



**Occurrence of Perfluorinated Chemicals
in Untreated New Jersey Drinking Water Sources**

Final Report

New Jersey Department of Environmental Protection
Division of Water Supply & Geoscience

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This report and all associated data will be maintained on file at the Bureau of Safe Drinking Water for a minimum of 10 years.

I. Introduction

Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been previously detected at low levels in New Jersey public water supplies. PFOA and PFOS are members of a group of organic compounds known as perfluorinated chemicals (PFCs). PFCs are widely used in industry as polymers, surfactants, and lubricants, and in consumer products as textile coatings, water and stain repellents, food packaging, and fire fighting foam. PFCs are persistent in the environment and are soluble in water.

In 2006, the New Jersey Department of Environmental Protection (Department) conducted a study of New Jersey water systems to determine the occurrence of PFOA and PFOS in wells and surface waters that are sources of drinking water. Sites selected included those near facilities where PFOA may have been used, handled, stored and/or manufactured, as well as facilities where previously collected data indicated the presence of a large number of tentatively identified compounds. The study showed that PFOA and PFOS were detected at low levels in 78% and 57%, respectively, of the water systems sampled. A summary of the results of the 2006 study is presented in a final report dated January 2007 available on the Department's website at: http://www.state.nj.us/dep/watersupply/final_pfoa_report.pdf

In 2007, the Department issued a health-based guidance level of 0.04 parts per billion (ppb) for PFOA. The guidance level was developed to provide protection from chronic or long-term exposure that might occur over an entire lifetime. In order to develop the guidance level, the Department used a risk assessment approach to evaluate the health effects associated with exposure. Detailed information regarding the basis for the guidance level is available on the Department's website at: http://www.state.nj.us/dep/watersupply/pfoa_dwguidance.pdf. Additional information about PFOA in drinking water and the basis for the New Jersey PFOA guidance level are found in Post et al. (2009). At present, the Department has not set guidance levels for PFOS or any other PFCs as additional evaluation of the health effects of these compounds is necessary.

Based on the detection of PFOA and PFOS in drinking water systems in the 2006 study, the Department recommended that those water systems with detections conduct additional monitoring to further determine the occurrence of PFOA and PFOS. Several water systems continue to conduct quarterly sampling and, in some cases, have taken steps to reduce the levels of PFOA in their drinking water.

In order to gain further knowledge on the occurrence of PFOA and other PFCs throughout New Jersey in drinking water sources, the Department initiated a second occurrence study in 2009 and early 2010 – the “2009 Study” – which is described in this report. Thirty-three raw water samples were collected from 31 public water system in 20 of the 21 counties in New Jersey, and are the focus of this report

Note that in November 2010 the Department collected three additional samples from the one community water system where the raw water sample exceeded the health-based guidance level. These samples and results are present in Appendix A of this 2009 Study, and are not discussed in the body of this report. Additional information about PFCs in drinking water and the results of the Department's 2009 study are found in Post et al. (2013a, 2013b). Post et al. (2013a, 2013b)

does not include data from two small noncommunity water systems and one very small community water system (serves 90 residents) that were sampled as part of this 2009 study.

II. Project Description

This occurrence study for PFOA and other PFCs, called the “2009 Study,” was designed to supplement the findings of the 2006 study. The main question the 2009 study was designed to answer is whether PFOA, PFOS and other PFCs occur in drinking water sources throughout New Jersey, or only in the targeted areas of the state that were sampled as part of the 2006 study. The 2009 study included analysis for ten PFCs, including PFOA and PFOS.

Sample sites in the 2009 study were located in 20 of 21 counties in New Jersey, unlike the 2006 study sample sites that were selected based on where the detection of PFOA was most expected. The 2009 study included 33 source water samples from 31 different public water systems, from both surface water and ground water sources.

Since the objective of the 2009 study was to determine the occurrence of PFCs in drinking water sources throughout New Jersey, the 2009 study included only *untreated* water samples, in contrast to the 2006 study which included samples from both raw (untreated) and treated water sources. PFCs are removed from drinking water by granular activated carbon and reverse osmosis (Rahman et al., 2014), while the standard treatment processes used at the sites included in the 2006 and 2009 studies do not effectively remove PFCs. Data on PFCs in raw and finished water from several sites included in the 2006 and 2009 studies confirms that PFC concentrations are generally not decreased in the finished water (Post et al., 2009, Post et al., 2013b). The presence or absence of PFCs helps further our understanding about the distribution of PFCs throughout the state. In this 2009 study, as in the 2006 study, the Department requested that all water systems with detections of PFCs sample the treated water, on a quarterly basis, for one year to determine the extent that PFCs are present in the *treated* drinking water.

In addition, to better understand treatment options available for the removal of unregulated organic contaminants, the Department is studying the effectiveness of granular activated carbon (GAC) removal technology in removing unregulated contaminants, including PFOA and PFOS, in pilot studies at two water systems that use groundwater: Fair Lawn Water Department (Bergen County) and Merchantville-Pennsauken Water Commission (Camden County). These pilot studies are currently ongoing.

In addition, the Department participated in a Water Research Foundation (Denver, Colorado) funded study of the occurrence and concentration of PFCs and precursors in raw and finished water supplies nationwide, in order to identify the primary physical and chemical processes that govern the fate of PFCs (WaterRF Project # 4322, report not yet final). The Department intends to use the monitoring and operational information gained from each of these studies to further study feasibility and effectiveness of using a treatment technology for removing PFCs.

