# Per- and Polyfluoroalkyl Substances (PFAS) Free Laboratory Analyses Program for Public Water Suppliers and Private Wells

## Final Report of the MassDEP-Drinking Water Program and UMass Amherst-Lowell

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MassDEP

UMass Amherst

UMASS LOWELL

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# Executive Summary

## *Background*

This report summarizes the Commonwealth of Massachusetts' Per- and Polyfluoroalkyl Substances (PFAS) Free Analyses Program for Public Water Suppliers and Private Wells (the Program). The Program was launched by the Massachusetts Department of Environmental Protection (MassDEP) with funding provided by the Baker-Polito Administration in 2019 and 2020, and concluded June 30, 2022. The Program was designed to provide the opportunity for free analysis of PFAS in drinking water samples for all Public Water Suppliers and select private wells in the Commonwealth in order to determine the extent of PFAS contamination of drinking water sources across the state.

## *Key Elements of the Program*

Key elements of the Program were as follows:

**Outreach and Informational Meetings**

MassDEP and its University of Massachusetts (UMass) partner conducted outreach to solicit public water system and private well owner applications. The private well portion of the Program also included informational meetings with local Boards of Health and other local officials to provide additional information about the Program and to gain assistance from local officials.

**Technical Assistance Materials**

MassDEP developed a number of training and technical assistance materials, including Question and Answer documents, PowerPoint presentations, template letters, dashboards and Story Maps, sampling instructions, and a PFAS webpage.

**Sampling**

Sampling was conducted by public water supplier operators and private well owners. Sampling instructions were provided to ensure proper sampling technique. 1,171 public water systems and 1,668 private wells were sampled as part of this program.

**Laboratory Analysis of Samples**

Samples collected under the Program were analyzed by MassDEP-certified laboratories contracted by MassDEP to perform the analysis. Results underwent a rigorous quality control review.

**Communication of Results and Follow-up Actions**

MassDEP provided each individual public water system and private well owner with their PFAS results. Results were accompanied by template communications including an explanation of the analytical results. For any private well exceeding the Massachusetts PFAS drinking water standard, MassDEP provided additional follow up and instruction on recommended actions.

**Budget**

Total expenditures for the Program were $3,885,370. Costs were incurred for project management, administrative support, technical assistance, and laboratory analysis of drinking water samples. Funding was provided by Massachusetts supplemental budget funding.

## Key Findings

Analysis of raw water PFAS6 results collected as part of the Program and independently by Public Water Systems (PWS), from 2,418 unique sampling sites at 1,286 PWSs showed that 53% of raw water samples were below 2 ng/L or parts per trillion (ppt), 35% were between 2 ppt and the Massachusetts Maximum Contaminant Level (MCL) of 20 ppt, and 12% exceeded the 20 ppt MCL. In total, over 60% of samples collected at Community PWS had detectable levels of PFAS6 above 2 ppt, whereas the majority of PFAS6 results from Non-transient Non-Community and Transient Non-Community systems were below 2 ppt. In finished water sources, 161 PWS detected PFAS6 above the 20 ppt MCL.

Analysis of PFAS6 results from the 1,668 private wells that were sampled as part of the Program showed that PFAS6 was detected in all four regions of Massachusetts (western, central, northeast, southeast). However, across all regions, the majority of wells (73%) had results below 2 ppt.

A total of 7,981 PFAS6 results collected between 2019 and 2022 from both Public Water Systems and private wells were compiled from 4,086 raw water source locations in 306 communities in the Commonwealth to examine the spatial distribution of PFAS6 statewide. Over 90% of the results were collected from groundwater sources and 91% of the water source locations were collected through the free sampling program.

This spatial distribution analysis showed that the northeast region had the most frequent detections of PFAS6, 77% of sites from that region detected PFAS6 above 2 ppt. However, this region had the fewest number of sites sampled (11%). The western region had the largest percentage (86.5%) of sites with results below 2 ppt, and the smallest percentage (2.5%) above 20 ppt. Overall, the compiled PFAS6 data showed that 61% of detections were below 2 ppt, 30% were greater than 2 ppt but did not exceed the 20 ppt MCL, and 9% were greater than the 20 ppt MCL. One statistically significant grouping of high PFAS6 results was identified where sites with statistically similar results were located within four miles of each other.

Analysis of results from groundwater and surface water showed a statistically significant difference between the water source type. The majority of groundwater sites had detections below 2 ppt, whereas the majority of results from surface water sources were above 2 ppt. For surface water, 13% of sites were above the MCL, while 9% were above the MCL in groundwater sources.

## Recommendations for the Future

Given the wide extent of PFAS detections across the Commonwealth's drinking water sources and the imminent promulgation of federal primary drinking water standards for PFOS and PFOA, it is prudent for MassDEP to further investigate PFAS contamination and continue to invest in sampling and remediation at public and private drinking water sources. Recommendations for further investment and research are provided in Section 12 of this Report.

# List of Acronyms

| | |
|---|---|
| **AFFFs** | Aqueous film-forming foams |
| **BWSC** | MassDEP Bureau of Waste Site Cleanup |
| **CoC** | Chain of Custody |
| **COM** | Community Systems |
| **CTDEEP** | Connecticut Department of Energy and Environmental Protection |
| **DWP** | Drinking Water Program |
| **FAQ** | Frequently Asked Questions document |
| **GenX** | Hexafluoropropylene oxide dimer acid |
| **HDPE** | High-density polyethylene |
| **IHS** | Indian Health Services |
| **ISA** | Inter-Agency Service Agreement |
| **LTO** | Laboratory task order |
| **MassDFS** | Massachusetts Department of Fire Services |
| **MCL** | Maximum Contaminant Level |
| **MDPH** | Massachusetts Department of Public Health |
| **MMCL or MCL** | Massachusetts Maximum Contaminant Level |
| **MRL** | Minimum Reporting Level |
| **MRWA** | Mass Rural Water Association |
| **NAICS** | North American Industry Classification System |
| **ng/L** | nanograms / Liter |
| **NTNC** | Non-Transient Non-Community systems |
| **ORS** | MassDEP Office of Research and Standards |
| **PFAS** | Per- and Polyfluoroalkyl Substances |
| **PFAS6** | PFAS6: Sum of the concentrations of six specific PFAS |
| **PFBS** | Perfluorobutane sulfonic acid |
| **PFDA** | Perfluorodecanoic acid |
| **PFHpA** | Perfluoroheptanoic acid |
| **PFHxS** | Perfluorohexane sulfonic acid |
| **PFNA** | Perfluorononanoic acid |
| **PFOA** | Perfluorooctanoic acid |
| **PFOS** | Perfluorooctane sulfonic acid |
| **ppt** | parts per trillion |
| **PW** | Private Well |
| **PWO** | Private Well Owners |
| **PWS** | Public Water Systems |
| **QC** | Quality Control |
| **SDWA** | Safe Drinking Water Act |
| **TAPs** | Technical Assistance Providers |
| **TNC** | Transient Non-Community systems |

| | |
|---|---|
| **UCMR3** | Third Unregulated Contaminant Monitoring Rule |
| **UMA** | University of Massachusetts, Amherst |
| **UMass** | University of Massachusetts |
| **UML** | University of Massachusetts, Lowell |
| **USEPA** | United States Environmental Protection Agency |
| **USGS** | U.S. Geological Survey |

# 1 Background on PFAS in Drinking Water

## 1.1. How PFAS Get into Drinking Water

Per- and Polyfluoroalkyl Substances (PFAS) are a family of chemicals that have been used since the 1950s throughout the world in the manufacture of stain-resistant, water-resistant, and non-stick products. PFAS are widely used in common consumer products such as coatings on outdoor clothing, carpets, cookware, leather goods, and ski and snowboard waxes. They are used in grease-resistant food packaging papers, fast food containers and wrappers, microwave popcorn bags, pizza boxes, candy wrappers, cleaning products, paints, varnishes, sealants and personal care products such as shampoo, dental floss, and cosmetics.

PFAS have also been found in some kinds of firefighting foams. Aqueous film-forming foams (AFFFs) have been used to extinguish flammable liquid-based fires at training and emergency response events at airports, shipyards, military bases, firefighting training facilities, chemical plants, and refineries.

Given the widespread use of PFAS chemicals, there are a number of different ways that PFAS can enter drinking water. Because PFAS are water soluble, over time PFAS from some firefighting foam, manufacturing sites, landfills, spills, air deposition from factories and other releases can seep into surface soils. From there, PFAS can leach into groundwater or surface water, and can contaminate drinking water. PFAS have also been found in rivers, lakes, fish, and wildlife.

Such contamination is typically localized and associated with a specific facility, for example, an airfield at which AFFF containing PFAS was used for firefighting or a facility where these chemicals were produced or used.

## 1.2. Health Effects of PFAS in Drinking Water

PFAS remain in the environment for a long time and do not break down easily. As a result, PFAS are widely detected in soil, water, air, and food. Exposure can occur when someone uses certain products that contain PFAS, eats PFAS-contaminated food, or drinks PFAS-contaminated water (Figure 1). When ingested, some PFAS can build up in the body and, over time, increase to a level at which health effects could occur.

Studies indicate that exposure to elevated levels of certain PFAS may cause a variety of health effects including developmental effects in fetuses and infants, effects on the thyroid, liver, kidneys, certain hormones, and the immune system. Some studies suggest a cancer risk may also exist in people exposed to higher levels of some PFAS chemicals. Exposure to PFAS chemicals is of particular concern to people in sensitive subgroups, including pregnant or nursing women, infants and people diagnosed by their health care provider to have a compromised immune system.

Scientists and regulators are still working to study and better understand the health risks posed by exposures to PFAS, and MassDEP is following developments in this area closel

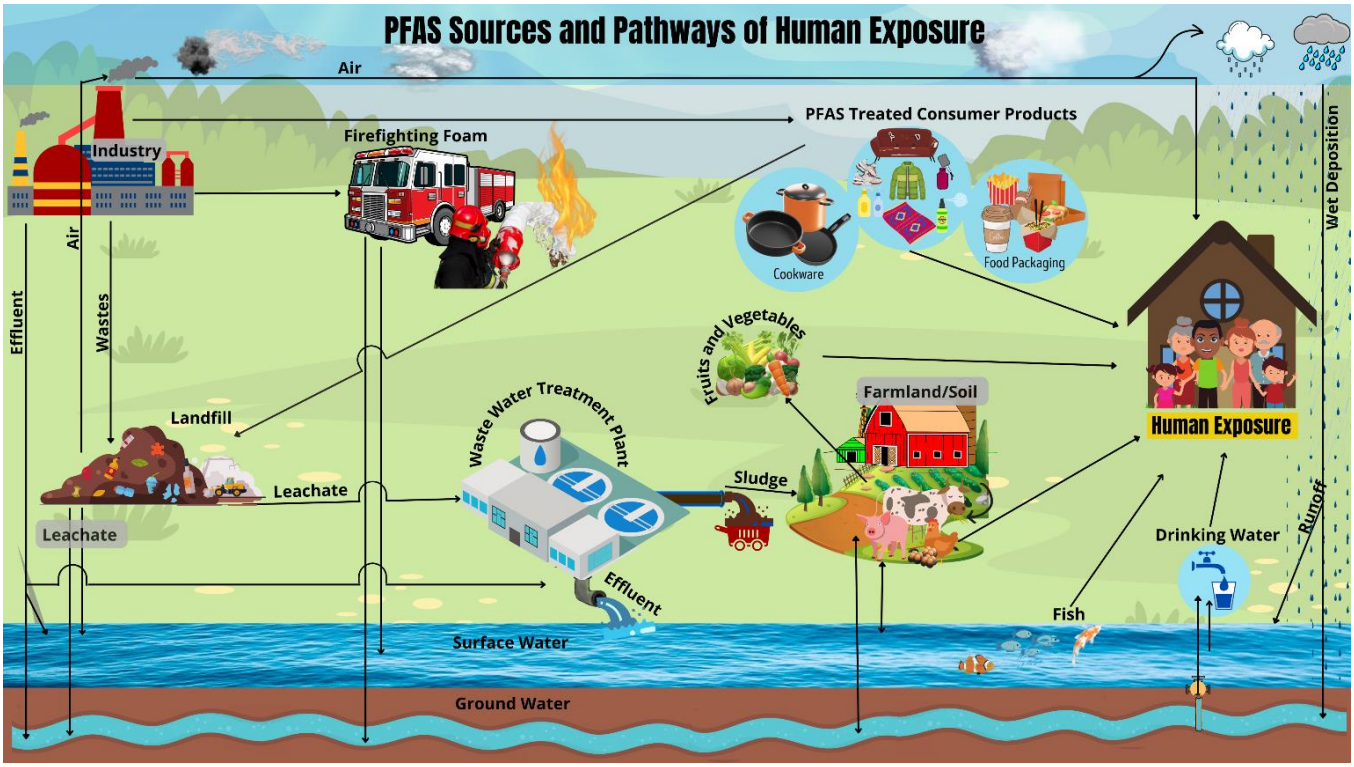


*Figure 1. PFAS Pathways into the environment and human exposure.*

Figure 1. The graphic presents possible human exposure pathways to PFAS and sources. The image does not intend to represent amounts of PFAS or differences between the effects of different exposure pathways. For more information about PFAS exposures see*: EPA* [*Exposure to PFAS.*]

## *1.3. Federal and State Regulation of PFAS in Drinking Water*

### *1.3.1. Federal PFAS Drinking Water Regulation*

There is currently no federal enforceable standard for PFAS in drinking water and PFAS are not covered in the Safe Drinking Water Act (SDWA). However, the known presence of PFAS in drinking water has led to federal action towards protecting public health from these contaminants. Of particular concern is regulation of PFAS in Public Water Systems (PWS). A PWS is an entity that provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or regularly serves an average of at least 25 people for at least 60 days a year.

In 2009, the United States Environmental Protection Agency (EPA) issued provisional guidelines of 200 nanograms / Liter (ng/L) or parts per trillion (ppt) for perfluorooctane sulfonic acid (PFOS) and 400 ppt for perfluorooctanoic acid (PFOA). Between 2013 and 2015, EPA required many public water suppliers to sample for PFAS compounds as part of the third Unregulated Contaminant Monitoring Rule (UCMR3) program. In 2016, as a result of new data and epidemiological studies, EPA established a lower health advisory of 70 ppt for the sum of PFOA and PFOS. Health advisories are non-regulatory values established by EPA to provide information on drinking water contaminants that may pose a risk to human health. EPA's health advisories are intended to offer lifetime protection from adverse health effects resulting from exposure to contaminants in drinking water.

On October 18, 2021, EPA released its PFAS Strategic Roadmap (Figure 2) which laid out an agency-wide approach to addressing PFAS contamination across the country and in various environmental media. The Roadmap includes an intent to establish enforceable primary drinking water regulations for PFOA and PFOS.

On June 15, 2022, EPA announced new interim health advisory levels for PFOA and PFOS, and final health advisories for two other PFAS chemicals, hexafluoropropylene oxide (HFPO) dimer acid and its ammonium salt (GenX) and perfluorobutane sulfonic acid and its potassium salt (PFBS). These health advisories are:

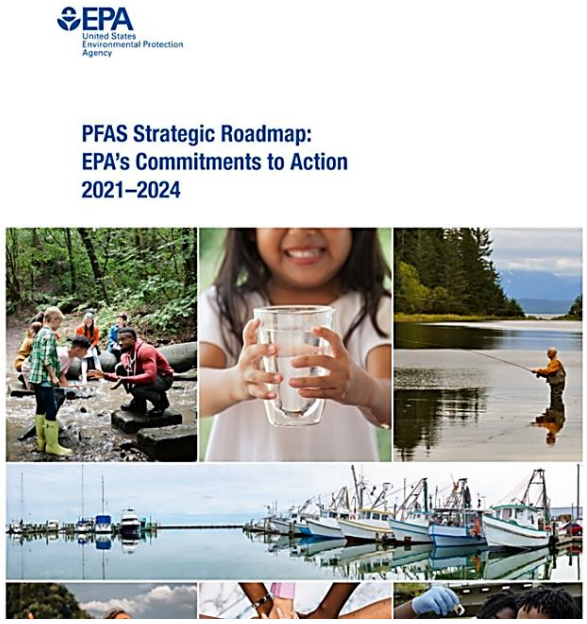


*Figure 2. PFAS Strategic Roadmap*

- ✓ Interim updated Health Advisory for PFOA = 0.004 ng/L
- ✓ Interim updated Health Advisory for PFOS = 0.02 ng/L
- ✓ Final Health Advisory for GenX chemicals = 10 ng/L
- ✓ Final Health Advisory for PFBS = 2,000 ng/L

Most recently, on March 14, 2023 EPA released proposed National Primary Drinking Water regulations for PFOA, PFOS and four other PFAS. EPA is proposing to set a Maximum Contaminant Level (MCL) of 4.0 ppt for PFOA and 4.0 ppt for PFOS and is proposing to address four additional PFAS (GenX, PFBS, Perfluorononanoic acid [PFNA], and Perfluorohexane sulfonic acid [PFHxS]) as a mixture using a Hazard Index MCL of 1.0

(unitless). A Hazard Index accounts for the increased risk from mixtures of PFAS. The final regulations and MCLs are expected by the end of 2023. For more information on EPA's proposed regulations see EPA Proposed PFAS Primary Drinking Water Regulations.

### 1.3.2. *MA PFAS Drinking Water Regulations and Public Water Supplier Compliance Requirements*

State agencies, such as MassDEP, have the authority to promulgate regulations that are more stringent than federal regulations promulgated by EPA. Since there is no federal drinking water standard for PFAS, MassDEP promulgated its own state standard for PFAS in drinking water that is more stringent than the EPA 70 ppt Health Advisory for PFOS and PFOA that existed at the time of the development of MassDEP's regulations.

On October 2, 2020, MassDEP published its PFAS public drinking water standard, called a Massachusetts Maximum Contaminant Level (MMCL or MCL) of 20 ng/L or ppt for community (COM) and non-transient non-community (NTNC) public water systems individually or for the sum of the concentrations of six specific PFAS. These PFAS are PFOS; PFOA; PFHxS; PFNA; perfluoroheptanoic acid (PFHpA); and perfluorodecanoic acid (PFDA). MassDEP abbreviates this set of six PFAS as "PFAS6." This drinking water standard is set to be protective against adverse health effects for all people consuming the water. The MassDEP Office of Research and Standards (ORS) determined through an in-depth review of recent scientific peer-reviewed research and in consultation with their Health Effects Advisory Committee that 20 ppt for PFAS6 was the appropriate level to protect consumers in sensitive subgroups such as pregnant or nursing women, infants, and people with compromised immune systems.

Transient non-community (TNC) systems, such as campgrounds or restaurants, are not subject to the PFAS6 MCL, however they are required to collect, analyze, and report results of one PFAS sampling round to MassDEP, and may be subject to a site-specific health assessment for elevated levels.

The PFAS drinking water regulations are incorporated into the Massachusetts Drinking Water Regulations at 310 CMR 22.07G. These regulations require PWSs to monitor for PFAS and to take corrective actions to reduce drinking water exposures to PFAS6 to below the MCL. The regulations also include provisions for Public Education and Public Notification for PFAS6 exceedances and violations, respectively, in order to provide important information to the public about their drinking water.

The regulations require PWSs to sample for PFAS at every entry point to their distribution system. COM and NTNC systems are required to begin PFAS sampling during an initial monitoring period based on the size of the population served and collect four quarterly samples within the first month of each quarter. Depending on the levels of PFAS6 detected in a systems' drinking water, the system may be required to conduct more frequent monitoring.

A detection of PFAS is defined as any PFAS contaminant level greater than a laboratory's minimum reporting level (MRL). The required MRL for each of the six PFAS6 compounds is less than or equal to 2.0 ng/l. Initial confirmatory samples are required for a detection of any PFAS, not just PFAS6. Any COM or NTNC system which has a confirmed PFAS6 detection above 10 ppt (or half the 20

ppt MCL) is required to conduct PFAS monitoring monthly, in order to determine compliance with the MCL or if the drinking water is reliably and consistently below the MCL. Compliance with the 20 ppt MCL is determined by a calculation of the average of the monthly samples taken over one quarter. Should this quarterly average exceed 20 ppt, the PWS is in violation of the PFAS6 drinking water standard.

Large COM and NTNC systems began their required PFAS monitoring in January 2021, with medium and small systems following in April 2021 and October 2021, respectively. TNCs were required to complete their monitoring requirements by September 30, 2022. The PFAS Free Analyses Program for PWS provided a round of free sampling that could be used as part of a system's regulatorily required monitoring.

The regulations also require that, by December 31, 2023, and every three years after that, MassDEP perform a review of the relevant developments in the science, assessment and regulation of PFAS for the purpose of evaluating whether to amend 310 CMR 22.07G(3) in light of any advancements in analytical or treatment technology, toxicology and/or any other relevant information. MassDEP will adopt regulations at least as stringent as EPA, when the final MCLs are released.

## 1.4. PFAS work efforts across the Commonwealth

Besides actions to regulate and address PFAS in Massachusetts drinking water supplies, several Massachusetts agencies and entities are taking action to address PFAS contamination across the Commonwealth. The following subsections summarize some of these actions.

### PFAS Interagency Task Force

In 2020, the Massachusetts legislature appointed the PFAS Interagency Task Force to investigate water and ground contamination of PFAS across the Commonwealth. The Commissioner of MassDEP was named to serve as one of the Task Force's 19 members. The Task Force held nine public hearings throughout 2021 and heard testimony from a wide range of stakeholders including researchers, advocacy groups, community members, municipal officials, state agencies, public water systems, industry groups, and legislators. In April 2022, the members of the Task Force adopted their final report, per their statutory charge. The final report outlined the Task Force's 30 recommendations in eight categories, including many that directly or indirectly impact PFAS in drinking water. The Task Force recommended expanding PFAS regulations and specifically recommended establishing standards for PFAS in drinking water that go beyond the PFAS6 standard.

### Attorney General PFAS Lawsuit

On May 25, 2022, Massachusetts Attorney General Maura Healey joined several other states in suing 13 manufacturers of PFAS chemicals used in firefighting foams for causing millions of dollars in damages to communities across the Commonwealth by knowingly contaminating drinking water sources, groundwater, and other natural resources with highly toxic PFAS chemicals that pose a serious threat to public health and the environment.

## *Statewide PFAS Funding*

In 2019 and 2020, the Massachusetts Legislature provided $28.4M in PFAS funding through two supplemental budgets: Chapter 142 of the Acts of 2019 and Chapter 31 of the Acts of 2020. These appropriations were intended for the testing and remediation of potential PFAS contamination of water supplies, and enabled MassDEP to offer a grant program to support the design of systems for treatment of drinking water in PFAS-impacted communities and to provide low interest loans, through the Clean Water Trust, for the remediation of affected water supplies.

Using $8.4M of these funds, MassDEP established a program to provide grants for treatment design to include reimbursement for costs already incurred, free PFAS testing for Public Water Supplies, and a free private well drinking water testing program in 85 towns in the Commonwealth.

## *PFAS Treatment Grant Program*

The PFAS Treatment Grant Program provided two rounds of competitive grants to PFAS6-impacted communities served by COM and NTNC systems for the costs of planning, conducting pilot studies, performing pump tests, engineering, and design work to eliminate or mitigate a public health risk from PFAS6 contamination of public drinking water. The most competitive projects proposed work that would maintain adequate capacity to meet demand, and that was necessary to achieve or maintain a reliable and consistent level of PFAS6 (below 10 ppt) to ensure compliance with applicable drinking water quality standards. These grant funds were also available to reimburse PFAS6-affected communities that already expended funds for this work.

Almost $5 M in grants were awarded in two rounds. Ten projects were funded in Round 1 and another 17 projects in Round 2.

## *PFAS6 Interim Response Grant Program*

The PFAS6 Interim Response Grant Program provided grant funds to help offset the cost of emergency response to MCL exceedances of PFAS6 contamination in drinking water. Eligible emergency response actions included costs of temporary solutions such as providing bottled water, temporarily purchasing water from another supplier or temporarily establishing an interconnection with another water supply.

These grants were also awarded in two rounds. In Round 1, 12 awardees received a total of $1.3 M, and in Round 2, 12 awardees received a total of $950,700. In Round 1, MassDEP provided funds to eligible projects not yet completed as well as reimbursement for costs already incurred. In Round 2, MassDEP provided funds to eligible projects only for reimbursement for costs already incurred.

## *Small Systems PFAS Grant Program*

The Small Systems PFAS Grant Program provided grant funds to small PWSs to reimburse or pay for new long-term treatment of PFAS in water supplies that have an exceedance of the PFAS6 MCL. The grant was open to public or private PWSs serving less than 3,300 users.

