Spring ENVS 0401A Project Statements

Background:
PFAS are a large group of human-made chemicals that have been used in industry and consumer products worldwide since the 1950s. There are thousands of PFAS, including PFOA (perfluorooctanoic acid) and PFOS (perfluorooctane sulfonic acid).

- PFAS do not occur naturally, but are widespread in the environment.
- PFAS are found in people, wildlife and fish all over the world.
- Some PFAS can stay in people's bodies for a long time.
- Some PFAS do not break down easily in the environment.

We know that PFAS are everywhere in the environment. Scientists have the most information on PFOA and PFOS, but since the other PFAS are similar, they likely have similar effects. PFOA and PFOS do not break down in soil. This means they can stay in the environment and contaminate drinking water sources even though they haven't been used in decades. PFOA and PFOS also don't break down in our bodies. It takes about two to four years for half the PFOA in your body to leave through your urine. It may take longer for other PFAS to leave your body.

PFAS exposure can come from drinking water, food, indoor dust, some consumer products, and workplaces. Most non-worker exposures occur through drinking contaminated water or eating food that contains PFAS. PFAS are used in a wide range of industrial applications, as well as many consumer products such as:

- food packaging materials
- non-stick cookware
- stain-resistant carpet treatments
- water-resistant clothing
- cleaning products
- paints, varnishes and sealants
- firefighting foam
- cosmetics
- some types of dental floss[1]

Since the discovery of PFOA contamination in Bennington in 2016, the Agency of Natural Resources (ANR) through the Department of Environmental Conservation (DEC) has undertaken a systematic investigation to identify the most likely sources of PFAS contamination and to confirm the presence or absence of contamination through site investigations. Since 2016, knowledge about PFAS use, presence, and toxicology has expanded rapidly. Vermont has been at the forefront of this effort and has played a key role in sharing knowledge with other states and the federal government. Working with partners in state government, ANR has shifted and expanded its PFAS investigation and management efforts to understand the full extent of the risk posed by these ubiquitous, manmade chemicals, and regulate them to protect public health and the environment. During the 2019 legislative session, ANR worked to advance these efforts through the development and passage of S.49 / Act 21. Under S.49, the Secretary of Natural

[1] VT Department of Health, PFAS in Public Drinking Water, July 2019

Resources was directed to publish a plan for public review and comment to complete a statewide investigation of potential sources of PFAS contamination. To date, the State has either tested for or evaluated data in four major categories: 1) PFAS impact monitoring, 2) PFAS industrial uses, 3) intensive PFAS use, and 4) PFAS in waste streams.[2]

Of the currently more than 4,000 PFAS compounds that are in commerce in the United States, Vermont has established a regulatory standard for five PFAS compounds. Vermont's standard for the combination of five PFAS (PFOA, PFOS, PFHxS (perfluorohexane sulfonic acid), PFHpA (perfluoroheptanoic acid) and PFNA (perfluorononanoic acid)) is 20 ppt (parts per trillion).[3]

While only five PFAS compounds are regulated in Vermont, and in light of the high number of PFAS compounds in commerce, the Vermont Legislature (also through S. 49 / Act 21) directed the Agency of Natural Resources to evaluate whether PFAS could be regulated as a class or subclass of compounds.[4] Many states already do so, including Alaska, California, Colorado, Connecticut, Massachusetts, Michigan, Minnesota, Nevada, New Jersey, Ohio, and Oregon.[5] This process is ongoing—advance notice of proposed rulemaking on this topic was given in October 2020 and the public comment period ran through the end of November.

