EPA Research Partner Support Stories

February 2025 Update





US EPA Research Supporting States

Addressing State Environmental Research Needs

The success of environmental protection and public health in the United States begins on the front lines at the state, tribal and local levels. US EPA's Office of Research and Development (EPA ORD) is a vital scientific and technical resource to states, territories, tribes and communities, providing the technical support and training, science-based tools, and innovative approaches and methods they need to meet their highest priority environmental and related public health challenges, while also laying the groundwork for long-term health and prosperity.

This document compiles summaries of how EPA ORD's work during the past several years, in partnership with state and territorial agencies, tribes, counties, communities and universities, has supported partners' efforts to protect human health and the environment. These stories highlight a wide range of research, development, decision support tools and technical assistance efforts focusing on air and water pollution, chemicals, Superfund and other contaminated site remediation, infrastructure, and homeland security – all of which are critically important to helping states, tribes and communities address their highest priority, on the ground environmental challenges. Each story includes a brief testimonial from a leader in the state, tribe or community to whom we provided support.

Collaboration and teamwork with state and territorial environmental and health agencies in particular have made it possible to better achieve the mission of protecting human health and the environment. EPA ORD has developed critical partnerships to ensure our work is relevant to real-world environmental challenges and that scientific findings and tools are delivered to decision makers in ways that make them immediately accessible and useful. EPA ORD has partnered with the Environmental Council of the States (ECOS, the national association of state environmental agency leaders) and its research arm—the Environmental Research Institute of the States (ERIS)—and the Association of State and Territorial Health Officials (ASTHO, the national association of state and territorial chief health officials) to ensure that our science and engineering efforts are useful and practical for those working at the intersection of the environment and public health. EPA ORD will continue to work directly with the states and territories to advance our shared mission to protect the public's health from environmental threats and hazards and to advance health and environmental equity for all.

Our partners provide significant insights into the environmental challenges they face and how EPA can best translate our science into well-informed decision tools for states, tribes and communities. Over the past several years, ECOS/ERIS, ASTHO and EPA ORD have strengthened the alignment of EPA's scientific and technical capabilities with state research priorities and needs through a series of meetings (including some tribes) and state surveys. As a result of this effort, EPA ORD better understands the science needs of state environmental and health agencies, and states better understand EPA ORD's research, tools, and role within EPA. In 2022, state environmental agencies identified their top challenges that could benefit from additional research, including PFAS, air quality, drinking water, water quality, waste and remediation, adaptation, and cross-media. EPA ORD values the information our state partners provide as it will help us to conduct research where it is most needed.

We look forward to continuing to strengthen our partnership with ECOS/ERIS, ASTHO, tribes and other partner groups to develop the science and engineering solutions to address their immediate and long-term needs.

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AIR – OZONE AND PARTICULATE MATTER

Partner: Connecticut Department of Energy and Environmental Protection (CT DEEP)
Challenge: Meeting air quality and climate goals simultaneously
Resource: Simulating air pollutant emissions and ozone impacts of state and regional greenhouse gas mitigation strategies
Project Period: 2021 – Present

"As a state that struggles to attain both the 2008 and 2015 health-based ozone standards, Connecticut truly appreciates EPA's partnership and assistance in developing new tools capable of quantifying co-benefits and timing from national and state-level energy policies that will inform and assist in planning to reduce ozone precursor emissions in our state." – CT DEEP Acting Chief of the Bureau of Air Management Paul Farrell

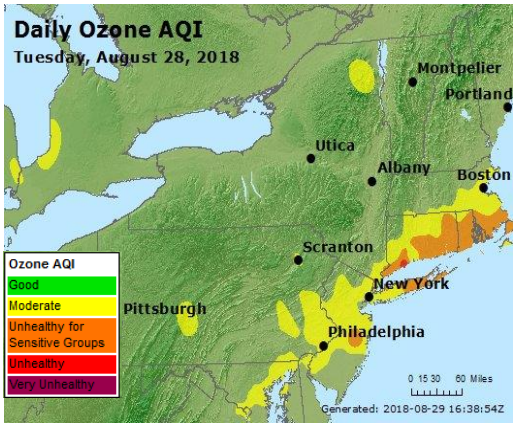
The state of Connecticut is struggling to meet the 2008 and 2015 National Ambient Air Quality Standards (NAAQS) for ozone (O3)—largely due to the flow of ozone and precursor emissions from neighboring states. However, CT and many upwind states have committed to deep decarbonization goals, and to meet these targets, the states will have to greatly increase their adoption of energy efficiency, renewable electricity, and vehicle electrification. These measures also tend to reduce air pollutant emissions, and thus have the potential to help CT attain the O3 NAAQS.

