Journal of South Carolina Water Resources, Volume 8, Issue 1, Pages 48–53, 2021

South Carolina Sampling, Analysis, and Governance of Per- and Polyfluoroalkyl Substances

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Abstract. The extent of sampling, analytical, and governance guidelines for per- and polyfluoroalkyl substances (PFAS) in individual states is currently inconsistent. There are no federally mandated regulations on PFAS, and the geochemical variations within different states can lead to regionally specific PFAS contamination, resulting in state-specific guidelines for PFAS contamination in different environmental matrices. There are no facilities in South Carolina known to currently or previously produce PFAS; however, they may be used in the production of other goods at industries throughout South Carolina, including Class B firefighting foams, consumer items, packaging, and stain- and weather-resistant fabrics. We assessed the sampling, analytical, and governance strategies of the South Carolina Department of Health and Environmental Control (SCDHEC) to understand current state-specific guidelines for PFAS contamination in South Carolina. This assessment indicates that SCDHEC has conducted sampling and analysis of community drinking water systems supplied by surface water for PFAS contamination. Additionally, risk indicators have been made for highly susceptible areas for likely PFAS contamination, including Department of Defense (DOD) and Department of Energy (DOE) sites, airports, and landfills in South Carolina. Recently, bills have been introduced into the South Carolina legislature to address PFAS. These proactive approaches in South Carolina aid in the assessment of the risks of PFAS contamination and are important steps for SCDHEC and South Carolina legislative stakeholders as they continue to develop and enforce state-specific standards for PFAS chemicals and await more information and official regulatory drivers from the US Environmental Protection Agency (US EPA).

INTRODUCTION

Per- and polyfluoroalkyl substances (PFAS) are a group of between 5,000 and 10,000 humanmade, fluorinated, organic chemicals that have been manufactured and used in various industries around the world (ITRC 2020; 3M 2020; Dorrance et al. 2017). PFAS have a unique combination of chemical properties, which result in benefits such as low surface tension, oil-repellent ability, and water solubility. These properties enable their use in applications including biocides, hydraulic fluids, firefighting foam, and household products (Rayne and Forest 2009; Kim et al. 2015; Ahrens et al. 2009) Their widespread use has led to their detection in food, commercial household products, workplaces, drinking water, and living organisms (Domingo and Nadal 2017; Kucharzyk et al. 2017; Rahman et al. 2014; Valsecchi et al. 2013). PFAS have been coined as "forever chemicals" due to the extremely strong carbon-fluorine bond. Because of their persistence in the environment and human body, as well as a lack of understanding the full health risks associated with exposure, PFAS are emerging contaminants of concern.

When assessing the hazards of chemicals, many states rely on guidance from federal agencies to sample, analyze, and regulate these chemicals. For PFAS, the US Environmental Protection Agency (US EPA) has developed sampling and analytical methods for 29 PFAS analytes in drinking water (US EPA 2020a). Aside from this, only nonenforced federal guidelines currently exist for PFAS, like the EPA PFAS Action Plan, which recommends the lifetime health advisory of 70 ppt for perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) combined. As a result, states like South Carolina (SC) have begun testing for PFAS (SCDHEC, 2020).

Due to the growing body of science and literature around PFAS, combined with public pressure on legislative bodies to regulate PFAS, it is important to understand what South Carolina is doing to ensure that its residents are safe from PFAS contamination as well as how the Department of Energy (DOE) and Department of Defense (DOD) are

involved. The goals of this paper are to analyze SCDHEC data and reports on PFAS chemicals and (1) identify major locations of PFAS contamination and highly susceptible locations for PFAS contamination in South Carolina, (2) identify the PFAS sampling and guidance procedures used by South Carolina, and (3) be aware and knowledgeable of current and impending PFAS regulations in South Carolina.

MATERIALS AND METHODS

PFAS information for South Carolina was collected by searching through the South Carolina Department of Health and Environmental Control (SCDHEC) website. The information found through the SCDHEC website was stored on a secure database. For information or data on PFAS sampling, analyses, or regulations that were missing or unavailable online, an email was sent to a point-of-contact within the SCDHEC, and the information was retrieved via email or telephone.

RESULTS AND DISCUSSION

VULNERABLE SITES FOR PFAS CONTAMINATION IN SOUTH CAROLINA

The SCDHEC Bureau of Water (BOW) released a report detailing the internal strategy to assess PFAS in drinking water (SCDHEC 2020). This report identified sites throughout the state where PFAS contamination was plausible and the existence of an associated risk based on the three most significant vulnerability factors: (1) PFAS source type, (2) drinking water source, and (3) groundwater aquifer system type based on peer-reviewed literature (Table 1).

