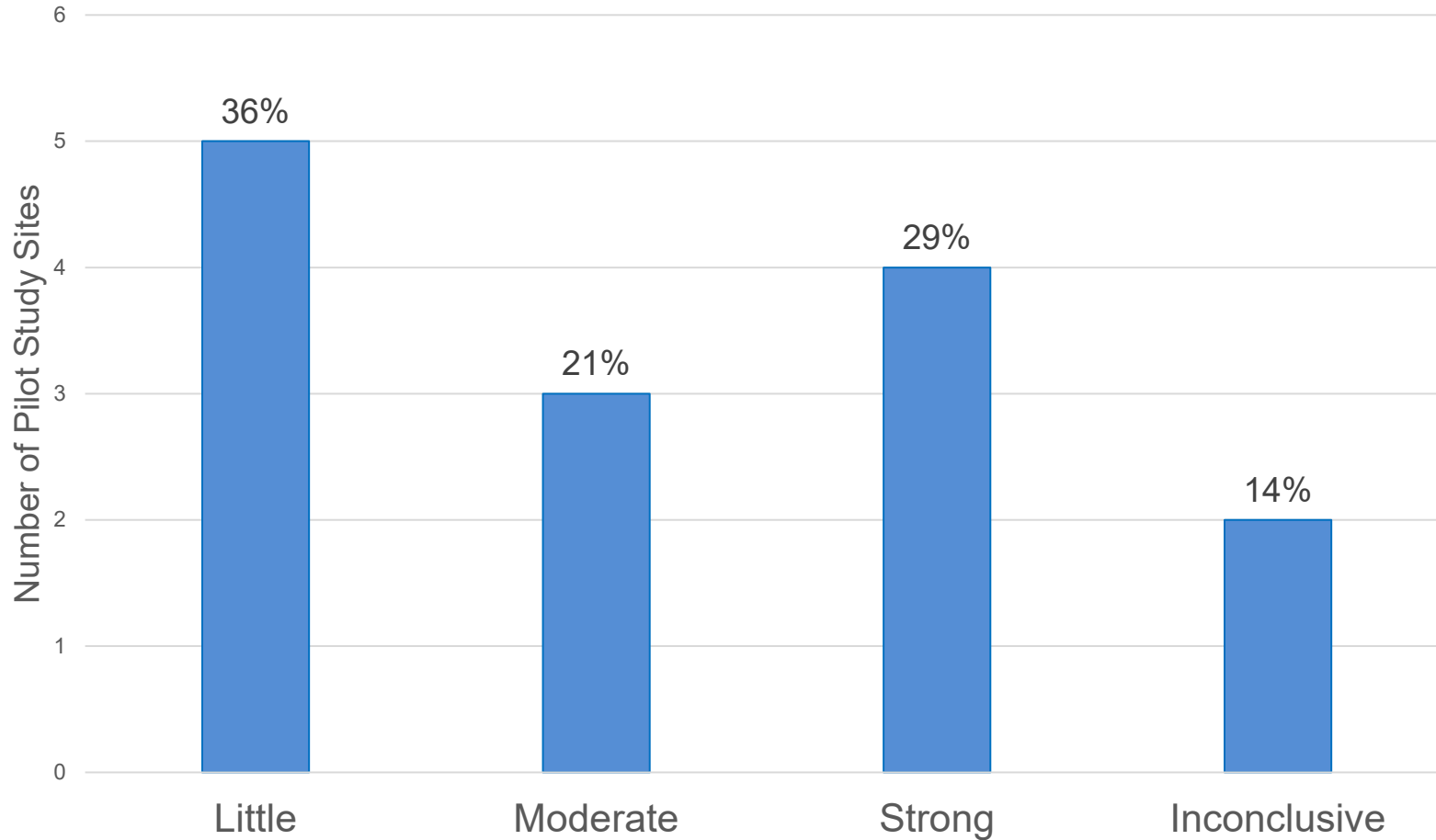
Upgradient ≥ Source

Source > Upgradient by less than order of magnitude

Source > Upgradient by order of magnitude or more