More than $1 M was awarded to 21 small PWS.

In addition to these grant programs, the Clean Water Trust has established PFAS projects as priority funding for 0% loans, and has provided over $200 M in State Revolving Fund financing. Additional funding for PFAS impacted communities is anticipated through the 2021 Bipartisan Infrastructure Law.

For a summary of PFAS projects supported by statewide funding, see Tab 6 “Grants in MA

dashboard" in the PFAS Story Map (Figure 3).

## *Department of Public Health – PFAS in Bottled Water*

The Massachusetts Department of Public Health (MDPH) Food Protection Program publishes a list of companies licensed to sell or distribute bottled water or carbonated non-alcoholic beverages in Massachusetts. This list includes only bottlers licensed by MDPH after they provided test results which show that their bottled water or beverages comply with drinking water standards for PFAS and other contaminants established by MassDEP, EPA, and the US Food and Drug Administration.

To access the MDPH list of bottlers see: https://www.mass.gov/doc/list-of-bottlers-may-12-2022-0.

## *PFAS and Waste Sites*

PFAS are considered to be "hazardous material" subject to the notification, assessment and cleanup requirements of the Massachusetts Waste Site Cleanup Program under the Massachusetts Contingency Plan, 310 CMR 40.0000. The MassDEP Bureau of Waste Site Cleanup (BWSC) conducts investigations around known PFAS contaminated sites with the goal of identifying a Potentially Responsible Party – and the source of the contamination.

For groundwater used as drinking water, MassDEP established a reportable concentration of 20 ppt for PFAS6, requiring that any private well owner with knowledge of PFAS6 equal to or greater than 20 ppt in their well water report that concentration to MassDEP.

MassDEP BWSC has conducted investigations at numerous private wells in response to

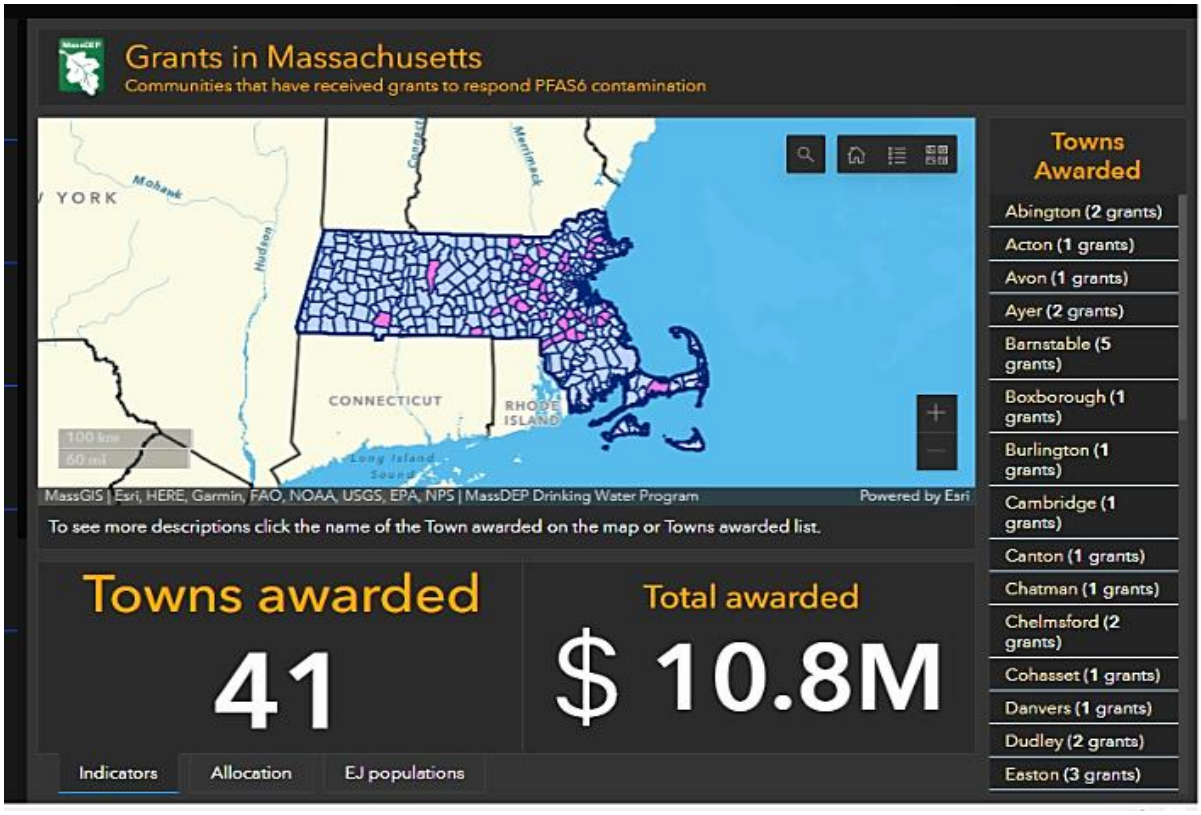


*Figure 3. Grants in Massachusetts dashboard*

sampling conducted under the Program and as of June 30, 2022, provided bottled water to the 10 private well owners who sampled above the imminent hazard level of 90 ppt as part of the Program.

For additional information about MassDEP BWSC investigations click here.

## *PFAS in Fire Fighting Foam: Takeback Program, Advisory, and Sampling Analysis*

PFAS containing AFFFs are effective at fighting certain fires but pose a threat to the environment and human health. MassDEP, in partnership with the Massachusetts Department of Fire Services (MassDFS), initiated a legacy AFFF collection and destruction program in 2018 that, to date, has collected more than 203,000 pounds (over 23,000 gallons) of legacy foam from 120 fire departments and facilities across the Commonwealth and the Massachusetts Department of Transportation. The pre-2003 versions of the foam use certain PFAS compounds, which have contaminated some groundwater and drinking water sources across the country. The take-back program ensures that these foams are removed from current stockpiles and appropriately neutralized.

In August 2021, the MassDFS and MassDEP issued a joint advisory for AFFF containing PFAS which advised fire departments to immediately cease using AFFF older than 2003 and reserve the use of current (post-2003) AFFF only when life safety is at risk. The advisory also included recommendations for use of Fluorine Free Foams, discontinuation of PFAS containing foams for training, and notification to MassDEP when PFAS containing foams are used.

MassDEP, in partnership with the Connecticut Department of Energy and Environmental Protection (CTDEEP) and fire services in both states, conducted a study involving the analysis of six aqueous AFFFs currently on the market and listed as "fluorine-free." Off-the-shelf foams were acquired by CTDEEP and provided to MassDEP's contract laboratory for PFAS analyses. The results of this study showed that one of the six foams had no detectable levels of fluorinated or other halogenated compounds, four of the foams showed very low levels, which may have been the result of other sources, and one of the foams showed several PFAS compounds and should not be considered a comparable Fluorine Free Foam.

## *PFAS in Residuals*

MassDEP regulates the land application of sludge and septage for beneficial purposes including residuals produced from sanitary wastewater sludge, drinking water treatment facility sludge, short paper fiber, and food waste.

All residual products sold, distributed, and applied in Massachusetts are subject to an Approval of Suitability, which classifies biosolids for different uses based on the chemical quality and treatment to reduce pathogens. Each approval must be renewed for up to five years. Since August 2020, MassDEP has required quarterly monitoring of PFAS in residuals that have an Approval of Suitability and are permitted to be reused through land application. This increased frequency in monitoring was implemented to address the need for more information on PFAS characteristics in residuals.

MassDEP is exploring actions to evaluate and address PFAS in residuals and convened a stakeholder process to gather information and share ideas. Information on PFAS is constantly evolving, and MassDEP will continue to evaluate this issue, especially in light of the new proposed EPA MCLs.

Additional information on MassDEP's efforts to establish standards for PFAS in residuals can be found at:

https://www.mass.gov/info-details/pfas-in-residuals.

### *PFAS in Massachusetts Rivers Study*

MassDEP jointly funded a U.S. Geological Survey (USGS) water quality study to evaluate the presence of PFAS in Massachusetts' rivers and streams. USGS conducted three rounds of sampling at each of 64 sites in 27 rivers from August to November 2020 and analyzed the samples for 24 individual PFAS. Sampling sites were located upstream or downstream of discharges from 24 wastewater treatment facilities and at 16 other stream sites, including sites downstream of suspected nonpoint and industrial sources and at sites not associated with suspected PFAS sources.

PFAS were detected in all 27 rivers sampled. Individual PFAS concentrations ranged from not detected in the laboratory to 109 ppt, and the sum of all 24 PFAS at a sampling location ranged between 0.3 and 399 ppt. The concentration of PFAS6 ranged from non-detect to 108 ppt. The highest concentrations were observed downstream of wastewater effluent discharges, but PFAS were also found in rivers upstream of these discharges. The lowest concentrations were observed in rivers located in less populated areas.

Multiple sources, including wastewater discharges, may contribute to riverine PFAS concentrations. MassDEP will continue to identify future monitoring objectives, potential studies, and other actions to better understand and address the distribution of PFAS in surface waters, relative contributions of different sources, and implications for public health and aquatic life.

### *Pesticide Products and Mosquito Control*

PFAS contamination was identified in September 2020 through citizen science testing of a pesticide product for mosquito control. EPA worked with MassDEP to investigate the source of the contamination. EPA determined that fluorinated high-density polyethylene (HDPE) containers that were used to store and transport a mosquito control pesticide product contained PFAS compounds that were leaching into the product.

The affected pesticide manufacturer has voluntarily stopped shipment of any products in fluorinated HPDE containers and is conducting its own testing to confirm EPA results and product stability in un-fluorinated containers. For additional information click here.

## *1.5. Free PFAS Laboratory Analyses Program for PWS and private wells*

MassDEP developed the Free PFAS Laboratory Analyses Program for Public Water Suppliers and Private Wells to:

1. **Provide the opportunity for free laboratory analysis of PFAS in drinking water to PWSs and select private well owners;**
2. **Characterize the extent of PFAS contamination in drinking water supplies across the Commonwealth.**

There are currently 1,598 active PWS in the Commonwealth. Of those, 1,466 are required to sample for PFAS under the drinking water regulations because they have their own source of drinking water. The Free PFAS Analyses Program for Public Water Suppliers provided analysis for 80% of active PWS in the Commonwealth.

MassDEP established the Program, in part, to assist the 1400+ PWS facing this new financial burden following the October 2020 establishment of the PFAS6 drinking water standard and associated monitoring requirements. MassDEP encouraged PWS to take advantage of the financial and technical assistance while available and allowed for samples collected under the Program to count towards regulatory requirements, even if collected prior to a systems' initial monitoring period.

There are approximately 200,000 private wells in Massachusetts serving 600,000 residents. The Free PFAS Analyses Program for Private Wells provided PFAS results to 1,668 private well owners in the Commonwealth. There is currently no state PFAS drinking water standard for private wells. However, since the PFAS6 MCL of 20 ppt was set to be protective against adverse health effects for all people consuming the water, MassDEP used this value to communicate with participants of the private well sampling program regarding potential health effects and recommendations concerning the installation of home treatment systems.

# 2 Funding for the free PFAS analysis program

Funding for the Free PFAS Analysis Program came primarily from the supplemental budgets discussed in Section 1.4. This funding included $2,277,570 allocated to an Inter-Agency Service Agreement (ISA) between MassDEP and the University of Massachusetts (UMass), Amherst (UMA) for implementation of the Program. The funding associated with the ISA went towards administrative and technical support and project management provided by UMA and University of Massachusetts, Lowell (UML). Additional supplemental budget funding was also allocated to laboratory services for four laboratories that were contracted by MassDEP to conduct the PFAS laboratory analyses for the Program. The laboratory services allocation totaled $1,705,311, for PWS and private well PFAS analysis. An additional $400,000 for laboratory analysis services was allocated to the Program from MassDEP available funds in 2021.

# 3 Inter-Agency Service Agreement with UMass Amherst (support from UMass Lowell)

In June 2020, MassDEP entered into an ISA with UMA for implementation of the Program. The ISA also identified UML as a primary subcontractor. MassDEP partnered with UMass to provide program management, technical assistance, outreach and training, and support for sampling and laboratory analysis services for implementation of the Program. Specifically, pursuant to the ISA, UMass was tasked with providing: 1) one or more qualified Program Directors to oversee implementation of all ISA tasks and obligations; 2) a Project Manager to be located in the Boston MassDEP office; 3) one or more Project Managers to coordinate the implementation of the Program between UMA and subcontractor UML; 4) multiple qualified Technical Assistance Providers (TAPs) to work with Public Water Suppliers and private well owners; 5) a qualified Lab Specialist to oversee all activities of approved laboratories for sample collection and testing; 6) an Analytical Specialist to ensure proper QA/QC and reporting of data; and 7) a qualified Fiscal Specialist to process and track all invoices and payments for laboratory, contractor and other services.

The responsibilities of UMass under the ISA included: 1) establishing an electronic Master File; 2) developing key materials; 3) assembling a team of managers and TAPs; 4) acting as the primary point of contact for the water suppliers on matters and questions related to the Program; 5) providing formal and informal technical assistance to all water suppliers in the form of meetings and answering questions; 6) providing resources and training to help operators collect the drinking water samples; 7) directing the samples to available approved laboratories and follow-through to see that the samples are tracked, analyzed, quality assured, and reported; 8) providing follow-up technical assistance to water suppliers after sample results have been received; 9) developing and maintaining a centralized fiscal management system; 10) establishing, maintaining, and monitoring a telephone call-in number and email account for technical assistance; 11) developing a risk

communication strategy and providing information for a risk communication brochure about PFAS; and 12) hosting informational meetings, one in each MassDEP region, for PWS operators, boards of health, private well owners, and other technical service providers to train about proper PFAS sample collection methods.

The ISA was amended in July 2021 to extend the services provided by UMass through June 30, 2022. Additionally, at that time, a new task was added to the ISA to conduct testing of point-of-use devices for the removal of PFAS6 from drinking water. The point-of-use testing project is ongoing, and a final report will be issued when findings are available.

# 4 Free PFAS Laboratory Analyses Program for Public Water Suppliers

The Free PFAS Laboratory Analyses Program for Public Water Suppliers was established to provide free PFAS drinking water laboratory analysis for all non-consecutive public water systems in the Commonwealth (those with their own drinking water source). A total of 1,171 eligible suppliers signed up for the Program.

The Program provided analysis of samples from Public Water Suppliers' source water (raw) and finished water sampling locations, providing financial and technical assistance to PWSs dealing with the new PFAS6 MCL and associated monitoring requirements. This opportunity was available to COM, NTNC and TNC non-consecutive systems, and covered the cost of analysis of water sampled, associated field blank analysis, and confirmation sampling, if necessary. This alleviated a financial burden of approximately $300 per sample for participating PWSs. Additionally, PFAS results collected, analyzed, and reported to MassDEP through the Program could be used by participating suppliers towards regulatory baseline testing requirements.

## *4.1. Program Elements and Implementation*

The following subsections summarize the elements of the Program and its implementation. The Program components described below are: soliciting participation from PWSs through a Notice of Interest form; contracting technical assistance providers and a laboratory specialist through the ISA; communicating with public water suppliers and their contract operators; assisting PWSs with sampling; laboratory analysis and associated quality control reviews; data entry of PFAS results; communication of results; and outreach activities to encourage participation by all eligible water suppliers.

### *4.1.1. Request for Interest*

On September 3, 2020, prior to the promulgation of the final drinking water regulations establishing the PFAS6 MCL, MassDEP sent an informational letter to all PWS in the Commonwealth to encourage early participation in the Program. The letter instructed PWSs to fill out a survey to indicate their interest. MassDEP eventually created a formal Notice of Interest form to collect applications and information necessary to establish a laboratory task order (LTO) for the specific PWS.

The Notice of Interest form collected information from the PWS applicants including: PWS identification number; PWS name; system type; maximum population served; ownership (municipal or non-municipal); primary contact information; PFAS sampling status; number of distribution system entry points with associated sources; and PFAS treatment. This information was transferred from the individual forms to a master list of applicants and distributed to UMass technical assistance providers to assist in establishing PWSs in the Program

### *4.1.2. Technical Assistance Providers and Laboratory Specialist*

To facilitate implementation of the Program

seven Technical Assistance Providers (TAPs) were hired to guide participating PWSs through the program stages. The TAPs initiated communications with PWS participants, created LTOs to initiate sampling, interpreted PFAS results from initial sampling, determined if confirmatory sampling was warranted, and interpreted results for participants.

As stipulated in the ISA, a Laboratory Specialist position was also established. This position was responsible for sending LTOs to the contract laboratories, communicating with the contract laboratories about analytical issues that affected quality control, and generally ensuring good communication and a positive working relationship between UMass, MassDEP, and the laboratories contracted to conduct the PFAS analyses.

### *4.1.3. Communication with Public Water Suppliers*

TAPs communicated with PWS participants through email and phone. Template email communications were sent to the PWS at each stage of the Program to provide and explain results, follow up on quality control issues, and set up confirmatory sampling. A closeout letter was sent once a PWS had completed a full round of free analyses. This letter explained that sampling was complete through the Program, and that the PWS should expect to receive future communications regarding PFAS monitoring requirements from regional MassDEP staff.

### *4.1.4. Sampling*

Under the Program for Public Water Suppliers, LTOs were developed by program TAPs and sent to one of four contract laboratories. The LTOs included information pertinent to the sampling event including: TAP contact information, PWS contact and shipping information, sampling location information such as location name and type (raw or finished), and the number of sampling bottles required based on the number of locations to be sampled. Upon receipt of an LTO the contract laboratory delivered sample bottles to the indicated shipping address for sample collection.

Generally, each PWS that participated in the Program was responsible for collecting their own drinking water samples. Samples were often collected by the system's operator or other designated individual. Prior to collection, the PWS was provided with a copy of the LTO and sampling instructions. The sampling instructions provided step-by-step directions for collecting PFAS drinking water samples, tips to avoid sample contamination, a materials list, and instructions for properly returning samples to the contract laboratory.

In addition to the drinking water samples, collection of a field blank representative of each sampling location was required, and instructions were provided for filling the field blank bottles.

Samplers were also instructed to properly complete required sections of the Chain of Custody (CoC) form. The CoC tracks custody of the samples from collector to receiver, and records important information about collection date, time, and sample temperature. This information is required to ensure the samples are reliable and have been preserved properly prior to analysis. Samplers were instructed to return their samples to the laboratory by scheduling pick up by the laboratory, directly delivering the samples to the laboratory, or using prepaid shipping labels provided for overnight courier.

Some PWS chose not to sample through the Program and paid for analysis of their required samples on their own. The results collected outside of the Program are also incorporated into the analyses described in Section 10 of this report.

### *4.1.5. Laboratory Analysis of Samples*

Laboratories are required to be certified by MassDEP for EPA methodologies 537 or 537.1 to analyze PWS water samples for PFAS. EPA Method 537 can detect 14 PFAS and EPA Method 537.1 can detect 18 PFAS. Both methods can detect the six state regulated compounds (PFAS6), along with eight or twelve other method analytes. MassDEP contracted with four laboratories certified in Massachusetts to conduct analysis of PFAS in drinking water. These laboratories were, Alpha Analytical, Eurofins Easton Analytical, GEL Laboratories, and Pace Analytical (formerly Con-Test).

#### *4.1.5.1 Quality Control Review of Data*

Throughout the Program, thousands of PWS samples were collected and analyzed for the presence of PFAS analytes. Although many of these water quality analyses were conducted through the Program, the MassDEP-UMass quality control (QC) team reviewed all PFAS results reported to MassDEP.

Upon receiving each PFAS report, the MassDEP-UMass QC team performed a quality control review of the results to ensure the accuracy and usability of the data. The quality control review ensures proper sample collection by PWSs and accurate water sample analysis and reporting of data by certified laboratories. The QC portion of the Program provided internship opportunities for 16 students, giving them real-world experience while encouraging them to grow as science and engineering students.

The QC review process has evolved along with state regulations and EPA methodologies. In September 2021, MassDEP began requiring electronic reporting of PFAS drinking water results using the Department's eDEP system, resulting in a shift away from paper reporting. The QC review form was revised, and new guidance documents were developed to cover issues specific to electronic reporting of laboratory data.

EPA methodologies have also adapted since the start of the Program. EPA Method 537 was the primary method for PFAS analysis in drinking water at the beginning of the Program, with EPA Method 537.1 growing in popularity as the Program progressed. QC review documentation was updated to reflect the specificities of EPA Method 537.1.

The quality control review process either found the PFAS results to be accepted, partially accepted, or rejected. Numerous reports included multiple water sample results, and where only some were acceptable those received a partial acceptance verdict. In total, 4,653 PWS PFAS results reports have been reviewed, and out of those, 4,147 (89.1%) were accepted, 133 (2.86%) were partially accepted, and 335 (7.2%) were rejected. Fewer than 1% of all reports received were put on hold for correctable lab revisions or labeled as duplicates when identical transactions were uploaded to the electronic reporting system (Table 1). A smaller percentage of QC rejections required resampling and many rejections were correctable by lab resubmissions and revised

reporting.

| PWS Report Verdicts | | |
|---|---|---|
| **Verdict** | **Number of Reports** | **Percentage of Reports** |
| Accept | 4,147 | 89.10% |
| Partial | 133 | 2.86% |
| Reject | 335 | 7.20% |
| Duplicate | 17 | 0.37% |
| Hold | 21 | 0.45% |
| Total | 4,653 | 100.00% |

*Table 1. PWS QC verdicts summary*

There are three levels to the QC review process. Levels one and two are completed for every report, while level three is only necessary if a water sample exceeds the PFAS6 MCL, or if other special circumstances are met such as testing of a new source or results received from a newly certified laboratory.

Level one focuses on basic QC information such as: MassDEP lab certification, minimum reporting levels (MRLs), unit of measurement, and holding times. These are automatically assessed by MassDEP's electronic reporting system, eDEP, upon submission by the laboratory.

Level two ensures that the results were correctly uploaded to eDEP by the certified laboratories, the samples were properly collected and stored during transportation, and that none of the field sample and field blank results are outside of acceptance criteria.

Level three focuses on the laboratory report's Batch QC, which contains components and analyses that are associated with every sample in the report. These components are reviewed to assess if there are any detections, recoveries, or relative percentage differences that are outside of acceptance criteria and could cause sample results to be biased and/or inaccurate.

PFAS laboratory results can be QC rejected based on analysis and/or sampling issues, as well as reporting issues. Following the September 2021 release of electronic reporting for PFAS drinking water results, MassDEP and UMass staff worked with laboratories to ensure reporting compliance through eDEP.

Overall, the majority of PFAS analyses were successful and provided accurate, unbiased results for drinking water samples from PWSs. The small percentage of results that were rejected and required resampling were rarely the fault of the analytical laboratory and had more to do with mistakes made during the collection process, such as not filling the sample bottles sufficiently, or the preservation of water samples during the transportation process.

#### *4.1.5.2 Data Entry*

Prior to eDEP being able to accept PFAS drinking water results, such results were manually data entered in order to be available internally to MassDEP staff and externally to the public via the EEA Data Portal.

PFAS data entry initially focused on the six regulated PFAS contaminants. PFAS6 was the focus for data entry to ensure the efficient and prompt movement of regulated contaminant data to the public data portal. It was important for this regulated contaminant data to be available to the public so that consumers of the water were informed and could make decisions in response to levels in their drinking water.

The September 2021 release of eDEP for PFAS drinking water data eliminated the requirement for manual data entry. Results that pass the MassDEP quality control review are passed to the MassDEP drinking water compliance database and from there automatically move to the public data portal. This allowed data entry staff to begin manual

entry of the non-regulated PFAS contaminants that were previously received. Since the beginning of the project, approximately 1,200 PFAS drinking water quality laboratory reports have been fully data entered. This equates to tens of thousands of individual PFAS contaminant results.

### *4.1.6. Communication of results and confirmation sampling for first PFAS detections*

PWS participants were informed of their results and any associated required follow up actions via template email letter sent by a TAP. TAPs informed PWSs of their initial results prior to the quality control review and followed up with the PWS for any required resampling in the event that the initial results did not pass the quality control check.

The Program provided free confirmation sample analysis, if required. COM and NTNC systems were provided a confirmation sample through the Program if there was a detection of any PFAS contaminant at one or more of the system's sampling locations, as required by the Drinking Water Regulations.

TNC systems were initially provided a confirmation sample for any detection as well. However, based on developing guidance, the confirmation level for TNCs was increased to PFAS6 above 16 ppt for systems with residential uses on site, and PFAS6 above 45 ppt for those without residential uses.