III. Sampling Plan

A sampling plan was developed to identify appropriate locations for sample collection. The main objective of sample site selection was to select sites throughout all of New Jersey that serve as sources of drinking water. Therefore, at least one sampling location was selected in each of 21 counties except Hudson County, as all water served to residents in that county is purchased from sources outside the county. The second objective was to gather samples primarily from surface waters and unconfined or semi-confined ground water wells with a high yield, as the prior study indicated PFOA occurred in surface waters and all but confined ground waters. However, one sample site was selected to represent a confined well as part of this study, and one sample site, presumed to be unconfined, was later determined to be confined. In addition, in this study no samples were collected from the public water systems included or referenced in the initial 2006 occurrence study.

PFOA, PFOS and an additional eight PFCs were analyzed in this study. The eight additional PFCs were included in the analysis since improvements to the analytical capabilities allowed for the additional PFCs to be quantified at minimal additional cost.

The sample collection process followed the protocol established for the original 2006 study. Thirty-three (33) drinking water samples and ten blanks, for a total of 43 samples, were collected between July 2009 and February 2010. All samples were analyzed by MWH Laboratories (MWH) in Monrovia, California and the results were transmitted to the Department electronically. The Department reviewed and evaluated the data presented in this report.

The complete list of sampling locations is presented as **Table 1**. These locations are illustrated on the map provided as **Figure 1**.

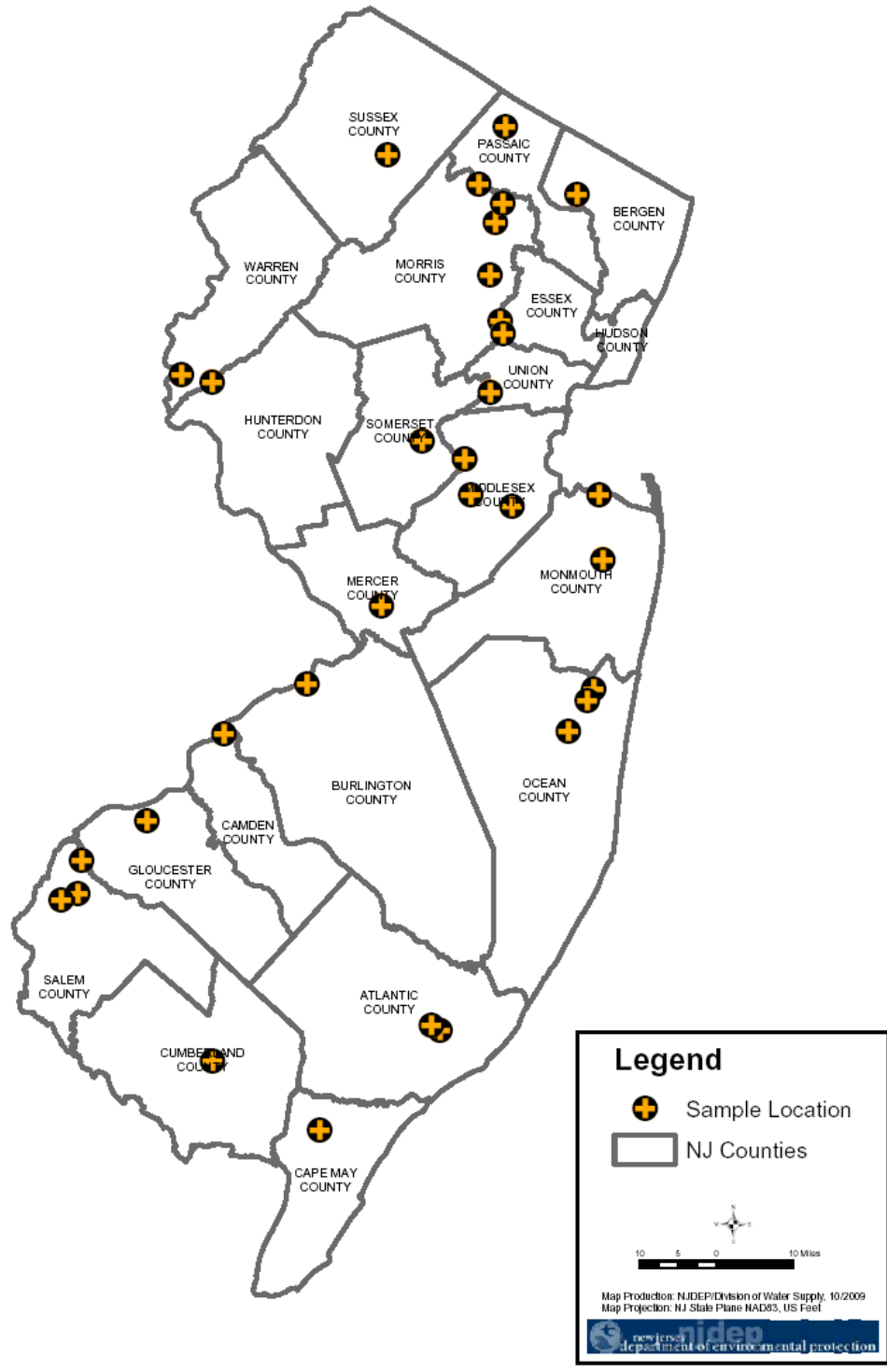
Table 1: Sampling Locations for Perfluorinated Chemicals - 2009 Study¹