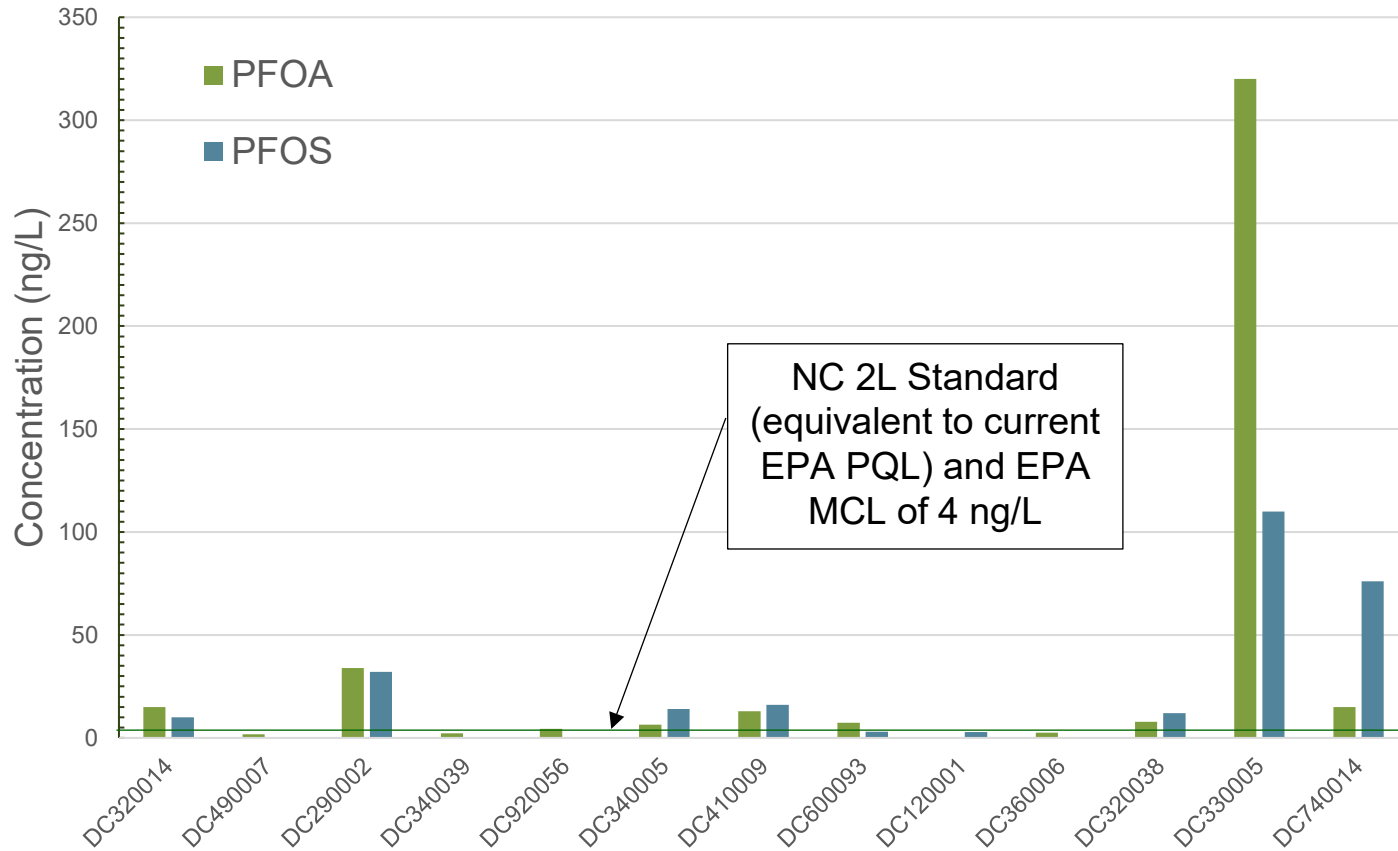
# Groundwater Sampling Conclusions – Site Categories



50% of sites indicated moderate or strong evidence of PFAS impacts from dry-cleaning operations.