If the confirmatory samples passed the quality control review, the TAP sent a closeout template letter to the PWS explaining the results and relaying that the sampling through the Program was complete. If the confirmatory results did not pass the quality control review, and required resampling, a new LTO was developed and provided to the contract laboratory for resampling. The Program provided the opportunity for resampling until the PWS had one complete round of free analyses.

### 4.1.7. Outreach Activities

Over the course of the Program MassDEP and its UMass partners conducted outreach to PWS to inform them of the Program and encourage their participation while funding was available. Particular focus was given to outreach targeting small COM and NTNC systems and TNCs. MassDEP recruited outreach assistance from several of its partner organizations, including RCAP Solutions, Mass Rural Water Association (MRWA), local Boards of Health, and the Massachusetts Restaurant Association. The Program saw increased participation that directly resulted from direct outreach to PWS. Specific outreach strategies are described in the following subsections.

#### 4.1.7.1 In the Main Newsletter / TNC Newsletter

Bi-weekly, MassDEP Drinking Water Program (DWP) sends the *In the Main* Newsletter to all PWSs and other subscribers, including many system operators. Throughout the Program, the newsletter contained a reminder to sign up for free analysis. As the Program progressed, these reminders were targeted to certain sized systems based on their monitoring requirements. Specific messaging

targeting TNCs was provided in several issues towards the end of the Program to encourage TNCs to sign up before funding was exhausted.

#### 4.1.7.2 Direct Contact through Partner Organizations

Over the course of the Program, MassDEP DWP provided lists of systems that had yet to sample for PFAS or sign up for the Program to partner organizations for direct outreach. Partners such as RCAP Solutions and MRWA directly contacted systems on provided lists to encourage their participation in the Program.

Local Boards of Health and the Massachusetts Restaurant Association were recruited to conduct outreach to specific TNCs who had not yet signed up for the Program or sampled on their own.

#### 4.1.7.3 Direct Calls to TNC Systems by UMass TAPs

Starting in January 2022, UMass TAPs directly called the primary operators of over 200 TNCs which had not yet signed up for the Program. This direct outreach was highly successful and resulted in an influx of TNC sign ups in January and February of 2022, including 90 TNC Notice of Interest forms received just in the first week of calls.

# 5 Free PFAS Analyses Program for Private Wells

The Free PFAS Laboratory Analyses Program for Private Wells was established to **1) <u>determine the extent of PFAS contamination</u>** of groundwater across the Commonwealth and, **2) <u>provide free PFAS analysis of private well drinking water</u>** to select private wells in 85 Massachusetts towns in which 60 percent or more of residences were served by private wells. 1,668 private wells were sampled and received results as part of this program.

*Figure 4. Private Well*

## *5.1. <u>Program Elements and Implementation</u>*

The following subsections summarize the elements of the private well Program and its implementation. The program components described below are: soliciting participation through a Notice of Interest Form; selection of applicants to invite to the Program through a developed methodology; acceptance / rejection of registrants; coordination with public entities; technical assistance materials; sampling; laboratory analysis; and communication with private well owners.

### *5.1.1. <u>Notice of Interest</u>*

MassDEP DWP staff created a website for the public to notify MassDEP of their interest in participating in the Program. Elements of the application included: contact information, well location and kit delivery address, optional well type, depth, and date of installation, and optional treatment information.

The Notice of Interest form also included a list of certifications which the applicant had to agree to before submitting a completed application. These certifications are listed below:

- I agree to return my signed agreement form within two weeks (14 calendar days) of receiving it.
- I agree to collect the water samples according to the instructions provided by MassDEP.
- I agree to sample and coordinate with the laboratory to return my sample(s) within two weeks (14 calendar days) of receiving my sampling kit.
- I agree to prepare the sample(s) for transportation via laboratory courier to the designated laboratory within the cooler provided.

- I understand that MassDEP cannot guarantee that the name and address of the well owner and the sampling results will not become public pursuant to a request for information under the Massachusetts Public Records Law.
- I understand MassDEP's Drinking Water Program will send a copy of the results letter to the local Board of Health in the municipality where the wells are located and to the MassDEP Bureau of Waste Site Cleanup (BWSC).
- I understand that the BWSC may contact me while characterizing PFAS levels and investigate any potential sources of PFAS in the town.
- I understand that private well owners are responsible for addressing contaminants in their well water.

Program staff shared the webpage during roll-out meetings with local officials and included the webpage link on postcards distributed to residents. During meetings with town officials, Program staff requested that town officials also share the Notice of Interest webpage with their residents, as they saw fit. Local officials shared the Notice of Interest form via: letters to homeowners, town websites, town social media accounts, word of mouth, posting on physical bulletin boards, and even handed it out at a local transfer station.

At various times, MassDEP's social media account posted about the Program with the website link; a UMass-PFAS Facebook account was created and shared multiple times and in various groups; and program information, including the Notice of Interest website, was shared by some state legislators.

### *5.1.2. Selection of Targeted Private Wells for Invitations*

#### *5.1.2.1 Methodology*

A methodology was developed and followed to identify and select Private Well Owners (PWO) in the 85 towns to be invited to apply to the Program. This method included collection and creation of GIS data layers, identification of residences not served by public water supplies, incorporation of feedback from various internal and external sources, creation of web maps, story maps, pdf maps and extraction of data. The following subsections describe the process for inviting PWOs through targeted outreach. Appendix A includes detailed methodologies and workflows developed to guide this process.

#### *a) Targeted Sampling Invitations*

Figure 5 displays the collection of GIS data layers of public and nonpublic locations which the literature identifies as possible sources of PFAS used in Step 2 of the methodology Appendix A-1. These GIS data layers of possible PFAS sources were collected or created by the GIS team to identify the targeted private wells as priority sites to be invited for sampling.

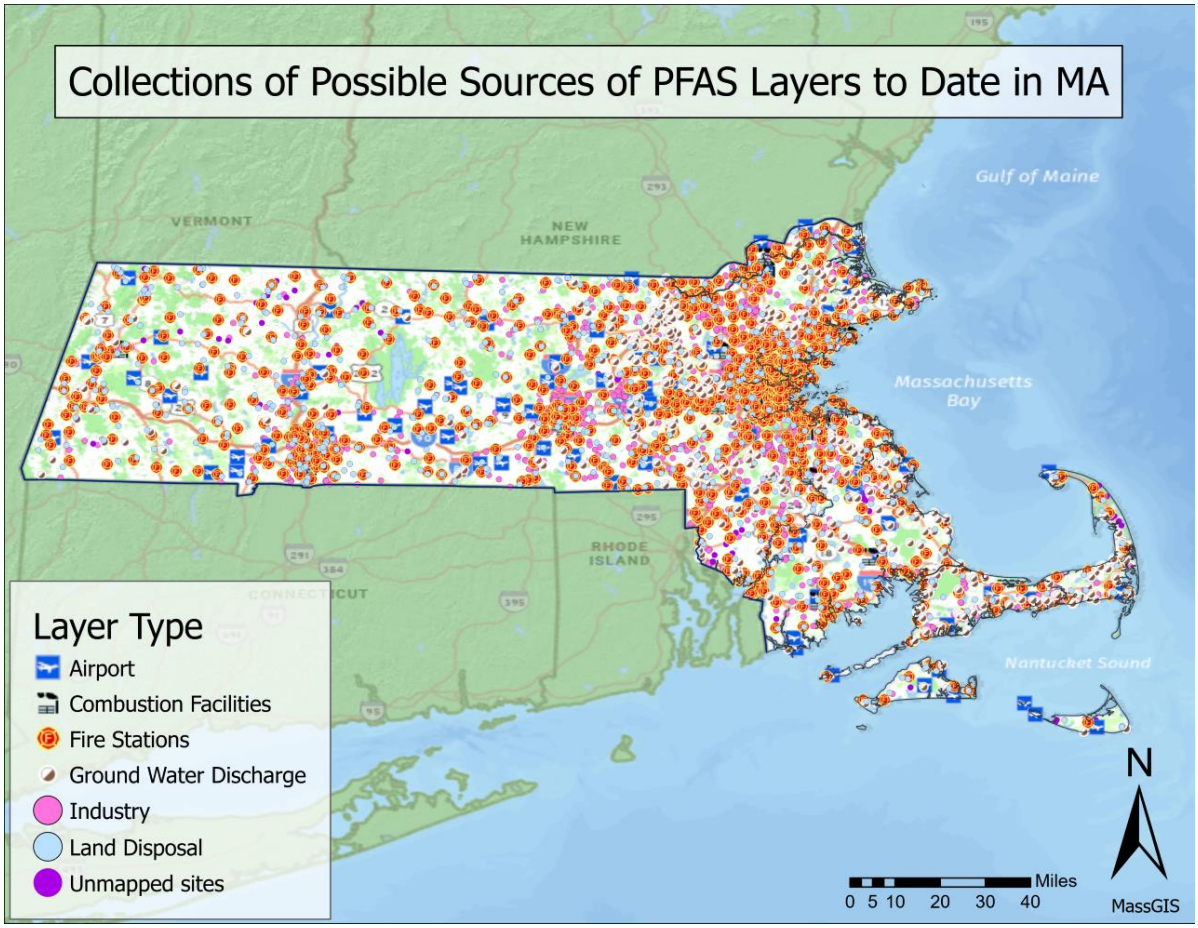


*Figure 5. Map with the collected data layers used to identify possible sources of PFAS to date in MA*

NOTE: Data layers presented in Figure 5 are only a reference of possible sources of PFAS and should not be considered definitive sources of PFAS contamination. Additional analysis is required to identify accurate locations where PFAS compounds were released. For more information on the individual possible sources of PFAS layers, see Appendix B.

As part of the selection process for wells potentially located near sources of contamination ("targeted wells"), the GIS team was trained by a MassDEP DWP hydrologist to use topology maps to estimate the ground water flow. To assign the number of targeted wells near possible PFAS sources, a set of tables was created with the number of sites to be selected depending on the population and the numbers of PFAS areas in the community (Appendix C).

## *a) Random Sampling Invitations*

For the Environmental Justice communities and communities with low application response, a layer of random sampling locations was created to invite PWOs located evenly throughout the town using the methodology described in Appendix A.

Figure 6 displays the final 121-point feature layers of private well addresses (85 towns with targeted wells and 36 with randomly selected wells) created in the selected communities and shared during the meetings with Boards of Health and local officials.

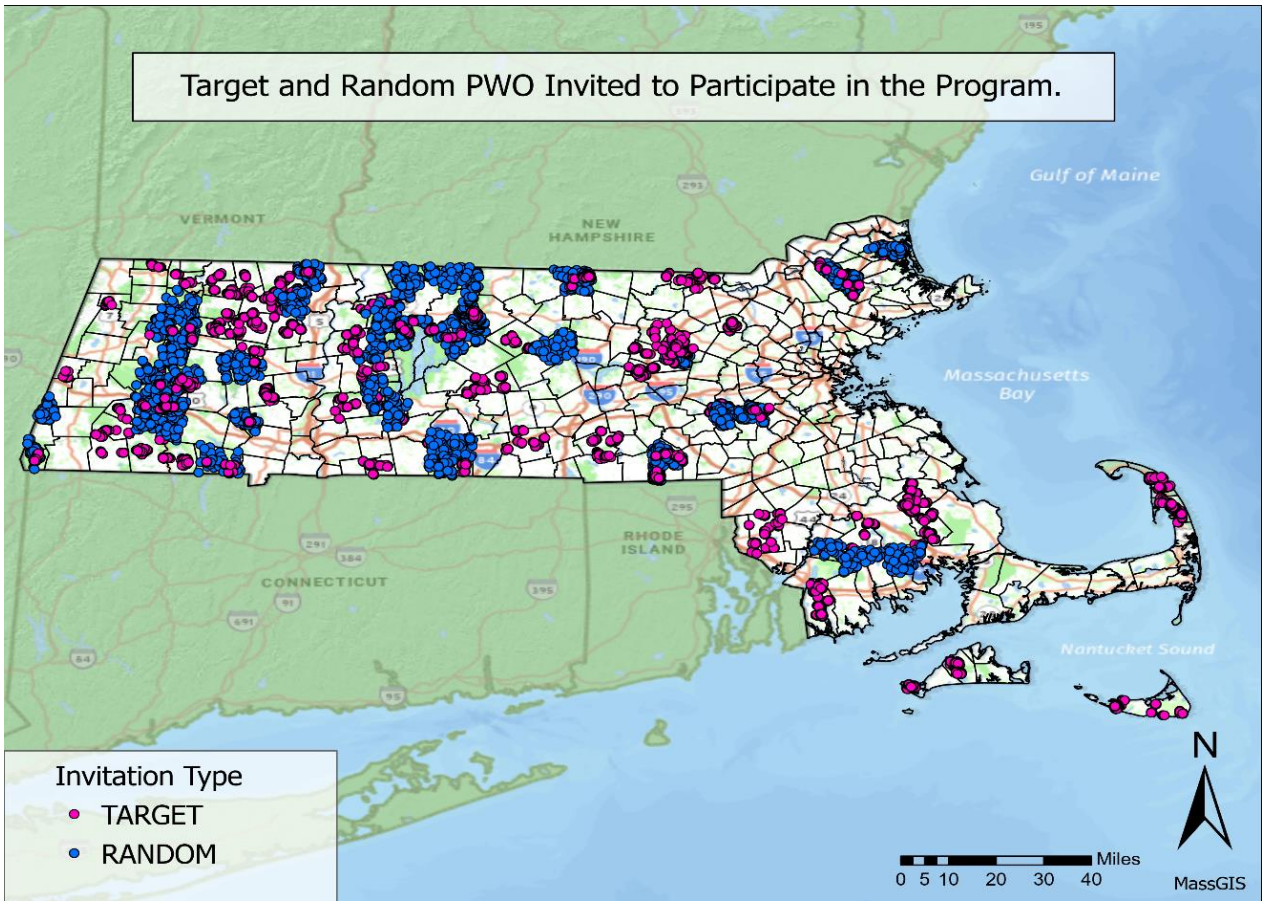


*Figure 6. MA Map showing the Targeted and Random locations invited to participate in the Program within the 85 communities.*

### *5.1.2.2 Feedback Workflow and Invitations*

All draft Town maps of targeted and random invitations underwent at least three internal and external reviews to ensure all priority locations for sampling were included in each town. These feedbacks included input from MassDEP regional BWSC staff, a hydrogeologic review from internal MassDEP-UMass staff, and incorporation of feedback received from local officials during the Boards of Health meetings. The Feedback Workflow is provided in Appendix D.

**For MassDEP regional and bureau staff analysis and feedback**, four regional story maps were created, with a separate tab for each town in a specific region. The maps included Targeted PWOs, Random PWOs and possible sources of PFAS contamination layers (Figure 7). Feedback included local knowledge of sites of possible PFAS releases and the locations that should be included in each map. Due to the occasionally incomplete and draft nature of the drinking water service areas, information on the extent of PWS service within the community was also solicited and consequently generated from discussions with regional staff and members of Boards of Health. Although the presence of a PWS system does not guarantee that a property within this area is

hooked up to the system, it did help prioritize the areas that would likely contain properties that were not being served by a PWS, therefore raising the level of participation in that community (maximizing the effort put into targeted and random invitations).

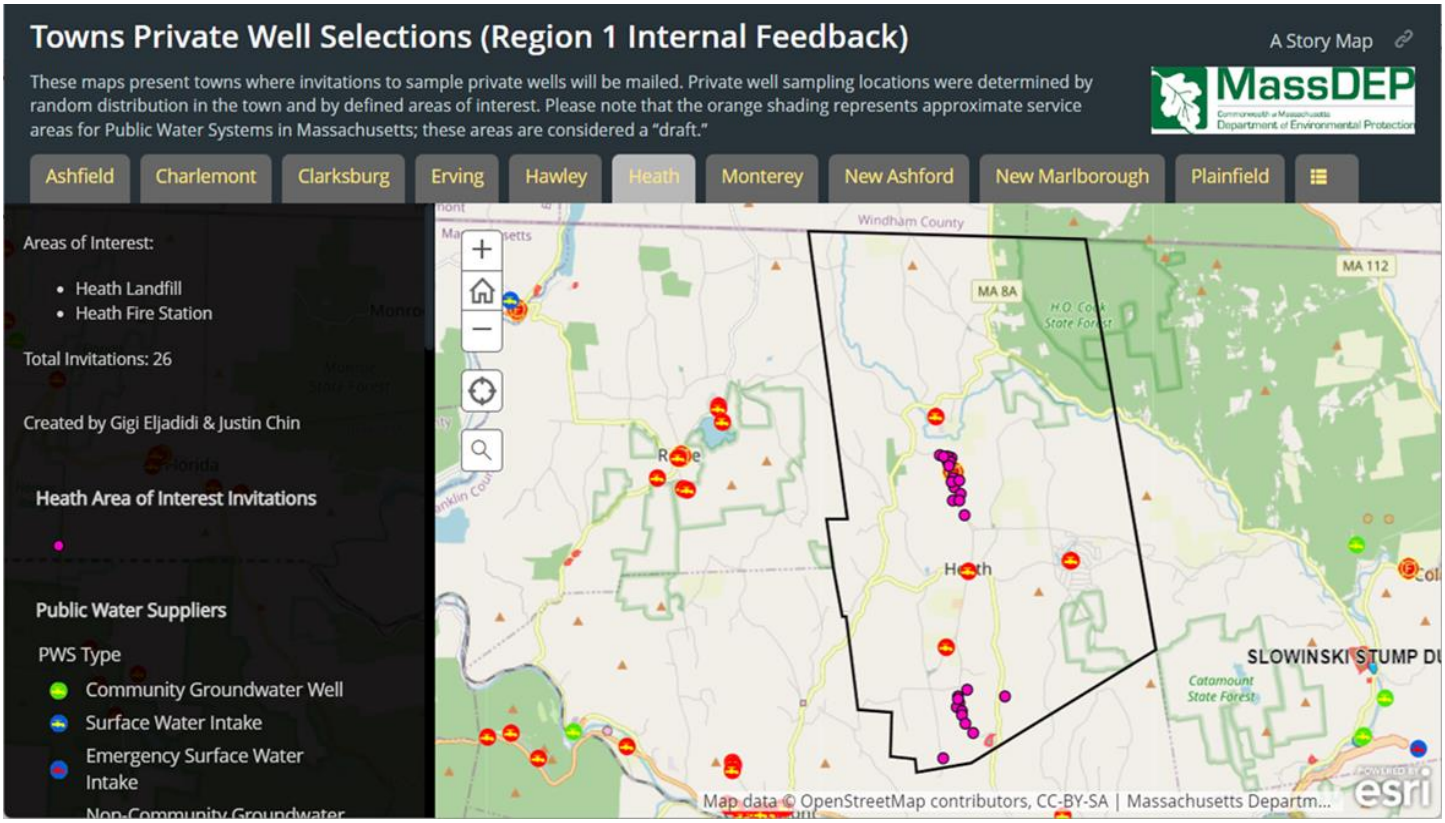


*Figure 7. Example of Western Region StoryMap shared with MassDEP regional and bureau staff for analysis and feedback of the targeted private well invitations*

After MassDEP regional feedback was incorporated into the layers, a second review by the UMass-MassDEP team was incorporated to prepare maps (Figure 8) to be shared with the Boards of Health and local officials for their input.

After final feedback from Boards of Health and local officials was incorporated into the feature layers, private well addresses were extracted from Random and Targeted feature layers to create the postcards that were mailed to PWOs invited to apply to the Program.

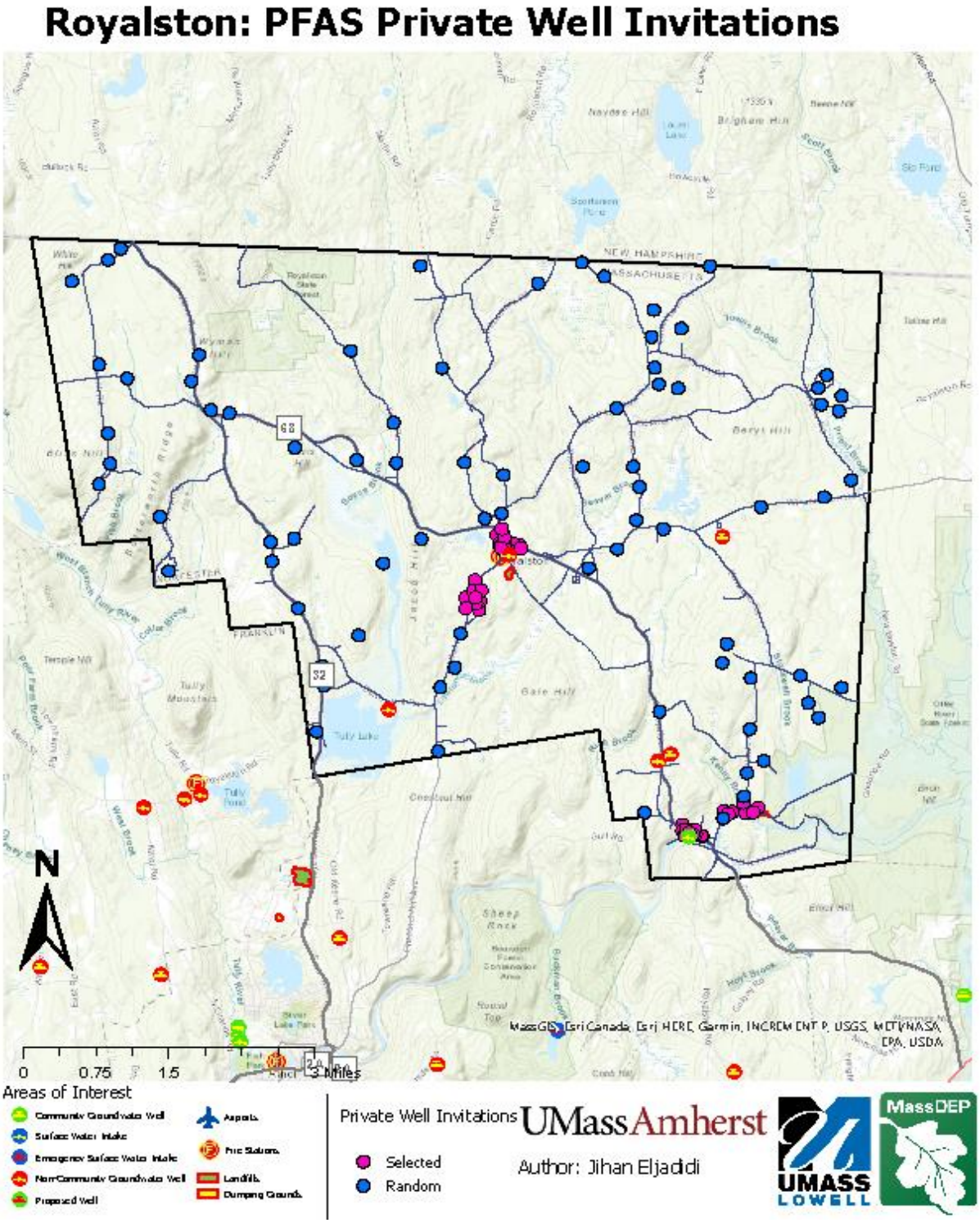


*Figure 8. Example of Royalston map shared with the Board of Health and local officials*

### 5.1.2.3 ***Private Well Owner Registrations***

#### *a)* Geocoding Registrations

A methodology was created to generate a geodatabase of all the locations of Program applications to be displayed in an interactive web map for further spatial analysis in order to approve or reject applicants. These applications were referred to as registrations. The method for developing this data included data engineering, geocode processing, data flow and a QA process (Appendix E).

#### *b) Registrations Acceptance Analysis Tool*

A web map (Figure 9) was created, updated weekly, and shared with MassDEP-UMass staff to use in analyzing whether registrations had the criteria needed for acceptance to the Program. The registration web map was also used as a database to record the accepted or rejected registrations. The recorded data layer was transferred to the main database to begin the process of sampling the approved PWO registrations. The web map included more than 10 data layers with information such as water features, topographic contours, and possible sources of PFAS.