Table 1. Number of Sites in South Carolina Identified as Plausible PFAS Locations with Associated Risk

Risk Ranking	Source Types	Number of Sites in South Carolina
1	DOD/DOE	11 DOD/1 DOE
2	PFAS or FP Manufacturing	0
3	Landfills	677
4	Part 139 Airports	8
5	Fire Training Areas	2+
6	Petroleum Refineries	0
7	Industrial	384
8	Wastewater Treatment Plants	746

Department of Defense and Department of Energy Sites

The most concerning sites for PFAS contamination in South Carolina are DOD facilities due to the potential usage of aqueous film forming foam (AFFF), the PFAS-containing military grade fire retardants, since 2014 (DOD 2018). The DOD and DOE are investigating PFAS as an emerging contaminant under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as it may endanger public health and the environment. The DOD is actively investigating its military installations in South Carolina through their PFAS Task Force (DOD, 2020), and the DOE is investigating its Savannah River Site (SRS) for potential PFAS contamination at the request of the SCDHEC (2020). The SCDHEC's Bureau of Land and Waste Management (BLWM) is actively working with the DOD on their investigation of the eleven South Carolina military installations (Figure 1), including the stakeholder review process.

South Carolina Regional and International Airports

Regional and international airports that serve scheduled and unscheduled flights with more than 30 passenger seats, serve scheduled air carrier operations in aircraft between 9 and 31 seats, and the Federal Aviation Administration (FAA) Administrator requires to have a certificate must be certified as a Part 139 airport. This certification requires the airport to have aircraft rescue and firefighting (ARFF) capabilities, which includes proper equipment (e.g., AFFF), personnel, and training. Under the FAA, Part 139 airports are required to conduct an annual timed drill for firefighting response using AFFF (FAA 2020). South Carolina houses 8 Part 139 airports (Figure 1) that have potentially performed annual fire drills with AFFF discharges (SCDHEC 2020).

South Carolina Fire Training Areas

In addition to DOD installations and Part 139 airports, fire training areas are those where the discharge of AFFF could have occurred. The BOW lists at least 500 fire stations in South Carolina with unknown usage of AFFF (SCDHEC 2020), but two areas are of high concern. Columbia, South Carolina, is home to a very large and extensive fire training facility in the US. The South Carolina Fire Academy Facility encompasses 208 acres north of Columbia and is known to have trained with AFFF. The Fire Academy was previously located at the Columbia Metropolitan Airport, and both locations are likely to have legacy PFAS concentrations from AFFF usage (SCDHEC 2020).

South Carolina Landfills

Landfills and their associated leachates are areas of potential PFAS contamination concern because historically PFAS were used in nonstick and weatherproofing applications, as well