# Groundwater Sampling Conclusions – Upgradient Sources

Upgradient Well Concentrations



Detectable PFOS and/or PFOA in every upgradient well.

Concentrations exceed 2L Standard (EPA PQL) and EPA MCL at 69% of sites.

# Groundwater Sampling Conclusions – Key COCs

Source well detections at moderate and strong evidence sites:

Category	Constituent	Frequency of Detection		
		>Lab PQL	>Lab PQL & >Background	>Lab PQL & ≥10 x Background
Long-chain	PFOA	100%	100%	57%
Short-chain	PFPeA	100%	100%	43%
Short-chain	PFHxA	100%	100%	43%
Short-chain	PFHpA	100%	100%	43%
Short-chain	PFBA	100%	100%	14%
Short-chain	PFBS	100%	100%	14%
Long-chain	PFHxS	100%	86%	14%
Long-chain	PFOS	86%	86%	14%
Long-chain	PFNA	43%	43%	14%
Short-chain	PFPeS	86%	86%	0%
Long-chain	PFHpS	43%	43%	0%
Long-chain	PFDA	29%	29%	0%

**PFOA most frequently detected compound at concentrations ≥ 10x background**

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Site	PFAS at Highest Concentration in Source Well (ng/L)	
	PFAS	Concentration
DC340005	PFOS	21
DC410009	PFOS	140
DC600093	PFOA	31
DC120001	PFOA	86
DC360006	PFPeA	710
DC320038	PFOA	150
DC920051	PFOA	110

Concentrations in ng/L or ppt

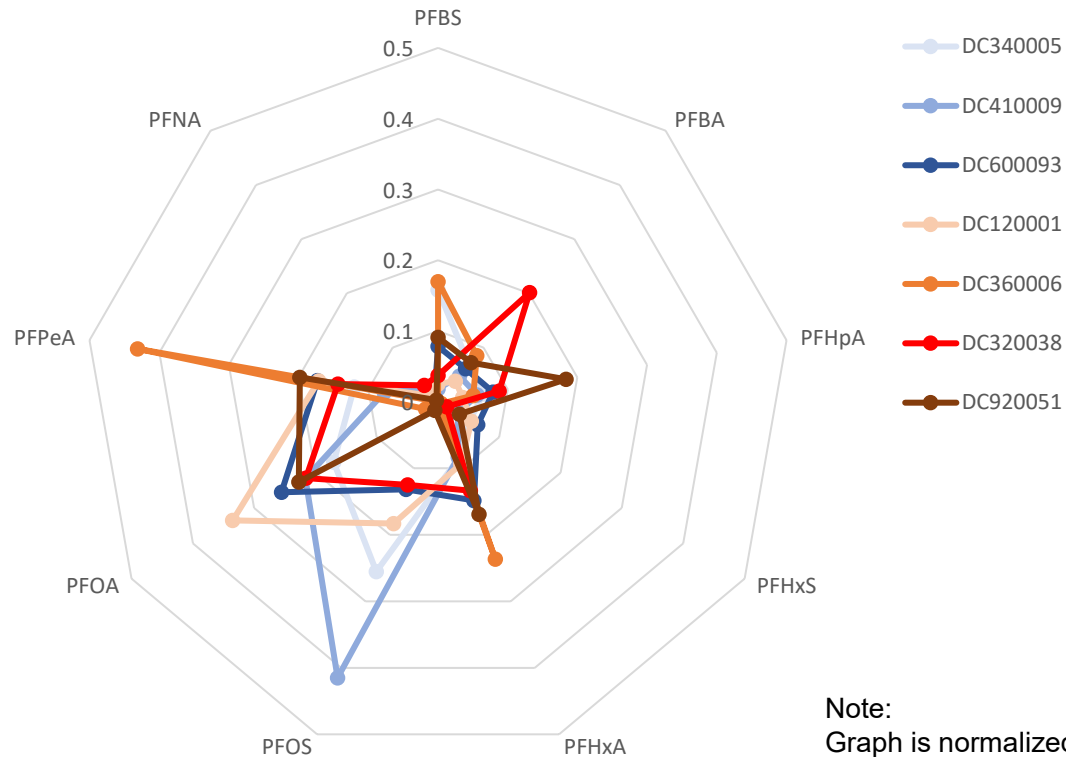
**Either PFOS or PFOA represent highest concentration at every site but one**