PWSID	Water System Name	County	Water Source Type	Source Name	SDWIS Source ID	Depth (ft)
0102001	Atlantic City MUA	Atlantic	Surface Water	Doughty Pond	IN001017	NA
0102001	Atlantic City MUA	Atlantic	Surface Water	Kuehnle Pond	IN001018	NA
0251001	Ridgewood Water Department	Bergen	Unconfined well	Ames Well 3	WL010031	350
0305001	Burlington City Water Department	Burlington	Surface Water	Delaware River - Intake 3	IN001004	NA
0408001	Camden City Water Department	Camden	Unconfined or semi confined wells	Morris/Delair TP (combined raw tap)	NA combined	several wells depths 117–144 ft
0516001	Woodbine MUA	Cape May	Unconfined well	Well 6	WL001005	223
0610001	Millville Water Department	Cumberland	Unconfined well	Well 1 - Airport Rd.	WL002007	181
0705001	East Orange Water Commission	* System in Essex Co.; Well in Morris Co.	Unconfined well	Well B-2	WL001004	130
0712001	New Jersey American - Short Hills	Essex	Surface Water	Passaic River	IN001006	NA
0714001	Newark Water Department	Essex	Surface Water	Pequannock Supply	IN003009	NA
0814001	Paulsboro Water Department	Gloucester	Unconfined well	Well 7 - Lodge Ave	WL003015	272
1003001	Bloomsbury Water Department	Hunterdon	Unconfined well	Well 2 - Lehigh Ave (Willow)	WL001006	300
1103001	Aqua NJ - Hamilton Square	Mercer	Unconfined well	Well 11 - Park Ave	WL001004	197 or 213
1214001	New Brunswick Water Department	Middlesex	Surface Water	Delaware & Raritan Canal - George St	IN001005	NA
1216001	Perth Amboy Water Department	Middlesex	Unconfined/GUI ²	Ranney Collector Well	WL001011	64
1225001	Middlesex Water Company	Middlesex	Surface Water	Delaware & Raritan Canal	IN001002	NA
1321001	Keansburg Water & Sewer Department	Monmouth	Confined Well	Well 5	WL001005	350
1345001	NJ American - Coastal, Northern System	Monmouth	Surface Water	Swimming River Reservoir/Colts Neck	IN001004	NA
1401001	Boonton Water Department	Morris	Surface Water	Taylortown Reservoir	IN001004	NA
1403001	Butler Water Department	Morris	Surface Water	Kikeout Reservoir	IN001003	NA
1424001	Southeast Morris County MUA	Morris	Unconfined well	Wing Well	WL010025	136
1429001	Parsippany-Troy Hills Water Department	Morris	Unconfined well	Well 21	WL034082	95
1506001	Brick Township MUA ³	Ocean	Surface Water	Metedeconk River - Intake 2B	IN001017	NA
1507005	United Water Toms River	Ocean	Unconfined well	Well 29	WL007044	135
1514002	Lakewood MUA	Ocean	Unconfined wells	Shorrock St TP (combined raw tap)	NA combined	wells 8, 9, 10 depths 77 – 80 ft
1615001	West Milford MUA Birch Hill	Passaic	Unconfined well	Well 32 - Birch Hill	WL001008	303
1706305	Bondie & Son (Transient NC system)	Salem	Unconfined Well	Well 1	WL001001	unknown
1713001	Handy's Mobile Home Park / Westwood Villas	Salem	Confined Well	Well 1 Replacement (aka Well 3)	WL001008	187
1713308	Salem County Sportsmans Club	Salem	Unconfined Well	Well 1 - Replacement Well	WL001001	105
1918004	Sparta Township Water Utility - Lake Mohawk	Sussex	Unconfined wells	Germany Flats Wells C & D combined raw.	NA combined	144 & 154
2004002	New Jersey American - Elizabethtown	*System in Union Co; Intake in Somerset Co.	Surface Water	Raritan River	IN073332	NA
2004002	New Jersey American - Elizabethtown	Union	Unconfined wells	Netherwood TP (combined raw tap)	NA combined	several wells depths 300 – 500 ft
2102001	Alpha Municipal Water Works	Warren	Unconfined well	Well 3 - Frace St	WL003007	243

¹ Samples were collected in 20 of 21 New Jersey counties. No samples were taken from Hudson County sources since all water served to these residents is purchased from sources outside the county.

² GUI: Ground water under the direct influence of surface water

Figure 1: 2009 Perfluorinated Chemicals Sampling Locations



IV. Sample Collection and Laboratory Analysis

The contract laboratory (MWH Laboratories, Monrovia CA) provided polyethylene bottles with non-Teflon lined caps, consistent with the laboratory quotation and Standard Operating Procedure for this study. Upon arrival at the Department's Division of Water Supply & Geoscience located at 401 East State Street, Trenton, NJ, the bottles were secured in a controlled environment until used for sampling.

