The Nelson A. Rockefeller Center at Dartmouth College
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The Class of 1964 Policy Research Shop

DRINKING WATER STANDARDS IN NEW HAMPSHIRE

Regulation of Perfluorinated Compounds

Presented to the New Hampshire House Committee on Resources, Recreation, and Development

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EXECUTIVE SUMMARY

The quality of drinking water is a staple and point of pride for the residents of New Hampshire. Unfortunately, it was recently discovered that the drinking water of several towns of the state has been contaminated by Perfluorinated compounds (PFCs). Although the research on the adverse health effects of these chemicals is not definitive, federal guidelines recommend a concentration level of no more than 70 parts per trillion of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in drinking water to protect the entire population against possible lifetime health effects. This report analyzes scientific studies on the potential adverse health effects of PFCs, federal guidelines, and regulations implemented by other states, in order to evaluate existing regulation of PFCs in New Hampshire. Based on this research, New Hampshire has the opportunity to address these emerging contaminants by expanding the scope of the investigation task force in charge of monitoring PFCs in drinking water sources across the state, considering additional regulations of other PFCs besides PFOA and PFOS, and establishing surface water, ambient air, and soil standards while revising current groundwater standards regularly as more scientific evidence becomes available.

1. INTRODUCTION

PFCs, a large group of manufactured chemicals, are found in a variety of household items including food wrappers and containers, cookware, furniture, and clothes. Despite their widespread use in consumer items, research studies have found a probable link between these chemicals and detrimental health effects in living organisms. In recent years, there have been instances of contamination of drinking water by industrial actors in New Hampshire, thus impacting the livelihood of New Hampshire residents. The first occurrence of PFCs contamination took place on Pease Tradeport in 2014. From an analysis of New Hampshire drinking water published in January of 2017, it was found that the southern area of New Hampshire, including the towns of Bedford, Litchfield, Londonberry, Manchester, and Merrimack, had the most samples with high levels of PFCs.[1] Due to the contamination of drinking water by PFCs, residents in some areas were advised to drink only bottled water, as their drinking water supplies have been deemed unsafe to consume.

Some of the possible adverse health effects associated with exposure to PFCs include low birth weight and reduced immunity in children, testicular cancer, kidney cancer, elevated cholesterol, and other health complications in adults. Although studies show a strong possible link between PFCs and adverse health effects, these findings are limited by the research design of animal studies, which cannot extrapolate their findings directly to humans. The policy options discussed in this report are based on peer-reviewed scientific literature on PFCs and their impacts on experimental subjects, federal guidelines, and case studies investigating the responses of other state governments to contamination of drinking water by PFCs.

2. PERFLUORINATED CHEMICALS

The increasing awareness of contamination of drinking water by PFCs has prompted federal and state environmental protection agencies to set guideline concentrations of PFCs in drinking water.[2] The growing concern about potential adverse health effects of PFCs on humans has been primarily driven by animal research and cross-sectional studies. This methodological limitation persuaded the Environmental Protection Agency (EPA) to establish non-enforceable lifetime health advisories for two types of PFCs: Perfluorooctanoic acid (PFOA) and Perfluorooctane Sulfonate (PFOS).[3] The EPA health advisory includes recommendations for state and local governments to analyze and address the presence of PFOA and PFOS in source and drinking water if concentration levels exceed the recommended levels. Most importantly, the EPA established a non-enforceable concentration level of 70 parts per trillion (ppt) for PFOS and PFOA in drinking water, a level which the agency believes provides a margin of protection for the entire population from exposure to these chemicals.[4]

2.1 History of PFCs Usage in Consumer and Industrial Products

PFCs have been widely used as an additive in the manufacturing process of consumer and industrial products, therefore humans are commonly exposed to these chemicals via inhalation and dermal contact.[5] The chemical structure of PFCs exacerbates the potential adverse health effects and environmental impact of these chemical compounds. For instance, PFCs have carbon-fluorine bonds that increase their resistance to degradation by natural processes.[6] In addition, these chemicals have an estimated elimination half-life in humans of about 3.5 years.[7] The concentrations of PFOS and PFOA in blood serum of sample populations significantly decreased after federal government initiatives were implemented in conjunction with key manufacturers to phase out the use of these chemicals starting in 2002. The median concentration of PFOA in blood serum samples was found to decrease by 34 percent while PFOS concentration decreased by 67 percent since 2002.[8] Nevertheless, the presence of PFOA in the environment remains an area of concern for at-risk populations due to its resistant chemical structure.

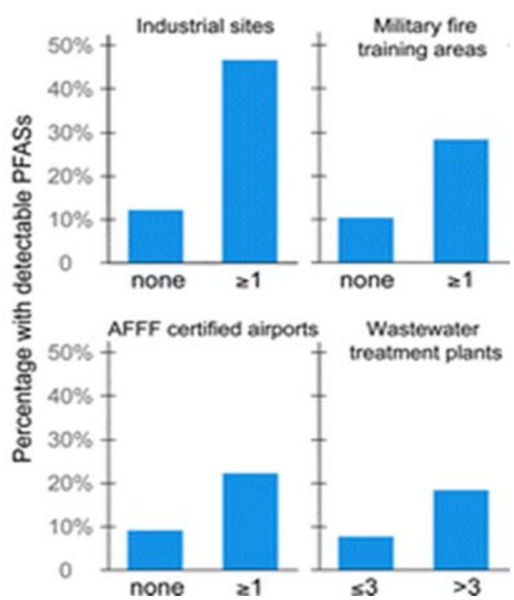

Figure 1: Percent of public water systems with detectable PFCs levels based on surrounding infrastructure 2013-2015.
Source: Hu et al, 2016.

In 2016, researchers published the results of a spatial analysis study that used national drinking water PFCs concentration data from the third Unregulated Contaminant Monitoring Rule

(UCMR3) program of the EPA.[9] The results showed a correlation between the number of industrial sites that manufacture these chemicals, the number of military fire training areas, and the number of wastewater treatment plants with the detection frequencies and concentrations of PFCs in public water systems.[10] Figure 1 shows the difference in the percentage of watersheds with detectable PFC concentrations based on the number of industrial sites, military fire training areas, airports that use Class B aqueous film-forming foams (AFFF), and wastewater treatment plants near those public water systems. In addition to these findings, the study reported that the drinking water supply of six million U.S. residents has PFCs concentration levels that exceed the federal recommended standard.[11]

2.2 Adverse Health Effects

Research studies indicate that exposure to PFOA and PFOS can cause detrimental health effects on humans. The populations most vulnerable to these chemicals include fetuses and breastfeeding infants, who may encounter these chemicals in the womb or breastmilk. Some potential adverse health effects associated with children exposed to these chemicals include low birth weight, accelerated puberty, and reduced immunity.[12] Although PFCs are not stored in fat tissues, research studies have found bioaccumulation of these chemicals as they move through the food chain.[13] The relatively long elimination half-life of PFCs in humans may cause further health complications to populations that are continuously exposed to them. For example, an epidemiological study conducted in West Virginia and Ohio, where the populations were exposed to PFOA, found correlations between PFOA exposure and testicular cancer, kidney cancer, elevated cholesterol, changes in thyroid hormone levels, complications during pregnancy, and ulcerative colitis.[14] Despite the growing literature on the potential adverse health effects caused by exposure to PFCs, these findings are limited due to the shortcomings of correlational designs and the difficulty of extrapolating the results of animal studies to humans.[15]

2.3 Environmental Impact

PFCs are widespread in the populated areas, particularly near industrial discharge points, but traces of these chemicals have also been found in oceans and arctic environments. The biological and chemical stability of PFCs allow for their long-rage transport to areas that are not necessarily associated with their manufacturing or general use.[16] PFCs are usually discharged into the environment through aerial emissions, factory runoff, wastewater treatment plant runoff, and firefighting activities, which may contaminate source and drinking water.[17] The resistant form of PFCs prevents their effective removal from drinking water with traditional water treatment methods.[18] In addition, three hypotheses may explain the long-range transport method of PFCs, which include: direct ocean transport, transportation as marine aerosols, or as byproducts of chemical degradation of volatile fluorotelomer alcohols.[19] The low volatility and ready water solubility of PFCs require water treatment plants to incorporate additional water treatment processes for these chemicals.