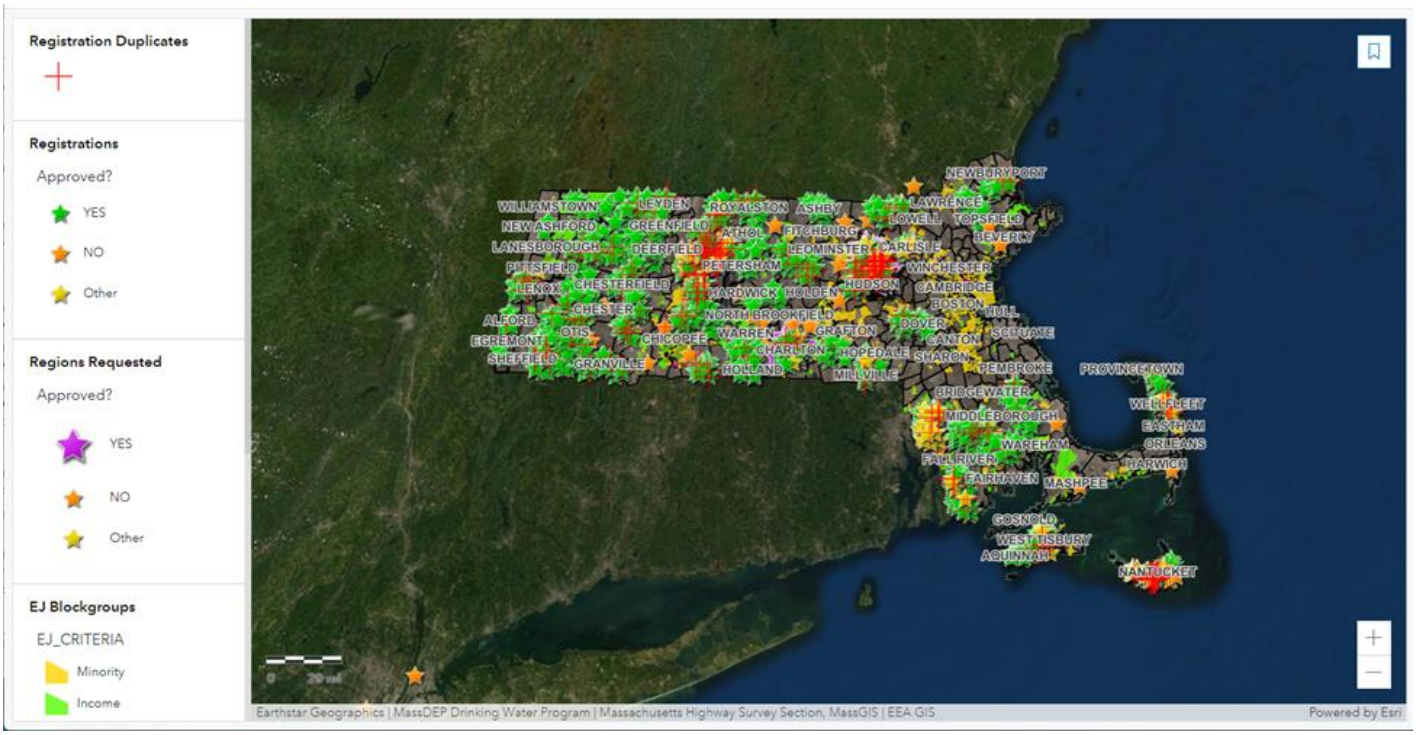


*Figure 9. PWO registrations acceptance analysis web map tool*

## *c)* Registrations Acceptance Criteria

MassDEP-UMass staff reviewed the PWO registrations acceptance analysis tool weekly to determine which applicants to accept or reject from the Program. Only applicants with addresses outside of the 85 towns in the Program were immediately rejected. In general, applicants within the select 85 towns were either accepted into the Program, or notified that their well would not be sampled at this time, but their applications were kept on file so that they can be considered if future sampling efforts occur.

The applications for sampling private wells for PFAS were assessed for acceptance into the Program based on one or more of the following criteria:

***1. Proximity to potential sources of PFAS.*** Many applicants were accepted into the Program because they were near, or estimated to be hydrologically downgradient of, facilities that commonly use PFAS including fire stations, airports with paved runways, landfills, junkyards, and facilities with a North American Industry Classification System (NAICS) rating PFAS use. Priority was given to well owners that received postcard invitations due to their proximity to possible sources of PFAS contamination.

***2. Proximity of private wells to other applicants.*** Grouping of private wells acceptances was avoided so that there was geographic distribution of wells across each town, especially in towns with more than 40 applicants.

***3. PFAS was detected in a nearby private or PWS well.*** In some cases, if PFAS was detected in a groundwater source near an applicant's well, they may have been accepted into the Program to help assess the extent of contamination.

***4. Existence of another PFAS sampling program.*** Private wells within identified groundwater PFAS contamination plumes being sampled under the oversight of the MassDEP BWSC were not sampled under the Program. Examples include Nantucket Airport and Martha's Vineyard Airport.

***5. New MassDEP BWSC investigations.*** Private wells sampled under the Program with levels of PFAS6 above 20 ppt were reported to the BWSC for use in their investigations into the sources of PFAS contamination of groundwater. In these cases, nearby applicants were not accepted into the Program because BWSC conducted focused outreach and sampling as part of their investigation. Examples include northern Leverett and Carlisle center.

***6. Reached 40 samples.*** The upper limit goal of sampling was 40 wells in each of the 85 towns. When 40 private wells had been sampled in a town, no additional applicants were accepted into the Program. Examples include Rehoboth and Carlisle.

***7. Private wells within mapped PWS service areas.*** It was assumed that homes within a PWS service area are supplied by the PWS. In some cases, however, private wells for potable supply are within a mapped PWS service area. Applicants within mapped PWS service areas were contacted to confirm that they have a private well for potable supply before they were accepted into the Program.

8. ***Proximity to possible PFAS sources identified by MassDEP regional staff review.*** Prior to sending the draft invitation locations to town officials, input on possible PFAS sources not currently identified on Program maps was requested from regional staff. These included some historic dumping areas, sites of fires, and more.

## 5.1.3. Coordination with Public Entities

### 5.1.3.1 Meetings with Boards of Health / Local Officials

Once draft maps were created and internal review feedback was incorporated, the Program reached out to local officials in each town to provide information about the Program and to coordinate an informational meeting. Once the town agreed to a time and day, a town-specific Zoom meeting link was created and emailed to town officials, state representative(s) and senators, and MassDEP's legislative liaison. A draft map showing the locations of the residences that would receive a postcard (*Figure 11* and 12) was provided to town officials prior to each meeting.

Meetings with municipalities included an approximately 20-minute presentation on the Program, time for feedback, discussion of targeted locations and potential areas of PFAS contamination. A template version of the meeting presentation can be found here.

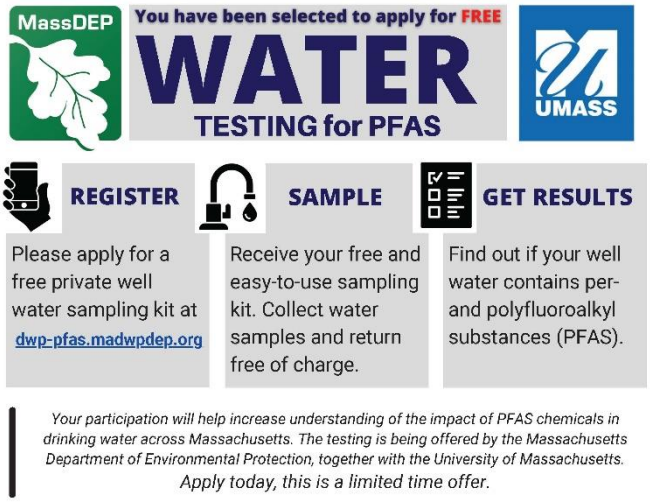


*Figure 11. PWO postcard invitation 1*

One purpose of these meetings was to request information from town officials about locations where fire-fighting training occurred, historic dumping areas, sites of fires where AFFF may have been used, clarification of old and new landfill areas, fire station locations, and any other potential area of PFAS contamination. This local knowledge provided valuable insight which the Program incorporated into the selection of Program participants.

During the meetings, local officials were also asked to share the Program's social media post with their residents to further spread the word about the Program.

In total, 48 meetings were held in the Western, Northeast, and Southeast regions. Twenty-one towns opted not to participate in a meeting. Outreach in the 16 towns in the Central region was conducted by Central regional staff.


*Figure 10. PWO postcard invitation 2*

### 5.1.3.2 Social Media Outreach

Social media was an integral part of the Program's outreach strategy and was highly effective in soliciting interest and applications. The Program developed social media post language and an infographic which could easily be shared to various social media platforms (Figure 12).


*Figure 12. Social media graphic*

The Program created a Program-specific Facebook account to disseminate the infographic to town-specific, county-specific and regional Facebook pages. The Program also encouraged town officials and legislators to reach out to their residents/constituents via their social media accounts.

The Program saw a direct correlation between social media posts and increased applications in towns where the posts were targeted. Posts to Facebook forums, legislators' pages, email blasts, newsletters, and posts on the NextDoor app were especially effective; even personal page posts and tweets resulted in increased applications.

### 5.1.3.3 Coordination with EPA and Indian Health Services

For the town of Aquinnah, home to the tribal nation The Wampanoag Tribe of Gay Head (Aquinnah), the Program wanted to offer tribal members with residences served by private wells the same opportunity for free analysis of their drinking water as were offered to other Aquinnah residents. GIS layers indicated the potential presence of several private wells on the tribal land. Program staff held multiple meetings with representatives from EPA Region 1 and Indian Health Services (IHS) in which the Program learned that there were no private wells located on tribal land. The residences on the tribal property were served by a tribal water system consisting of several wells. MassDEP offered to test the tribal water supply through the Free Analyses Program for PWS, to which EPA and IHS agreed. MassDEP paid for the tribal system sampling through Program funding and the results were sent directly to EPA and the Tribal contact without MassDEP being copied, because as a sovereign nation, the tribal water system is not regulated by the State. IHS and tribal officials also offered to help spread the word about the Program to tribal members living off of tribal land.

### 5.1.4. Technical Assistance Materials

A number of private well technical assistance materials and documents were developed to provide information to the public and guide applicants and participants through the Program. Specific technical assistance materials are cataloged in the subsections below.

#### 5.1.4.1 Frequently Asked Questions Document

A Frequently Asked Question document (FAQ) was created to lay out the Program and provide basic information to residents and town officials. This document went through several iterations as the Program evolved and includes the most pertinent information of benefit to applicants, participants, and the public. This FAQ was provided to all applicants and participants of the Program and was posted on the MassDEP PFAS Webpage for public access.

#### 5.1.4.2 Agreement Form

Once a homeowner's application was reviewed and accepted, the homeowner was sent an agreement form which provided more details regarding the Program and required a signature. Only applicants who completed a signed agreement form were provided a sampling kit and allowed to participate in the Program. The Program employed an electronic signature to allow online completion of the form.

#### 5.1.4.3 21E Addendum

BWSC addressed concerns regarding liability and cleanup implications related to PFAS in groundwater above Reportable Concentrations in the Private Wells PFAS Sampling Program 21E Questions and Answers document which was included as an addendum to the Program agreement form.

#### 5.1.4.4 Sampling Instructions and Video

The Program developed written sampling instructions to help private well owners successfully collect and transport PFAS samples for analysis. There were three sets of instructions/sampling protocols, depending on laboratory and location. One set for Pace Laboratories; one for Alpha Analytical mainland; and one for Alpha Analytical islands, for those towns in the Program located on Nantucket or Martha's Vineyard. Hard copies of the sampling instructions were provided to the homeowner in their sampling kit delivered by the contract laboratory. The Program also created an instructional video to direct homeowners on the proper sampling protocol. The video was posted on the MassDEP YouTube page, and links were provided in various program correspondence and documentation provided to participants. To view the instructional video, click here.

The combination of written instructions, video instructions, and MassDEP-UMass team technical assistance, collectively allowed for homeowners to collect samples without a professional present in their home.

### 5.1.5. Sampling of Private Wells

Private well owners were sent sampling kits via laboratory courier delivery and were responsible for collecting their own water samples according to the protocol provided. The Program employed two of the MassDEP contracted laboratories to deliver sampling kits to private well owners: Alpha Analytical and Pace Laboratories (formerly Con-Test). The Program assigned towns to one of these two contract laboratories based on geography to ease delivery and pickup efficiency. Towns roughly east of Worcester were assigned to Alpha Analytical, based in Mansfield, Massachusetts, and towns roughly west of Worcester, were assigned to Pace Laboratories, based in East Longmeadow, Massachusetts.

#### 5.1.5.1 Pre-and Post-Treatment Sampling

Applicants were asked to indicate if they have a treatment system and if it is a point of entry (i.e., whole house) or a point of use (i.e., single tap) treatment system. In the initial part of the Program, if the homeowner indicated they had a treatment system and were able to collect water samples prior to treatment, the Program would provide private well owners with two sampling kits for testing both treated and raw water.

Given the cost of two samples and the variety in the types of treatment technologies used by homeowners, the Program adjusted to offering only one sample to each homeowner. The Program requested that the one sample be collected prior to treatment, if feasible.

Sampling instructions directed the private well owners to collect from a bathroom tap if they did not have a treatment system, as bathrooms are less likely to be connected to a point of use treatment system than a kitchen faucet.

Pre-treatment samples were preferred because they further the purpose of the Program to characterize PFAS contamination of groundwater across the Commonwealth.

### 5.1.6. Laboratory Analysis of Samples

Laboratories participating in the analysis of private well water samples for PFAS as part of the Program were required to be certified by MassDEP for EPA methodologies 537 or 537.1. MassDEP primarily utilized two of the contract laboratories for private well PFAS analysis due to convenience of laboratory courier pick up of sampling kits.

#### 5.1.6.1 Quality Control Review of Private Well Results

Private well water samples underwent a quality control review by the MassDEP-UMass QC team. In total, 1,839 private well water reports underwent the quality control review. Out of those reports, 95.8% were found acceptable, and the remaining 4.2% consists of partial acceptances and rejections. Private well samples which did not pass the quality control review were typically rejected for elevated MRLs due to insufficient sample volume or contamination issues, which arise from sampling errors. Overall, most homeowners properly collected water samples from their private well and the associated laboratory results were acceptable.

### 5.1.7. Results review, communications, and confirmatory sampling

#### 5.1.7.1 Private Well PFAS6 Web map Results Tool

A web map tool (Figure 13) was created to review the locations of all sampled private wells in relation to surrounding information and was used for internal communications. The web map displayed several layers such as the point feature layer that was created and updated weekly with the private well PFAS6 results, PWO invitations, PWO registrations, possible sources of PFAS, water features and topographic contours. The MassDEP-UMass team had access to the geodatabase to update or add new results when a new high result was received and needed a quick review.

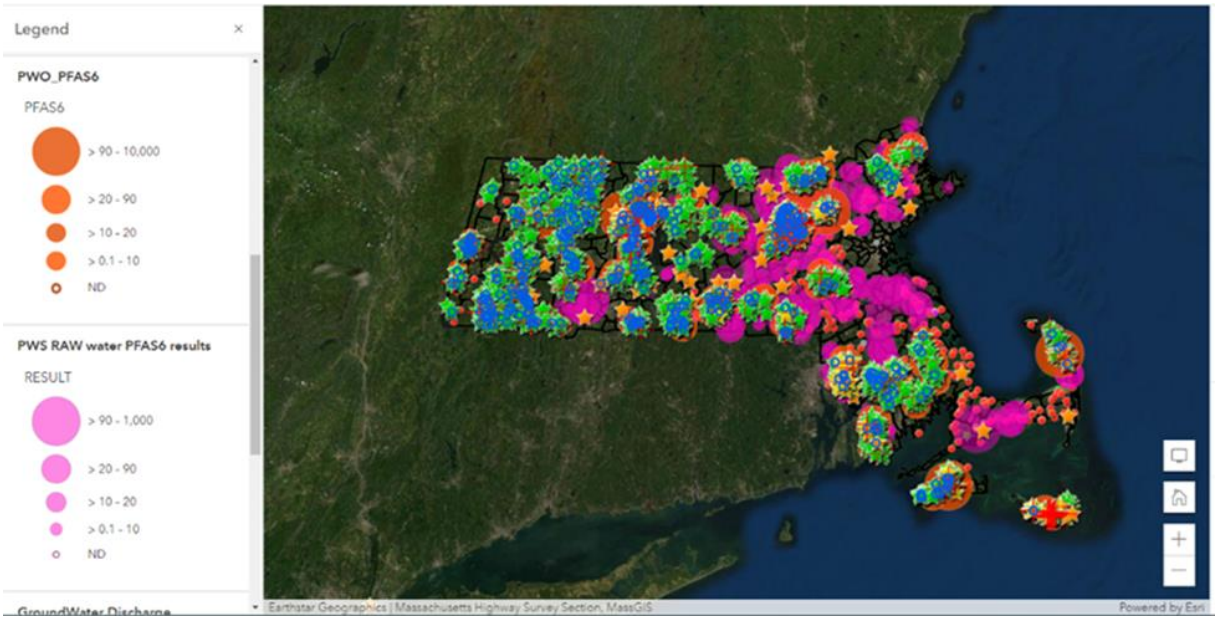


*Figure 13. PFAS results map tool.*

#### 5.1.7.2 Results Communications and confirmatory sampling

##### a) Communications To Private Well Owners

The Program communicated private well PFAS results to participants through template email communications and if warranted, phone calls.

Email template communications were always copied to the local board of health contact and included the laboratory results report as an attachment. Links to additional resources were also provided, including directions for finding certified laboratories to conduct additional PFAS analysis outside of that provided by the Program.

##### 1. For results less than 10 ppt

If PFAS6 results were non-detect, or detectable but less than 10 ppt, a template email letter would be sent to the homeowner explaining the results and including a statement that no further action is requested of the homeowner as part of the Program.

##### 2. For results greater than 10 ppt

If PFAS6 results were greater than 10 ppt, but less than 20 ppt, the template email included

a request for the homeowner to conduct confirmatory sampling.

If PFAS6 results were over 20 ppt, but less than 90 ppt, the template email requested confirmatory sampling, explained that the results were over the PFAS6 MCL and reportable concentration level, and provided additional information on potential impacts of consuming the water to sensitive subgroups.

Finally, if PFAS6 results were above 90 ppt, the template email stated that the PFAS6 levels constitute an imminent hazard and that MassDEP suggests use of an alternate source of water for consumption.

Any homeowner with results above 20 ppt also received a direct phone call from the Private Well Program Coordinator including the following information:

- What PFAS are, why they are a concern, and where they are used and found
- Private well water is not regulated by MassDEP and homeowners are responsible for their own water quality
- MassDEP has a public water supply drinking water standard for PFAS6
- Explain sensitive subpopulations for PFAS
- Confirm presence or lack of treatment in their home
- Explain that PFAS is readily treatable and review online resources
- Explain downgradient property status, if appropriate.
- Ask information about the well and location
- Ask if the homeowner is willing to collect confirmation samples

Homeowners who conducted confirmatory sampling received additional template email communications and copies of their confirmatory laboratory results reports.

### *b) Communications To MassDEP*

When Program staff received results indicating a PFAS6 result greater than 20 ppt, the Private Wells Program Coordinator would create an email alert for internal MassDEP management personnel, which included the following information:

- The sampling location
- Whether the location was a targeted private well for invitation to the Program
- Whether the location was in an environmental justice block group
- The PFAS6 results and any other elevated PFAS analytes of note
- The type of well and whether or not the homeowner indicated they have a point of use or point of entry treatment system
- A table summarizing all Program PFAS6 results in the specific town
- Nearby notable locations of interest
- Several maps indicating the location of the private well and the results
- A statement that the private well owner would receive a phone call to discuss their results, in accordance with Program protocol

This email would be addressed to the MassDEP DWP Director, with several key program staff copied and provided to applicable MassDEP regional staff, BWSC staff, and MassDEP management.

# 6 Agency / Entity Roles

MassDEP partnered with UMass to create a successful program. MassDEP played a large role in the development of the Program, including drafting initial program materials, conducting outreach, maintaining the PFAS website, working with regional staff and outside partners to solicit PWS participation in the Program, disseminating weekly program "Friday Update" reports, and providing data, fiscal, and overall management. MassDEP developed the Notice of Interest forms and initial roll out materials. As the Program was implemented, UMass developed additional guidance materials and updated fact sheets and question and answer forms.

MassDEP contracted with UMass to implement the Program through an ISA. UMass hired personnel for project management, technical assistance, administrative and fiscal support, laboratory coordination, and support for data entry and quality control reviews. UMass personnel conducted informational meetings with local officials for the private well program and assisted PWSs with all aspects of the sampling program.

MassDEP contracted with four laboratories for analysis, and MassDEP staff worked closely with these laboratories to ensure that all samples were properly submitted electronically via the electronic reporting system (eDEP).

UMass responded to questions from private well owners and guided participants through sampling and results interpretation. MassDEP and UMass staff provided technical assistance to PWSs on sampling, results interpretation, and regulatory compliance.

# 7 Project Management and Governance

The bulk of the Program elements were implemented by teams from both MassDEP and UMass. The MassDEP team included managers and technical staff, including one Project Manager housed in the Boston DWP office. The UMass Project Management team included two Principal Investigators/Project Directors at UMA and one at UML, and two Project Managers, one at UMA and one at UML. The UMass executive team also included a Private Well Program Coordinator, a Laboratory Specialist, a Quality Control Team Lead and a Technical Assistance Lead.

Coordination between MassDEP and UMass was paramount for this project and was facilitated through weekly meetings. Weekly meetings were conducted for the PWS Sampling Workgroup, the Private Well Sampling Workgroup, the Private Well Outreach Team, the UMass Program Team, the PFAS Regional Workgroup and the Program Executive Committee. Additional workgroup meetings for GIS, data entry and QC were held as needed.

Topics discussed during these meetings included but were not limited to: 1) project status updates; 2) implementation priorities and strategies; 3) identification of issues and resolution strategies; 4) project reporting and tracking; and 5) project budget and funding.

A MassDEP PFAS Team meeting was also held weekly to discuss issues of importance relating to PFAS and the MassDEP DWP. During these meetings program staff including the Boston DWP Project Manager provided Program updates. The MassDEP PFAS Leadership Team also met weekly to discuss on-going project implementation issues, including identifying issues that needed to be raised and discussed with UMass and MassDEP senior management, and identifying, assigning, and tracking tasks required for continued implementation of the Program.

# 8 Press Coverage and Interest

Due to the emerging national and statewide understanding of and attention to PFAS contamination, the issue of PFAS in drinking water supplies was of strong interest to local and national news media outlets throughout the timeline of the Program. When the Program was launched, it was picked up by a number of media outlets across the state. Articles and media stories related to PFAS in drinking water supplies were prevalent during the extent of the Program, including stories from outlets such as the *Boston Globe*, WBUR, *The New York Times*, and NPR.com. Local papers such as the *Vineyard Gazette*, ran articles directly relating to the Program and PFAS contamination of public and private drinking water supplies discovered due to sampling conducted through the Program.

The Program also utilized regional local newspapers as an advertising strategy to reach private well owners, requesting that they publish the Program's infographic to spread the word and help solicit applications from homeowners in targeted program towns. At the time of this report, media in Massachusetts continue to express interest in the Program, its sampling results, and PFAS contamination of drinking water supplies in the Commonwealth in general.

# 9 Budget

## 9.1. UMass Project Management, Technical Assistance, and Laboratory Analysis

The Program was active from July 1, 2020 through June 30, 2022. The original total funds were **$8,400,000**, to be allocated as follows:

- $2,277,570 through an ISA to the University of Massachusetts Amherst
- $1,157,243 for laboratory analyses
- $4,965,187 for grants to communities to mitigate PFAS pollution in their drinking water.

In 2022, MassDEP allocated an additional $2,632,178, bringing the total project budget to $11,032,178. As of September, 2022, all funds were encumbered, and $10,838,478 had been expended as follows:

- $2,111,099 to the University of Massachusetts Amherst
- $1,476,460 for laboratory analyses ($927,167 for public water supplies and $549,293 for privately-owned wells)
- $4,826,514 for PFAS Treatment grants
- $2,126,594 for PFAS6 Interim Response Grant
- $297,811 for additional laboratory services

The University of Massachusetts expenses covered project management, administrative support, TAPs, and students hired to conduct quality control evaluations of laboratory reports, data entry, and assistance to the private wells program.

## 9.2. MassDEP Staff Time

A number of MassDEP staff assisted with project tasks, including but not limited to: development of fact sheets, template letters, and other outreach materials; quality control reviews; management of data entry; coordination with regional staff; tracking of compliance data; follow up with private well owners; and communication with contract laboratories and public water suppliers.

# 10 Outputs/Findings

A total of 1,121 PWS and 1,668 private well owners took advantage of the Program. A total of 4,232 PWS water samples and 2,475 private well samples were collected, including confirmatory samples and resamples. These samples provided vital information about the extent of PFAS contamination across the state, as well as informing individual PWS and private well owners about the quality of their water, at no cost to them. The results presented in this section are limited to work conducted under the scope of this Program and by the MassDEP DWP. Additional MassDEP PFAS work is ongoing.

Through the private well program, 85 private well owners with results over 20 ppt were directly contacted and provided technical assistance on well maintenance and treatment. These 85 private well locations were also referred to MassDEP BWSC for further investigation, allowing for the potential to determine the source of the PFAS contamination.