[2] VT ANR PFAS Statewide Sampling Plan, June 2019
[3] VT Department of Health, PFAS in Public Drinking Water, July 2019
[4] https://legislature.vermont.gov/bill/status/2020/S.49
[5] AGENCY OF NATURAL RESOURCES DEPARTMENT OF ENVIRONMENTAL CONSERVATION DRINKING WATER AND GROUNDWATER PROTECTION DIVISION ADVANCE NOTICE ON THE REGULATION OF PERFLUOROALKYL, POLYFLUOROALKYL SUBSTANCES (PFAS) AS A CLASS. (August 14, 2020)

Project #1: PFAS & Biosolids: Developing Effective Communication Materials for WWTPs

Partner: Eamon Twohig, Vermont DEC Waste Management and Prevention Division Residuals Management and Emerging Contaminants Program Manager

Introduction

The Residuals Management and Emergent Contaminants Program "oversees the management of **residual materials**, industrial and municipal wastes with the potential for beneficial reuse. Examples of residual materials include wastewater treatment sludges and biosolids, septage, short paper fiber, wood ashes and water treatment residuals. In Vermont, residuals management activities must be authorized via solid waste certifications (biosolids), sludge management plans, or certificates of approval (short paper fiber, wood ash)."[6]

One example of beneficial reuse is that "residual materials that meet specific criteria established in the Vermont Solid Waste Rules may be land applied for agronomic value. Sludges and septage that meet specific pollutant limits and that are treated to US EPA biosolids standards for pathogen and vector attraction reduction, may be applied to the land under a site-specific permit or, after addition pathogen treatment, distributed to the public."[7]

"The three primary management options for sludge or biosolids that are currently available to Vermont WWTFs are land application after an approved pathogen treatment process, landfilling, or incineration. Although there are several emerging technologies that offer alternative strategies for sludge management (most of which generally fit into those three basic categories), none are currently sited where their use is economically feasible for Vermont municipalities and relatively few are being operated as full-scale facilities with a documentable track record of their capabilities."[8]

Project Need

- VT's beneficial reuse of biosolids on par with the national average of 50-60%
- As testing and research capacity has evolved, awareness of the pervasiveness and persistence of PFAS in the environment has expanded and this class of compounds is known to be present in biosolids
    - 2019 data from testing biosolids, soils, and groundwater
- Extremely limited options for dealing with waste and a ban on the use of biosolids could result in even bigger challenges.
    - In response to this conundrum, starting in 2021, biosolid reuse permits will require PFAS monitoring
    - Waste Water Treatment Plants (WWTPs) / municipalities with biosolids programs need to work on pre-treatment before biosolids are reused, but this is expensive and staff-time intensive
- Another key goal is to focus more on pollution prevention and address upstream sources – i.e. need to address PFAS at the product manufacture and use level so that these chemicals don't end up in the waste stream.

[6] https://dec.vermont.gov/waste-management/residuals-management

[7] ibid

[8] https://dec.vermont.gov/sites/dec/files/wmp/residual/RMSWhitePaper20180507.pdf

    - Ideally the state would be able to draw on recent scientific literature identifying PFAS in products to develop a statewide list of entities using PFAS and whether they are even aware that they are using. (Tricky to "finger point" businesses in the fear that they may leave the state). This knowledge would inform the DEC where next to target their efforts beyond their current work with WWTPs, landfills, contaminated sites, and car washes.
    - The state would also like to be much more proactive in providing educational materials regarding waste stream sources of PFAS as there is no effective outreach occurring in this realm to date

This student team will contribute to these last two bulleted goals under pollution prevention by:

- Developing materials for WWTP operators in order to facilitate communication & collaboration with residents and business in the communities they serve.
    - This could take the form of a series of case studies—e.g. for the Town of Middlebury and a representative sample of towns that have higher amounts of PFAS in their waste stream—that would include:
        - Potential product correlations (i.e. comparing businesses/industries within a community to biosolids data for that town)
        - Providing resources to extend WWTPs capacity to identify and be in conversation with businesses either manufacturing or using these products
        - Raise awareness of consumer use of these products
        - Financial implications / funding sources for treatment vs. avoiding pollution in the first place via upstream solutions
- Working with any new communication materials that you develop as well as similar materials being developed by the NH Biosolids Improvement Working Group, use your creativity and tech savvy to develop a communications plan for your partner to help effectively disseminate these materials.