Between July 2009 and February 2010, grab samples were collected from each of the sampling locations listed in Table 1. These samples were obtained from raw water sample taps used by each water utility for other raw water sampling requirements under N.J.A.C. 7:10-1 *et seq.* All sampling procedures were in conformance with N.J.A.C. 7:18-1 *et seq.*, 40 C.F.R. 141 and the protocol previously established for the original 2006 study. Department personnel conducted all sampling. Samples were packed in coolers with ice upon collection and shipped overnight to the contract laboratory. In order to minimize the possibility of introducing PFCs into the samples from other sources, sampling personnel took special precautions during sampling including: avoiding fluoropolymers such as in pre-wrapped foods or snacks; did not use Post-it-Notes; wore clothing that had been washed at least six times; and used only containers supplied by the contract laboratory. These additional sampling precautions were consistent with those specified in the original study Quality Assurance Plan.

A total of ten field blanks were prepared in several locations throughout the State to ensure that PFCs were not being found as a result of background contamination. A field blank was prepared on each day that samples were collected and sent to MWH Laboratories for analysis. Field blank data were analyzed and evaluated with other sample results as an assessment of potential contamination. The final study resulted in the collection and analysis of 43 samples (33 drinking water samples and ten blanks).

All samples were analyzed for the presence of PFOA, PFOS, and eight additional PFCs using MWH Laboratories' Standard Operating Procedure (SOP) for "Determination of Perfluorinated Pollutants in Environmental Matrices by Online Solid-Phase Extraction coupled with High-Performance Liquid Chromatography/Mass Spectrometry in Tandem Analysis," SOP ID: HPLC 12, Revision 2.0 dated and signed July 11, 2008. This is a performance-based method developed by MWH and based on the best available technology for the analysis of PFCs. The method's low concentration method reporting limit (i.e. reporting limit) was 0.005 ppb. It was reviewed and approved by the Department's Office of Quality Assurance (OQA) prior to this study.

At the onset of the study, the United States Environmental Protection Agency's (EPA) new Method 537 (finalized September 2009) for the analysis of PFCs was not yet released. Therefore, no laboratories certified for Method 537 were available for this project. That said, the technology and the analytical protocols used by the MWH method for this project are equivalent to those of the newly released EPA method 537.

N.J.A.C. 7:18-1 *et seq.* and 40 C.F.R. 141 were followed for all quality assurance and quality control (QA/QC) practices, including precision and accuracy. All data were reported as acceptable by the laboratory, and ultimately all data were also reported as acceptable by the

OQA. As QA/QC questions with some of the analytical reports received from MWH Laboratories arose, the data from these reports were referred to the Department's OQA for evaluation. In each instance, the OQA verified the reported results as acceptable. Some analytical reports were re-issued to reflect revisions.

All but one of the field blanks contained no PFCs above the laboratory reporting level. One field blank contained 0.059 ppb of perfluoro-n-nonanoic acid (PFNA). However, none of the samples collected on that date with that field blank contained a reportable amount of PFNA.

As mentioned in Section III, three additional samples were collected outside the original sampling plan in November 2010. During the November 2010 sampling event, the same procedures above were followed.

V. Results and Discussion

The 33 drinking water samples and ten blanks collected for this study were analyzed for a total of 10 PFCs, including PFOA and PFOS. Only PFOA and PFOS were included in the prior Department 2006 occurrence study. The 10 PFCs that were analyzed as part of this study can be grouped into two classes of perfluorinated chemicals: perfluorocarboxylic acids [$\text{CF}_3(\text{CF}_2)_n\text{CO}_2\text{H}$] and perfluorosulfonic acids [$\text{CF}_3(\text{CF}_2)_n\text{SO}_3\text{H}$]. PFOA is a perfluorocarboxylic acid, and PFOS is a perfluorosulfonic acid. The 10 PFCs included in the analysis are listed below with their abbreviations, by classification and ascending carbon chain length order.

Table 2: Perfluorinated Chemicals Analyzed – 2009 Study

perfluorocarboxylic acids:

perfluorobutanoic acid (PFBA)
perfluoropentanoic acid (PFPeA)
perfluoro-n-hexanoic acid (PFHxA)
perfluoro-n-heptanoic acid (PFHpA)
perfluorooctanoic acid (PFOA)
perfluoro-n-nonanoic acid (PFNA)
perfluoro-n-decanoic acid (PFDA)

perfluorosulfonic acids:

perfluoro-1-butanedisulfonate (PFBS)
perfluoro-1-hexanedisulfonate (PFHxS)
perfluorooctane sulfonate (PFOS)

Eleven (11) of the 33 samples (33%) did not contain reportable levels of any of the 10 PFCs. Ten of these samples were from groundwater sources and one was from a surface water source. No PFCs were found in either of the confined groundwater well sampling locations.

PFCs were detected in 22 of 33 samples (67%). The PFC most often detected was PFOA, which was found in 18 of the 33 samples (55%). Of the 18 PFOA detections, more were detected in surface water (11) than in ground water (7). In four of those 18 samples, PFOA was the only

PFC detected. The detected PFOA concentrations ranged from 0.006 ppb to 0.10 ppb. Two of these detected values were greater than the Department's health-based guidance level of 0.04 ppb. One (0.057 ppb) was in a ground water sample, and one (0.10 ppb) was in a surface water sample.