3. FEDERAL REGULATIONS

In May 2016, the U.S. Environmental Protection Agency (EPA) designated a lifetime health advisory for PFOS and PFOA. Health advisories are not enforceable, rather, they function as a set of recommendations for state, tribal, or local officials responsible for the maintenance of public water systems.[20] They are informed by peer-reviewed studies and, according to the EPA, provide information on chemicals that may contaminate drinking water and pose a risk to those exposed to these contaminants.

3.1 Federal Water Regulation Standards

The EPA health advisory established a standard concentration level of 70 ppt that, according to the agency, provides a level of protection for all populations, including the most vulnerable, from a lifetime exposure to PFOS and PFOA.[21] In 2012, prior to the release of this health advisory, the EPA had included PFOS and PFOA under the UCMR 3 program, which required state and local officials to monitor and report the concentration levels of these chemicals if they met a certain threshold.[22] The concentration data is typically used by the EPA to determine if it will establish a regulatory drinking water standard. Table A summarizes the occurrence of PFCs in public water systems (PWSs), lifetime health advisory level, and the UCMR 3 designation.

The EPA partnered with the leading manufacturers of PFOS and PFOA to phase out their manufacturing. Most notably, in 2006 the EPA created the 2010/2015 PFOA Stewardship Program, where it invited the eight leading companies in the industry to commit to the objective of reducing the emissions of PFOA in their facilities by 95 percent from a 2000 baseline by 2015.[23] These companies reported their PFOA emissions from every year since 2000 and achieved their goal by transitioning to alternative chemicals.[24] These initiatives complement EPA PFC guidelines on drinking water**,** which provide useful

Occurrence of PFCs in Public Water Systems (PWSs)

Compound	EPA Lifetime Health Advisory (LHA) Concentration (µg/L)* (2016)	UCMR 3 Minimum Reporting Level (MRL) (µg/L)*	% of PWSs with Results ≥ MRL*	% of PWSs with Results > LHA*
PFOS	0.070	0.040	0.30%	0.90%
PFOA	0.070	0.020	0.09%	0.30%
PFNA	N/A	0.020	--	--
PFHxS	N/A	0.030	--	--
PFHpA	N/A	0.010	--	--
PFBS	N/A	0.090	--	--

*4,864 reporting PWSs - Data from EPA UCMR 3

Table A: Specifications of concentration guidelines and occurrence of PFCs in Public Water Systems
Source: "Perfluorinated Compounds: Prevalence and Assessment in Drinking Water." 2016, Page: 2.

insight to state and local governments currently dealing with contamination of drinking water by PFOA and PFOS.

3.2 Assessing Contamination of Drinking Water

The chemical structure of PFCs poses a challenge for public water system administrators because conventional testing methods, such as gas chromatography/mass spectrometry (GC/MS), do not accurately capture concentration levels of PFCs.[25] Prior to 2009, there was no standardized testing method for PFCs until the EPA released Method 537, which established the testing methodology of liquid chromatography with tandem mass spectrometry (LC/MS-MS) as a standard analytical tool for measuring the level of PFCs in drinking water.[26] This testing method utilizes solid phase extraction which is then analyzed with LC/MS-MS. The complexity of this process increases the accuracy of the results compared to conventional testing methods. During the implementation of Method 537, the EPA approved certain laboratories to perform UCMR 3 monitoring.[27] Due to the non-enforceable category that PFOA and PFOS fall under, the EPA only requires water system administrators to use Method 537 when reporting concentration levels within the data collection period under UCMR 3.[28] The EPA recommends that local officials wishing to analyze drinking water samples during "non-UCMR" monitoring periods utilize state accredited laboratories if available. In addition, the Department of Defense (DOD) is looking to create a PFAS laboratory accreditation program.[29]

3.3 Treatment Methods

A variety of treatment methods proven to remove most PFCs from water sources are available. The most cost-efficient methods include closing contaminated wells and blending water sources to dilute the concentration of PFAS.[30] On the other hand, public water systems require extensive treatment methods of source water. These include: granular activated carbon (GAC), anion exchange, high-pressure membrane filtration, and advanced oxidation process (AOP). Table C in the Appendix illustrates further details of these treatment methods including their PFC removal percentage rate, application, and their pros and cons. Based on this information, the most effective treatment methods are granular activated carbon and membrane filtration due to their 90 percent rate of removal of PFCs compared to other methods.[31] The EPA advises water treatment entities to carefully design and maintain processes based on these methods to successfully treat contaminated water.

4. COMPARATIVE ANALYSIS OF WATER REGULATION STANDARDS

To better understand the economic implications of states implementing permanent enforceable regulations of PFCs, it is important to evaluate their enacted policies and response to cases of PFCs contamination. The research methodology employed to assess the costs and benefits of passing state guidelines includes an overview of state regulation standards of PFCs and case studies that analyze the specific drinking water regulation acts passed in New York, Vermont, Texas, and Michigan. In addition, relevant cases of PFCs contamination in West Virginia and Alabama are reviewed since these two states currently do not regulate any PFCs.

4.1 State Regulation Standards of PFCs

Several states have established their own guidelines to monitor and reduce the presence of PFCs in the environment. These state mandated regulatory standards sometimes impose stricter measures than the non-regulatory EPA health advisory guidelines. The creation of enforceable regulations by these states could be explained as reactive measures to occurrences of PFCs contamination that will hold polluters accountable in the future. Figure 2 illustrates the areas in the U.S. with public water systems that have detectable PFCs concentration levels.

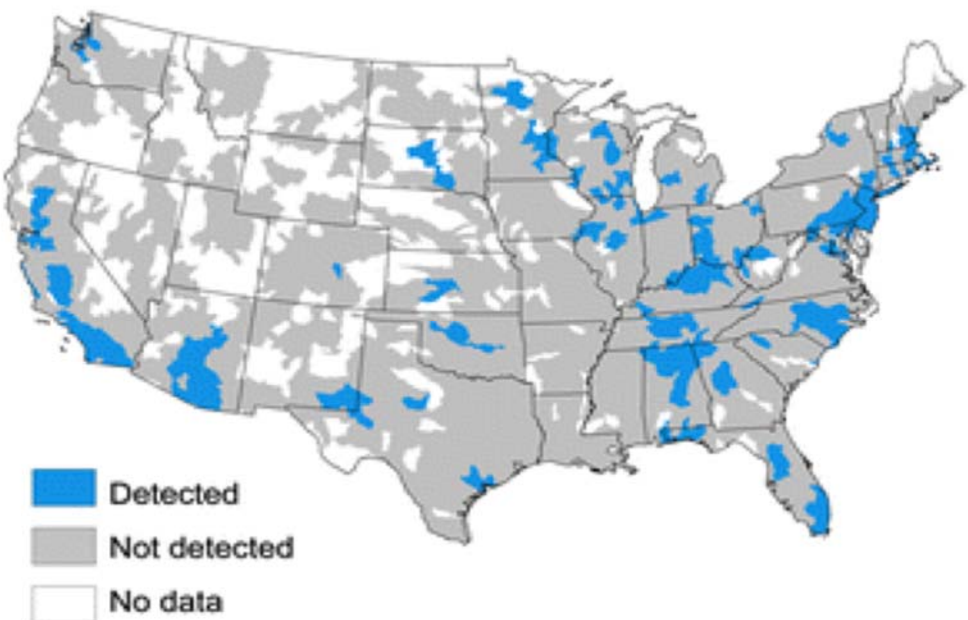

Figure 2: Public water systems in the U.S. with detectable concentration levels of PFCs 2013-2015.
Source: Hu et al, 2016.

4.2 Case Studies

New York, Vermont, Texas, and Michigan are four notable states with major cases regarding PFCs contamination of public water systems. These states responded with investigations of the source of pollution and the introduction of measures that revise drinking water regulations. In the case of New York and Vermont, both states implemented permanent enforceable measures for manufacturers and looked towards the source of contamination for funding of clean up and testing. Both states represent effective action taken in response to each specific case. On the other hand, Texas has established a bureaucratic framework that deals with drinking water and soil contaminants, but the limit concentration levels for PFOA and PFOS in Texas exceed federal recommended standards. Lastly, the state legislatures of West Virginia and Alabama have only followed federal guidelines when dealing with cases of PFCs contamination.

