NC PFAST NETWORK FINAL REPORT
EXECUTIVE SUMMARY

The North Carolina Per- and Polyfluoroalkyl Substances (PFAS) Testing Network, the **NC PFAST Network**, is a multi-university research collaboration convened by the North Carolina Policy Collaboratory (the Collaboratory) in response to legislative mandates from the North Carolina General Assembly (NCGA) to address public concerns regarding the occurrence of PFAS contaminants in North Carolina and their effects on humans, wildlife, and the environment.

PFAS are a very large group of currently unregulated, non-naturally occurring chemicals that do not break down easily in the environment. PFAS include the widely-recognized perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and GenX as well as more than 7,800 other per- and polyfluorinated chemicals. They have been used in manufacturing and industrial processes since the 1940s and are components in some firefighting foams and many consumer products. The chemical properties of PFAS make them and products containing them resistant to water, oil, grease, stains, and heat. However, these very useful characteristics are offset by PFAS's extreme stability and tendency to persist in environmental media such as groundwater, surface waters, air, soil, and plants, and to biomagnify and bioaccumulate in animals (e.g., fish) and humans, leading to a number of adverse human health effects.

In 2016, the U.S. Environmental Protection Agency (EPA) established a lifetime health advisory level (HAL), which is not an enforceable regulatory standard (sometimes referred to as a maximum containment level, MCL), of 70 ng/L (or 70 parts per trillion, ppt) for the sum of PFOA and PFOS concentrations in drinking water. EPA is now moving forward to develop a national drinking water regulation under the Safe Drinking Water Act for PFOS and PFOA; however, all other PFAS, such as GenX and other legacy and emerging PFAS, are yet to be considered for regulation. Furthermore, current federally approved methods for measuring PFAS are limited to a subset of well-established compounds such as PFOS, PFOA, GenX and other PFAS with carbon chain lengths of 4 to 12. The development and application of highly sensitive, advanced analytical techniques at universities and other research institutions has revealed that there are many emerging (or previously unrecognized) PFAS present in drinking water sources and other environmental media throughout the state and across the globe.

North Carolina is an ideal location to study PFAS, given the presence of a fluoropolymer and specialty chemicals manufacturing facility (the Chemours Company Fayetteville Works site), large military bases, airports, and other users of fluorinated firefighting foams, and urban waste streams, all of which are potential sources for PFAS emissions into the state's environment. For example, in the seminal study by Sun et al. published in 2016 in the journal of *Environmental Science & Technology (ES&T) Letters*, it was demonstrated that EPA's HAL for the sum of PFOS and PFOA was exceeded on 57 of 127 sampling days in the Cape Fear River watershed. In raw water from a drinking water treatment plant downstream of the Chemours Company Fayetteville Works site, the average concentration of GenX, which is a replacement for PFOA, was determined to be 631 ng/L (or ppt). Importantly, six other emerging PFAS (i.e., of the perfluoroalkyl ether carboxylic acid (PFECA) class) were observed to have very large signatures (uncalibrated) relative to GenX, raising serious concerns that their concentrations were also well above the EPA's HAL of 70 ppt for the sum of PFOS and PFAS in drinking water sources. In fact, a follow-on publication by Zhang et al. published in 2019 in *ES&T Letters* showed the sum concentration of PFAS in a 2015 sample of the Cape Fear River at the intake to the Wilmington drinking water treatment plant exceeded 100,000 ng/L. In the absence of a national regulatory safe drinking water standard for PFAS chemicals, this ground-breaking work by Sun et al., and the available toxicity studies at the time, led the NC Department of Health and Human Services (DHHS) to set a provisional health goal of 140 ng/L (or ppt) for GenX in 2017. However, similar to the EPA's HAL for the sum of PFOS and PFAS, this is not an enforceable drinking water standard.

Notably, 5 other states with high levels of PFAS contamination, including Michigan, New Jersey, Vermont, New Hampshire, and Massachusetts, have adopted strict state-enforceable standards that are even lower than EPA's HAL of 70 ppt for the sum of PFOS and PFOA. For example, Michigan is one of the most restrictive states for selected and well-established PFAS; specifically, they set the limit on PFOA and PFOS at 8 ppt and 16 ppt, respectively, in drinking water, as well as limits on 5 other PFAS (i.e., PFNA, PFHxS, GenX, PFBS, and PFHxA). Likewise, Vermont and Massachusetts set limits below 20 ppt for the sum of 5 (VT) or 6 (MA) PFAS including PFOA and PFOS. Currently, no enforceable safe drinking water standard has been established by the state of NC, which is in part due to limited understanding of how extensive PFAS contamination is across the state's environment and the mechanisms and magnitude of toxicity associated with some PFAS that occur at the highest concentrations in NC.

In response to increasing public awareness of GenX and other emerging PFAS in the Cape Fear River watershed, and recognizing the serious threats PFAS pose to the

environment and to the health and quality of life of all North Carolinians, the NCGA funded the NC PFAST Network in summer 2018 to help inform state regulators and policymakers regarding sources and levels of PFAS in the state's environment, strategies for reducing or eliminating PFAS exposures, and improved understanding of the toxic effects of PFAS. The NC PFAST Network is uniquely suited to carry out this important work by leveraging the collective expertise, technical resources, and advanced instrumentation of faculty and their research groups at NC State University, UNC Wilmington, UNC Chapel Hill, UNC Charlotte, Duke University, East Carolina University, and NC A&T University. The faculty and their respective research groups that make up the NC PFAST Network are leading environmental engineers, scientists and toxicologists that have strong national and international reputations in studying legacy and emerging PFAS in surface water, groundwater, air (i.e., fine particulates and rainwater), plants, wildlife and humans. In addition, since many PFAS are being identified for the first time, and analytical standards are not yet commercially available, the Network has utilized expertise in synthetic organic chemistry to devise novel synthetic routes to make some of these emerging PFAS for researchers. Furthermore, NC PFAST Network experts in science communication and stakeholder engagement have ensure research findings are accessible to all stakeholders. Descriptions of the research teams, copies of monthly newsletters, infographics and other useful information can be found on the NC PFAST Network website (https://ncpfastnetwork.com/). This report summarizes two and a half years of testing and research conducted by the NC PFAST Network and provides recommendations for additional monitoring efforts, research studies, and regulations.

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