PFOS and/or PFOA are key COCs for most dry-cleaning sites.



# Groundwater Sampling Conclusions – PFAS Groundwater Signatures

**Normalized Radar Graph**  
Source Monitoring Wells - Moderate and Strong Evidence Sites



Note:  
Graph is normalized to show the percentage contribution of select PFAS constituents scaled such that the total for all constituents equals one.

- Notable percentages of PFOS and PFOA
- Variable percentages of other PFAS
- No detectable PFAS precursors via EPA 1633 analysis

No specific signature for PFAS at dry-cleaners is apparent based on the pilot study results, other than the predominance of PFOS and/or PFOA. Trends may emerge as additional data are collected.





# Groundwater Sampling Conclusions – Concentrations Relative to Other Sources

Groundwater Concentration Source	PFOS	PFOA
NC Study	ND to 550	ND to 270
FDEP Study	40.1 to 3,480	50.9 to 2,640
Published mean for primary-source sites (fire training areas and manufacturing plants)*	93,000	64,000
Published mean for secondary-source sites (biosolids application, treated wastewater use, and landfills)*	42	325
Published mean for no-known source sites (sites with no confirmed nearby PFAS source)*	46	13

Notes:  
 ND = Not detected above method detection limit.  
 Concentrations in ng/L or ppt.  
 Johnson, et al, 2022.

Dry-cleaners represent a less significant source of PFAS in the environment in comparison to primary-source sites (fire training areas and manufacturing plants).



## *Groundwater Sampling Conclusions – Type of Operations*

Little evidence of PFAS impacts due to dry-cleaning operations at distribution facility where no active dry-cleaning or waste solvent storage on-site