Project #2: Legislative Policy Research

Partner: Senator Virginia Lyons, Chair of Senate Health and Welfare Committee

Introduction

In May of 2020, the Vermont Senate passed legislation (S.295) that would ban PFAS and other toxic chemicals from certain products. S. 295 targets four different categories of consumer products that are major sources of PFAS exposure and environmental contamination including food packaging, firefighting foam, residential carpets and rugs, and children's products. Vermont Conservation Voters provides the following highlights of this legislation:

- "Passing S.295 will put Vermont in line with other states (including New Hampshire, New York, Colorado, and Washington), allowing us to ensure our firefighters and residents are protected by reducing the use of harmful and unnecessary PFAS chemicals in firefighting foam.
- The bill bans PFAS from food packaging and authorizes restrictions on phthalates and bisphenols, building on similar legislation already enacted in Washington and Maine.
- The bill bans PFAS from residential carpets and rugs; Vermont would be the first state to do so legislatively. The chemicals find their way into dust and air in our homes and ultimately into our bodies, posing a particular exposure risk to young children who spend a lot of time playing on the floor.
- Finally, this bill adds PFAS chemicals to the Act 188 list of Chemicals of High Concern to Children. The addition of PFAS to this list will simply require reporting the use of these chemicals by manufacturers if they are being used in children's products sold in Vermont." [9,10]

This bill, introduced by your partner Senator Virginia Lyons, along with Senators Bray and Campion, has widespread support from firefighters, business groups, educators, public health and children's advocates, and environmental groups. The bill was stymied by the VT legislature's need to prioritize pandemic-related recovery and relief efforts last spring.

Project Need

Senator Lyons plans to reintroduce this bill during the 2021 legislative session which begins January 6, 2021. It will begin again in the Senate and be accompanied by additional supporting testimony. About the time our semester gets underway, the bill will have "crossed over" from the senate to the house for their deliberations. Despite pushback from businesses involved in the manufacture of the products this bill targets, Senator Lyons is reasonably certain of successful passage. While the timing of our semester precludes informing possible changes to the bill as introduced, there are several opportunities for this student team to engage with the policy process, think about implementation, and to identify and inform next steps.

To those ends, this student team will:

- Research and identify what additional consumer products should be addressed by legislation (either as amendments to S. 295 or in future legislation)

[9] https://vermontconservationvoters.com/vermont-senate-passes-bill-to-protect-vermont-firefighters-and-families-from-toxic-chemicals/

[10] https://legislature.vermont.gov/bill/status/2020/S.295

- Research PFAS replacements–many of which are equally problematic—to inform legislators what other chemicals they should be keeping tabs on as they consider future legislation
- Related to identifying and informing next steps, this could take the form of
    - working with Senator Lyons to develop an implementation strategy for S. 295 (assuming successful passage) and thinking about how, administratively, to expand to other products
    - conduct additional research that will inform future legislation. Areas of interest for Senator Lyons include
        - possible additional regulation needs for the spreading of biosolids
        - Extended Producer Responsibility (EPR) for plastic packaging

Project #3: Identifying Key Drivers of PFAS Breakthrough in Groundwater Wells Point of Entry (POET) Treatment Systems

Partner: Richard Spiese, Environmental Analyst, Vermont Department of Environmental Conservation, Waste Management and Prevention Division, Contaminated Sites Section

Introduction

The Vermont Department of Environmental Conservation (DEC) initiated an investigation into potential PFAS contamination from two former Teflon fabric-coating facilities in Bennington and North Bennington, VT in February of 2016. The facilities operated from 1968-2002, one smaller facility in Bennington from 1969-1978, a newer larger facility in North Bennington from 1978-2002. ChemFab operated the facilities through 2000 before then being purchased by Saint-Gobain for the last two years. The investigation lead to the discovery of widespread contamination in drinking water wells and groundwater in the Bennington area, primarily by perfluorooctanoic acid (PFOA; one PFAS compound).