EPA ORD researchers, EPA Region 1 New England), and the Joint Global Change Research Institute (JGCRI) collaborated with CT DEEP to apply the GLIMPSE modeling framework to examine several mitigation scenarios. One of these scenarios, *StateTargets*, simulated the impact of state greenhouse gas (GHG) reduction targets and onroad vehicle electrification targets. The second, *NetZeroZEV*, imposed a national target to reduce net CO2 emissions to zero by 2050, combined with the national application of the onroad vehicle electrification targets. The mitigation scenarios both yielded NOx reductions. For example, in 2032, national NOx emissions under *NetZeroZEV* were reduced by 5.3%. By 2050, this had grown to 21%.

The project team also explored ways to translate these emission changes into insights about O3 attainment. Preliminary results suggest that the NOx reductions under these decarbonization scenarios could reduce O3 concentrations at CT monitoring sites by 7-11 ppb by 2032 relative to 2023, with reductions growing to nearly 15-20 ppb by 2050. This research provides CT DEEP with quantitative estimates of O3 co-benefits, showing that these benefits are expected to occur at a magnitude and timing that is relevant from an air quality planning context.

CT DEEP staff were beta testers and provided valuable feedback on the GLIMPSE software and Users' Guide which were released in June 2023. The project team is continuing to work with CT DEEP to identify management strategies to achieve both air quality and climate benefits.

Partners: Northeast States for Coordinated Air Use Management (NESCAUM), Connecticut Department of Energy and Environmental Protection (CTDEEP), New Jersey Department of Environmental Protection (NJDEP), New York State Department of Environmental Conservation (NYSDEC), New York State Energy Research and Development Authority (NYSERDA)
Challenge: Better understanding the causes of ground-level ozone formation and transport in the New York City metropolitan area
Resource: Deployment of advanced air quality monitoring tools at eight sites as part of the Long Island Sound Tropospheric Ozone Study (LISTOS) and subsequent data analysis in collaboration with NASA, NOAA, University of Maryland, SUNY-Albany, SUNY-Stony Brook, City College of New York, and Yale University
Project Period: 2018 – Present



"ORD's coordination with and support of LISTOS has helped New York better understand precursors of ground level ozone in the New York City area so that we will be able to better address it." – NYSDEC Division of Air Resources Research Scientist Dirk Felton

Surface-level ozone is formed when nitrogen oxides and volatile organic compounds react with one another in the presence of sunlight. While air pollution levels have dropped over the years across the United States, the New York City (NYC) metropolitan area and surrounding region continue to persistently exceed both past and recently revised federal health-based air quality standards for ground-level ozone.

To better understand and address this challenge, EPA scientists collaborated in a multi-agency field study in spring and summer 2018 called the Long Island Sound Tropospheric Ozone Study (LISTOS). Data collected during LISTOS provided scientists and decision makers more detailed information on the sources of ground-level ozone photochemical formation and its transport downwind of NYC. Measurement assets supporting this field study included a combination of aircraft and ground-based measurements from numerous research organizations.

The main part of the study ran from June – August 2018, but many ORD supported measurements are continuing in collaboration with the states to address their need to develop and carry out an enhanced monitoring plan with EPA. Since the summer of 2018, information garnered from the study and its subsequent analysis have help guide discussions about emission control scenarios for reducing ground-level ozone formation with the aim of eventually meeting the national standards.

EPA and its partners have continued to collect and analyze enhanced ozone monitoring measurements seeking to improve understanding of the persistent challenge to address ozone air pollution. These activities include measurements to support validation of the NASA TEMPO mission launched in April 2023 that is collecting hourly maps of ozone and ozone precursors across the contiguous United States, Puerto Rico, Canada and Mexico. Additionally, data collected since 2018 are supporting a R1/R2 ROAR project assessing regional NOx emissions inventories and an R1 R2P2 project investigating the relationship of ozone pollution to measured boundary layer mixing depths. For more information on the Long Island Sound Tropospheric Ozone Study, go to the Northeast States for Coordinated Air Use Management webpage.