Program outputs also included the technical assistance documents described in this report, including FAQs and sampling guidance documents and instructional videos. The dashboards and Story Maps described in Section 10.3 also resulted from the Program and will continue to provide information internally and to the public about PFAS in Massachusetts drinking water.

## *10.1. GIS methodologies, geodatabases, web maps tools and training*

The MassDEP-UMass GIS team created geodatabases (Table 2) used for the Free PFAS Analyses Program for Private Wells (Section 5), PFAS Sampling data description and analysis (Section 10.3) and for the data analysis presented in Section 10.3.5.

The MassDEP-UMass GIS team created the GIS methodology for the identification of targeted locations and to invite specific private wells owner to the Program (Section 5.1.2). A second GIS methodology was created to geocode the private wells that applied to the Program (Section 5.1.2.3).

| Geodatabase Name | Mapped sites |
|---|---|
| Potential Private Wells Locations | **> 11,000+** |
| Private Well Owners Registrations | **> 4,500+** |
| Unmapped possible sources of PFAS | **> 100+** |
| PFAS results from:<br>1.-**1,668** Private Wells (**83** towns)<br>2.- **2,436** Public Water sources (**303** towns)<br>3.- **38** BWSC PFAS investigations ( **787** locations, **15** towns) | **> 9,600+** |

*Table 2. List of Geodatabases created.*

To analyze, share and communicate the PFAS6 results and the status of the PWS and private well sampling programs, the MassDEP-UMass GIS team created web maps tools, dashboards, StoryMaps and pdf maps (Table 3).

| # and Type | Description |
|---|---|
| 84 pdf maps | Shared with the Board of Health and local officials, section 5.1.3.1 |
| 85 web maps | Displayed in the dashboards, pdfs and StoryMaps. |
| 2 web map tools | Used in the selection of Private Well Owner Registrations, section 5.1.2.3 and in the PFAS6 results communications, section 5.1.7.2 |
| 5 StoryMaps | Public and internal shared with MassDEP regional staff and management, section 10.2 |
| 3 dashboards | Public and internal shared with MassDEP regional staff and management, section 10.2 |

*Table 3. List of visualization tools*

MassDEP-UMass staff gave various GIS training sessions to UMass students (~9) for the formation of the GIS team.

## 10.2. Dashboards and StoryMaps

To communicate the status of the Program, the MassDEP-UMass GIS team created Internal and External dashboards and StoryMaps for the public and for MassDEP-UMass management.

### 10.2.1. For the Public

In August of 2020, the StoryMap "Addressing PFAS Contamination" was launched (Figure 14) and made accessible from the MassDEP Per- and Polyfluoroalkyl Substances (PFAS) information webpage. The StoryMap consists of seven tabs that present interactive maps, dashboards and photographs that describe the efforts by MassDEP and Massachusetts PWSs to address PFAS contamination. Tab 3 displays the Public Water Systems Tested dashboard; an interactive map showing all communities that have participated in the Program and the number of PWSs in each of these communities (Figure 15).

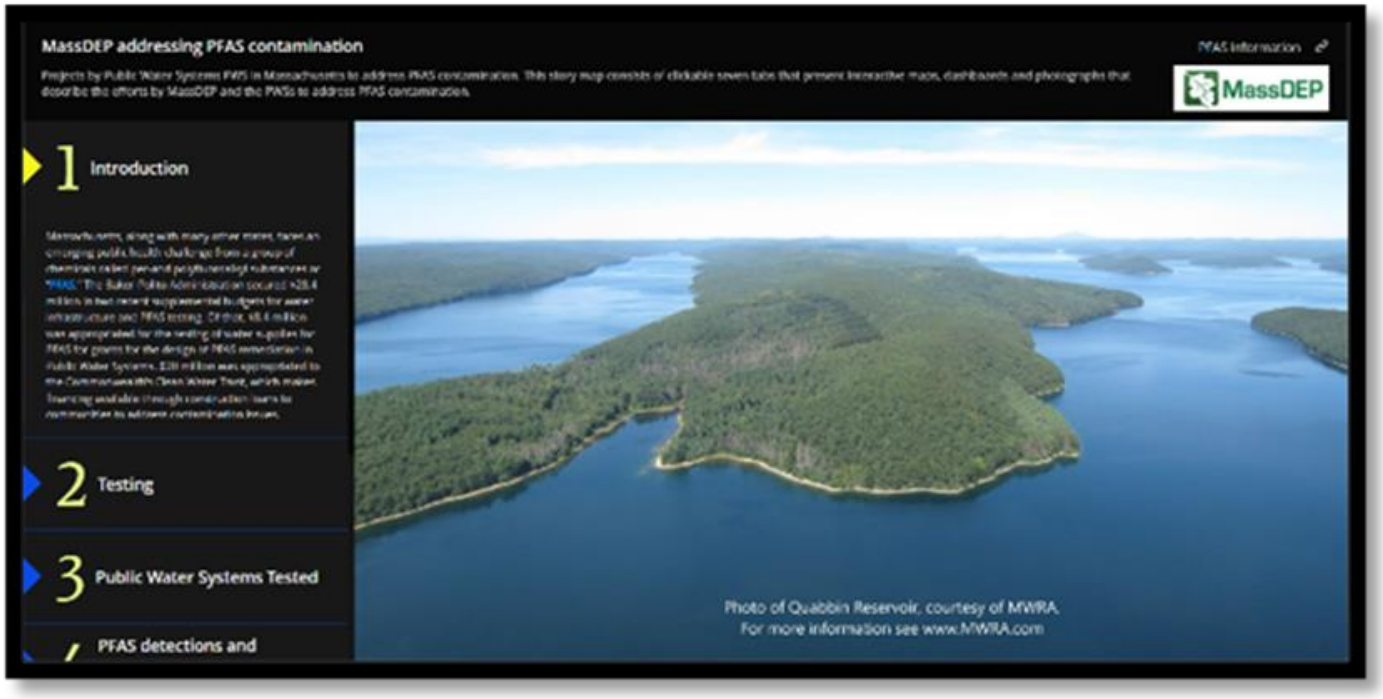


*Figure 14. Public StoryMap: Addressing PFAS Contamination.*

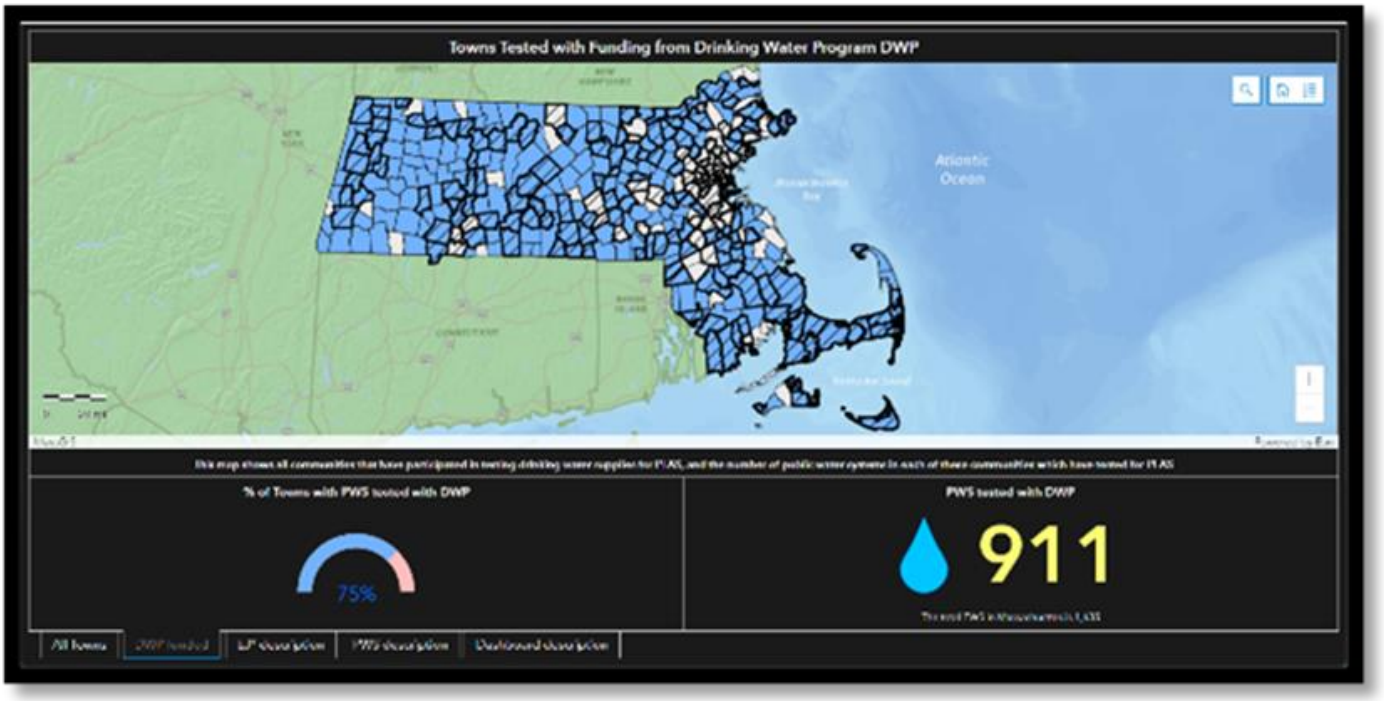


*Figure 15. Public dashboard: Public Water Systems Tested.*

In March of 2021, the MassDEP Private Wells PFAS Sampling Program dashboard was launched (Figure 16), and it is accessible from the MassDEP Per- and Polyfluoroalkyl Substances (PFAS) in Private Well Drinking Water Supplies FAQ webpage. It displays an interactive map that shows the 85 Program eligible towns, and information regarding the number of wells sampled by community.


*Figure 16. Public dashboard: MassDEP Private Wells PFAS Sampling Program*

The dashboard also displays a downloadable table including the individual private well PFAS6 results organized by community (Figure 17). Street addresses of the private wells are not shown on the MassDEP website but were provided to the local Boards of Health along with the testing results.

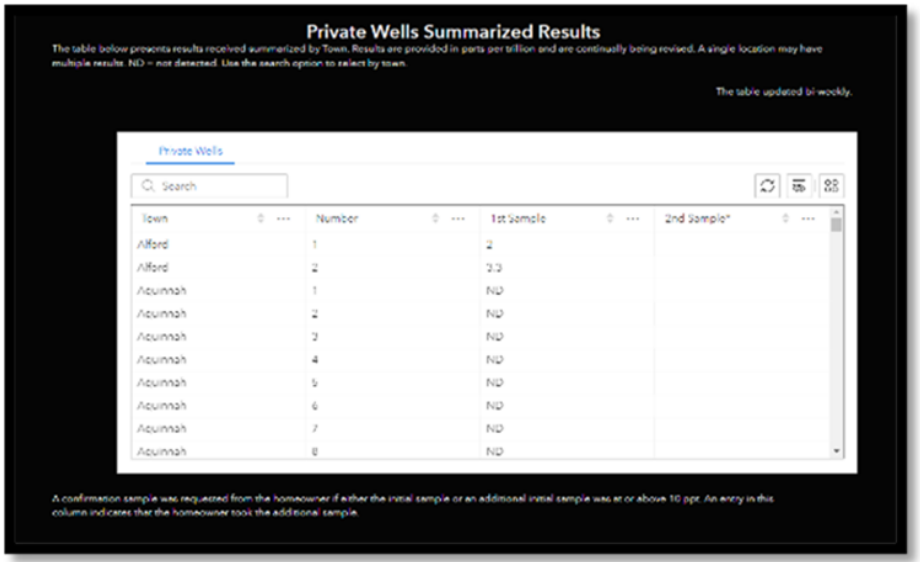


*Figure 17. Individual Private Well PFAS6 results table summarized by community*

The StoryMap and dashboard have an average of 145 and 55 views per day, respectively, and the links to the webmaps have been used as a reference in web sites such as PFAS Massachusetts Sierra Club, 7 Boston News, the Final Report of the PFAS Interagency Task force, Detection in Public Water Systems section and on various Massachusetts community web sites (e.g. Concord and Wellesley).

### *10.2.2. For MassDEP-UMass management:*

Two dashboards, one for Public Water Systems (Figure 18) and another for Private Wells (Figure 19) were created to inform MassDEP regional staff and management of the status of the Program. Information displayed included numbers of samples by community, money spent, Environmental Justice communities tested, and the number of private well owners that signed their agreement forms. Links to the dashboards were shared in the Internal bi-weekly Friday Update on PFAS.

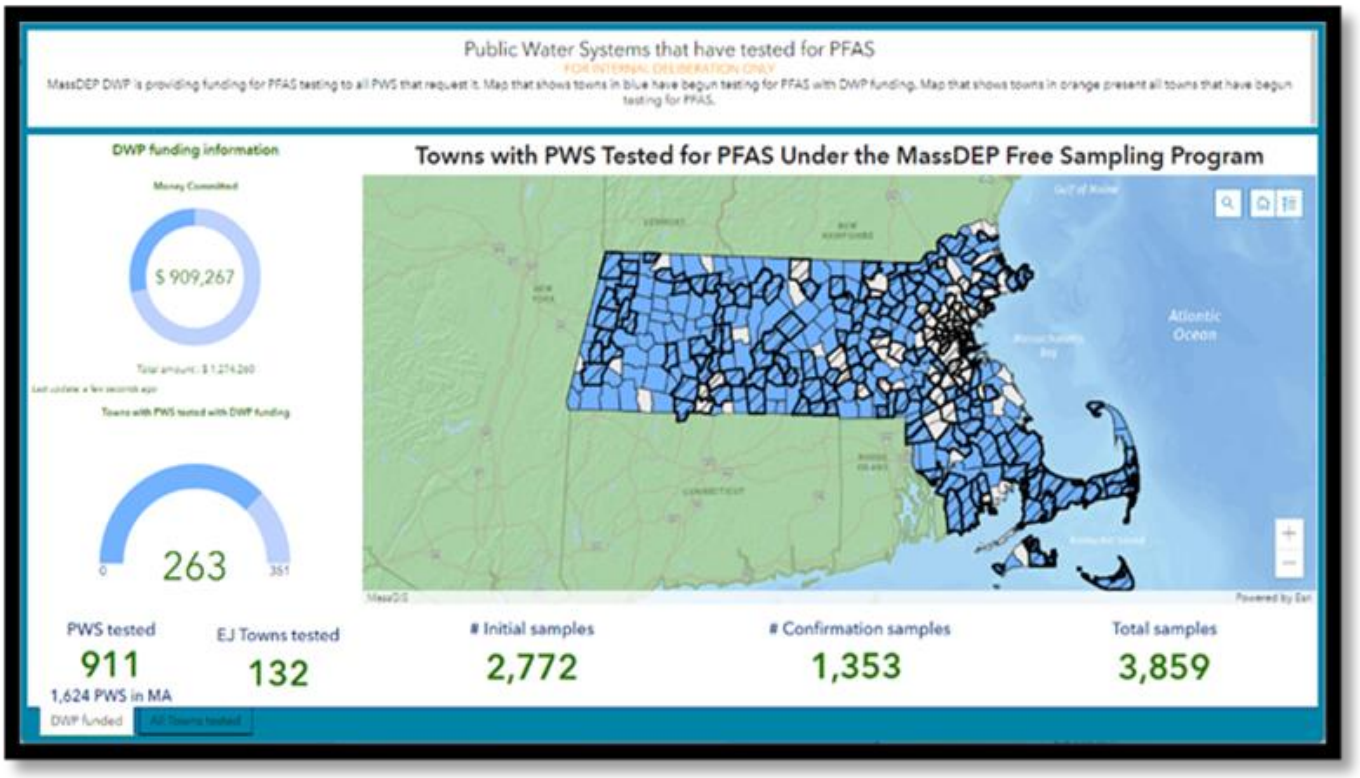


*Figure 18. Public Water Systems Program internal dashboard*

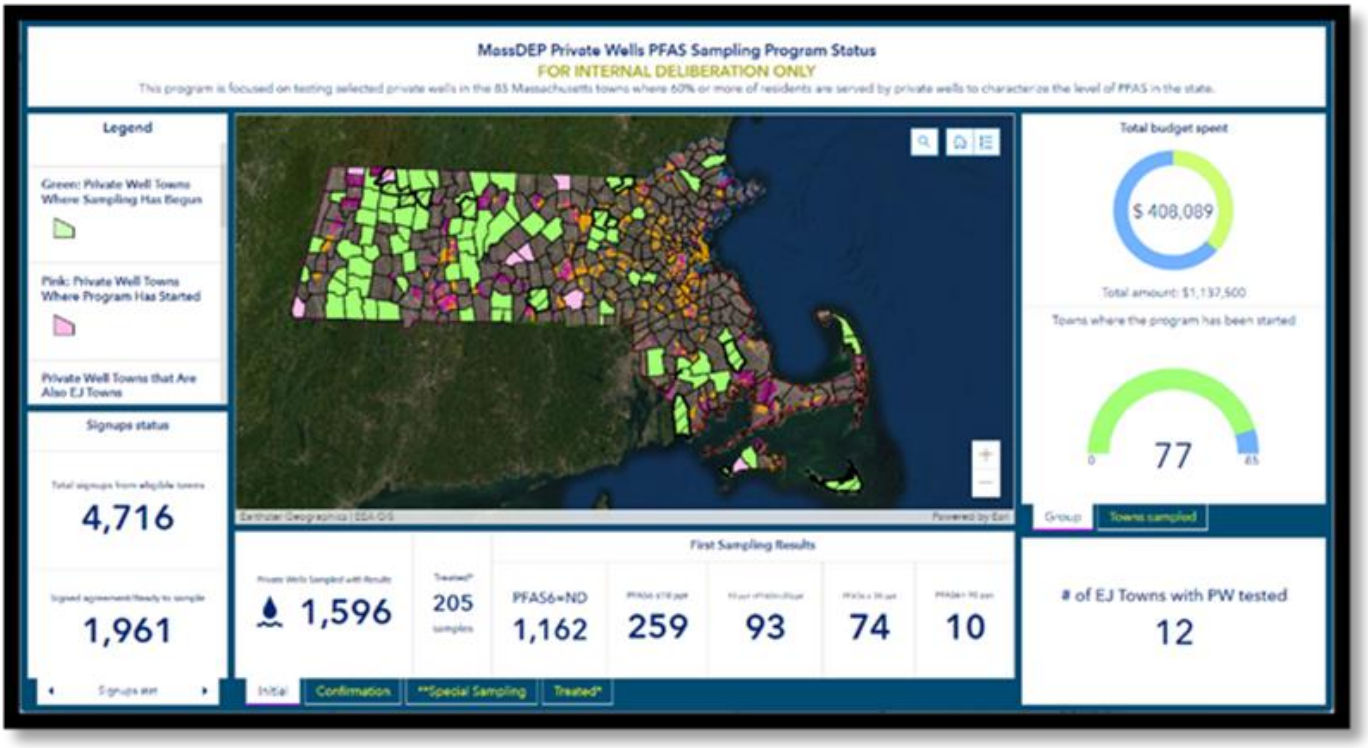


*Figure 19. Private Wells PFAS Sampling Program internal dashboard*

## 10.3. PFAS Sampling data description and analysis

### 10.3.1. PWS PFAS6 Sampling Data Description

Currently there are 1,598 active PWS in the State of which 1,425 are required to test for PFAS (have their own water source). As of October 2022, almost all had tested their sources for PFAS, and the remaining TNC systems required to sample were receiving technical assistance to complete their testing. Of those which had completed sampling, 161 PWS detected PFAS6 above the MCL in one or more finished water sources. However, 95% of the Commonwealth's population are drinking water from a COM PWS which currently meets the PFAS6 drinking water standard.

MassDEP offered one round of free sampling to PWS at all their finished water sources as well as their raw water sources (for blended sources or sources with treatment). Results from 3,970 water samples were collected from 2,059 water source locations from 1,121 PWS through the free sampling program including initial samples, confirmatory samples and resamples, for both finished and raw water samples. Additional PWS samples were collected outside of the Program and included in the analysis -- when PWS chose to take their initial samples at their own expense, and when subsequent required samples were not covered under the one round of free sampling.

#### 10.3.1.1 PWS PFAS6 Raw Water Analysis

Raw water samples are water samples collected from a reservoir or well prior to any treatment of the water. PWSs are not universally required to sample raw water for PFAS by the drinking water regulations; therefore, not all PWSs tested their raw water. Data presented in this section (2,418 locations from 1,286 PWS) are results from raw water samples or finished water samples from water treatment plants that have no treatment installed known to reduce PFAS.

Raw water results showed that 12% of samples exceeded the MCL (20 ppt), and more than 50% were below 2 ppt (Figure 20)

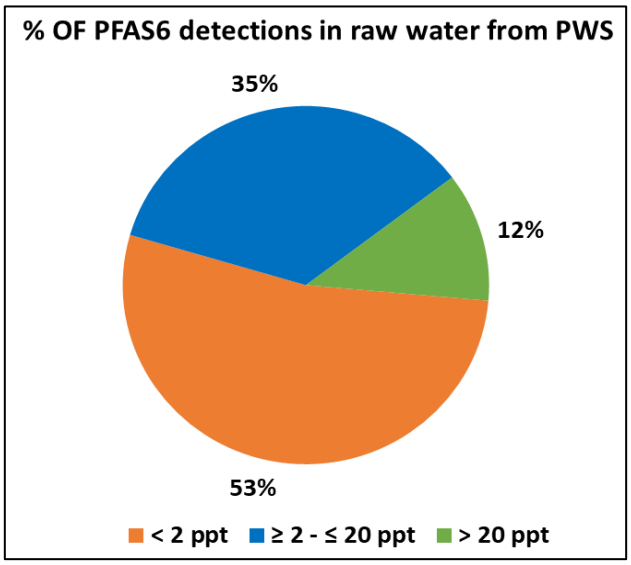


*Figure 20. PFAS6 detections in raw water from PWS*

Classifying the results by system type, 75% of the water sources from Transient Non Community (TNC) and 61% from Non-transient Non-Community (NTNC) systems had less than 2 ppt and only 7% (TNC) and 14% (NTNC) were over the MCL. On the other hand, more than 50% of the water sources from Community (COM) systems had results over 2 ppt, nevertheless, only 14% were over the MCL (Figure 21)..

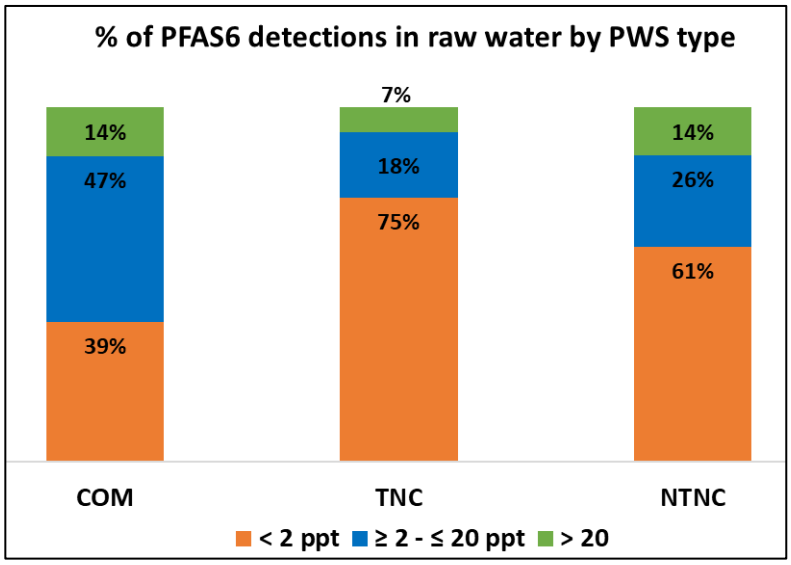


*Figure 21. Percent of PFAS6 detections in raw water by PWS type.*

## *10.3.2. Private Wells PFAS6 Sampling Data Description*

A total of 4,438 private well owners in eligible towns signed up for the program, 84% (3,707) were accepted. Of the accepted applicants, 55% (2,042) signed the agreement form and of those, 82% (1,668) sampled their wells and received results. From the 85 total towns invited to participate in the Program, one (Mount Washington), did not include any homeowners that sampled their wells. 17 communities (20%) sampled less than five wells, 29 communities (34%) sampled between six and 20 wells and 39 (46%) sampled more than 20 wells (Figure 22). Appendix F presents the Private Wells sampling data summarized by town.