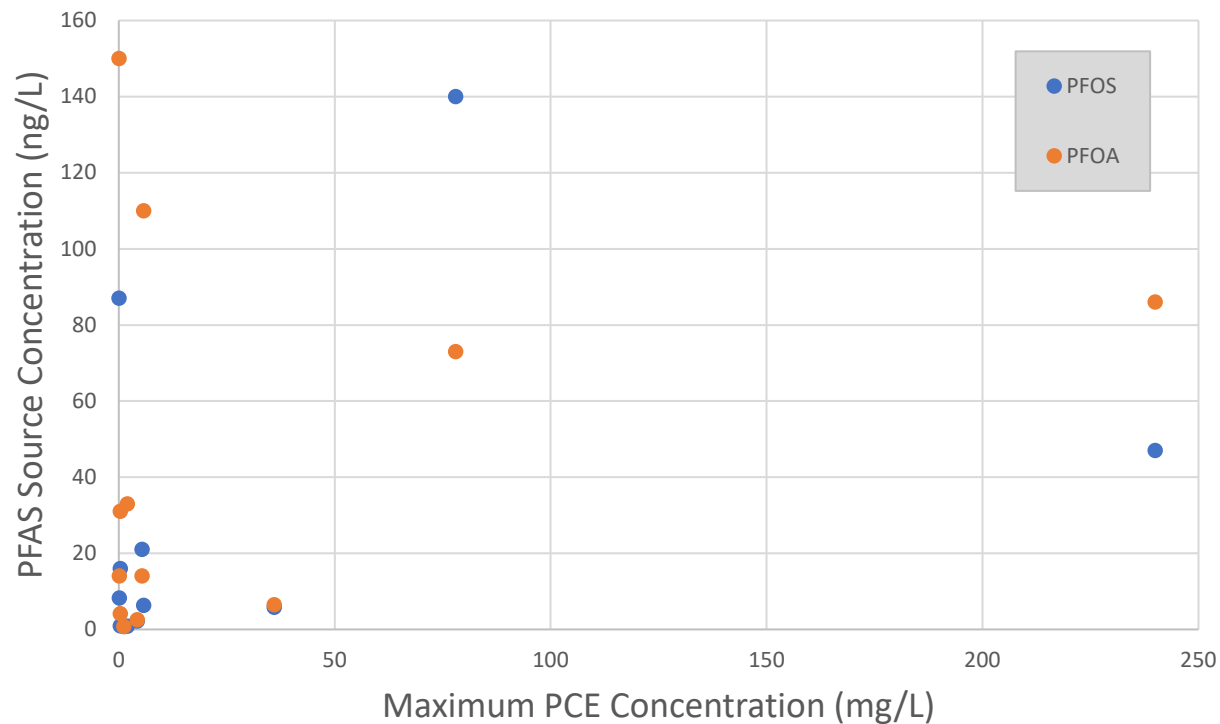
PFAS concerns lower for distribution facilities where no active dry-cleaning performed.

Little evidence of PFAS impacts due to dry-cleaning operations at two sites that operated prior to 1960s



PFAS concerns lower for dry-cleaners that operated before the mid to late 1960s.

# Groundwater Sampling Conclusions – PCE Concentrations & Years Operating



PCE concentrations in groundwater are not good predictors of PFAS impacts.

# Process Sampling



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## *Process Sampling – Study Design*

- Virgin solvent
- Used solvent
- Raw water source
- Post-wet wash water
- Pre-carbon mister contact water
- Post-carbon mister contact water
- Detergents
- Spotting agents
- Additives



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## *Process Sampling – Study Design*



- Process samples collected at 5 sites
- Many product containers opened by dry-cleaner prior to sampling
- Unopened PCE solvent and several spotting agents purchased directly from FabriClean Supply
- EPA Method 537 Analysis

## *Process Sampling – Study Design*

- Samples were primarily commercial products or heavily impacted waste materials
- Samples were diluted by laboratory to protect equipment
- Some non-detects may reflect higher detection limits, not absence of PFAS
- Data include frequent lab flags



Process sample concentrations should be considered approximate estimates and less precise than groundwater sample concentrations.

# Process Sampling Conclusions – Solvent Samples

PFAS COC		Virgin dry-cleaning solvent samples		Used dry-cleaning solvent samples	
		DC290002-VS	DC-VS	DC340005-SS	DC320021 - SS
Long-Chain	PFOA	<1000	<970	25,000	4,900
	PFOS	<1000	<970	1,500	11,000
	PFHxS	<1000	<970	<980	980 J
	PFNA	<1000	<970	1,000	470 J
	PFDA	<1000	<970	5,100	2,000
	PFDS	<1000	<970	<980	450 J
	PFDoA	<1000	<970	2,100	970 J
	PFTeDA	<1000	<970	710 J	370 J
	PFUnA	<1000	<970	370 J	<1000
Short-Chain	HFPO-DA	<1500	<1500	<1500	<1500
	PFBA	<2500	<2400	16,000	2,000 J
	PFBS	<1000	<970	1,800	440 J
	PFPeA	<1000	<970	6,700	500 J
	PFHxA	<1000	<970	57,000	4,700
	PFHpA	<1000	<970	3,100	550 J
Pre-cursors	NEtFOSE	<1500	<1500	23,000	82,000
	NEtFOSAA	<1500	<1500	370 J	350 J
	NMeFOSE	<1500	<1500	12,000	57,000
	8:2 FTS	<1500	<1500	6,100	25,000