After PFOA, the PFCs with the next highest frequencies of detections were PFOS, PFPeA, and PFNA. Each of these three PFCs was detected in 9 samples. However these three PFCs were not detected in the same nine samples. PFDA was the only PFC that was not detected above the reporting level in any of the 33 samples.

The occurrence of PFCs in each water system sample is shown in **Table 3**. The number of PFCs detected in each sample is presented in **Table 4**. The frequency of detections for each of the PFCs is shown in **Table 5**. **Figure 2** presents this information graphically.

Table 3: Occurrence of Perfluorinated Chemicals in Water Sources

PWSID	System Name	County	Water source type	PFOA ppb	PFOS ppb	PFBA ppb	PFPeA ppb	PFHxA ppb	PFHpA ppb	PFNA ppb	PFDA ppb	PFBS ppb	PFHxS ppb
0102001	Atlantic City - Doughty Pond	Atlantic	SW	0.032	0.025	ND	0.010	0.017	0.008	ND	ND	0.006	0.044
0102001	Atlantic City - Kuehnle Pond	Atlantic	SW	0.033	0.043	ND	0.015	0.016	0.010	0.005	ND	0.006	0.046
0251001	Ridgewood Water Department	Bergen	GW-U	0.030	0.007	0.006 ^(a)	0.011	0.012	ND	0.006	ND	0.006	ND
0305001	Burlington City Water Department	Burlington	SW	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0408001	Camden City Water Department	Camden	GW-U	0.014	0.012	ND	0.010	0.009	0.005	0.013	ND	ND	0.007
0516001	Woodbine MUA	Cape May	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0610001	Millville Water Department	Cumberland	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
0705001	East Orange Water Commission	Morris	GW-U	0.009	ND	ND	ND	ND	ND	ND	ND	ND	ND
0712001	NJ American Water - Short Hills	Essex	SW	0.009	ND	ND	ND	ND	ND	ND	ND	ND	ND
0714001	Newark Water Department	Essex	SW	0.006	ND	ND	ND	ND	ND	0.009	ND	ND	ND
0814001	Paulsboro Water Department	Gloucester	GW-U	0.026	0.010	ND	ND	0.006	ND	0.096	ND	ND	ND
1003001	Bloomsbury Water Department	Hunterdon	GW-U	ND	0.005	ND	ND	ND	ND	ND	ND	ND	ND
1103001	Aqua NJ - Hamilton Square	Mercer	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1214001	New Brunswick Water Department	Middlesex	SW	0.011	0.007	ND	ND	ND	ND	ND	ND	ND	ND
1216001	Perth Amboy Water Department	Middlesex	GW-U / GUI	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND
1225001	Middlesex Water Company	Middlesex	SW	0.010	0.006	ND	ND	ND	ND	ND	ND	ND	ND
1321001	Keansburg Water & Sewer Department	Monmouth	GW-C	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1345001	NJ American Water - Coastal, Northern System	Monmouth	SW	0.010	ND	ND	ND	ND	ND	ND	ND	ND	ND
1401001	Boonton Water Department	Morris	SW	0.012	ND	ND	ND	ND	ND	0.019	ND	ND	ND
1403001	Butler Water Department	Morris	SW	0.010	ND	ND	ND	ND	ND	0.014	ND	ND	ND
1424001	Southeast Morris County MUA	Morris	GW-U	ND	ND	ND	ND	ND	ND	0.08 ^(b)	ND	ND	ND
1429001	Parsippany Troy Hills Water Department	Morris	GW-U	ND	ND	ND	ND	ND	ND	0.017	ND	ND	ND
1506001	Brick Township MUA	Ocean	SW	0.100	ND	ND	0.008	0.012	0.010	ND	ND	ND	ND
1507005	United Water Toms River	Ocean	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1514002	Lakewood MUA	Ocean	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1615001	West Milford MUA - Birch Hill	Passaic	GW-U	ND	ND	ND	0.074	ND	ND	ND	ND	ND	ND
1706305	Bondie & Sons	Salem	GW-U	0.057	ND	ND	0.021	0.036	0.022	ND	ND	ND	0.009
1713001	Handy's Mobile Home Park/Westwood Villas	Salem	GW-C	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1713308	Salem County Sportsmans Club	Salem	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1918004	Sparta Township Water Utility - Lake Mohawk	Sussex	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2004002	NJ American Elizabethtown - Raritan River	Somerset	SW	0.016	ND	ND	0.007	ND	ND	ND	ND	ND	ND
2004002	NJ American Elizabethtown - Netherwood Wellfield	Somerset	GW-U	0.031	0.010	ND	0.009	0.009	ND	ND	ND	ND	0.010
2102001	Alpha Municipal Water Works	Warren	GW-U	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

SW: Surface Water

GUI: Ground water under the direct influence of surface water

GW-U: Ground water, unconfined well

GW-C: Ground water, confined well

(a) PFBA was found in the associated method blank which may indicate contamination of the sample for this compound.

(b) PFNA was not detected in a followup sample at this site taken on 9/16/13.