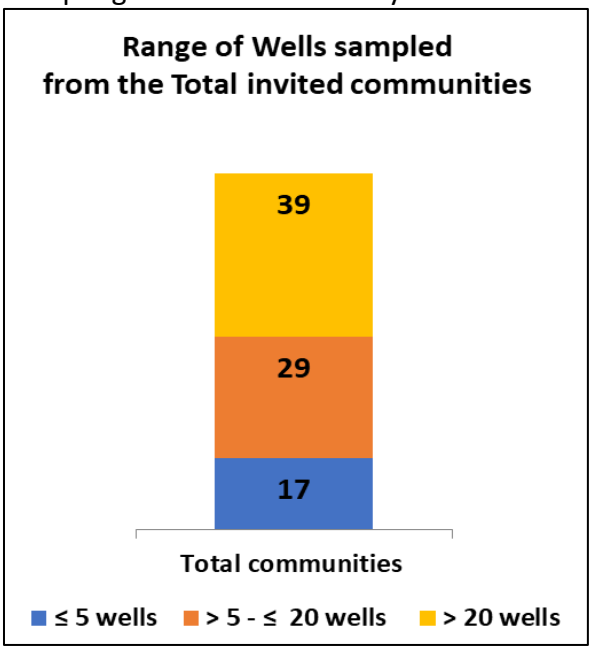


*Figure 22. Range of Wells sampled from the Total invited communities*

PFAS6 was detected in all four regions in Massachusetts. The Northeast region had the highest percentage of sites sampled with results exceeding the 20 ppt MCL (17%), but also the fewest communities sampled. The largest group of PFAS6 results from the Northeast region, (45%), were between 2 and 20 ppt. In the Western region, 2% of sites exceeded the 20 ppt MCL and 88% were below 2 ppt. The Southeast and Central regions had very similar results. In the Southeast and Central regions, 68% and 61% of results were below 2 ppt, and 7% and 8% of results exceeded the 20 ppt MCL, respectively (Table 4).

From the total sites sampled, the majority (73%) had concentrations less than 2 ppt, followed by those between 2 and 20 ppt (21%) and then those greater than the MCL of 20 ppt (6%) (Figure 23).

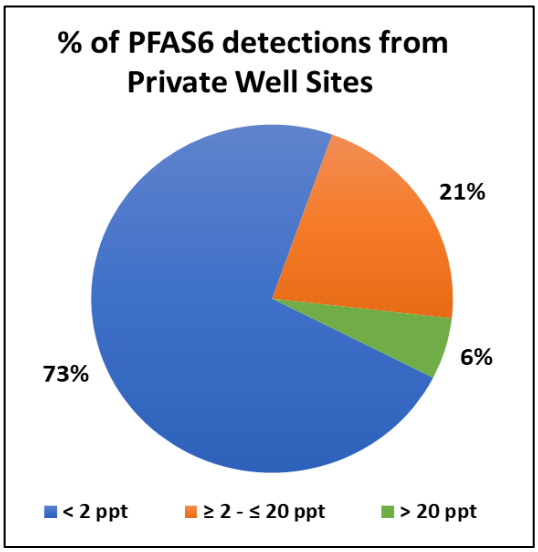


*Figure 23. PFAS6 detections from Private Well Sites*

| Region | # of Communities | Total sites sampled | % of sites below 2 ppt | % of sites between 2 and 20 ppt | % of sites over 20 ppt | Max PFAS6 detection (ppt) |
|---|---|---|---|---|---|---|
| WERO | 49 | 791 | 88% | 10% | 2% | 310 |
| CERO | 16 | 267 | 61% | 31% | 8% | 180 |
| NERO | 6 | 187 | 39% | 45% | 17% | 1369 |
| SERO | 14 | 423 | 68% | 25% | 7% | 199 |

*Table 4. Private well sites sampled summarized by region*

## 10.3.3. Statewide PFAS6 data analysis

### 10.3.3.1 Sampling sites description

For the analysis described in this section, 7,981 PFAS6 results were compiled at 4,086 raw water source locations in 306 communities in the Commonwealth to study the PFAS6 statewide spatial distribution. Results contain samples collected from 2019 to 2022 (Table 5) for both public water sources (59%) and private wells (41%). From the total PWS source locations, 96% are ground water and 4% are surface water (Figure 24).

| Number of Samples | | |
|---|---|---|
| Year | PWS | PWO |
| 2019 | 75 | 0 |
| 2020 | 653 | 0 |
| 2021 | 3144 | 1225 |
| 2022 | 2103 | 781 |

*Table 5. Number of PFAS6 results compiled from Public Water Sources and Private Wells Owner by year*

PWSs with only finished water samples from water treatment plants with PFAS treatment installed were not used in the analysis to provide a clearer picture of the extent of PFAS contamination of ground and surface water sources in the Commonwealth.

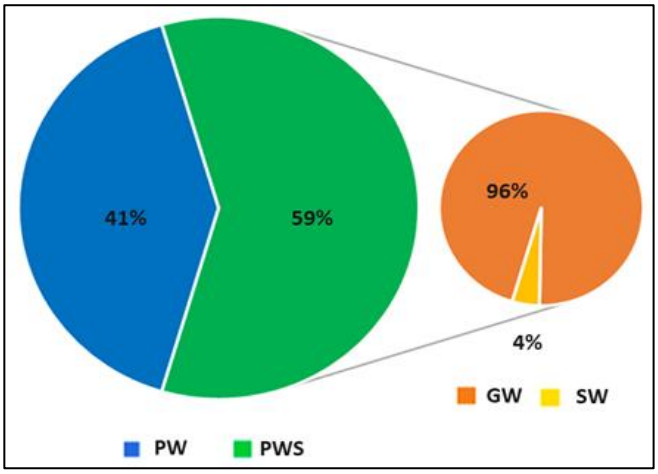


*Figure 24. Percent of Private Wells and Public Water Sources sampled and water source type*

The number of sites tested by community range from one to 93 (Figure 25). The Western region had the highest number of locations (1,405 sites, 34%), followed by Southeast (1,211, 30%), Central (1,030, 25%) and Northeast (440, 11%) (Figure 26).

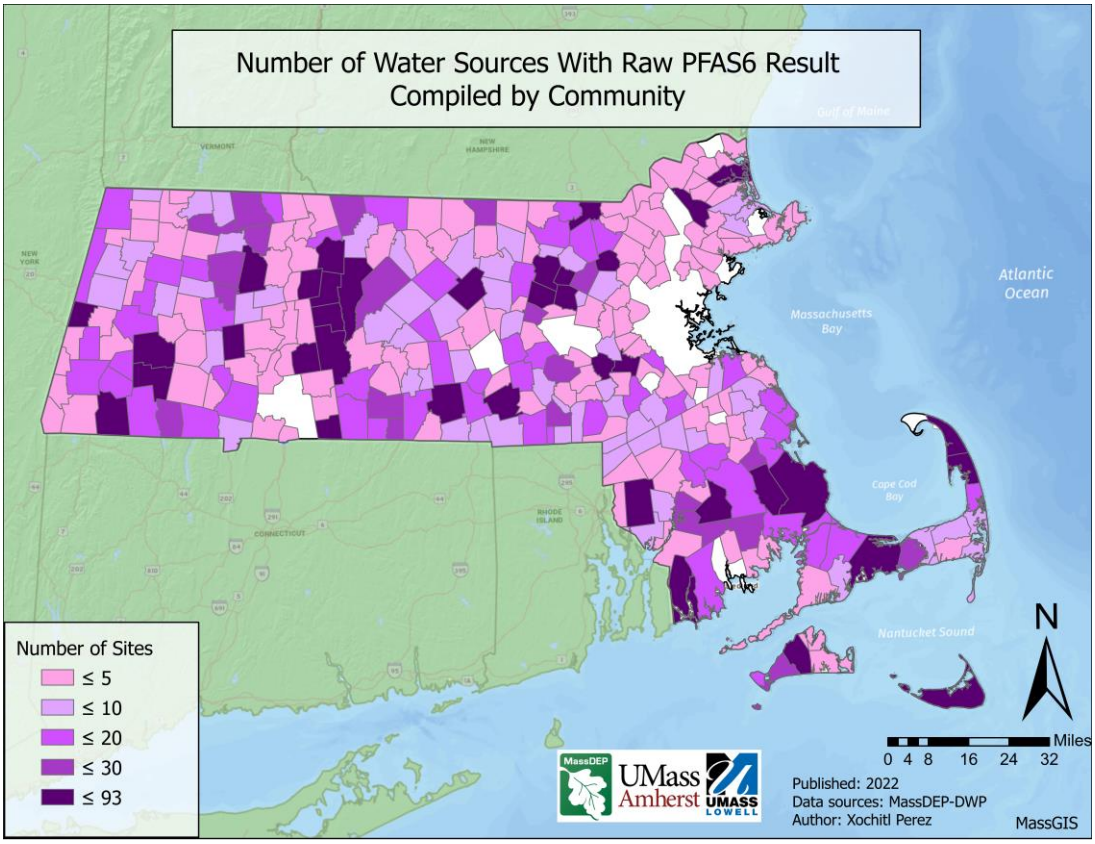


*Figure 25. MA map showing the number of sites with raw PFAS6 results compiled by community*

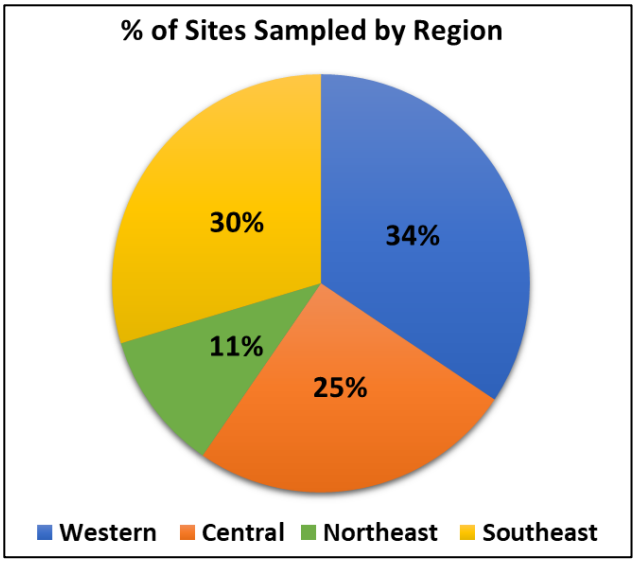


*Figure 26. Percent of sites sampled by region*

### *10.3.3.2* ***PFAS6 Spatial Distribution***

To create the statewide PFAS6 distribution statewide (Figure 27) a hexagon grid was used as it is recommended for large areas such as cities or states and it reduces bias from aggregating values into different size polygons (Arc Pro, 2022). Each polygon aggregates all results in a hexagon grid and displays the maximum PFAS6 concentration measured within the area.

The two highest concentrations detected in the Northeast region were 1,369 ppt and 464 ppt. 77.1% of the Northeast sites were over 2 ppt with 20.7% exceeding the MCL of 20 ppt. The Western region's highest concentration detected was 813 ppt. 13.5% of the Western sites were over 2 ppt with only 2.5% exceeding the 20 ppt MCL. The Central region's two highest concentrations detected were 490 ppt and 410 ppt. 50.8% of the Central sites were over 2 ppt, with 13.4% exceeding the 20 ppt MCL. The highest concentration detected in the Southeast region was 199 ppt. 44.2% of the Southeast sites were over 2 ppt with only 9.8% exceeding the 20 ppt MCL (Figure 29).

From the total sites sampled, 61% of results were less than 2ppt, 30% of sites were at or above 2 ppt but did not exceed the MCL of 20 ppt, and 9% had results over 20 ppt (Figure 28).

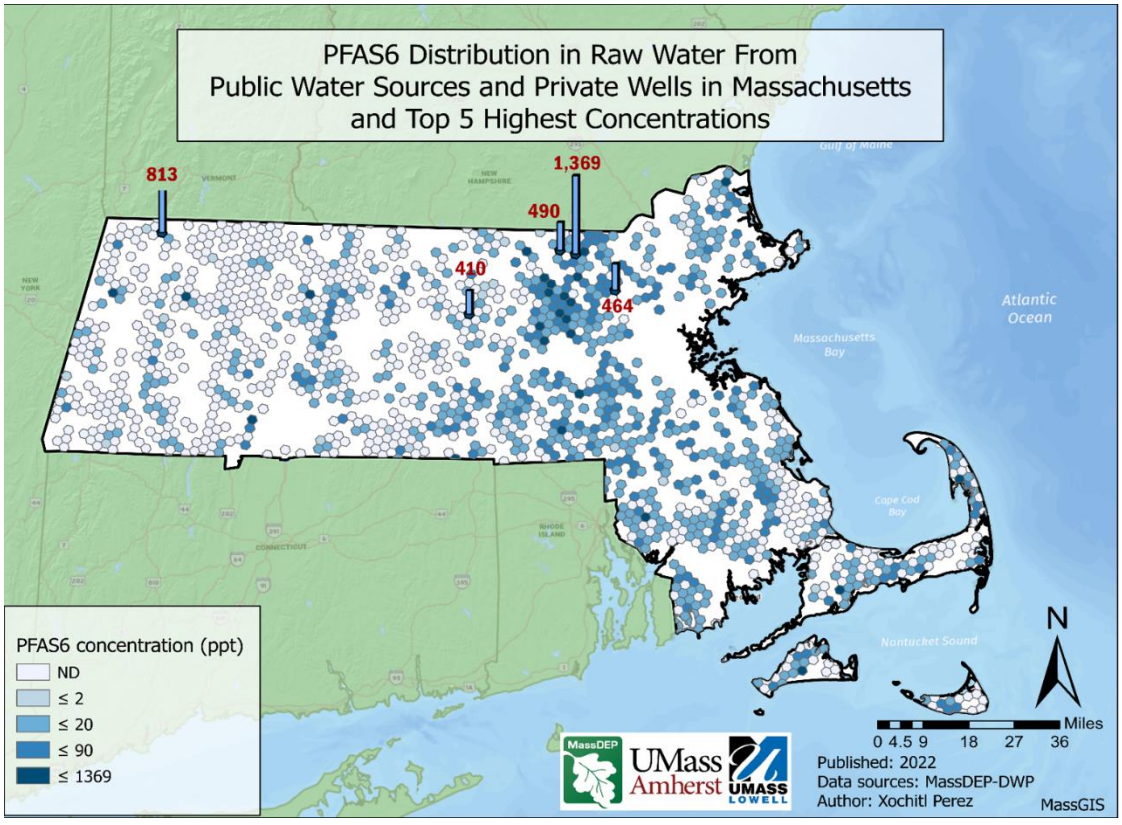


*Figure 27. PFAS6 Distribution in PWSs and Private Wells and five highest concentrations*

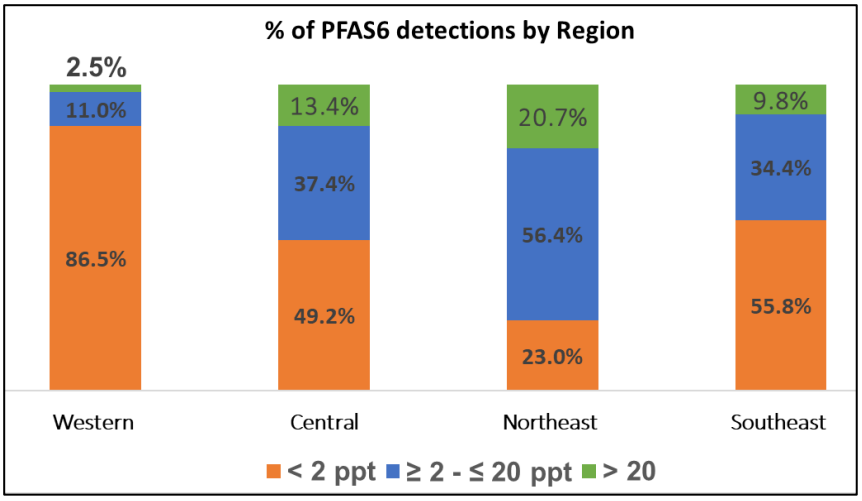


*Figure 29. Percent of PFAS6 detections by region.*

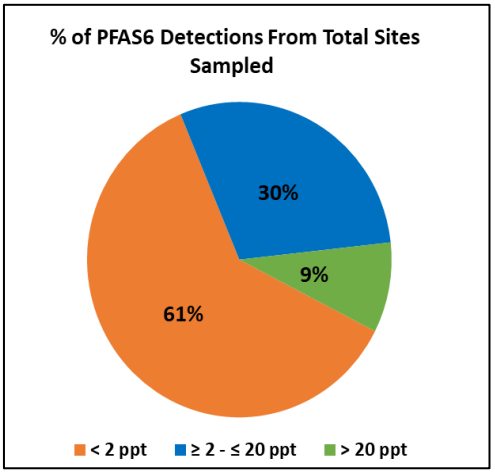


*Figure 28. Percent of PFAS6 detections statewide.*

### *10.3.3.3 Spatial statistical analysis*

#### *a) PFAS6 statistically significant groupings in Massachusetts*

To identify statistically significant groups of sites with similar results over 2 ppt statewide, the Cluster and Outlier Analysis (Anselin Local Moran's) with Zone of indifference, Euclidean Distance Method, Row Standardization with 999 permutations was used to identify sites that have similar values (either high or low PFAS6 values). Then the Density-base Clustering tool was used to highlight groupings with more than six sites and not more than four miles (6,437 meters) away from each other.

Figure 31 displays the groupings with PFAS6 detections that are no more than four miles away from each other and have statistically significant similar values (low (2-19 ppt) or high (19.1-1,370 ppt). Only one grouping located between Central and Northeast was identified with more than 60 sites and values over 20 ppt. However, nine groupings were identified across the four regions with values between 2 and 20 ppt. Three groupings were in the Southeastern region (30-67 sites, 19 outliers), three in Western region (10-23 sites, 6 outliers), two in Central (8-17 sites, 2 outliers) and one in Northeast region (36 sites, 2 outliers).

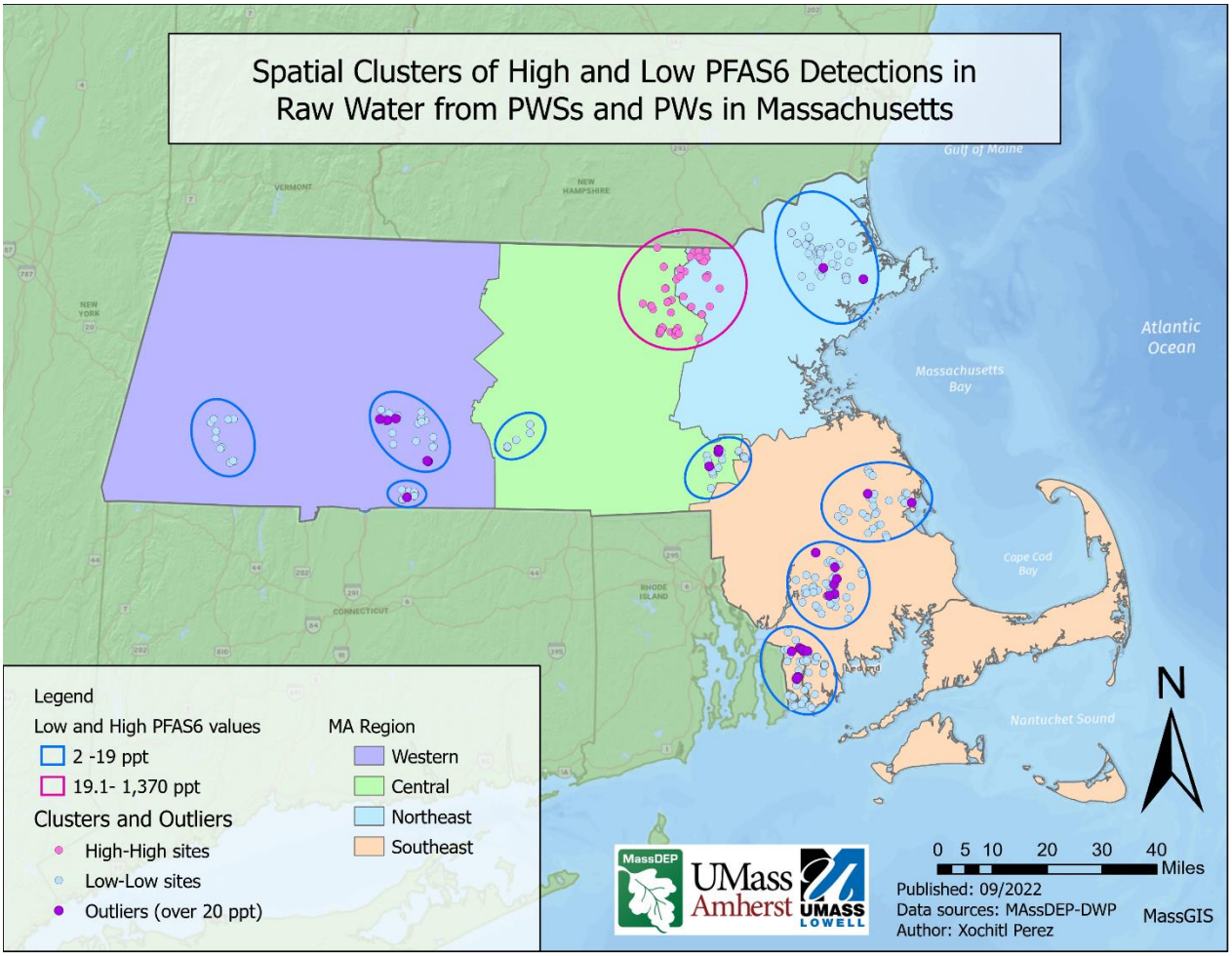


*Figure 31. MA map showing statistically significant groupings with Low and High PFAS6 detections and outliers statewide and by region*

## b) GW and surface water PFAS6 detections

Statistical analysis of results between surface water (SW) and groundwater (GW) showed a statistically significant difference, (Kruskal-Wallis, X2(1) =8.7, p = 0.003). Groundwater had the highest PFAS6 detection (1,369 ppt), however 62% of the total samples were below 2 ppt and only 9% were over the MCL. On the other hand, in surface water, 51% of the sites showed results over 2 ppt and 13% were over the MCL with the highest concentration of 108 ppt (Figure 30).

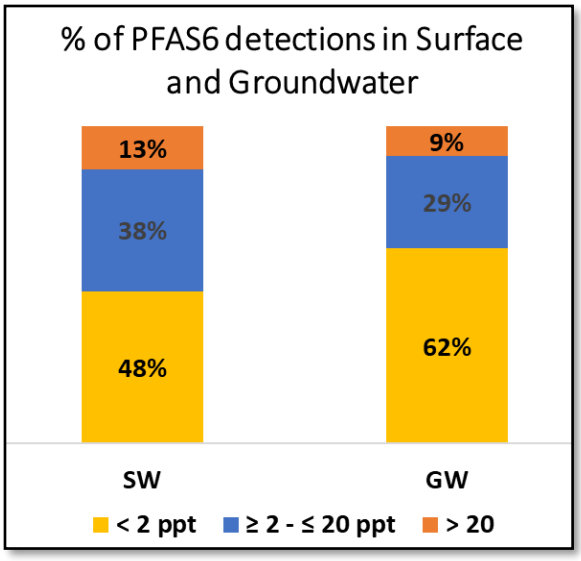


*Figure 30. Percent of PFAS6 detections in surface and ground water*

### *10.3.4. Conclusions and recommendations*

The extent of PFAS6 contamination in drinking water sources across the Commonwealth was analyzed and described in this section. The PFAS distribution described in this section was from raw water samples collected between 2019-2022 and from 4,086 raw water source locations in 306 communities in Massachusetts. Different variables, such as adding new sampling locations or new results for previously sampled locations, could change the PFAS6 distribution described in this report. The maps provided here present a snapshot in time of the PFAS6 distribution in Massachusetts. To monitor and characterize a temporal PFAS distribution in MA we recommend continuing sampling raw water from the water sources and to analyze the raw water from the locations where only finish water was sampled.

All four regions in Massachusetts have PFAS6 detections, however there was a significant difference between their sampling sites results (Kruskal-Wallis, X2(3) =764.5, p = 2.2 X10-165).

The Northeast region had the highest percentage (77%) of sites with PFAS6 detections over 2 ppt. Two large statistically significant groupings (more than 25 sites) were identified in this region, one in the northeastern section of the region with PFAS6 detections between 2- 20 ppt and a second with values over 20 ppt. On the other hand, in the Central region nearly 50% of the sites were below 2 ppt, with only 13% exceeding the MCL, however the grouping with the highest PFAS6 values was also detected in this region.

The Southeast region had three large statistically significant grouping of sites with results between 2- 20 ppt. In total, more than 50% of sampling sites in the Southeast region had results below 2 ppt and 10% exceeded the MCL. The Western region had three smaller groupings (less than 25 sites) with results between 2- 20 ppt, however the region had the lowest percentage (2%) of sites exceeding the MCL and the highest percentage (87%) of sites below 2 ppt.