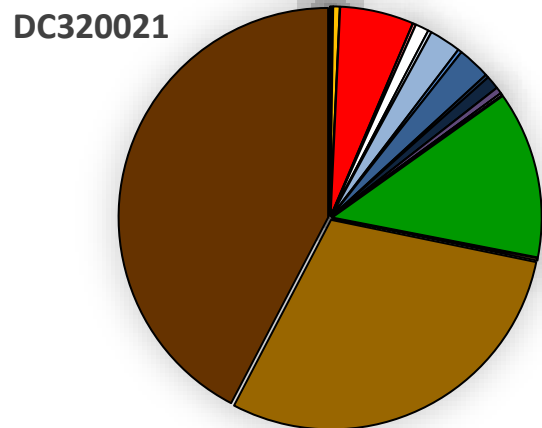
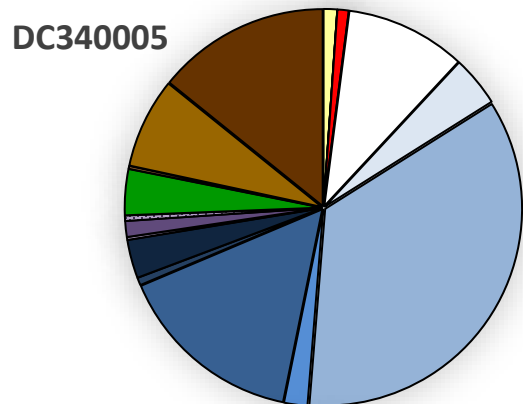
- Virgin PCE and petroleum solvent (DF-2000) samples showed no detectable PFAS
- Significantly elevated PFAS in used PCE solvent samples

PFAS are likely present in used solvents due to leaching from clothing during the cleaning process, but PFAS are not significant constituents of typical chlorinated and petroleum-based dry-cleaning solvents themselves.

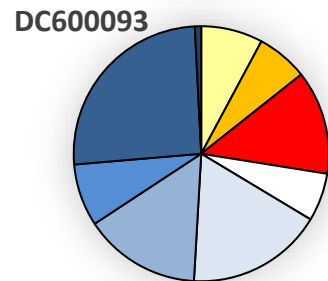
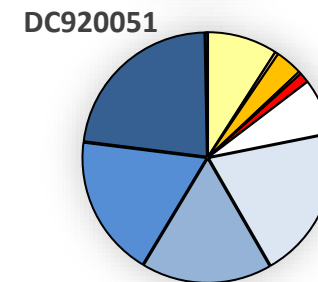
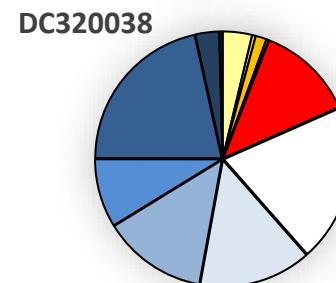
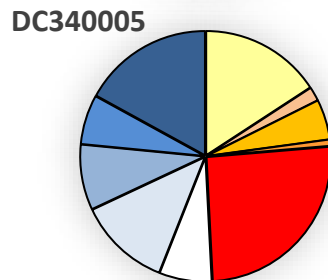
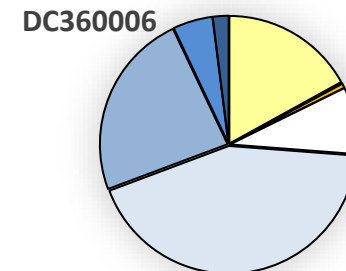
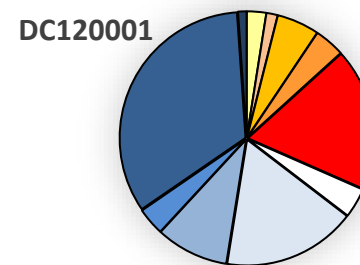
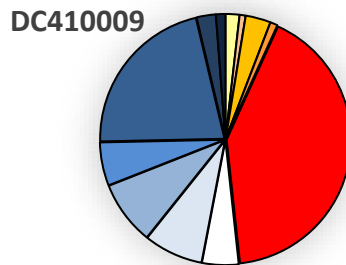
Notes:  
Concentrations in ng/L or ppt  
J = estimated concentration