4.2.1 New York

In 2016, New York was the first state to use emergency rulemaking to define PFOS and PFOA as hazardous substances.[32] This state defined measure requires proper storage of the substance, limits its release into the environment, and allows the state to use its legal authority and funding to investigate and clean up the contaminated sites.[33] In February of 2016, Governor Cuomo created a Water Quality Rapid Response Team in charge of analyzing water contamination across the state of New York.[34] This included the identification of potentially compromised public water systems and private wells near 250 facilities that reported the use of PFCs. Furthermore, Governor Cuomo signed the $2 billion Clean Water Act in 2017 to improve drinking water infrastructure, support the cleanup of Gabreski Air National Guard Base, and expedite the investigation of a contaminated site in the Navy/Northrop Grumman Plume.[35]

Through the New York State Department of Health (DOH), Hoosick Falls received free bottled water for its residents, installed a temporary carbon filtration system at the municipal water treatment plant, and installed a new GAC filtration system, which filters water at a high volume to allow residents to have continuous access to clean drinking water.[36] The New York State Department of Environmental Conservation (DEC) and the DOH also provided free water sampling and point-of-entry filtration systems for residents with private wells.[37] On July 31, 2017, the EPA announced the addition of the Saint-Gobain Performance Plastics (Saint-Gobain) site in Hoosick Falls to the Superfund National Priorities List, which would allow the EPA to collaborate with the New York state agencies in the investigation and clean-up efforts.[38]

In Newburgh, after PFC contamination was detected, the city transitioned to an alternative drinking water supply from Brown's Pond and Catskill Aqueduct of New York City in May and June 2016, respectively.[39] New York also funded Catskill Aqueduct water payments and the construction of a GAC filtration system to remove PFCs from service water drawn from Lake Washington.[40] The results from water samples indicated that the source of PFCs contamination was the Steward Air National Guard Base, thus, the U.S. Department of Defense was held responsible for the site clean-up.[41] Since 2016, the DEC has continued to analyze samples of groundwater, surface water, sediment, storm water outfalls, drainage areas, ponds, and culverts to monitor the concentration of PFCs and develop other remediation strategies.[42]

In Petersburgh, the DEC found PFOA contamination in private wells near the Taconic Plastics facility, and listed the facility as a Class 2 inactive hazardous waste disposal site.[43] The DEC and DOH negotiated a consent order requiring Taconic Plastics to financially cooperate with the clean-up process. Taconic Plastics was required to pay for additional point-of-entry-treatment systems for contaminated wells, fund the operation of a GAC filtration system, provide residents with bottled water, implement a remedial program for its waste disposal site, and reimburse the state and county for the costs of the investigation.[44]

4.2.2 Vermont

The Vermont Department of Environmental Conservation sampled the community water system and five water wells in North Bennington in early 2016 to address concerns regarding a nearby PFCs industrial user: Chemfab.[45] The water wells showed PFOA concentrations ranging from 40 to 2,880 ppt. In response, an emergency health advisory concentration level of 20 ppt for PFOA was established in the state.[46] From April to June 2016, The Vermont Department of Health (DOH) conducted blood tests on 477 adults and children affected by the PFOA contamination in North Bennington.[47] The results of these blood tests found that the PFOA concentration in the blood serum of the group was 10.0 ug/L higher than the 2.1 ug/L average for the general US population.[48] The DOH gave all health care providers in the state a summary of health outcomes associated with high concentration levels of PFOA, even though they could not guarantee that PFOA exposure actually caused any future or current health conditions among those exposed to the chemical.[49]

In December 2016, the Legislative Committee on Administrative Rules in Vermont permanently set concentration levels for PFOA and PFOS in drinking water at 20 ppt.[50] The contamination had been linked to Chemfab, now owned by Saint-Gobain, who shut down and moved their operations to Merrimack, New Hampshire in 2001.[51] Saint-Gobain filed three lawsuits against the state of Vermont in April 2016 to challenge the new concentration standard.[52] In July 2017, Saint-Gobain dropped its lawsuits and reached a settlement of $20 million with the state, which went towards a project that would extend the community water system to 200 affected homes.[53]

4.2.3 Texas

The Texas Commission on Environmental Quality (TCEQ) established protective concentration levels (PCLs) for 16 PFASs, including PFOA and PFOS.[54] This designation forms part of the larger Texas Risk Reduction Program (TRRP), which is comprised of these and other chemicals of concern (COCs).[55] The three-tiered program provides guidelines for stakeholders assessing the levels of COCs in soil, groundwater, and surface water.[56] TRRP requires remediation sites to undergo an ecological risk assessment (ERA).[57] As demonstrated in Figure 3 in the Appendix, the assessment must first conclude if the site qualifies for exclusion from further tests before moving on to the required assessments under Tier 2 and optional assessments in Tier 3.

The assessments consist of identification of environmental media, soil, groundwater, or surface water affected by the chemical, and an evaluation of the existing infrastructure that controls the release of these chemicals.[58] After testing the samples collected from the compromised property, the assessor must choose one of two response options.[59] Under Remedy Standard A, contaminated media must be removed to reduce the concentration of the contaminant. Remedy Standard B allows the official conducting the assessment to choose a response measure from removal, contamination, or implementing control measures to prevent contaminated media from exceeding critical concentration levels.[60] Specific information on the multi-step response process mandated by TRRP is illustrated in Figure 4 in the Appendix. The addition of PFASs to the TRRP proactively addresses possible instances of contamination. Drinking water regulations in Texas supplement the non-enforceable federal drinking water advisories to standardize the response from state government agencies for these situations. However, the maximum concentration levels for PFCs mandated by the TCEQ are higher than the concentration level recommended by the EPA. Table B shows a detailed list of the 16 PFCs listed as COCs and their respective concentration levels.

Chemical of Concern	**Abbreviation**	**Health Value (ppb)**	**Health Value (ppt)**
Perfluorohexane sulfonic acid	PFHxS	0.093	93
Perfluorobutyric acid	PFBA	71	71,000
Perfluorobutanesulfonic acid	PFBS	34	34,000
Perfluoroheptanoic acid	PFHpA	0.56	560
Perfluorononanoic acid	PFNA	0.29	290
Perfluorotetradecanoic acid	PFTeDA	0.29	290
Perfluorotridecanoic acid	PFTrDA	0.29	290
Perfluorooctane sulfonamide	PFOSA	0.29	290
Perfluoro-n-pentanoic acid	PFPeA	0.093	93
Perfluoroundecanoic acid	PFUnA	0.29	290
Perfluorooctanesulfonic acid	PFOS	0.56	560
Perfluorohexanoic acid	PFHxA	0.096	96
Perfluorododecanoic acid	PFDoA	0.29	290
Perfluorooctanoic acid	PFOA	0.29	290
Perfluorodecanoic acid	PFDA	0.37	370
Perfluorodecane sulfonic acid	PFDS	0.29	290

Table B: TRRP Protective Concentration Levels for 16 PFCs established by the TCEQ.
Source: Integral Consulting Inc. "Compendium of State Regulatory Activities on Emerging Contaminants." May 2016. http://www.integral-corp.com/wp-content/uploads/2016/06/Integral_EC_State-Summary-Report_Final.pdf

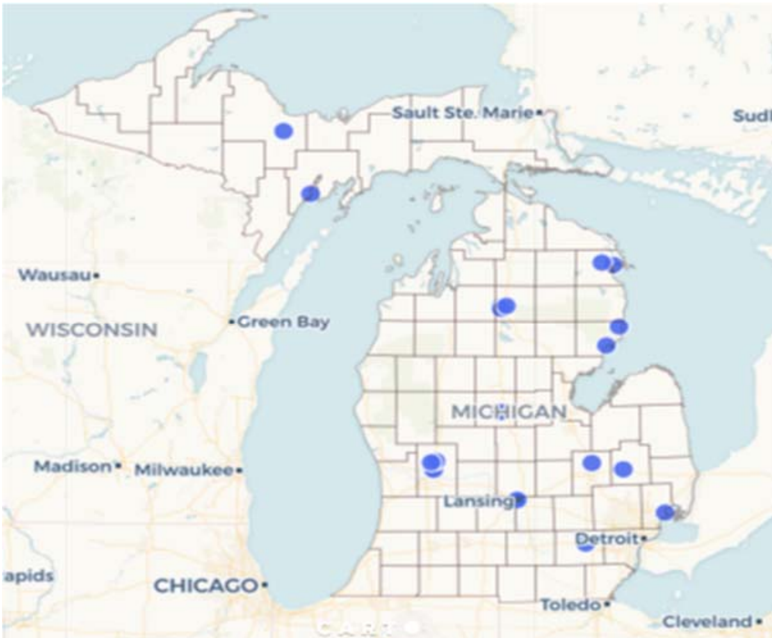

Figure 5: The blue dots indicate the location of communities in Michigan with PFAS contaminated sites.
Source: Bridge Magazine, 2018.