Table 4: Number of PFCs Detected in Each Sample

PWSID #	Water System Name	County	Water source type	# PFCs detected
0102001	Atlantic City - Doughty Pond	Atlantic	SW	7
0102001	Atlantic City - Kuehnle Pond	Atlantic	SW	8
0251001	Ridgewood Water Department	Bergen	GW-U	7
0305001	Burlington City Water Department	Burlington	SW	0
0408001	Camden City Water Department	Camden	GW-U	7
0516001	Woodbine MUA	Cape May	GW-U	0
0610001	Millville Water Department	Cumberland	GW-U	0
0705001	East Orange Water Commission	Morris	GW-U	1
0712001	NJ American Water - Short Hills	Essex	SW	1
0714001	Newark Water Department	Essex	SW	2
0814001	Paulsboro Water Department	Gloucester	GW-U	4
1003001	Bloomsbury Water Department	Hunterdon	GW-U	1
1103001	Aqua NJ - Hamilton Square	Mercer	GW-U	0
1214001	New Brunswick Water Department	Middlesex	SW	2
1216001	Perth Amboy Water Department	Middlesex	GW-U / GUI	1
1225001	Middlesex Water Company	Middlesex	SW	2
1321001	Keansburg Water & Sewer Department	Monmouth	GW-C	0
1345001	NJ American Water - Coastal, Northern System	Monmouth	SW	1
1401001	Boonton Water Department	Morris	SW	2
1403001	Butler Water Department	Morris	SW	2
1424001	Southeast Morris County MUA	Morris	GW-U	1
1429001	Parsippany Troy Hills Water Department	Morris	GW-U	1
1506001	Brick Township MUA	Ocean	SW	4
1507005	United Water Toms River	Ocean	GW-U	0
1514002	Lakewood MUA	Ocean	GW-U	0
1615001	West Milford MUA - Birch Hill	Passaic	GW-U	1
1706305	Bondie & Sons	Salem	GW-U	5
1713001	Handy's Mobile Home Park/Westwood Villas	Salem	GW-C	0
1713308	Salem County Sportsmans Club	Salem	GW-U	0
1918004	Sparta Township Water Utility - Lake Mohawk	Sussex	GW-U	0
2004002	NJ American Elizabethtown - Raritan River	Somerset	SW	2
2004002	NJ American Elizabethtown - Netherwood Wellfield	Somerset	GW-U	5
2102001	Alpha Municipal Water Works	Warren	GW-U	0

SW - surface water

GUI - ground water under the direct influence of surface water

GW-U - ground water, unconfined

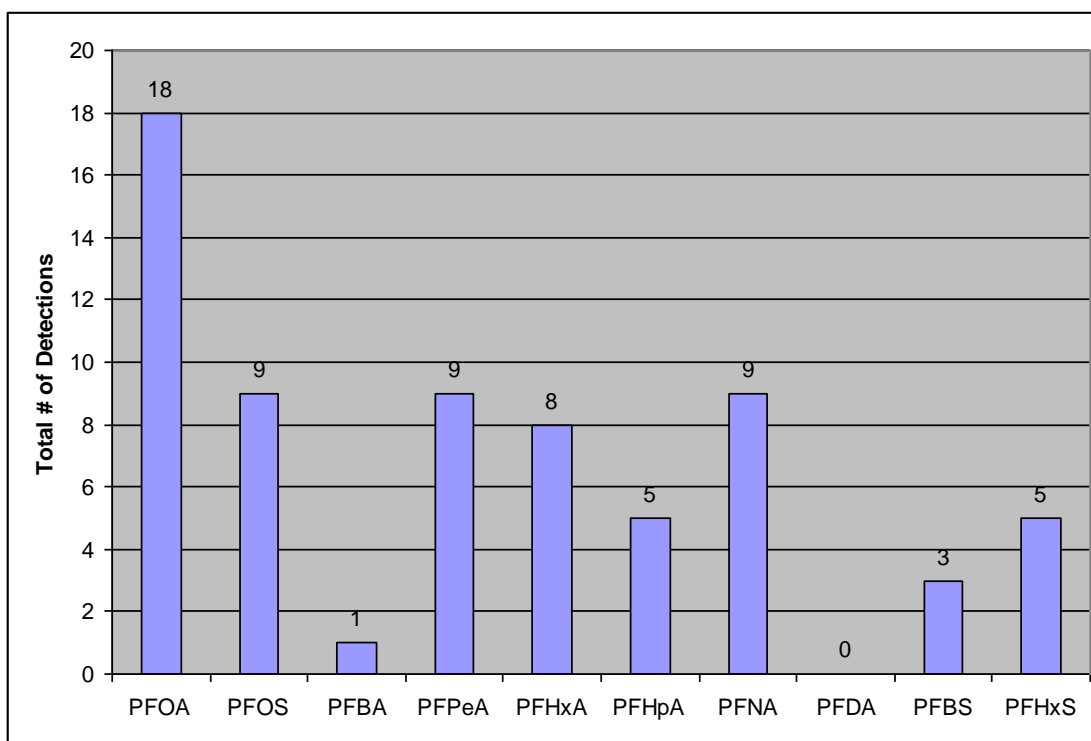
GW-C - ground water, confined

Table 5: Frequency of Detection by Perfluorinated Chemical

Parameter	# of Detections	% Detections	Range (ppb)
PFOA	18/33	55	0.006 – 0.100
PFOS	9/33	27	0.005 – 0.043
PFPeA	9/33	27	0.007 – 0.074
PFNA	9/33	27	0.005 – 0.096
PFHxA	8/33	24	0.006 – 0.036
PFHxS	5/33	15	0.007 – 0.046
PFHpA	5/33	15	0.005 – 0.022
PFBS	3/33	9	0.006
PFBA	1/33	3	0.006 ^(a)
PFDA	0/33	0	<0.005

^(a) PFBA was found in the associated method blank which may indicate contamination of the sample for this compound.