# Process Sampling Conclusions – PFAS Used Solvent Signatures

## Used Solvent Samples



## Groundwater Samples (Moderate and Strong)



- More precursors (green and brown) in used solvent samples
- Precursors may transform into PFOS, PFOA, and other terminal PFAS in the environment

# Process Sampling Conclusions – Wet Wash Samples

NC and FDEP Wet Wash Effluent and Used Solvent Sampling Data

	PFOS	PFOA
Wet Wash Effluent		
NC Study	<250	<500
FL Study	2.36-279	2.1-103.16
Spent Solvent		
NC Study	1,500-11,000	4,900-25,000
FDEP Study	16,597-18,549	2,812-20,559

**Notes:**

Concentrations in ng/L or ppt

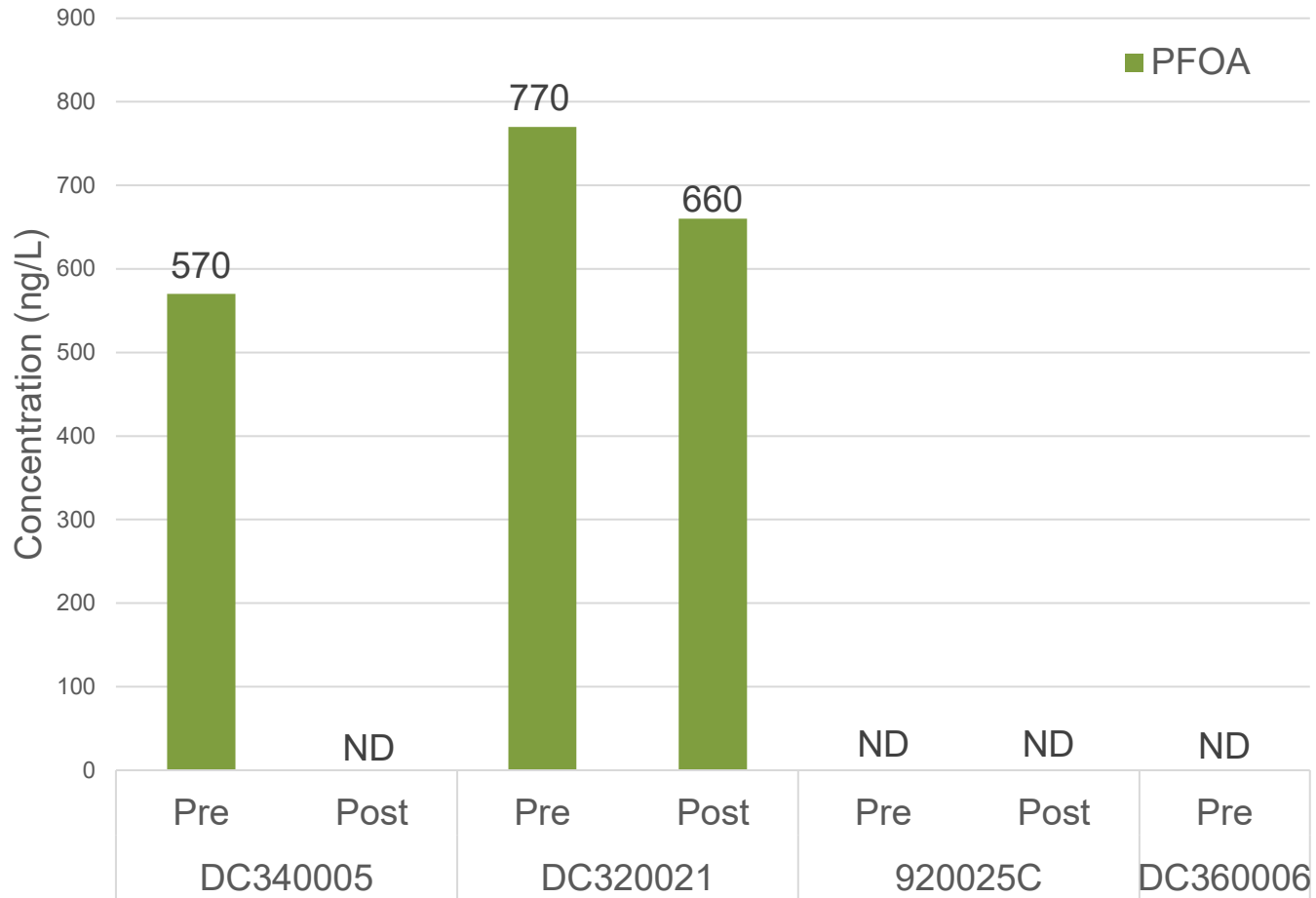
'<' = Indicates approximate method detection limit (range from 240-250 ng/L for PFOA and 480-490 ng/L for PFOS)