4.2.4 Michigan

The highly publicized case of lead water contamination in Flint, Michigan has heightened the sensitivity and attention of state officials to issues surrounding drinking water. In December 2017, Michigan introduced a bill that proposed setting the standard for PFCs to 5 ppt – 14 times lower than the EPA-recommended levels as a response to reports of PFCs contamination in 23 sites across the state. Prior to the introduction of this bill, Michigan did not have mandated concentration levels for these contaminants. Although these proposed measures did not pass, Michigan legislators compromised by setting enforceable concentration levels of 70 ppt for PFOAs and PFOS in drinking water.[61] As of January 10, 2018, the DEQ has the authority to take regulatory enforcement actions.[62] For instance, the department can issue violation notices, take legal action, or mandate the responsible party to conduct activities that address PFOA and PFOS contamination.[63]

Support for tightened regulations has occurred as a result of findings indicating that there are 23 sites in 14 different communities across Michigan where environmental regulators have found contaminations of PFCs.[64] Figure 5 illustrates the location of these contaminated sites.[65]

In November 2017, the Governor of Michigan, Rick Snyder, developed a PFAS Action Response Team as an initiative to increase statewide cooperation and coordination among government agencies to inform and empower the public while mitigating potential effects of exposure.[66] The team performs local public outreach to ensure that members of impacted areas are informed, conducts long-term mitigation planning, establishes routine communication protocols, and assesses the status of any PFAS contamination observed.[67] The PFAS Action Response Team is staffed by government employees of the Executive Office of the Governor and each department involved. Michigan lawmakers also allocated more than $23 million to the response efforts conducted by state agencies for the fiscal year ending in September 30, 2018 in the form of supplemental appropriations.[68]

Wolverine Worldwide, a shoemaking company, used 3M Scotchgard chemicals containing PFOS and had dumped tannery sludge waste in landfills, gravel pits, and farms in Plainfield, Michigan for decades.[69] After high levels of PFOA were detected in various sites surrounding the dumping area, the manufacturer voluntarily conducted tests and provided filtration systems for residents with private wells.[70] Several lawsuits were filed against both Wolverine and 3M, including a lawsuit filed by the Michigan Department of Environmental Quality (DEQ) for the cleanup costs of chemicals near the now-defunct Wolverine factory in Grand Rapids.[71]

4.2.5 Other States

Multiple law-suits have come out of PFOS and PFOA contamination of public water systems located near manufacturing plants. According to a 2004 study by ChemRisk Inc., the Washington Works plant, formerly owned by DuPont, released more than 1.7 million pounds of PFOA into the surrounding environment.[72] DuPont had reached an initial settlement in 2004 of $350 million to fund a six-year epidemiological study, which found "probable links" between PFOA and diseases such as kidney cancer, testicular cancer, high blood pressure, ulcerative colitis, and thyroid disease.[73] Following this study, about 3,500 Ohio Valley citizens diagnosed with said ailments sued DuPont for personal injury.[74] In February of 2017, DuPont and Chemours, now two companies after a split, agreed to a settlement of $670.7 million to resolve several lawsuits dealing with the release of PFOA in Parkersburg, West Virginia.[75]

In the region of Decatur, Alabama, three manufacturers, 3M, Daikin America, Inc. (Daikin), and Toray Carbon Fibers America, Inc. (Toray), released contaminated water to be treated at the Decatur Utilities Dry Creek Wastewater Treatment Plant (Decatur Utilities).[76] In 2007, one of these manufacturers notified the EPA of a compound leakage into the Decatur Utilities.[77] Biosolids from these utilities had been used as soil amendments on about 5000 acres of private land in Lawrence, Morgan and Limestone Counties over a period of 12 years.[78] In reaction, the EPA supplied drinking water to residents who used wells in these areas and arranged for residents to connect to the public water system. Furthermore, lawsuits have been filed against 3M, Daikin, and 36 other industrial actors.[79] The West Morgan-East Lawrence Water and Sewer Authority settled for $5 million with Daikin, in order to fund a permanent filtration system for removing PFCs and to prevent a similar situation from occurring in the future.[80]

5. REGULATION STANDARDS OF PFCS IN NEW HAMPSHIRE

This section reviews cases of PFCs contamination reported in New Hampshire, the response by the agencies involved in the investigation and clean-up process, and agreements negotiated with industrial actors. The evaluation of these three components allows for a comparison between the actions taken by regulators in New Hampshire and the regulations implemented by other states dealing with similar situations of PFCs contamination.

5.1 New Hampshire Relevant PFCs Investigation Sites

On May 12, 2014, the U.S. Air Force notified the New Hampshire Department of Environmental Services (DES) that the water samples collected from the Haven water supply on the Pease Tradeport had PFOS levels exceeding the Provisional Health Advisory level set by the EPA.[81] The EPA provisional health advisory only applied to short-term drinking water exposure and has since been updated to a lifetime health advisory level. In response, the Smith and Harrison wells on the Tradeport were also tested for PFOS, PFOA, and Perfluorohexane sulfonic acid (PFHXs), and city officials from Portsmouth shut down the Haven well. In 2015, the New Hampshire Department of Health and Human Services (DHHS) established a blood testing program for people who lived, worked, or attended child care on the Pease Tradeport.[82] A total of 1,578 participated in the program and the DHHS reported that the participants had higher blood levels of PFOS, PFOA, and PFHxS as compared to the general U.S population.[83] In September 2016, the city of Portsmouth installed two granular activated carbon vessels to remove and filter PFCs from the Smith and Harrison wells at Grafton Road water facility at the Pease Tradeport.[84]

On March 4, 2016, the DES announced another investigation of PFCs in drinking water after Saint-Gobain notified the department that PFOA was detected at low levels in samples from four faucets in their Merrimack facility.[85] As of January 10, 2017, the NHDES investigated 1,619 samples collected from 20 investigation areas across the state for PFOA and PFOS. The results demonstrated that 222 of the samples had combined levels of PFOA and PFOS that exceed the EPA lifetime health advisory level of 70 ppt.[86] According to the report, 183 water samples out of 843 collected in the Saint-Gobain Investigation Area, which includes the towns of Bedford, Litchfield, Londonderry, Manchester and Merrimack, had combined levels of PFOA and PFOS that exceed 70 ppt.[87]

On May 11, 2016, the DES announced the expansion of the investigation to Amherst near the former location of Textiles Coated International, Inc. (TCI).[88] According to a press release from the DES, TCI operated at the Amherst location between 1985 and 2006 and currently operates in Manchester since 2005.[89] In January 2017, the DES reported that 21 samples out of 235 collected from the TCI Investigation Area in Amherst had combined levels of PFOA and PFOS that exceed 70 ppt.[90]

5.2 Response to PFCs Contamination in New Hampshire

In May 2016, The NHDES announced the emergency rule to establish Ambient Groundwater Quality Standards (AGQS) for PFOA and PFOS. The NHDES set three groundwater standards: 70 ppt for PFOA, 70 ppt for PFOS, and 70 ppt for PFOA and PFOS combined. As of October 2016, the NHDES permanently adopted these groundwater standards.[91] Under the provisions of Env-A 1400, the NH-DES already had established ambient air limits for ammonium perfluorooctanoate (APFO), an ammonium salt of PFOA, of 0.050 ug/m^3 (24-hours) and 0.024 ug/m^3 (annual).[92] In addition to these groundwater and ambient air limits, the Environmental Health Program of the NH-DES announced direct contact risk-based soil concentration levels for PFOA[93] and PFOS of 0.5 mg/kg for both chemicals in two internal memos published in June 2016.[94]

On November 22, 2016, the NH-DES sent a letter to relevant stakeholders requesting sampling for PFCs as part of groundwater management permits and the investigation of certain contaminated sites.[95] The letter listed the following contaminated sites that should include PFCs as part of their groundwater sampling programs: active hazardous waste sites, sites with ongoing environmental site evaluation, sites with a history indicating the industrial processes that may have used products or commercial products containing PFCs, unlined landfills, lined landfills, sites associated with groundwater release detection permits, and fire training areas, airports, or sites where significant quantities of AFFF may have been used.[96] The letter also provided guidance on groundwater sampling protocols when collecting water samples for PFCs.[97]

The NH-DES collaborated with the NH-DHHS as part of the investigation process by offering blood testing for individuals living in the areas where high levels of PFCs were found in the drinking water supply.[98] In the summer of 2016, The NH-DHHS expanded PFC blood testing program to private-well owning residents of Amherst, Bedford, Litchfield, Manchester, and Merrimack that live on streets with registered PFCs level above 70 ppt.[99] In addition to these communities, the DHHS conducted a Community Exposure Assessment among the Merrimack Village District (MVD) public water system.[100] The results found that participants from both the MVD Community Exposure Assessment and the southern New Hampshire area had higher blood levels of PFOA compared to the general U.S. population.[101] Figure 6 illustrates the comparison of average PFCs blood levels of the participants from the Pease Tradeport, southern New Hampshire and MVD communities to the general U.S. population.