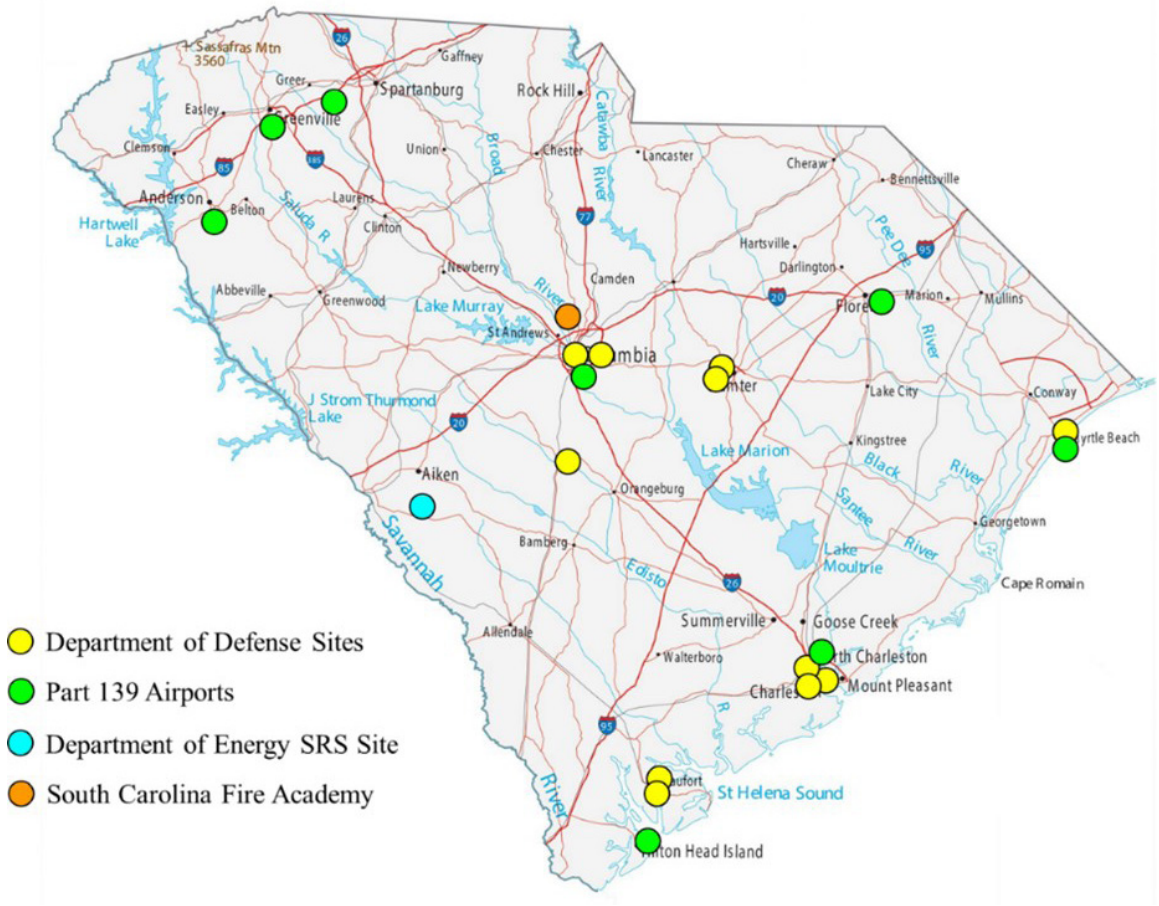

Figure 1. Vulnerable locations for PFAS contamination in South Carolina. The 500+ fire stations in South Carolina with unknown AFFF usage are not included in the map.

as food packaging, that have been discarded. South Carolina has 677 total landfills comprised of Class 2 (construction and demolition debris), Class 3 (municipal solid waste, construction, demolition, and industrial solid waste), and industrial-only landfills. Active landfills (N=107) can accept municipal solid waste, debris, and industrial solid waste, while inactive (N=570) landfills either are not operational or are operational but have not accepted waste since 1940. Active landfills are of most concern for PFAS because these chemicals do not degrade over time and may leach out of the landfills (i.e., landfill leachate). Figure 2 highlights the locations of current active Class 2 and Class 3 landfills in South Carolina that are susceptible to PFAS contamination (SCDHEC 2020).

Other Vulnerable Sites in South Carolina

The SCDHEC BOW has identified high-risk industrial facilities and has grouped them into the following: (1) organic chemicals, plastics, and synthetic fibers; (2) pulp and paper; (3) textiles; and (4) airports/other. South Carolina is home to 65 organic chemicals, plastics, and synthetic fiber facilities; 11 pulp and paper facilities; 68 textile facilities; and 240 airports or other potential locations (SCDHEC, 2020). Wastewater treatment plants are locations ideal to be investigated due to the acceptance of industrial waste. There are 746 wastewater treatment plants in South Carolina: 146 domestic facilities, 90 municipal facilities (with pretreatment), 126 municipal facilities (without pretreatment), and 362 individually permitted facilities (SCDHEC 2020).

SOUTH CAROLINA PFAS SAMPLING AND ANALYSIS

There has been a varied response by states with respect to PFAS sampling requirements. Of the 50 US states, 22 are not actively sampling, and the remaining 38 are sampling in one type of environmental matrix as of July 2021 (ITRC 2021). All states that have reported sampling efforts monitor drinking water using standards recommended by either the US EPA or the Interstate Technology and Regulatory Council (ITRC 2020). Out of the 38 states, 12 report sampling groundwater, while only 9 are sampling surface water.

South Carolina has sampled and analyzed for PFAS in community drinking water systems where raw water is supplied by surface waters using US EPA methods 533 and 537.1 [US EPA 2020a). These standard US EPA methods provide information on sampling methods, including the correct equipment to use when sampling, the method for

sampling, information on decontaminating equipment after sampling, information on collecting and handling samples, and shipping samples for PFAS drinking water samples. The SCDHEC has sampled for PFAS in 44 community drinking water systems, while 10 other community drinking water systems have provided data to the SCDHEC on sampling and analysis results. Trends and observations of compliance sampling performed by the SCDHEC are shown in Table 2 (SCDHEC 2020). However, it is important to note that the US EPA method 537.1 has method detection limits for individual compounds between 10 and 90 parts per trillion (ppt), and more sensitive methods are now available. The method detection limits from this method can be presumed insufficient to meet reporting guidelines for health advisory levels established by PFAS guidance documents in states that have developed their own PFAS sampling and analytical guidelines.