Only includes used PCE solvent liquid samples from FDEP study.

- No PFAS detected in wet wash effluent during NC Study, but elevated detection limits
- Some PFAS detected in wet wash effluent during FDEP Study, but orders of magnitude below typical used solvent concentrations

Dry-cleaning operations are likely the more significant contributor to PFAS impacts at dry-cleaning sites as opposed to wet wash operations.

# Process Sampling Conclusions – Mister Contact Water Samples



- Some estimated PFAS concentrations detected in contact water associated with facility misters
- Additional sampling and evaluation of mister carbon changeout dates warranted prior to making significant conclusion

# Process Sampling Conclusions – Spotting Agent, Detergent, & Additive Samples

Constituent	Spotting agent D	
	Open Container	New Container
PFOA	1,800,000	<9500
PFNA	57,000	<9500
PFDA	300,000	<9500
PFDoA	120,000	<9500
PFTeDA	42,000	<9500
PFTTrDA	4,000	<9500
PFUnA	15,000	<9500
PFBA	210,000	<24000
PFPeA	82,000	<9500
PFHxA	650,000	<9500
PFHpA	110,000	<9500
8:2 FTS	540 J	<14000
7:3 FTCA	60,000	<9500
5:3 FTCA	1,700	<9500
3:3 FTCA	200 J	<9500

Constituent	Detergent A	
	Open Container	New Container
PFOA	17,000	<9700
PFNA	1,500	<9700
PFDA	10,000	<9700
PFDoA	4,800	<9700
PFTeDA	1,500	<9700
HFPO-DA	1,200 J	<15000
PFHxA	33,000	<9700
PFHpA	1,500	<9700

- Elevated PFAS in previously opened containers
- No detectable PFAS in unopened containers
- Representativeness of samples from previously opened containers is uncertain
- Products are typically used in relatively small quantities and therefore represent a lower-magnitude potential PFAS source compared to used dry-cleaning solvents



Notes:  
 Data only shown for samples with most notable PFAS detections.  
 Concentrations in ng/L or ppt  
 J = estimated concentration

## *PFAS and the DSCA Program – Next Steps*



*Department of Environmental Quality*

- DSCA Program will use the pilot study data to guide development of a plan for management of PFAS at NC dry-cleaning sites
- Expect to focus on receptor protection
- More to come!





Questions?

*Dry-Cleaning Solvent Cleanup Act  
Division of Waste Management  
Department of Environmental Quality*