Lastly, the NH-DES also created a website for the New Hampshire PFCs Investigation that contains the results of tests for PFCs in drinking water conducted throughout the state, press releases regarding the investigation, and additional resources for eligible residents such as a list of bottled water delivery areas and a request form for private well testing for PFCs.[102]

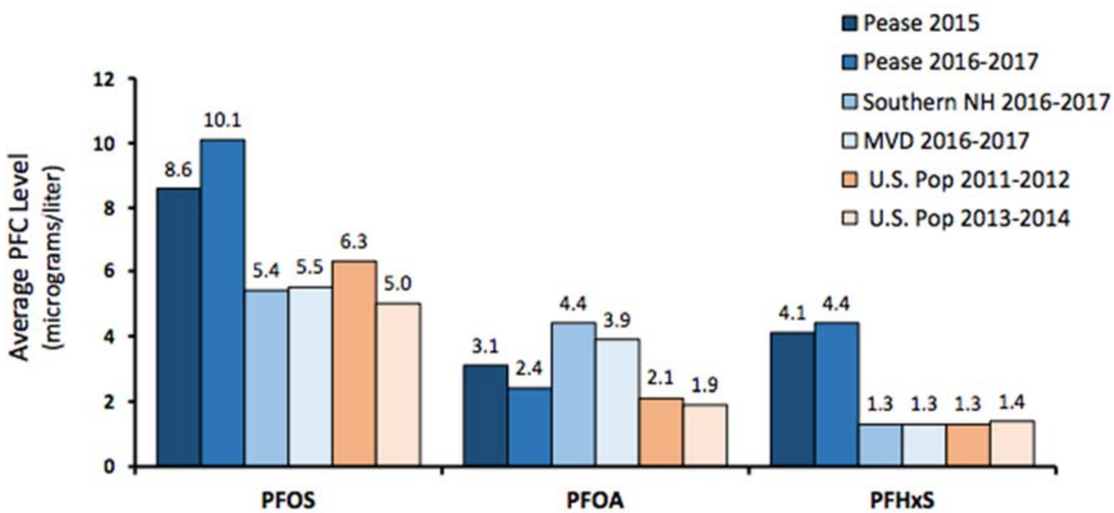

Figure 6: Average PFC levels of New Hampshire Communities compared to U.S. Population as of July 2017
Source: New Hampshire Department of Health and Human Services, October 2017.

5.3 Industry Response to PFCs Contamination In New Hampshire

On April 7, 2016, the NH-DES announced that it would expand the efforts to deliver bottled water to approximately 400 properties in Merrimack and Litchfield within a 1-mile radius from the Saint-Gobain plant.[103] This decision was made after the results of samples from the area indicated high levels of PFOA. Saint-Gobain indicated that it would provide the bottled water to the NH-DES.[104] Saint-Gobain also provided point-of-use treatment systems for more than 50 properties and connected more than 450 residences to municipal water lines. In March 2018, Saint-Gobain and the NH-DES reached an agreement to permanently provide safe drinking water to 302 properties in segments of the towns of Bedford, Litchfield, and Merrimack in addition to the 450 properties already addressed.[105] The Consent Decree also provides for site investigation activities including, but not limited to, groundwater, drinking water, surface water, soil and air testing, and source remediation if necessary.[106]

On April 21, 2017, the NH-DES announced that TCI had agreed to fund design efforts to potentially extend public water service to 110 properties in Amherst affected by PFOA contamination.[107] The NH-DES announced that TCI signed an agreement to connect 102 properties in Amherst to the Pennichuck public water system on October 6, 2017. The project is expected to be completed by June 15, 2018.[108]

6. POLICY OPTIONS

Based on an examination of the approaches of other states to PFCs contamination, New Hampshire has implemented similar measures as other states, especially to those enacted in New York, Michigan, and Vermont. This approach includes forming a task force in charge of the investigation and clean-up process and establishing permanent groundwater standards for PFOA and PFOS. New Hampshire, New York and Vermont also conducted blood testing of individuals living in areas with PFCs contamination. On the other hand, states that have not enacted enforceable regulations, such as West Virginia and Alabama, have relied on assistance from the federal government, and some local governments and individuals in those states eventually reached settlements with the alleged polluters. Although New Hampshire regulators have enacted necessary regulation to address PFCs contamination, New Hampshire has the option to enact additional legislation to prevent the contamination of drinking water by PFCs in the future.

One option may be to expand the investigative team in New Hampshire to mirror the designated teams found in other states, such as the Water Quality Rapid Response Team in New York and the PFAS Action Response Team in Michigan. These teams are dedicated to monitoring PFCs in drinking water, informing legislators of relevant scientific data to enact appropriate policies, and conducting community outreach. New Hampshire could include professional members from various disciplines on the investigative team, such as community outreach coordinators and health professionals, to ultimately facilitate multidisciplinary investigative and clean-up efforts. An interdisciplinary approach might also contribute to the ongoing scientific research on PFCs such as the potential long-term adverse health effects on humans and the impact of PFCs air emissions on drinking water. Furthermore, the data gathered by the New Hampshire investigative team has the potential to guide policies on air emissions of PFCs and other PFCs chemicals besides PFOA and PFOS.

Given the possible transportation methods of PFCs and the different routes of exposure other than drinking water, New Hampshire also has the opportunity to enact surface water quality standards for PFCs. More research needs to be conducted on dermal contact and fish consumption in order to guide these policies. As more scientific data becomes available on the impact of soil on food and water quality, the soil standards for PFCs in New Hampshire may need to be revised.

New Hampshire may continue to enforce the EPA lifetime health advisory level of 70 ppt for PFOA and PFOS, but these standards need to be periodically revisited to ensure they reflect relevant scientific findings since the potential adverse health effects of these chemicals remains uncertain. Furthermore, since these chemicals are currently consider emerging contaminants, any policy under consideration should take into account the economic and health trade-offs. In considering these policies, New Hampshire legislators need to evaluate the potential short-term and long-term implications of new regulations on the economy of the state and the health of its residents.

7. CONCLUSION

New Hampshire has adopted regulations similar to other states that have experienced PFCs contamination in drinking water. Therefore, the New Hampshire legislature has the opportunity to continue monitoring scientific developments and policy measures implemented in other states in order to continue protecting the health of New Hampshire residents. In sum, this report explored peer reviewed literature, federal guidelines, and regulations implemented by other states to guide policy recommendations. These policy recommendations include: expanding the size and responsibilities of the PFCs investigation team, monitor scientific research on PFCs in order to enact appropriate policies that protect the health of the population, and taking into consideration the potential economic and health implications of any policy proposed in the future.