Partners: Wisconsin Department of Natural Resources (DNR), Lake Michigan Air Directors Consortium (LADCO)
Challenge: Better understanding ozone formation and transport impacting the shorelines of Lake Michigan
Resource: Advanced air quality monitoring methods deployed at various sites across Lake Michigan's western shorelines, including on-board federal research vessel in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and research groups at NASA, the University of Iowa, the University of Northern Iowa, the University of Minnesota, the University of Wisconsin via the National Science Foundation, and the Electric Power Research Institute (EPRI)
Project Period: 2017 – 2022

"This study will improve the models that we use to inform science-based decision making." – Wisconsin DNR Pat Stevens (former Assistant Deputy Secretary and Environmental Management Division Administrator)

Ozone is formed when compounds such as nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with sunlight. Despite dramatic reductions in these ozone precursor emissions, many areas bordering Lake Michigan continue to experience elevated ozone concentrations. This long-standing issue is one of the more challenging air quality issues in the eastern US.

A problem that is hindering states and stakeholders addressing this challenge is associated with the formation of ozone over Lake Michigan and the complex interaction of the meteorology and ozone chemistry, including the transport of ozone and ozone precursors in the region, which are not completely understood. Photochemical models are important tools for understanding such transport issues. However, these models historically have been unable to reproduce the lake breeze effect present around Lake Michigan, making it difficult for states, LADCO and EPA to accurately predict and address ozone concentrations along the Lake Michigan lakeshore. LADCO is a regional planning organization that includes representation from Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin

In the summer of 2017, EPA ORD, LADCO, academic and private institutions, and other state and federal agencies pooled their expertise and resources to commence the Lake Michigan Ozone Study (LMOS-2017). Under LMOS, EPA worked with partners to collect information that continues to be used to better inform air quality models and improve the scientific understanding of ozone formation around Lake Michigan. EPA ORD, in conjunction with NOAA and NASA, outfitted a NOAA research vessel with EPA instruments to support over-the-water measurements. NASA and EPRI provided airborne remote sensing measurement to complement EPA and state surface measurements to help understand pollutant transport over Lake Michigan. These measurements will be combined with satellite data have been used by EPA and other researchers to better understand ozone chemistry and transport over the area, and better inform efforts to reduce ozone formation along the shoreline.

All LMOS data have been posted in a public archive (archive https://www-air.larc.nasa.gov/missions/lmos/), and the science team published early results of the study in an April 2019 synthesis report. The LMOS data sets have been used to support at least a dozen peer reviewed publications, which include numerous modeling studies are being conducted by external collaborators and by EPA's Office of Air Quality Planning and Standards and Region 5, including a recent publication assessing WFR-CMAQ model performance.

AIR – QUALITY

Partners: Environmental Law and Policy Center (ELPC) and Morton Arboretum with support from Illinois Department of Transportation, City of Chicago, Chicago Public Schools, Chicago Metropolitan Agency for Planning
Challenge: Near-road air pollution exposure in vulnerable student populations
Resource: Tools and technical support to mitigate near-road air pollution with strategically placed vegetative barriers
Project Period: 2020 –2021

A Chicago school, as depicted in a base map, overlaid with the EnviroAtlas near-road tree

"EPA's technical support has been invaluable to assessing which area schools could have safer, cleaner air by installing a vegetative buffer. We look forward to continuing the collaboration through successful implementation." – Environmental Law & Policy Center Senior Policy Advocate Susan Mudd

Numerous health studies show that people who live, work and go to school near large roadways and transportation facilities face increased health risks from air pollution exposure, including asthma and other respiratory diseases, cardiovascular effects, cancer and premature mortality.

EPA ORD researchers worked with partners in Illinois to use the Agency-developed EnviroAtlas and the report Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality to improve air quality for schools located near major roadways.

EnviroAtlas is a robust, interactive web-based resource that provides geospatial data, easy-to-use tools, and other resources that help users identify and incorporate aspects of the natural environment to improve public health.

EPA scientists consulted with the partners on using green infrastructure to mitigate near-road air pollutant exposure in vulnerable student populations. They provided a virtual demonstration of EnviroAtlas' fine-scale data availability, and ELPC identified Chicago schools within 200 meters of major expressways and assessed those school sites with respect to existing near-road tree cover. EPA researchers also developed a list of factors for partners to consider for identifying and prioritizing schools that may benefit from vegetative barriers to improve air quality.

EnviroAtlas is publicly accessible at https://www.epa.gov/enviroatlas.