Of the over 630 drinking water wells that were tested, 465 had detectable levels of PFOA with over 335 of these with measuring above 20 parts per trillion (ppt; Vermont groundwater standard). To address the widespread contamination in drinking water, point-of-entry treatment (POETs) systems were installed on all wells with contamination above the 20 ppt standard. In addition, most homes have been, or will be, connected to municipal water. Homes not yet connected to municipal water, including those with POET systems will continue to be monitored until there is no long-term risk to public health.[11]

Because of this case, Vermont is recognized as a national leader in understanding and addressing the impact of PFAS contamination and has conducted extensive testing around the state. Those investigations, combined with the review of existing testing data, have helped state agencies to identify, characterize and address risks to public health and environmental contamination as quickly as possible. Vermont has also been recognized as a model for their communications and outreach plan associated with the Bennington contamination, including communication with members of the affected community. The dedicated web portal for Bennington can be found here. The latest community briefing from December 2020 provides these updates:

- 480 residences or businesses were eligible to get connected to municipal water since waterline extension work began in 2016. Currently, a total of 436 out of the 480 are either connected or have agreed to get connected. To date, 365 residences or businesses have been connected.
- All water wells in this area with PFAS levels above the groundwater standards (currently 20 parts per trillion of the cumulative concentrations of PFOA, PFOS, PFNA, PFHpA, and PFHxS) have treatment systems.
- With over 4 years of monitoring data, the sampling results show that treatment systems effectively remove the targeted PFAS. Wells that have had no PFAS detected or PFAS levels below the groundwater standards are staying below the groundwater standards and showing no increasing trends at this time

[11] VT ANR PFAS Statewide Sampling Plan, June 2019

Project Need

The POET systems installed in residential wells in the Bennington area have primarily been pressure-filtration systems using granular activated carbon (GAC) for adsorption, one of several proven PFAS treatment strategies. In addition to being effective, benefits of GAC systems are their relatively low cost and ease of installation. One drawback is that GAC systems require fairly regular filter replacements based on PFAS "breakthrough" which is related to the amount of water treated and PFAS concentration.[12]

Of the approximately 30 homes not yet connected to the municipal drinking water system (but with POET systems), wells are tested once a year, twice a year, or quarterly based on current PFAS concentrations. Monitoring water quality in these wells continues to add to the DEC's robust data set including well characteristics, well water volume yields, breakthrough times, and water chemistry (e.g. hardness, pH, iron) among other variables. These data are primed for continued evaluation and statistical evaluation as they were last analyzed in 2018.

The primary question of interest to your partner is:

- What are the key drivers of breakthrough other than water volume and PFAS concentration?
    - For example, how / do water chemistry variables influence breakthrough times?
    - Are their simple correlations or multi-variable drivers?
    - Or is water volume and PFAS concentrations the primary driver of carbon breakthrough?

This work will build off of preliminary research conducted in 2018 where 19 wells that experienced breakthrough from February of 2017 through July of 2018 were analyzed based on water volume, pH, hardness, and total dissolved solids. Findings from this project will inform (1) our understanding of the effectiveness of granular activated carbon as a treatment technology for longer-term PFAS remediation, and (2) other key water quality parameters that may serve as useful indicators for early breakthrough. Such information has value in designing and monitoring POET systems and possible pretreatment of influent water in Bennington and elsewhere that could lengthen the changeout time of the carbon vessels thereby saving money using this water treatment technology.

There are opportunities to share the results of your analyses with regional PFAS working groups that your partner participates in or is affiliated with, Saint-Gobain and the associated consulting and engineering firms that have conducted the ongoing monitoring, and as part of the ongoing community communications mentioned above.

[12] https://dec.vermont.gov/sites/dec/files/PFAS/Draft-Final-PFAs-Response.pdf

Project #4: PFAS in the Waste Stream: Mass Balance Accounting and Extended Producer Responsibility

Partners: Kim Crosby, Environmental Compliance Manager and Samuel Nicolai, Vice President of Engineering & Compliance, Casella Waste Systems, Inc.

Introduction

Casella Waste Systems, Inc. operates permitted facilities in six New England States including Vermont's sole landfill, located in Coventry.[13] They also have staff in over 40 states working on industrial waste diversion priorities. Over the past 3-4 years Casella has been making a concerted effort to research and understand PFAS in the waste stream, in line with the growing awareness of—and attention given to—these persistent and problematic compounds.