8. APPENDIX

Treatment Method	Treatment Process	Documented PFC Removal Percentages	Relative Treatment Cost	Application	Treatment Considerations	
					Pros	Cons
Activated Carbon	Granulated activated carbon (GAC) or powdered activated carbon (PAC)	PFOA ≥ 90% PFOS ≥ 90% PFNA ≥ 90%	$$	Surface Water, Groundwater, PWSs, Households	• Widely used for PFC removal, high removal rates possible • GAC provides better removal than PAC • Useful for responding to spills • In-house options are available for point of use or point of entry systems	• Conflicting results on which PFCs are removed most effectively • Possibility of competitive adsorption with other compounds present, such as natural organic matter • Low rate of adsorption in GAC may result in long mass transfer zones and adjustment of associated operating requirements • Requires thermal regeneration of GAC • Creates waste residuals to dispose of exhausted carbon • Process optimization necessary (pH, temperature, contact time)
Anion Exchange	Special ion exchange material (commercial resins or petrochemical compounds) shaped as beads exchange anions and replace hydroxyl groups	PFOA = 10-90% PFOS = ≥ 90% PFNA = 67%	$$	Surface Water, Groundwater	• PFOS removed well by anion exchange but sorption rates depend on polymer matrix and porosity • Can partially remove PFOA, PFNA, PFOS	• Reject brine must be properly disposed of • Costs are similar to activated carbon but depend greatly on resin and treatment system • Rate of exchange will depend on many factors, including influent PFC concentration, design of the anion exchange, solution ionic strength and bead material • Surface water supplies may need clarification/filtration before treatment • Less effective at short-chain PFC removal
Membrane Filtration	Reverse Osmosis (RO): semi-permeable membrane to allow osmotic pressure to retain PFCs Nanofiltration (NF): uses filters with pore sizes around 0.001 micron and a high water flux to filter PFCs	PFOA = ≥ 90% PFOS = ≥ 90% PFNA = ≥ 90%	$$$	Surface Water, Groundwater, PWSs, Households (RO)	• Excellent PFC removal • May be designed for under-sink or residential well water PFC treatment • Can be successfully combined with GAC for higher PFC removal rates • Multi-contaminant removal • Reasonable for groundwater systems	• Reject water must be treated before discharging • High capital expense with high energy demands • Susceptible to fouling • May require pre-treatment due to high fouling tendencies • RO is preferable to NF due to higher removal efficiency
Advanced Oxidation Processes (AOP)	UV/H_2O_2 $UV/S_2O_8^{2-}$	PFOA = < 10% PFOS = 10 to 50% PFNA = < 10%	$$$	Surface Water, Groundwater	• Can oxidize a multitude of contaminants to degradation products using reactive hydroxyl radicals	• Less effective at breaking down organic compounds such as PFCs • No significant difference in removal of PFCs observed between different AOP methods • Significant energy input is needed to achieve moderate PFAS oxidation with AOP

Table C: Summary of Water Treatment Methods to Remove High Concentrations of PFCs
Source: "Perfluorinated Compounds: Prevalence and Assessment in Drinking Water." 2016, Page: 4.

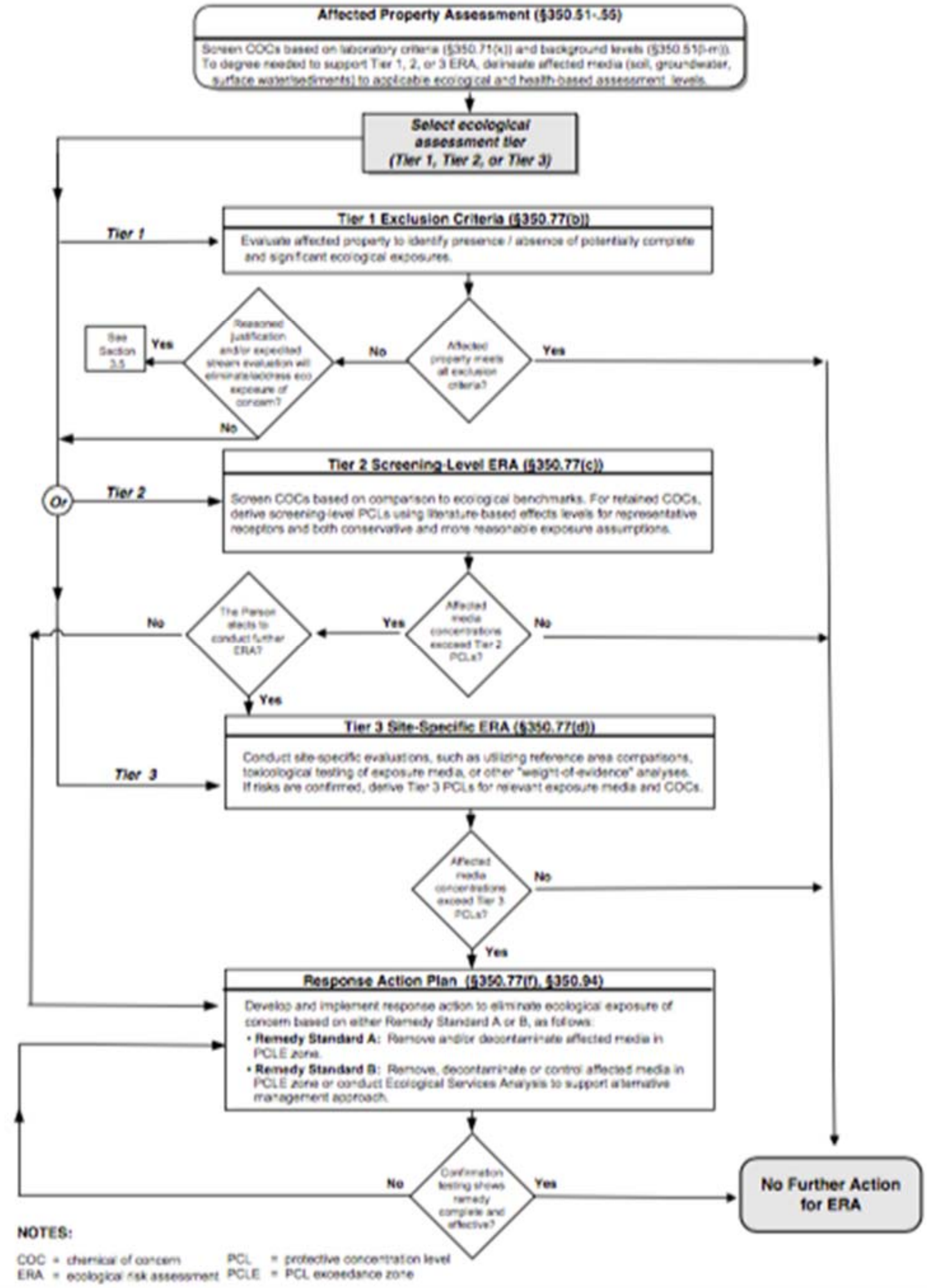

Figure 3: Overview of tiered ERA Process, by the Texas Commission on Environmental Quality.
Source: "Conducting Ecological Risk Assessments at Remediation Sites in Texas" 2017, Page: 20.