From the total sites sampled, more than 50% of results were less than 2 ppt, however 12% of samples from PWSs and 9% from private wells exceeded the MCL. Only 4% of the total samples from PWSs were from surface water sources, but more than 50% of those samples had PFAS6 detections over 2 ppt, with 13% exceeding the MCL. This is in comparison to samples from groundwater sources where more than 60% had detections below 2 ppt and only 9% exceeded the MCL.

Both COM and NTNC PWSs had 14% of sampled sites with PFAS6 detections exceeding the MCL. TNC systems had 7% of sampled sites with detections exceeding the MCL. COM systems also had the highest percentage (>50%) of samples above 2 ppt, whereas more that 50% of the results for NTNC and TNC systems were below 2 ppt.

Data analysis identified the Northeast region as particularly affected by PFAS accumulation and high concentrations. This region is the most densely populated (46% of the total population in MA) and contains the highest number of Environmental Justice groups (55% of the total EJ blocks in MA). However, this region had the lowest number of sampling sites. This is in part due to the large number of PWSs in the Northeast region which purchase their water from larger systems

such as MWRA. To have a better understanding of the PFAS distribution in the areas with no data, additional sampling is recommended in the towns with fewer than five sampling sites, where possible.

The analysis discussed in this report was focused on the characterization of the extent of the six PFAS compounds regulated in Massachusetts. The analysis described in the next section includes the individual distribution of regulated and non-regulated PFAS compounds, correlation between PFAS abundance and variables such as land use or population, PFAS signature, and sources attribution analysis.

Further study of samples from different environmental media, such as water from non-potable sources and soils, is needed to have a better understanding of the extent of PFAS contamination across the Commonwealth.

### *10.3.5. Publication of an article*

The distribution of the sum of PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA compounds has been described in this report, however, in order to understand individual PFAS distribution and to identify risk locations and PFAS sources, more analysis is required. UMass in collaboration with MassDEP are working on additional analysis that will include PFAS results from PWS raw water source locations, Waste Site Cleanup PFAS investigation sites, and PFAS in Massachusetts Rivers sampling locations, the analysis and objectives are described in the following paragraph and of the results will be published as an article.

Statistical and spatial analysis including correlations, principal component analysis, and geoprocessing with Multivariate clustering has been used to **1.- Study the presence and extent of individual PFAS** in Massachusetts water sources including 12 unregulated PFAS such as PFBS and PFHxA, **2.- Identify the most present and persistent PFAS** statewide, **3.- Identify the most impacted** areas, **4.- identify PFAS sources correlated to PFAS signature** from water sources **5.- identify the correlation** between impacted water sources and land use and the number of possible PFAS sources. Data collection and analyses are still in progress, however, the final draft is expected to be released in the coming months. For more information, please contact MassDEP DWP or UMass.

# 11 Benefits of the Program

The results of PFAS sampling of drinking water, along with the work of others doing PFAS testing, such as the USGS, has **allowed MassDEP to document the widespread contamination of the Commonwealth's sources of drinking water**, and the contamination of rivers, streams and lakes. In May 2022, the Massachusetts Attorney General sued 13 manufacturers of PFAS chemicals for causing millions of dollars in damages to communities across Massachusetts.

Through the Program, **MassDEP was able to financially assist PWS by providing them with a first round of PFAS sampling**. UMass produced a training video for PWS on the proper procedures for collecting PFAS samples and held a couple of training sessions at treatment plants (pre-Covid).

MassDEP issued regulations requiring all PWS to test for PFAS in October 2020. The **MassDEP Drinking Water Program promoted the Program through newsletters and presentations in conjunction with RCAP and various water works associations**. The free sampling was made as easy as possible for the PWS by UMass arranging to have the coolers and sampling bottles delivered and picked up by the laboratory. UMass TAPs were able to help the PWS by answering questions. By offering free sampling, **MassDEP was able to avoid many PWS failing to comply with the new regulations** by failing to collect or incorrectly collecting samples.

Initially, there was a lot of concern that samples might be contaminated due to the presence of PFAS in numerous consumer products (such as waterproof jackets). **The testing program enabled MassDEP to rule this out as a problem.**

**The private well sampling enabled MassDEP to determine whether PFAS contamination was present in communities where greater than 60% of the residents obtain their water from a private well**. Meetings were held with the Boards of Health and other local officials in these communities and the testing results were provided to the Boards of Health as they were received. This enabled MassDEP to **educate the Boards of Health about PFAS in groundwater**. Following the end of the Program, MassDEP provided the Boards of Health with a compiled Excel file of all results in their town for their use in responding to requests from the public and others. Because the Boards of Health often regulate the private wells in their communities, they can use this information for advising private well owners, or in some situations, requiring private well owners to test for PFAS such as when a new well is drilled or a property changes hands.

**Working with UMass enabled MassDEP to engage with many students**. Over 40 students were involved with the Program in some capacity, both undergraduates and graduate students. The students learned about PFAS contamination of drinking water, how to read and interpret laboratory reports and conduct a quality control review, how to enter testing data in the water quality database, and how to create GIS maps. Through this partnership **MassDEP was able to train the next generation of drinking water professionals, while getting valuable assistance**.

**Graduate students conducted research associated with the analysis of the results of this report.** For example, students participated and won second place in the poster contest at the New England Water Environment Association 2022 Annual Conference (Figure 32). Additionally, two posters were presented at the Press conference "McGovern, Comerford Will Highlight PFAS Mitigation Money in Infrastructure Bill at UMass Facility that Plays Key Role in PFAS Research" that took place outside of the WET Center on the UMass Amherst campus (Figure 33). To see posters presented at the event see Appendix G and to see the press conference click here.

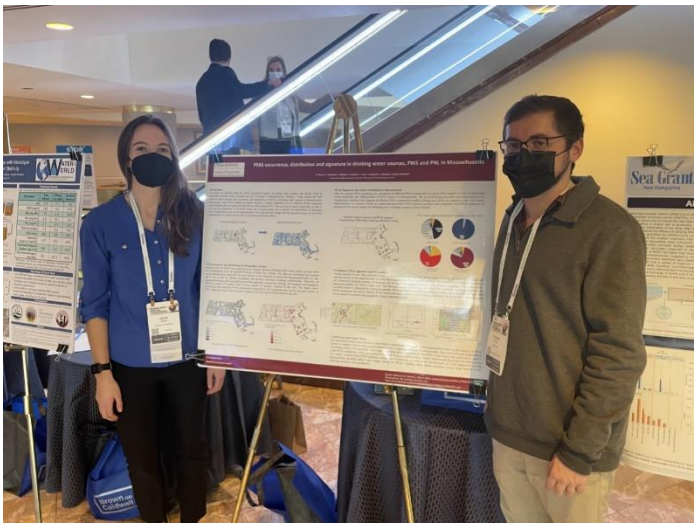

*Figure 32. Janice Weldon and Christian Pasichny presenting a poster at the NEWEA 2022*

*Figure 33. UMass research team presenting posters at a press conference outside the WET*

The process of identifying sources of PFAS contamination of groundwater is difficult. The testing results from the Program were immediately provided to the MassDEP BWSC. UMass also provided BWSC with the maps they created of the sampling locations and results. BWSC is doing extensive work investigating contamination by testing properties adjacent to public sources of drinking water where PFAS was detected and identifying Potentially Responsible Parties, where possible. In addition, BWSC set a level of 90 ppt as an imminent hazard for consumption of drinking water. **They immediately provided bottled water to the 10 private well owners who**

**detected PFAS above that level** in their wells as part of the Program and will be installing treatment devices in homes to remove PFAS**.**

The quality control review MassDEP elected to perform for PFAS laboratory reports is more complicated than for other types of drinking water testing laboratory reports. In addition, the laboratories were only recently certified by MassDEP for the analysis of PFAS samples and did not always provide the required documentation in the reports. UMass assisted MassDEP in **developing a procedure and checklist for reviewing laboratory reports in addition to creating several guidance documents on quality control review of PFAS drinking water results**. UMass worked with the laboratories so that they understood all the requirements.

Approximately 5% of private well owners found PFAS contamination in their wells above the MCL and approximately 10% of PWS found PFAS above the MCL in one or more of their sources. The research being done by UMass in identifying potential sources will enable us to identify areas where future research is needed.

# 12 Recommendations for MassDEP Programs, Procedures, and Regulations

Given the wide extent of PFAS detections across the Commonwealth's drinking water sources and the imminent federal primary drinking water standards for PFOS and PFOA, it is prudent for MassDEP to further investigate PFAS contamination and continue to invest in sampling and remediation at PWSs. Should additional funding become available, some recommended projects could include providing:

- Additional free sampling for small COM and NTNC PWS (those serving less than 10,000 people) to assist with offsetting the cost of required quarterly and/or monthly monitoring, depending on PFAS levels.
- Free initial and confirmatory sampling for TNC PWS that have not yet sampled. TNC PWS are often the smallest PWSs, with fewer resources to conduct required monitoring.
- Raw water sampling for PWS that only chose to test their finished water sources for PFAS. Raw water sampling is not universally required by the drinking water regulations; however, collection of additional raw water results would add to the dataset utilized in this report and create a more robust picture of groundwater and surface water PFAS contamination across the State.
- Capacity support to PWS with detections of PFOA and / or PFOS or the Health Index PFAS in response to the proposed EPA MCLs

Private wells are not regulated by MassDEP, however the Program and additional work conducted by MassDEP BWSC, showed that many private well owners are also at risk of PFAS contamination of their drinking water sources. Should additional funding become available, some recommended potential private well projects include:

- Expanding free private well sampling to areas that are served by mixed public and private water supplies. Massachusetts has an estimated 200,000 private wells serving approximately 600,000 people, many of which live in urban areas additionally served by PWSs. Certain private drinking water wells may be more exposed to possible PFAS contamination than more rural wells since they are closer to land uses typically associated with PFAS use, and many are also located in EJ areas that have been subject to a disproportionate share of negative environmental consequences. This would expand the scope of MassDEP's understanding of statewide PFAS contamination of private wells.
- Expanding free private well sampling into additional towns that did not meet the initial 60% threshold for inclusion in the Program. Data from this project could be used to both correlate PFAS detections with land uses and provide information to assist MassDEP's Water Utilities Resilience and Water Management Act parcel delineation projects.

# 13 Resources for More Information

PFAS Explained:
https://www.epa.gov/pfas/pfas-explained
PFAS Strategic Roadmap:
https://www.epa.gov/pfas/pfas-strategic-roadmap-epas-commitments-action-2021-2024
EPA's PFAS Health Advisories:
https://www.epa.gov/sdwa/drinking-water-health-advisories-pfoa-and-pfos
PFAS6 drinking water standard:
310 CMR 22.00: The Massachusetts Drinking Water Regulations.
MMCL, MassDEP's technical support document:
Per- and Polyfluoroalkyl Substances (PFAS): An Updated Subgroup Approach to Groundwater and Drinking Water Values
PFAS Interagency Task Force report:
https://malegislature.gov/Commissions/Detail/556/Documents
PFAS Attorney General's Lawsuit s:
https://www.mass.gov/news/ag-healey-sues-manufacturers-of-toxic-forever-chemicals-for-contaminating-massachusetts-drinking-water-and-damaging-natural-resources
PFAS Treatment Grant Program and awardees:
https://www.mass.gov/info-details/water-resources-grants-financial-assistance#pfas-treatment-grant-
PFAS6 Interim Response Grant Program:
https://www.mass.gov/info-details/water-resources-grants-financial-assistance#interim-pfas6-response-program-
MDPH list of bottlers see:
https://www.mass.gov/doc/list-of-bottlers-may-12-2022-0
MassDEP PFAS foam Advisory:
https://www.mass.gov/doc/pfas-foam-advisory/download
MassDEP BWSC investigations:
https://www.mass.gov/topics/cleanup-of-sites-spills
PFAS in foam analysis:
https://www.mass.gov/doc/summary-of-the-massdepctdeep-sampling-analysis-of-select-fluorine-free-foams/download
MassDEP's PFAS in residuals:
https://www.mass.gov/info-details/pfas-in-residuals
Pesticide Products and Mosquito Control:
https://content.govdelivery.com/accounts/USAEPAOPPT/bulletins/2b8444f
PFAS in MA rivers:
https://www.mass.gov/doc/pfas-in-massachusetts-rivers-presentation/download
Private Wells FAQ:

https://www.mass.gov/doc/frequently-asked-questions-about-the-massdep-private-wells-pfas-sampling-program/download?_ga=2.168484705.1959656813.1651514897-1537723489.1647721266

*Appendix A. Workflow for the creation of the targeted and random invitations.*

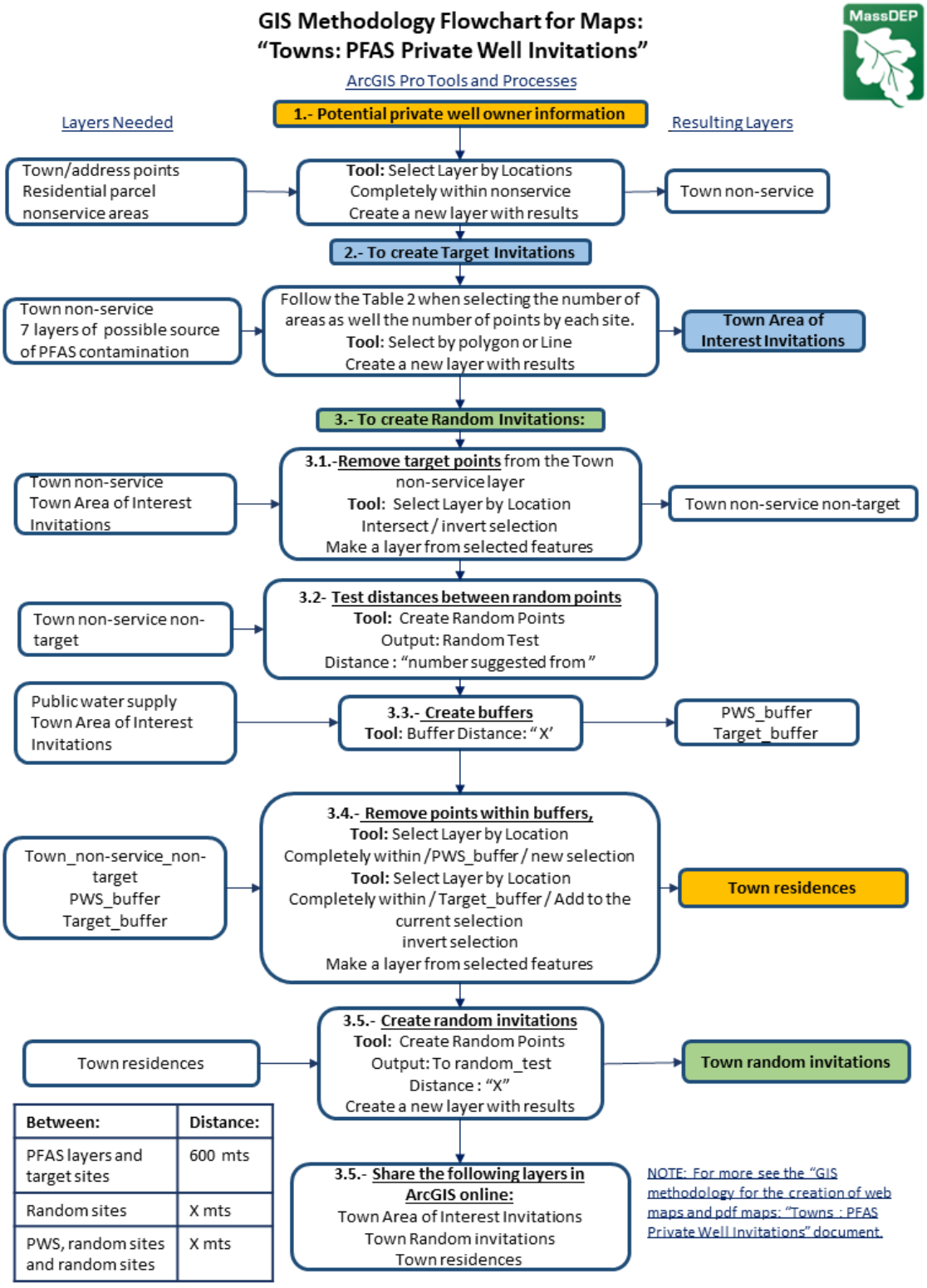


Figure A-1 GIS methodology workflow for the creation of the targeted and random invitations feature layer

## *Identifying Residences Not Served by Public Water*

To identify residential properties potentially served by private wells, the methodology incorporates the use of a GIS datalayer called MassDEP Residential Parcels for Selected Towns Not in (Public) Water service areas (referred to as Residential Parcel Non-Service Areas in step 2.1, Fig 1) developed by the MassDEP Water Management Act program together with the MassDEP GIS program. This datalayer is a modified subset of the MassGIS 2020 Standardized Assessors' Parcels (now referred to as the MassGIS Property Tax Parcels datalayer) for residential parcels within the selected 85 towns of the PFAS project that do not intersect the 2020 Draft layer of MassDEP's Estimated Water Service Areas dataset (see below) showing water supply service areas for registered community public water supplies in Massachusetts for the 85 towns. Various data were used to identify the parcels as residential, including the use codes and building styles in the Assessor tables, land use in the MassGIS 2016 Land Use/Land Cover datalayer, structures in the MassGIS 2019 2-D Structures datalayer, and imagery in the USGS 2019 Ortho Imagery datalayer. In the case of multiple records within a parcel (such as apartment buildings), the parcel address corresponds to the first parcel listed, and other attribute fields (building area, etc.) are the sum of the records. This data is currently under development and is being posted here for ongoing use and analysis. There may be significant omissions or errors. For further information on the methodology for the development of the MassDEP Residential Parcels for Selected Towns Not in (Public) Water Service Areas, QA/QC process and limitations, please refer to MADEP Data Improvements for Water-Use Estimation in Massachusetts, USGS Water Use Data and Research Grant Project – Final Report. November 8, 2020.

The sources for the delineation of MassDEP's Estimated PWS Service Areas include: information from water suppliers, maps submitted and maintained at DEP offices, online maps available from municipal websites, the MassGIS Public Water Supply Service Territories (2005) available for a limited number of towns, and various other infrastructure mapping projects. Some service areas are estimated service areas based on road centerlines, parcel served information, water system GIS data or digital images of maps or reports. Some PWS system areas have not been mapped while others may contain errors or outdated information - this data is still under development at MassDEP. For more information on this datalayer please contact the WURP program: https://www.mass.gov/guides/water-utility-resilience-program.

## *Identifying Private Wells for Targeted and Random Sampling*

Address points from the MAD Address point layer within the Residential Parcel Non-Service Areas layer were extracted for each town and then were subsequently processed according to the methodology in Appendix A to create a selection of random and targeted locations. Although these are technically the center of each parcel, these are referred to as Private Wells throughout the methodology.

## *Appendix B. Contact information for Possible PFAS sources layers.*

| Layer name | Layer location/link/ information |
|---|---|
| Airports | MassGIS Data: Layers from MassDOT |
| Combustion Facilities | MassGIS Data: MassDEP Major Facilities |
| Ground Water Discharge | MassGIS Data: MassDEP Ground Water Discharge Permits |
| Land Disposal Areas | MassGIS Data: MassDEP Solid Waste Diversion and Disposal |
| Massachusetts Fire Stations | MassGIS Data: Fire Stations |
| Industry | Facilities with a North American Industry Classification System (NAICS) rating PFAS use. MassDEP BAW: Internal layer. For more information: joshua.cook@mass.gov |
| Unmapped sites | MassDEP DWP: internal layer. Collection of locations that BOH and MassDEP regions have identified as possible PFAS sources. For more information: Program.Director-DWP@mass.gov |

*Table B-1 Possible PFAS sources layers information.*

NOTE: Additional layers such as military bases and locations where some residuals may have been either distributed or land applied were also used as references for possible sources of PFAS.

The "MassDEP Residuals" data layer shows locations where storage of Type I residuals prior to final placement were reported to MassDEP, and where MassDEP approved land application of Type II residuals. Based upon subsequent investigation, it is unknown whether these materials may have been distributed further and/or applied within study area. The residuals include Type I material which, in accordance with 310 CMR 32.00, is approved for use without further approval, and Type II material which required site specific approval. Current Type I and Type II approval criteria do not have standards for PFAS compounds. MassDEP cannot independently confirm whether residuals were stored or land applied at these locations. However, sites from these layers were not displayed in this report as these layers are still under development. Please contact the MassDEP DWP for additional information (program.director-dwp@mass.gov).

## *Appendix C. Assigning invitations in each town.*

Assigning number of points near PSOPCA and number of random points by town population

| Towns ≥ 1000 PW | | | | |
|---|---|---|---|---|
| # of PSOPCA | # of points selected near PSOPCA | Total target point | # of random points | Total points |
| 1 | 20 | 20 | 90 | 110 |
| 2 | 20 | 40 | 80 | 120 |
| 3 | 20 | 60 | 80 | 140 |
| 4 | 20 | 80 | 80 | 160 |
| 5 | 20 | 100 | 60 | 160 |
| 6 | 15 | 90 | 70 | 160 |
| 7 | 15 | 105 | 60 | 165 |
| 8 | 15 | 120 | 50 | 170 |
| <9 | 15 | | 50 | |

| Towns < 1000 PW | | | | |
|---|---|---|---|---|
| # of PSOPCA | # of points selected near PSOPCA | Total target point | # of random points | Total points |
| 1 | 20 | 20 | 80 | 100 |
| 2 | 20 | 40 | 60 | 100 |
| 3 | 15 | 45 | 55 | 100 |
| 4 | 15 | 60 | 40 | 100 |
| 5 | 10 | 50 | 50 | 100 |
| 6 | 10 | 60 | 40 | 100 |
| 7 | 10 | 70 | 30 | 100 |
| 8 | 10 | 80 | 30 | 110 |
| <9 | 10 | | 30 | |

| Towns ≤ 500 PW | | | | |
|---|---|---|---|---|
| # of PSOPCA | # of points selected near PSOPCA | Total target point | # of random points | Total points |
| 1 | 20 | 20 | 60 | 80 |
| 2 | 15 | 30 | 50 | 80 |
| 3 | 15 | 45 | 35 | 80 |
| 4 | 15 | 60 | 20 | 80 |
| 5 | 10 | 50 | 30 | 80 |
| 6 | 10 | 60 | 20 | 80 |
| 7 | 10 | 70 | 20 | 90 |
| 8 | 10 | 80 | 20 | 100 |
| <9 | 10 | | 20 | |

*Table C-1 Number of target and random sites to be assigned in each town by population and number of Possible Sources of PFAS Contamination Areas (PSOPCA)*

Tables used in the Appendix A "GIS methodology workflow for the creation of the targeted and random invitations" Step 2, to assign the number of wells in each town to receive postcard invitations by population and number of Possible Sources of PFAS Contamination Areas (PSOPCA). These tables were utilized by the GIS team to determine the initial number of invitations to send in each town. Additional invitations may have been sent based on feedback received after sharing draft town maps. PW = Private Wells.