As mandated by the conditions of their Vermont facility operating permit, Casella contracted with Sanborn Head and Associates to study potential PFAS sources in the waste streams disposed at the Coventry facility. This "waste source testing" was conducted from April-August of 2019 and sample results were analyzed in the context of the most current available Vermont waste stream characterization data at the time of the study (more recent data are now available). Of the 100 samples from multiple waste streams, PFAS were detected in 95 of the samples with the highest concentrations found in bulky items, textiles, and carpeting. Based on sampled PFAS concentrations and mass of different forms of waste *coming in to* the landfill, these data offered insights into which waste streams have the highest potential to contribute PFAS to the leachate *coming out of* the landfill.[14] The data also provides information as to how potential waste diversion practices would or would not affect the mass flux into the landfill. More work is needed, though, to better characterize and quantify this mass flux of PFAS and to add more specificity in terms of sources—e.g. to what extent do high concentration sources like textiles and carpeting show up in household vs. municipal vs. construction & demolition waste streams.

These research questions take on heightened importance with anticipated changes at the federal level. The Biden administration is expected to designate PFAS as a hazardous substance and set enforceable limits for PFAS in the Safe Drinking Water Act and landfill operators are proactively discussing how to best prepare for future federal PFAS regulations. Some landfill operators predict that once the EPA sets more specific limits and regulations, they will be required to monitor and track PFAS through landfill leachate and gas sampling. While some operators like Casella have begun collecting data on how and where PFAS appear in their facilities, most are in the "very early days" of PFAS monitoring.[15] Understanding the sources of PFAS in the waste stream will provide legislative, regulatory, and industry decision-makers with valuable information to prioritize strategies such as manufacturing bans, diversion programs, and effective waste management disposal practices.

[13] https://www.casella.com/locations/coventry-vt-landfill-newsvt
[14] Sanborn Head: PFAS Waste Source Testing Report for New England Waste Services of Vermont
[15] https://www.wastedive.com/news/pfas-biden-landfill-leachate-hazardous-waste/593781/

Project Need

Casella is seeking to advance their understanding of PFAS mass fluxes entering and leaving landfills. The 2019 Waste Source Testing Report detailed above was intended to evaluate potential sources of PFAS coming into one landfill. Based on some initial data, the researchers also calculated estimates of the mass flux entering the landfill on a daily basis. However, the original scope of work wasn't really intended to answer the specific question of mass flux and your partners are therefore seeking a more detailed investigation of the data. Based on your review of the research completed to date, this team will develop a set of strategies for this "deeper dive". Example questions of interest to your partners include:

- How representative were the 2014 waste characterization data compared to other sources of data, both in Vermont and outside? Are the conclusions dramatically different when you look at more recent or older waste characterization data?
- Vermont has some unique characteristics in the implementation of recycling, organics diversion, and architectural waste. Using the concentration data and other states' waste data, can you infer that Vermont has a higher or lower mass of PFAS flux than other states?
- How can the assumptions be fine-tuned? Carpet was a huge part of the mass, but the data are heavily dependent on the accuracy of the estimates of carpet fibers vs. carpet backing. Is it possible to fine-tune the fabrics data, e.g. attempting to estimate high-PFAS fabric vs. low- or no-PFAS fabrics?
- Food packaging is a particular area of interest for several reasons—it is ubiquitous, often contains high levels of PFAS, and Vermont legislators are working on "extended producer responsibility" legislation to address the issue at the industry / production level to prevent this problematic packaging from ending up in landfills in the first place. Your partners are interested in more accurate accounting for this input and welcome your insights in the design and development of a methodology to quantity packaging used in VT and packaging containing PFAS.
- Knowing that this type of research and sampling will be a growing opportunity for the solid waste management industry, at the completion of your work, offer recommendations for how would you design new sampling or research strategies to answer questions of interest that might not yet be answerable with the available data?

One closing point of note for this team: Given the sensitivity of the topics under question, good communication with your partners re. how data are generated and shared is required.