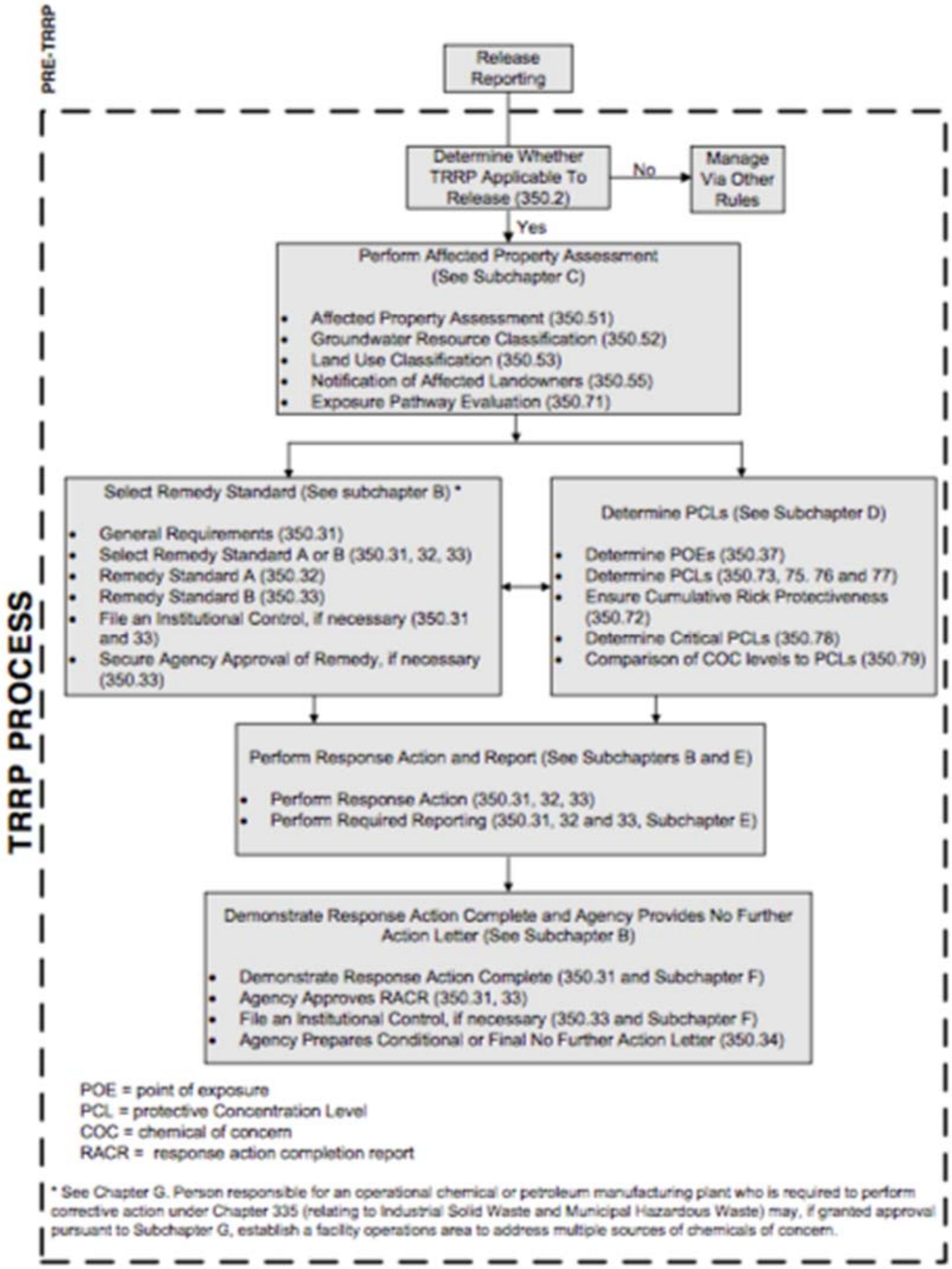

Figure 4: General overview of TRRP process, by the Texas Commission on Environmental Quality.
Source: "Conducting Ecological Risk Assessments at Remediation Sites in Texas" 2017, Page: 22.

9. REFERENCES

[1] "NHDES State-wide Perfluorinated Chemicals (PFC) in Drinking Water Investigation," New Hampshire Department of Environmental Services, last modified January 10, 2017, https://www.des.nh.gov/organization/commissioner/documents/pfoa-statewide-status-20170110.pdf.
[2] "Perfluorinated Compounds: Prevalence and Assessment in Drinking Water." *American Water Works Association*, 2016, https://nysawwa.org/docs/pdfs/1468266080.pdf.
[3] "Drinking Water Health Advisories for PFOA and PFOS." *U.S. Environmental Protection Agency*, 2017, https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] "Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS): Information Paper." *Association of State and Territorial Solid Waste Management Officials (ASTSWMO)*, August 2015, http://astswmo.org/files/policies/Federal_Facilities/2015-08-ASTSWMO-PFCs-IssuePaper-Final.pdf.
[8] Ibid.
[9] Hu, Xindi C., David Q. Andrews, Andrew B. Lindstrom, Thomas A. Bruton, Laurel A. Schaider, Philippe Grandjean, Rainer Lohmann et al. "Detection of poly-and perfluoroalkyl substances (PFASs) in US drinking water linked to industrial sites, military fire training areas, and wastewater treatment plants." *Environmental science & technology letters* 3, no. 10 (2016): 344-350.
[10] Ibid.
[11] Ibid.
[12] "Perfluorinated Chemicals (PFCs)." *National Institute of Environmental Health Sciences*, July 2016, https://www.niehs.nih.gov/health/materials/perflourinated_chemicals_508.pdf.
[13] Ibid.
[14] "Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS): Information Paper." *ASTSWMO*, August 2015, http://astswmo.org/files/policies/Federal_Facilities/2015-08-ASTSWMO-PFCs-IssuePaper-Final.pdf.
[15] Ibid.
[16] Ibid.
[17] "Perfluorinated Compounds: Prevalence and Assessment in Drinking Water" *American Water Works Association*, 2016, https://nysawwa.org/docs/pdfs/1468266080.pdf
[18] Ibid.
[19] "Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS): Information Paper." *ASTSWMO*, August 2015,

http://astswmo.org/files/policies/Federal_Facilities/2015-08-ASTSWMO-PFCs-IssuePaper-Final.pdf.
[20] "Drinking Water Health Advisories for PFOA and PFOS." *U.S. Environmental Protection Agency*, 2017, https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] "Perfluorinated Chemicals (PFCs): Perfluorooctanoic Acid (PFOA) & Perfluorooctane Sulfonate (PFOS): Information Paper." *ASTSWMO*, August 2015, http://astswmo.org/files/policies/Federal_Facilities/2015-08-ASTSWMO-PFCs-IssuePaper-Final.pdf.
[27] U.S. Environmental Protection Agency. "Drinking Water Health Advisories for PFOA and PFOS." 2017, https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos.
[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] Ibid.
[32] "Perfluorinated Compounds (PFCs)." *New York Department of Environmental Conservation*, June 2017, http://www.dec.ny.gov/chemical/108831.html.
[33] Ibid.
[34] Ibid.
[35] "Governor Cuomo Signs Legislation Investing $2.5 billion in Clean Water Infrastructure and Water Quality Protection." *Governor Andrew Cuomo Pressroom*, April 2017, https://www.governor.ny.gov/news/governor-cuomo-signs-legislation-investing-25-billion-clean-water-infrastructure-and-water.
[36] "Hoosick Falls – Information for Communities Impacted by Perfluorinated Compounds (PFCs)," Region 4 – Environmental Remediation Project Information, New York State Department of Environmental Conservation, accessed March 10, 2018, http://www.dec.ny.gov/chemical/108791.html.
[37] Ibid.
[38] "EPA Adds Saint-Gobain Performance Plastics Site in Hoosick Falls, NY to the Federal Superfund List," United States Environmental Protection Agency, last modified July 31, 2017, https://www.epa.gov/newsreleases/epa-adds-saint-gobain-performance-plastics-site-hoosick-falls-ny-federal-superfund-list.
[39] "Newburgh – Information for Communities Impacted by Perfluorinated Compounds (PFCs)," Region 4 – Environmental Remediation Project Information, New York State Department of Environmental Conservation, accessed March 10, 2018, http://www.dec.ny.gov/chemical/108825.html.

[40] Ibid.
[41] Ibid.
[42] Ibid.
[43] "Petersburgh – Information for Communities Impacted by Perfluorinated Compounds (PFCs)," Region 4 – Environmental Remediation Project Information, New York State Department of Environmental Conservation, accessed March 10, 2018, http://www.dec.ny.gov/chemical/108820.html.
[44] Ibid.
[45] "PFOA in Drinking Water 2016," *Vermont Department of Health*, accessed March 10, 2018, http://www.healthvermont.gov/response/environmental/pfoa-drinking-water-2016.
[46] Ibid.
[47] "Health Department Announces PFOA Blood Test Results," Vermont Department of Health, July 26, 2016, http://www.healthvermont.gov/sites/default/files/documents/2016/11/Health%20Department%20Announces%20PFOA%20Blood%20Test%20Results.pdf.
[48] Ibid.
[49] Ibid.
[50] "Hazardous Waste Management Regulations," Vermont Department of Environmental Conservation, last modified December 16, 2016, http://dec.vermont.gov/sites/dec/files/documents/2016_12_16VermontHWMRAdopted.pdf.
[51] Ibid.
[52] Ibid.
[53] Howard Weiss-Tisman, "Saint-Gobain Drops its Lawsuit Over Vermont's Safe Drinking Water for PFOA," *New Hampshire Public Radio*, July 27, 2017, http://nhpr.org/post/saint-gobain-drops-its-lawsuit-over-vermonts-safe-drinking-water-standard-pfoa#stream/0.
[54] "Compendium of State Regulatory Activities on Emerging Contaminants," Integral Consulting Inc., May 2016, http://www.integral-corp.com/wp-content/uploads/2016/06/Integral_EC_State-Summary-Report_Final.pdf.
[55] Texas. Remediation Division. *Conducting Ecological Risk Assessments at Remediation Sites in Texas.* Austin, TX: Texas Commission on Environmental Quality, 2017. https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg-263.pdf.
[56] Ibid.
[57] Ibid.
[58] Ibid.
[59] Ibid.
[60] Ibid.
[61] "State Takes Action to Strengthen Environmental Criteria in Response to PFAS Contamination," *Michigan Department of Environmental Quality*, last modified January 9, 2018, http://www.michigan.gov/deq/0,4561,7-135--457220--,00.html.