Figure 2: Frequency of Detection by Perfluorinated Chemical



The occurrence of these compounds is further evaluated by grouping the sampling results by source, i.e., surface water samples vs. ground water samples.

A. Surface Water Samples

Twelve surface water intakes were sampled as part of this study. In surface sources, PFOA was the most commonly found PFC, detected in all but one surface water sample. PFBA and PFDA

were not detected above the reporting limit in any of the surface water samples. **Table 6** shows the frequency of detections and the range of concentrations for each PFC detected in surface water samples.

Table 6: Frequency of Detection by Perfluorinated Chemical in Surface Water Samples

Parameter	# of Detections	% Detections	Range (ppb)
PFOA	11/12	92	0.006 – 0.100
PFOS	4/12	33	0.006 – 0.043
PFPeA	4/12	33	0.007 – 0.015
PFNA	4/12	33	0.005 – 0.019
PFHxA	3/12	25	0.012 – 0.017
PFHpA	3/12	25	0.008 – 0.022
PFBS	2/12	17	0.006
PFHxS	2/12	17	0.044 - 0.046
PFBA	0/12	0	< 0.005
PFDA	0/12	0	< 0.005

B. Ground Water Samples

A total of 21 ground water samples were collected for this study. In ground water samples, PFOA was again the most commonly detected PFC. PFDA was the only PFC not detected in any ground water sample. No PFCs were detected in the two confined wells sampled. The other 19 ground water samples were from either unconfined or semi-confined wells. The frequency of detections and the range of concentrations for each PFC detected in ground water samples are presented in **Table 7**.

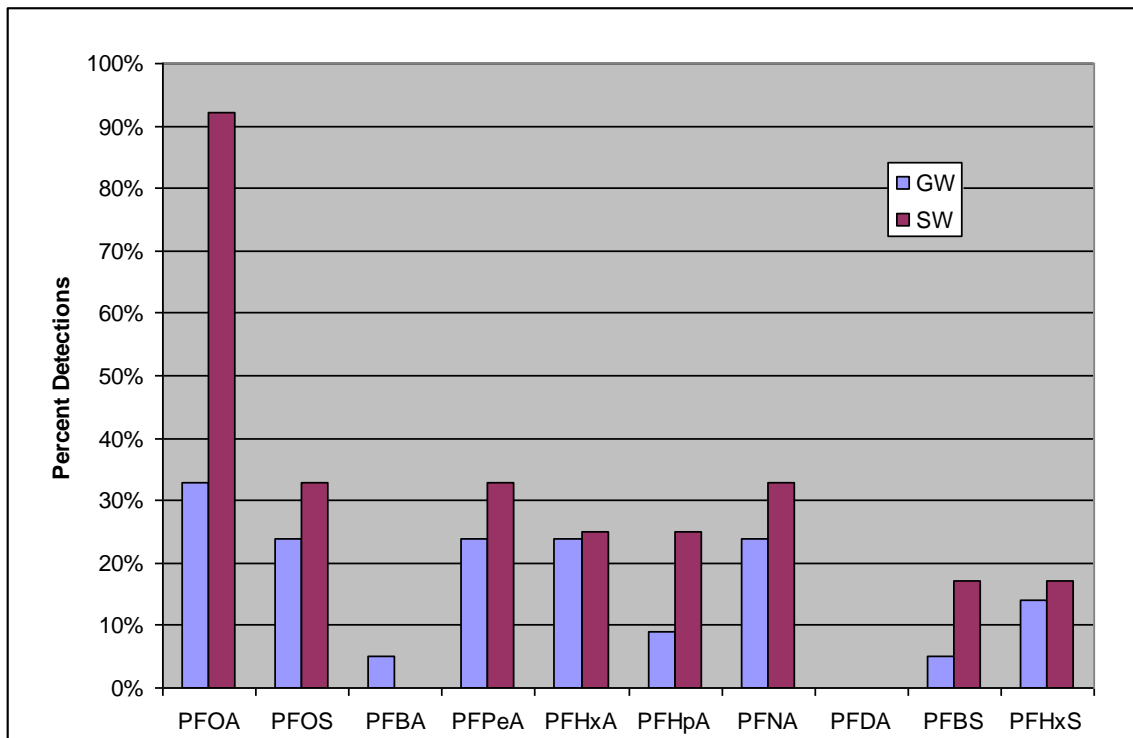
Table 7: Frequency of Detection of Perfluorinated Chemical in Ground Water Samples

Parameter	# of Detections	% Detections	Range (ppb)
PFOA	7/21	33	0.009 – 0.057
PFOS	5/21	24	0.005 – 0.012
PFPeA	5/21	24	0.009 – 0.074
PFNA	5/21	24	0.006 – 0.096
PFHxA	5/21	24	0.006 – 0.036
PFHxS	3/21	10	0.007 – 0.010
PFHpA	2/21	9	0.005 - 0.022
PFBS	1/21	5	0.006
PFBA	1/21	5	0.006 ^(a)
PFDA	0/21	0	<0.005

^(a) PFBA was found in the associated method blank which may indicate contamination of the sample for this compound.