This sampling effort has accounted for approximately 3.3 million of the approximate 4 million users (82%) of community water systems in South Carolina (see Table 2). Current efforts include the SCDHEC sampling of community drinking water systems supplied by groundwater, and the SCDHEC BOW workgroup is developing strategies to assess PFAS contamination in ambient surface waters and groundwater, including fish tissue (SCDEC 2020). Peer-reviewed literature has found PFAS in sediments and wildlife tissues previously (Fair et al. 2019; Tipton et al 2019; White et al. 2015). In addition to PFAS testing by the SCDHEC, the company Corix Utilities, which is a parent company of Blue Granite Water Company of South Carolina, is planning regular testing for PFAS at 365 of its water systems across the country, even though the US federal government doesn't require routine testing (Fretwell 2020).

SOUTH CAROLINA CURRENT AND IMPENDING PFAS REGULATIONS

The US EPA has set a lifetime health advisory for PFOA and PFOS in the amount of 70 parts per trillion (ppt) combined. A health advisory provides information on contaminants that are known or suspected to have adverse health effects on people. These are nonenforceable and nonregulatory but provide information to states agencies and public health officials on information spanning from health effects, analytical methods, treatment options, and so forth associated with drinking water contamination. This is used to be a buffer or offer a margin of protection to protect all

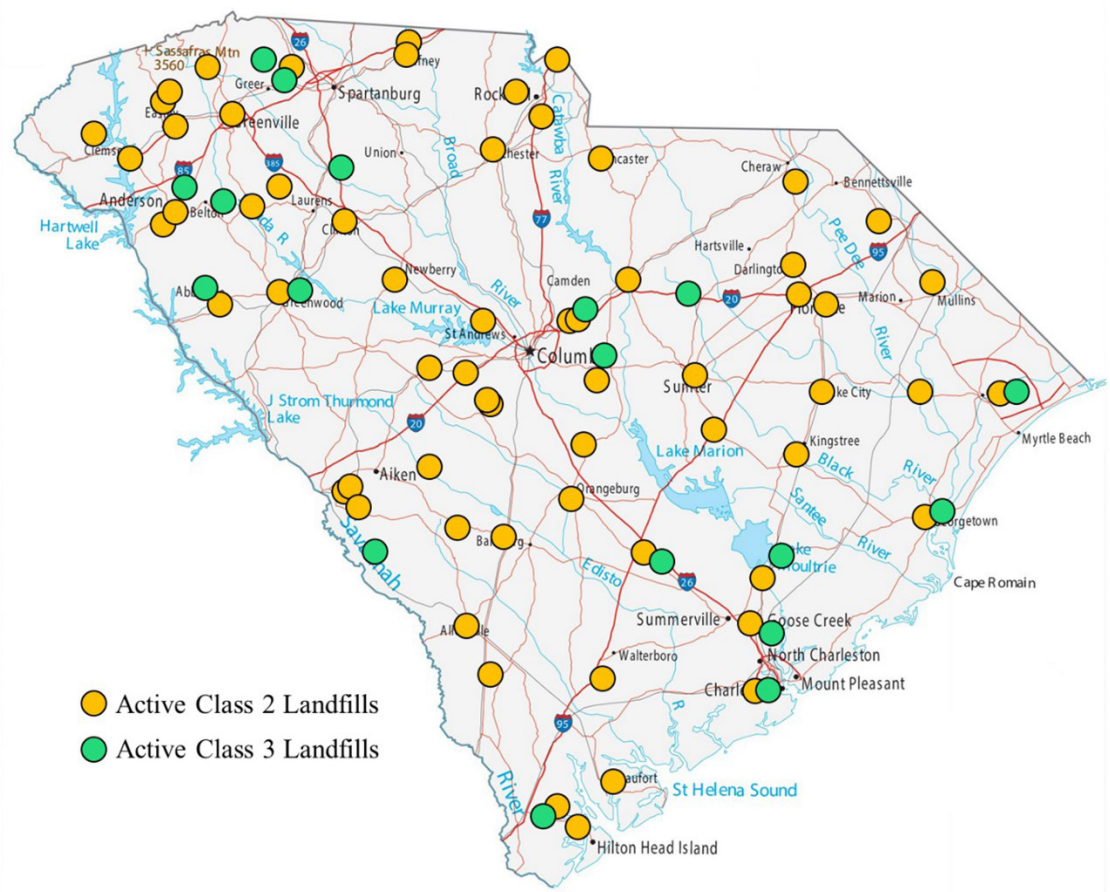

Figure 2. Active Class 2 and Class 3 landfills in South Carolina that are vulnerable to PFAS contamination.