[62] Michigan Department of Environmental Quality, "States Takes Action to Strengthen Environmental Criteria in Response to PFAS Contamination."
[63] Ibid.
[64] Ibid.
[65] Jim Malewitz and Mike Wilkinson, "Map: Find PFAS chemical threats to Michigan drinking water near your town," *Bridge Magazine*, January 17, 2018, http://www.bridgemi.com/michigan-environment-watch/map-find-pfas-chemical-threats-michigan-drinking-water-near-your-town**.**
[66] "Taking Action, Protecting Michigan: Governor's Directive Creates the PFAS Action Response Team," *State of Michigan*, accessed March 9, 2018, http://www.michigan.gov/som/0,4669,7-192-45414_45929_83470---,00.html.
[67] Ibid.
[68] Michigan. 99th State Legislature, *Enrolled House Bill No. 4320*. Lansing, MI: Michigan State Legislature, 2017. http://www.legislature.mi.gov/documents/2017-2018/publicact/pdf/2017-PA-0201.pdf
[69] Mitch Smith, "Miles from Flint: Residents Turn Off Taps in New Water Crisis," *New York Times*, November 24, 2017, https://www.nytimes.com/2017/11/24/us/michigan-water-wolverine-contamination.html.
[70] Ibid.
[71] Tiffany Kary, "Footwear Maker Faces Lawsuits Over Use of 3M's Scotchgard," *Bloomberg*, February 27, 2018, https://www.bloomberg.com/news/articles/2018-02-27/wolverine-world-wide-faces-michigan-suits-over-3m-s-scotchgard.
[72] Jeff Mordock, "Taking on DuPont: Illnesses, deaths blamed on pollution from W. Va. Plant," The News Journal, accessed March 31, 2018, https://www.delawareonline.com/story/news/2016/04/01/dupont-illnesses-deaths-c8/81151346/.
[73] Rothenber, Eric. "Perfluorinated Chemicals: Litigation and Regulatory Update." *Lexology,* January 2017, https://www.lexology.com/library/detail.aspx?g=9ba26928-3aac-40d0-b2cb-a7e83126baf3.
[74] Ibid.
[75] Jeff Mordock, "DuPont, Chemours to pay $670 million over PFOA suits," *The News Journal*, February 14, 2017, https://www.delawareonline.com/story/news/2017/02/13/dupont-and-chemours-pay-670m-settle-pfoa-litigation/97842870/.
[76] "Perfluorochemical Contamination Near Decatur, AL: Fact Sheet." *U.S. Environmental Protection Agency,* April 2013, https://archive.epa.gov/pesticides/region4/water/documents/web/pdf/epa_decatur_fact_sheet_final.pdf.
[77] "Perfluorochemical Contamination of Biosolids Near Decatur, Alabama." *U.S. Environmental Protection Agency: Water Protection,* February 2016, https://archive.epa.gov/pesticides/region4/water/documents/web/html/pfcindex.html
[78] Ibid.

[79] Brackin, John. "3M, DuPont Sued Over Alabama Water Contamination." *Courthouse News*, May 2017, https://www.courthousenews.com/3m-dupont-sued-alabama-water-contamination/
[80] Lawson, Brian. "West Morgan-East Lawrence Water Authority Receives Five Million Dollar Lawsuit Settlement from Daikin." *WHNT 19 News*, May 2017, http://whnt.com/2017/05/11/west-morgan-east-lawrence-water-authority-receives-5-million-lawsuit-settlement-from-daikin/.
[81] "Pease Tradeport Water System Investigation," New Hampshire Department of Health and Human Services, accessed March 31, 2018, https://www.dhhs.nh.gov/dphs/investigation-pease.htm.
[82] Ibid.
[83] **"**Comparing the 2015 Pease Perfluorochemical (PFC) Blood Test Results to Other Populations Tested in the United States." *New Hampshire Division of Public Health Services*, December 2016,https://www.dhhs.nh.gov/dphs/documents/public-comp-slides.pdf.
[84] Ibid.
[85] "NHDES, Merrimack Village District, and Saint-Gobain Performance Plastics Investigating Perfluorochemical Found in Drinking Water," *New Hampshire Department of Environmental Services*, last modified March 4, 2016, https://www.des.nh.gov/media/pr/2016/20160304-saint-gobain.htm.
[86] "NHDES State-wide Perfluorinated Chemicals in Drinking Water Investigation." *New Hampshire Department of Environmental Services*, January 2017. https://www.des.nh.gov/organization/commissioner/documents/pfoa-statewide-status-20170110.pdf.
[87] Ibid.
[88] "NHDES Expanding Perfluorooctanoic Acid (PFOA) Investigation Elevated Levels of PFOA Found in Amherst," *New Hampshire Department of Environmental Services*, last modified May 11, 2016, https://www.des.nh.gov/media/pr/2016/20160511-pfoa.htm.
[89] Ibid.
[90] New Hampshire Department of Environmental Services, "NHDES State-wide Perfluorinated Chemicals in Drinking Water Investigation."
[91] "NH PFAS Investigation." *New Hampshire Department of Environmental Services.* https://www4.des.state.nh.us/nh-pfas-investigation/
[92]New Hampshire Department of Environmental Services Commissioner, *New Hampshire Code of Administrative Rules: CHAPTER Env-A 1400 Regulated Toxic Air Pollutants*. Concord, NH: New Hampshire Department of Environmental Services, 2018. https://www.des.nh.gov/organization/commissioner/legal/rules/documents/env-a1400.pdf
[93] David B. Larson, "Direct Contact Risk-Based Soil Concentration: Perfluorooctanoic Acid," New Hampshire Department of Environmental Services Memo, June 17, 2016, https://www.des.nh.gov/organization/commissioner/documents/pfoa-soil-standard.pdf.
[94] David B. Larson, "Direct Contact Risk-Based Soil Concentration: Perfluorooctane Sulfonate," New Hampshire Department of Environmental Services Memo, June 28,

2016, https://www.des.nh.gov/organization/commissioner/documents/pfoa-dcrb-value.pdf.

[95] Thomas S. Burack, "Sampling for Per- and Polyfluoroakyl Substances/Perfluorinated Chemicals (PFASs/PFCs) at Contaminated Sites," New Hampshire Department of Environmental Services letter, November 22, 2016, https://www.des.nh.gov/organization/divisions/waste/hwrb/documents/pfc-stakeholder-notification-20161122.pdf.

[96] Ibid.

[97] Ibid.

[98] "PFC Blood Testing Program." *New Hampshire Department of Health and Human Services. https://www.dhhs.nh.gov/dphs/pfcs/blood-testing.htm.*

[99] "Perfluorochemicals (PFCs) Blood Testing Program," Division of Public Health Services, New Hampshire Department of Health and Human Services, accessed March 31, 2018, https://www.dhhs.nh.gov/dphs/pfcs/blood-testing.htm.

[100] "Summary of the New Hampshire Department of Health and Human Services' Perfluorochemical (PFC) Blood Testing Program, 2016-2017," *New Hampshire Department of Health and Human Services,* October 2017, https://www.dhhs.nh.gov/dphs/pfcs/documents/results-summary.pdf.

[101] Ibid.

[102] "Southern NH PFOA Investigation Private Well-Testing Request Form." *New Hampshire Department of Environmental Services.* https://www.surveymonkey.com/r/NHDES-S-03-008

[103] "NHDES Southern N.H. PFOA Investigation Update Bottled Water to Be Provided to Approximately 400 Properties," *New Hampshire Department of Environmental Services,* April 7, 2016, https://www.des.nh.gov/media/pr/2016/20160331-bottled-water.htm.

[104] Ibid.

[105] "New Hampshire Department of Environmental Services and Saint-Gobain Performance Plastics Reach Agreement on Consent Decree." *New Hampshire Department of Environmental Services*, March 20, 2018, https://www.des.nh.gov/media/pr/2018/20180320-saint-gobain-plastics.htm.

[106] Ibid.

[107] "NHDES and Textile Coated International Announce Agreement to Fund Design Work on Potential Public Water Extension in Amherst," *New Hampshire Department of Environmental Services,* April 21, 2017, https://www.des.nh.gov/media/pr/2017/20170421-public-water-amherst.htm.

[108] "NHDES Announces Agreement to Begin Water Line Extension to Amherst Properties," *New Hampshire Department of Environmental Services*, October 6, 2017, https://www.des.nh.gov/media/pr/2017/20171006-water-line-amherst.htm.