Figure 3 presents a comparison of surface water and ground water detections for each PFC. For the data obtained through this study, PFCs were detected more frequently in surface water samples.

Figure 3: Percent Detections of Perfluorinated Chemicals in Ground Water and Surface Water Samples



VI. Conclusion

In 2006, the Department conducted a study of New Jersey drinking water systems which showed that PFOA and PFOS were detected at low levels in the water systems sampled (78% and 57%, respectively). In response to these detections, the Department recommended that water supplies with detections perform additional monitoring, and in 2007, issued a health-based guidance level for PFOA.

Between July 2009 and February 2010, a second occurrence study was conducted. In this study, 33 samples from 31 water systems were collected from untreated groundwater and surface water sources of drinking water from 20 of 21 counties in New Jersey and analyzed for 10 PFCs. This 2009 study showed that PFCs were detected in 22 of 33 samples (67%). The PFC most often detected was PFOA, which was found in 18 of the 33 samples (55%).

PFCs were detected in 11 of 12 surface water samples and in 11 of 19 of the unconfined groundwater samples (2 samples were from confined wells). In response to these findings, the

Department requested that all water systems with detections of PFCs sample the treated water quarterly for one year to determine the extent that PFCs are present in the treated drinking water.

Currently, the PFCs evaluated in this study are not regulated in drinking water. However, in 2007 the Department set a health-based guidance level for PFOA of 0.04 ppb based on a lifetime exposure. The EPA has set a Provisional Health Advisory value of 0.4 ppb for PFOA and 0.2 ppb for PFOS based on short term exposures. Guidance values have not been developed for other PFCs as additional evaluation of the health effects of these compounds is necessary.

To better understand treatment options available for the removal of unregulated organic contaminants, the Department is studying the effectiveness of granular activated carbon (GAC) removal technology in removing unregulated contaminants, including PFOA and PFOS, in two water systems that use groundwater: Fair Lawn Water Department (Bergen County) and Merchantville-Pennsauken Water Commission (Camden County). These pilot studies are currently in the construction phase.

In addition, the Department participated in a Water Research Foundation (Denver, Colorado) funded study of the occurrence and concentration of PFCs and precursors in raw and finished water supplies nationwide, in order to identify the primary physical and chemical processes that govern the fate of PFCs (WaterRF Project # 4322, report not yet final). . The Department intends to use the monitoring and operational information gained from each of these studies to further study feasibility and effectiveness of using a treatment technology for removing PFCs.

The results obtained through this study will be used in conjunction with previously obtained data to better understand the occurrence of these compounds in order for the Department to determine if there is a need for further evaluation and/or regulation of PFOA and other PFCs in New Jersey drinking water supplies.

VII. References

MWH Laboratories, 2008. The Determination of Perfluorinated Pollutants in Environmental Matrices by Online Solid Phase Extraction coupled with High Performance Liquid Chromatography/Mass Spectrometry in Tandem. SOP: PFC, SOP ID: HPLC 12, Revision Date 07/11/08, pp. 1-24.

NJDEP. (2007) Determination of Perfluorooctanoic Acid (PFOA) in Aqueous Samples. Final Report, January 2007: http://www.nj.gov/dep/watersupply/final_pfoa_report.pdf.

Post, G.B., Louis, J.B., Cooper, K.R., Boros-Russo, B.J., Lippincott, R.L. (2009). Occurrence and potential significance of perfluorooctanoic acid (PFOA) detected in New Jersey public drinking water systems. *Environ. Sci. Technol.* 43, 4547–4554.

Post, G.B., Louis, J.B., Lippincott, R.L., and Procopio, N.A. (2013a). Occurrence of perfluorinated chemicals in raw water from New Jersey public drinking water systems. *Environ. Sci. Technol.* 47, 13266-75.

Post, G.B., Louis, J.B., Lippincott, R.L., and Procopio, N.A. (2013). Occurrence of perfluorinated chemicals in raw water from New Jersey public drinking water systems. *Environ. Sci. Technol.* 47, Supporting Information,, 7 pages. Publicly available at http://pubs.acs.org/doi/suppl/10.1021/es402884x/suppl_file/es402884x-file004.pdf

Rahman, M.F., Peldszus, S., Anderson, W.B. (2014). Behaviour, and fate of perfluoroalkyl and polyfluoroalkyl substances (PFASs) in drinking water treatment: a review. *Water Res.* 50, 318-40.

APPENDIX A

Follow-up Sampling of Treated Water at the Brick Municipal Utilities Authority

In November 2010, three additional samples, including one finished water sample, were collected from the community water system in the 2009 study that had PFOA in the source water above the Department's health-based guidance level of 0.04 ppb. These samples were sent to MWH in Monrovia, California for analysis.

The detected PFOA values in these follow-up samples were 0.054 ppb in the surface water source, 0.01 ppb in the tested ground water source, and 0.04 ppb in the finished (treated) water sample. The level detected in the finished water sample is equal to the Department's health-based guidance level. Note that because these follow-up samples were collected outside of the study sampling plan and do not affect the study's occurrence determination objective, the results were not included in the statistical evaluation of study results.