Table 2. Summary of Findings from SCDHEC Sampling of Public Water Systems (SCDHEC, 2020)

Observation	Result
Community Drinking Water Systems Sampled by SCDHEC	44
Community Drinking Water Systems that Provided Data to SCDHEC	10
Population Served of Sampled Water Systems	82%
Number of Exceedances of EPA's LHA of 70 ppt	0
Maximum PFOA Concentration Measured	18 ppt
Maximum PFOS Concentration Measured	16 ppt
Maximum Combined PFOA and PFOS Measured	32 ppt

Americans from adverse health effects from unregulated contaminant exposure. In the US EPA's 2020 PFAS Action Plan, the main focus of their PFAS drinking water goals are to move forward with the establishment of a maximum contaminant level for PFOA and PFOS under the Safe Drinking Water Act (SDWA) (US EPA 2020b). A part of the SDWA established in 1974 is the Unregulated Contaminant Monitoring Rule (UCMR), which began in 1999 and which cycles through a maximum of 30 unregulated contaminants. Every 5 years, the list of contaminants is updated, and they are monitored throughout the country in public water systems serving more than 10,000 people (US EPA 2020b). Under UCMR 3, the SCDHEC tested for applicable PFAS at all public water systems fitting the monitoring criteria. Additionally, small sites serving under 10,000 people were randomly tested (SCDHEC 2020).

As noted earlier, there is a mixed response by states in monitoring requirements for PFAS. The US EPA (2020b) put out an action plan addressing strategies and potential regulatory decisions. The SCDHEC has complied with federal requirements, such as sampling public water systems, but has decided that more scientific information is required before recommending regulations to be passed on a state level. South Carolina is following the US EPA's Health Advisory Bulletin until such time as either state or federal regulations are enacted (SCDHEC 2020). The SCDHEC will remain involved and up to date regarding national regulatory progress (SCDHEC 2020).

The regulation of PFAS chemicals at both the state and federal levels is ever changing. As new information surrounding PFAS emerges, guidance documents and legislation become outdated quickly. This is evident in South Carolina, where new and amended bills continue to be introduced into the South Carolina legislature. Bill 4718 was introduced in January 2020. This bill was added to amend pending Bill 5339 (Cancer Prevention Act) by adding a section to require the SCDHEC to promulgate regulations to establish MCLs for certain pollutants, specifically PFOA, PFOS, other PFAS, hexavalent chromium, 1,4 dioxane, and other contaminants where regulations have been established in 2 or more states. It is required that decisions be made based on studies, peer-reviewed science, information from the Agency for Toxic Substances and Disease Registry (ATSDR), and evidence from other states. Additionally, new House Bill H.3515 was introduced in the current session and is in committee following a joint resolution in both the State House and Senate. Bills 5339 and 4718 have been introduced to the SC House and are in committee. To be passed, the bills are required to be passed by both the SC House and the SC Senate, ratified, and approved or vetoed by the governor (SC State Government 2020).

CONCLUSIONS

Currently, the assessments made by the SCDHEC are most concerned with protecting the public from exposure to PFAS contamination. The focus of sampling has been on drinking waters provided to South Carolina residents, with less focus on the assessment of PFAS-contaminated sources. Due to the lack of case-specific information about PFAS use or disposal at given sites within South Carolina, the necessity for a standard method that can be used for vulnerable sites within the state becomes apparent. Other states, like Michigan, California, and New York, have developed and made public state-specific sampling and testing guidelines for PFAS chemicals in a multitude of environmental matrices (Michigan 2021; California 2021; New York 2021). It is imperative that the SCDHEC (a) remains vigilant in gathering new data of PFAS contamination as new or updated information is presented; (b) communicates information with stakeholders and the public in a timely, consistent, and transparent fashion; and (c) extends sampling and analytical efforts to other environmental matrices for a variety of PFAS analytes once methods and specific guidelines are available.

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