*Appendix D. Workflow for feedback on the private well invitation maps.*

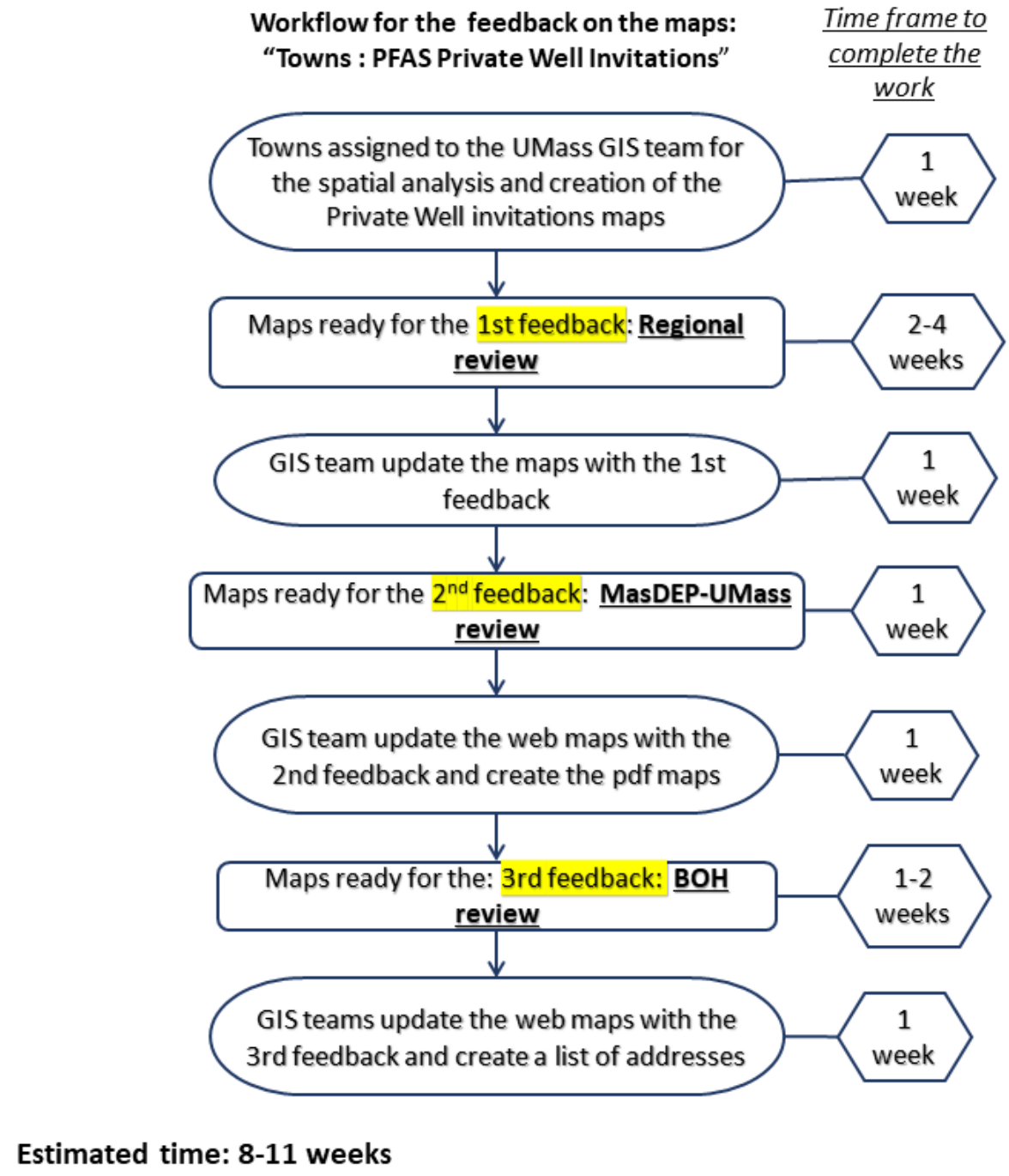


*Figure D-1. Workflow for feedback on the private well invitation maps and estimated time frame for completion.*

## *Appendix E. Methodology to geocode PWO registrations and data flow*

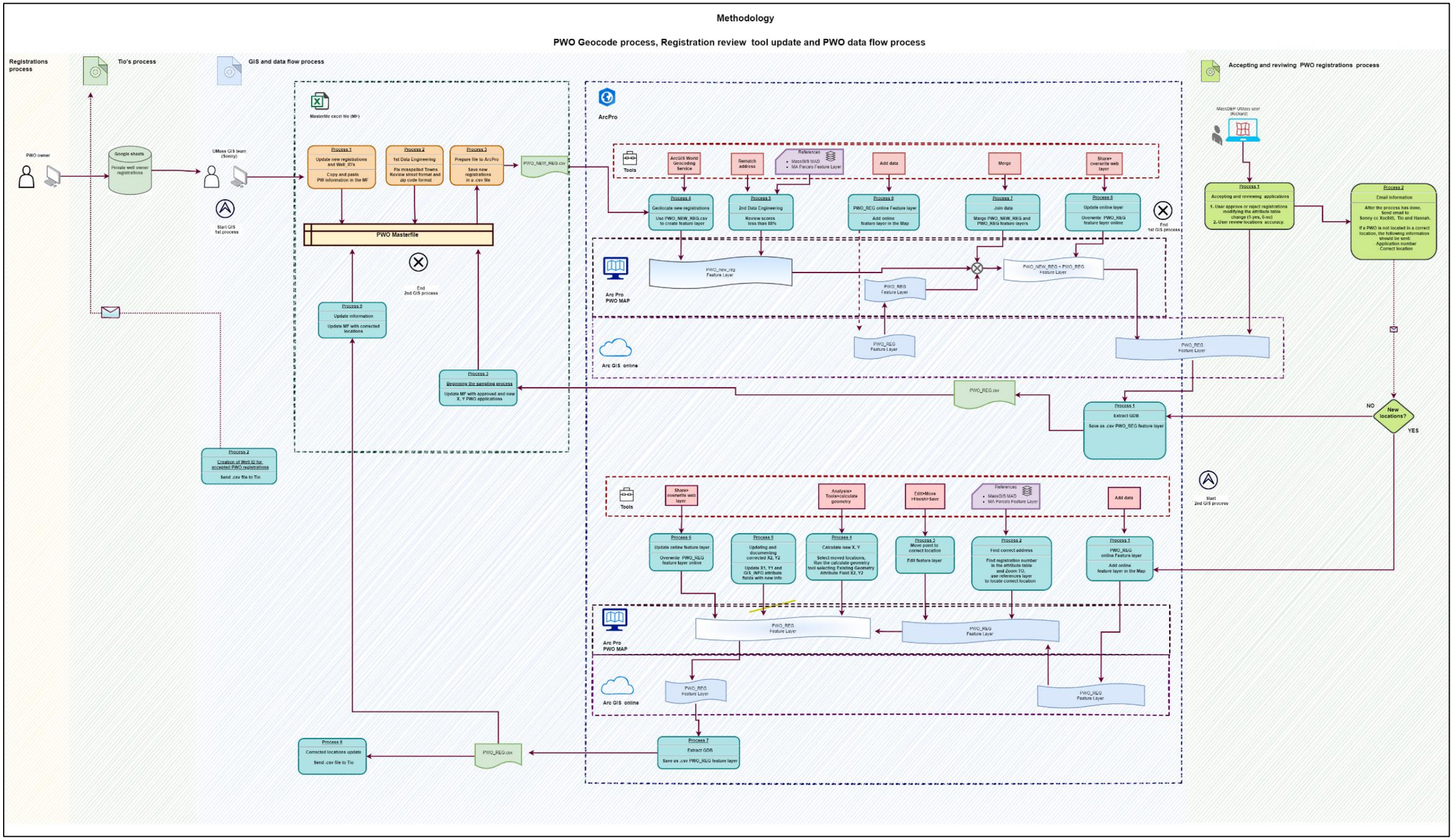


*Figure E-1. Methodology to geocode PWO registrations and data flow.*

## *Appendix F.Tables describing Private Wells sampling data summarized by town.*

| Community name | Total signups | Total accepted registrations | Total wells sampled | PFAS6 max concentration (ppt) | % of results over MMCL PFAS6 | % of results less than 2 ppt |
|---|---|---|---|---|---|---|
| Alford | 18 | 18 | 5 | 3 | 0% | 40% |
| Aquinnah | 23 | 23 | 10 | 0 | 0% | 100% |
| Ashby | 39 | 39 | 18 | 8 | 0% | 72% |
| Ashfield | 44 | 44 | 24 | 0 | 0% | 100% |
| Becket | 67 | 67 | 26 | 8 | 0% | 92% |
| Belchertown | 90 | 90 | 28 | 14 | 0% | 75% |
| Berkley | 79 | 79 | 28 | 8 | 0% | 93% |
| Berlin | 24 | 24 | 5 | 22 | 20% | 0% |
| Bolton | 113 | 78 | 25 | 13 | 0% | 60% |
| Boxborough | 126 | 84 | 43 | 180 | 19% | 37% |
| Boxford | 68 | 68 | 34 | 15 | 0% | 62% |
| Brimfield | 30 | 30 | 9 | 2 | 0% | 89% |
| Buckland | 16 | 16 | 7 | 0 | 0% | 100% |
| Carlisle | 89 | 76 | 40 | 464 | 28% | 35% |
| Carver | 58 | 58 | 31 | 40 | 19% | 42% |
| Charlemont | 11 | 11 | 5 | 0 | 0% | 100% |
| Charlton | 95 | 82 | 26 | 46 | 8% | 58% |
| Chesterfield | 27 | 26 | 8 | 0 | 0% | 100% |
| Chilmark | 40 | 40 | 19 | 50 | 5% | 74% |
| Clarksburg | 3 | 3 | 2 | 0 | 0% | 100% |
| Colrain | 39 | 39 | 18 | 0 | 0% | 100% |
| Conway | 66 | 66 | 31 | 0 | 0% | 100% |
| Dover | 25 | 25 | 16 | 25 | 6% | 31% |
| Dunstable | 15 | 15 | 8 | 3 | 0% | 75% |
| Erving | 24 | 24 | 8 | 0 | 0% | 100% |
| Florida | 4 | 4 | 1 | 0 | 0% | 100% |
| Freetown | 51 | 51 | 26 | 16 | 0% | 50% |
| Goshen | 25 | 25 | 14 | 8 | 0% | 86% |
| Granby | 81 | 81 | 29 | 26 | 7% | 66% |
| Granville | 32 | 31 | 9 | 6 | 0% | 89% |
| Hampden | 89 | 89 | 35 | 7 | 0% | 77% |
| Harvard | 103 | 68 | 31 | 29 | 3% | 81% |
| Hawley | 4 | 4 | 1 | 0 | 0% | 100% |
| Heath | 9 | 9 | 4 | 0 | 0% | 100% |
| Holland | 32 | 32 | 17 | 27 | 6% | 65% |
| Hubbardston | 15 | 15 | 4 | 0 | 0% | 100% |
| Lakeville | 96 | 89 | 40 | 47 | 8% | 63% |
| Leverett | 101 | 65 | 40 | 171 | 8% | 85% |
| Leyden | 20 | 20 | 12 | 0 | 0% | 100% |
| Mendon | 27 | 27 | 10 | 8 | 0% | 60% |
| Middlefield | 9 | 9 | 3 | 0 | 0% | 100% |
| Millville | 30 | 30 | 6 | 22 | 17% | 0% |

| Community name | Total signups | Total accepted registrations | Total wells sampled | PFAS6 max concentration (ppt) | % of results over MMCL PFAS6 | % of results less than 2 ppt |
|---|---|---|---|---|---|---|
| Monterey | 17 | 17 | 5 | 0 | 0% | 100% |
| Montgomery | 36 | 36 | 15 | 17 | 0% | 73% |
| Mount Washington | 3 | 3 | 0 | 0 | NA | NA |
| Nantucket | 287 | 70 | 41 | 51 | 12% | 66% |
| New Ashford | 8 | 8 | 3 | 0 | 0% | 100% |
| New Braintree | 3 | 3 | 2 | 0 | 0% | 100% |
| New Marlborough | 64 | 64 | 25 | 3 | 0% | 88% |
| New Salem | 127 | 96 | 39 | 5 | 0% | 95% |
| Newbury | 43 | 43 | 25 | 74 | 24% | 36% |
| Oakham | 11 | 11 | 5 | 0 | 0% | 100% |
| Otis | 65 | 65 | 22 | 3 | 0% | 91% |
| Pelham | 85 | 80 | 38 | 37 | 5% | 87% |
| Peru | 13 | 13 | 9 | 2 | 0% | 89% |
| Petersham | 38 | 38 | 15 | 6 | 0% | 87% |
| Phillipston | 4 | 4 | 3 | 23 | 33% | 67% |
| Plainfield | 24 | 24 | 13 | 310 | 8% | 85% |
| Plympton | 34 | 34 | 13 | 12 | 0% | 62% |
| Princeton | 52 | 52 | 32 | 11 | 0% | 78% |
| Rehoboth | 167 | 85 | 40 | 25 | 5% | 63% |
| Richmond | 100 | 100 | 34 | 10 | 0% | 97% |
| Rochester | 28 | 28 | 15 | 22 | 7% | 80% |
| Rowe | 3 | 3 | 2 | 0 | 0% | 100% |
| Royalston | 27 | 27 | 11 | 2 | 0% | 82% |
| Sandisfield | 28 | 28 | 8 | 0 | 0% | 100% |
| Savoy | 8 | 8 | 2 | 0 | 0% | 100% |
| Shelburne | 40 | 40 | 20 | 8 | 0% | 85% |
| Sherborn | 60 | 59 | 34 | 26 | 15% | 38% |
| Shutesbury | 106 | 63 | 40 | 85 | 13% | 75% |
| Stow | 144 | 82 | 42 | 109 | 14% | 57% |
| Sutton | 17 | 17 | 7 | 35 | 14% | 57% |
| Tolland | 60 | 60 | 21 | 11 | 0% | 86% |
| Truro | 50 | 50 | 33 | 12 | 0% | 91% |
| Tyngsborough | 105 | 104 | 38 | 1369 | 21% | 26% |
| Tyringham | 18 | 18 | 11 | 0 | 0% | 100% |
| Wales | 13 | 13 | 7 | 0 | 0% | 100% |
| Warwick | 38 | 38 | 22 | 11 | 0% | 77% |
| Washington | 16 | 16 | 10 | 14 | 0% | 90% |
| Wellfleet | 93 | 70 | 45 | 139 | 9% | 71% |
| Wendell | 77 | 76 | 40 | 17 | 0% | 95% |
| West Tisbury | 160 | 97 | 42 | 199 | 10% | 79% |
| Westhampton | 75 | 75 | 33 | 77 | 3% | 91% |
| Westport | 113 | 94 | 40 | 34 | 5% | 53% |
| Windsor | 24 | 24 | 10 | 3 | 0% | 90% |

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Civil and Environmental Engineering

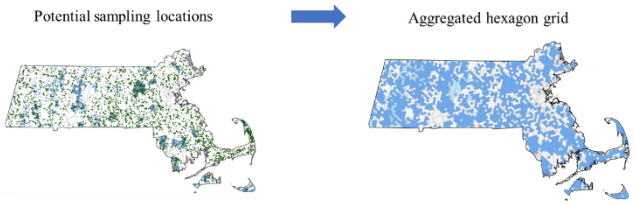
# PFAS occurrence, distribution and signature in drinking water sources, PWS and PW, in Massachusetts

X. Perez[1], C. Pasichny[1], A. Rayan[1], J. Weldon[1], Y. Bozkurt[2], L. Pan[1]., J. Tobiason[1], and D. Reckhow[1]

[1]University of Massachusetts, Amherst, [2]University of Massachusetts, Lowell

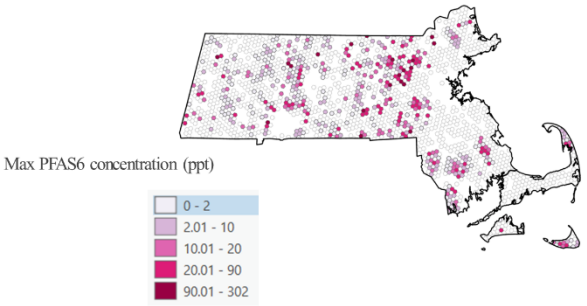
**Introduction:**

As results are gathered from the PFAS Sampling Program for public water systems and private wells by MassDEP Drinking Water Program and the University of Massachusetts Amherst, a large dataset has been collected which displays the occurrence and distribution of PFAS in drinking water sources in Massachusetts. Furthermore, each PFAS sample measured contains a unique distribution of 18 different PFAS compound concentrations that are measured followed the EPA method 537.1. This presents a unique opportunity to analyze not only the distribution of PFAS as a whole across the Commonwealth, but to look at the distribution of individual PFAS compounds across the commonwealth, which could provide insight into the potential source of the PFAS contamination in certain areas to lend in potential remediation efforts.



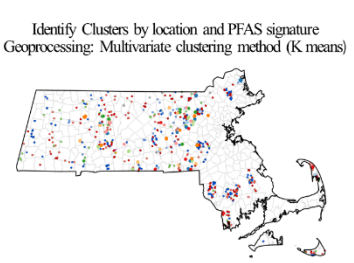

**PFAS occurrence and distribution by Geographic Location**

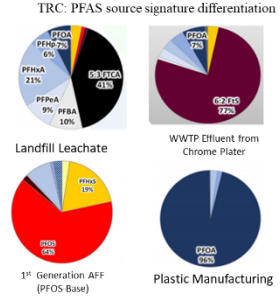
Sampling sites for PFAS were gathered across multiple datasets including public water systems, private wells, and investigations from the MassDEP Bureau of Waste Site Cleanup. These data were normalized and mapped across Massachusetts using GIS. For this research, it was important to present the data geographically in a way that is not skewed by political boundaries and protects individual sampling confidentiality. Therefore, an aggregated hexagon grid was created across Massachusetts to present the findings. The hexagons will represent a different number of samples based on however many samples were collected in that area. The figure below shows the preliminary results of the maximum PFAS concentration measured across Massachusetts.




**PFAS, Signature and Source attribution in Massachusetts**

Here we examine PFAS signatures, i.e., proportion of different PFAS compounds in a given PFAS sample in order to understand source attribution and differentiation of PFAS sources in Massachusetts. We are performing Principal component analysis for emphasizing variations and bringing out distinct PFAS composition profiles (Zhang et al,.2016) for sampling sites with similar characteristics, i.e., clusters. Cluster or clusters having similar PFAS signature profiles were compared with PFAS signatures of potential PFAS sources nearby for attributing one or multiple sources to these Clusters.

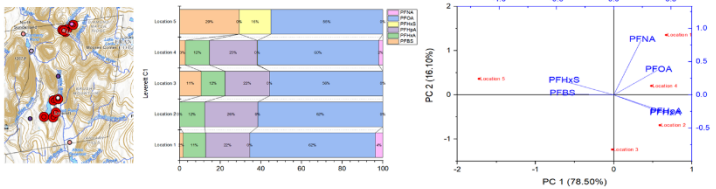



**Leverett preliminary PFAS signature and PCA analysis**

Leverett, a town in Western Massachusetts, has multiple identified potential PFAS sources, two landfills, a fire station, a dumping ground, and two unknown sources. In order to find the signature and attribute sources to the sampling sites, the sites were mapped into GIS to identify clusters. The clusters were determined based on two criteria-(i) minimum number of locations and (ii) maximum distance between sites. Here, a minimum of five sites and a maximum distance of 1500 m were used for Leverett. Next, PCA analysis was performed on this cluster with respect to fractions of PFAS compounds and used to identify PFAS compounds that co-occur to form a unique signature. The PC1 and PC2 for this Leverett cluster explained 78.5% and 16.1% variations in results.

- Highest PFAS conc: (PFOA) 120 ppt
- Max PFAS6: 171.93 ppt
- Max PFAS18: 201.63 ppt
- Total sampling events: 50




**POU STUDY**

The Mobile Water Innovation Laboratory (MBIL) will be used, and other resources at its disposal to test 10 commonly used POU treatment devices. The POU devices were selected from a list of 50 well known devices based on type, cost, and removal efficiencies. The tests will be executed on-site at 4 PWS locations selected by MassDEP based on (i)supply of water with PFAS6 > 20 ppt, (ii) security and accessibility of location (iii) sites from which wastewater could easily be disposed of, and (iv) The MBIL could be equipped for parallel POU testing. The POU devices and related piping and controls are tested before implementation at the first location. Samples of combined influent device effluent water will be collected and preserved in trisma and ice and later analyzed for PFAS using Xevo TQ XS triple quadrupole LC/MS instrument.

Acknowledgments to:
MssDEP Drinking Water Program
UMass PFAS team

MassDEP

*Figure H-1. UMass-MassDEP poster 1*

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# PFAS Sampling Program for Public Water Systems and Private Wells in Massachusetts

X. Perez[1], C. Pasichny[1], J. Tobiason[1], and D. Reckhow[1]
[1]University of Massachusetts, Amherst

**Introduction:**

Per- and polyfluoroalkyl substances (PFAS) are a family of chemicals that have been used since the1950's for the manufacture of a large number of products (e.g. food packaging, cosmetics, medical products, firefighting foams, clothing, and housewares clothing) (https://pfas-1.itrcweb.org/2-5-pfas-uses/). Unfortunately, toxicological studies have shown that exposure to some PFAS may be associated with a wide range of adverse human health effects (ATSDR. 2018). In May 2016, USEPA established a lifetime health advisory of 70 ng/L for PFOA and PFOS in drinking water (USEPA 2016, USEPA 2016). The Massachusetts Department of Environmental Protection (MassDEP), on October 2, 2020, set a public drinking water PFAS standard, establishing a Massachusetts Maximum Contamination Level (MMCL) of 20 nanograms per liter (ng/L) (or parts per trillion (ppt)) – individually or for the sum of the concentrations of six specific PFAS (MassDEP-PFAS). To assist the 1,635 MA public water systems (see Figure 1) that provide drinking water to the public in preparing for the new PFAS regulations, the Baker-Polito Administration provided funding to MassDEP for testing for PFAS in public drinking water (MassDEP-PFAS). The funding also includes PFAS testing for a limited number of private wells, focusing on the 85 Massachusetts towns (see Figure 1) where 60% or more of residents are served by private wells (MassDEP-PFAS-Private wells).

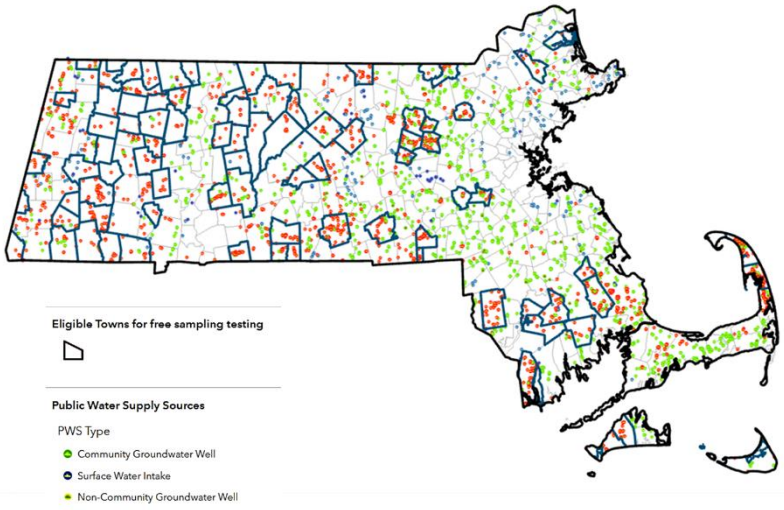


Figure 1: All Public Water Systems in Massachusetts and all 85 towns eligible for Private Well sampling

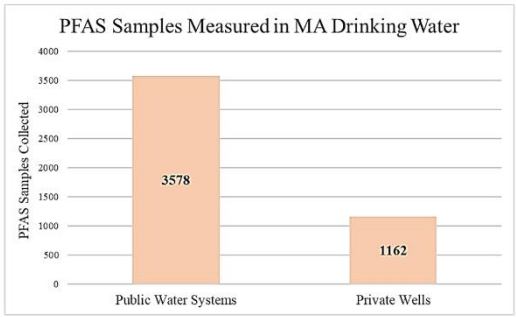


Figure 2: Total Number of Samples Measured for PFAS across Public Water Systems and Private Wells

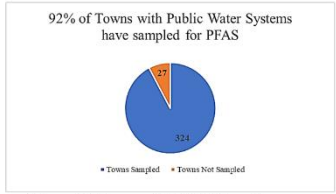


Figure 3: Towns with PWS Samples

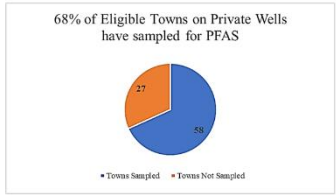


Figure 4: Towns with Private Well Samples

**UMass Amherst–MassDEP**

The University of Massachusetts Amherst is supporting the MassDEP Drinking Water Program to develop and facilitate the statewide free sampling program for Public Water Suppliers (PWS) and targeted private well owners. UMass Amherst has been providing program management, technical assistance, outreach and training, and support for sampling and laboratory analysis services necessary to implement the PFAS Statewide Sampling Program. It is projected to that between 1,300 and 2,500 PWS entry point samples will be collected, plus accompanying quality assurance samples. An additional 3,500 samples are expected to be collected from targeted private wells. Figure 2 present the number of samples that have been collected so far from public water systems and private wells. Figure 3 and 4 present the number of towns that have sampled for PFAS through the free sampling program. Results from all PFAS samples are stored and managed by UMass Amherst, and results from this program can be viewed by the public on MassDEP's official website (https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas#pfas-detected-in-drinking-water-supplies-in-massachusetts-).

**References:**

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MasDEP-PFAS-Private wells. https://www.mass.gov/info-details/per-and-polyfluoroalkyl-substances-pfas-in-private-well-drinking-water-supplies-faq

Acknowledgments to:
MassDEP Drinking Water Program

MassDEP

*Figure H-2. UMass-MassDEP poster 2*