Partners: Utah Department of Environmental Quality (DEQ), Colorado Department of Public Health and Environment (CDPHE), West Virginia Department of Environmental Protection (DEP), oil and gas cooperators
Challenge: Support efficient development of US energy resources while protecting human health
Resource: Next generation measurement methods
Project Period: 2016 – 2023

"EPA ORD has been a valuable partner in our efforts to advance needed energy development while improving air quality in the Uinta Basin."
– Utah DEQ Alan Matheson (former Executive Director)

Oil and natural gas production have increased significantly within Utah's Uinta Basin, Colorado's Denver-Julesburg Basin, West Virginia's Marcellus Shale, and across the United States over the last decades. Approximately three-quarters of the production in the Uinta Basin is on Indian Country within the Uintah and Ouray Reservation. Oil and natural gas extraction and production activities co-emit volatile organic compounds, and greenhouse gases directly to the atmosphere. Industry, regulators and communities have shared interests in understanding and minimizing sources of harmful air emissions from oil and gas production activities.

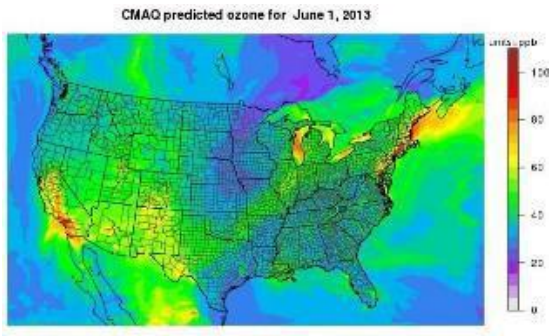
EPA ORD researchers in collaboration with Region 8 (Mountains and Plains) are working with Utah and Colorado state officials and oil and gas operators to conduct emissions research on pneumatic controllers used in upstream production. Pneumatic controllers provide process control and safety functions and emit natural gas to the atmosphere. Because of the very large number of these devices, they contribute significantly to air emissions, however some uncertainty remains regarding the real-world emissions from these devices. In 2016, research was conducted in cooperation with oil and gas operators in the Uinta Basin, Utah, on assessing emissions from pneumatic controllers using next generation measurement methods. In 2018, EPA ORD worked with CPDHE to conducted field surveys of pneumatic controller emissions in the Denver-Julesburg Basin. Next, EPA ORD performed cooperative research with Region 3 (Mid-Atlantic) and a Marcellus Shale oil and gas operator on emission measurements and inventory analysis of production in West Virginia, providing useful data to WV DEP for pneumatic controller and other emission sources.

The collaboration between EPA, the states of Utah, Colorado and West Virginia, and oil and gas operators will improve understanding of these devices and measurement methods, and ultimately support better development of US energy assets in ways that also protect human health and the environment.

Additional resources:

- Quantification of natural gas and other hydrocarbons from production sites in northern West Virginia using tracer flux ratio methodology
- Evaluating natural gas emissions from pneumatic controllers from upstream oil and gas facilities in West Virginia
- Methane emissions from oil and gas production sites and their storage tanks in West Virginia
- Understanding Oil and Gas Pneumatic Controllers in the Denver-Julesburg Basin using Optical Gas Imaging
- Assessment of Uinta Basin Oil and Natural Gas Well Pad Pneumatic Controller Emissions
- Advancing Understanding of Emissions from Oil and Natural Gas Production Operations to Support EPA's Air Quality Modeling of Ozone Non-Attainment Areas; Final Summary Report

Partners: California Air Resources Board, Georgia Environmental Protection Division, Maryland Department of the Environment, New Jersey Department of Environmental Protection, New York State Department of Environmental Conservation, North Carolina Department of Environmental Quality, Utah Department of Environmental Conservation, Virginia Department of Environmental Quality, San Joaquim Valley Unified Pollution Control District, South Coast Air Quality Management District
Challenge: Need for effective strategies to reduce harmful air pollutants
Resource: EPA's Community Multiscale Air Quality (CMAQ) Modeling System
Project Period: 2005 – Present



"Maryland has made dramatic progress over the past 10 years in reducing ozone and fine particle pollution. We have invested heavily into research and modeling and this investment has been one of the reasons we have been successful. The CMAQ photochemical model has been the key tool we have used to design and refine control strategies. It has helped us find least cost solutions to reduce ozone and fine particle pollution." – ECOS Executive Director Ben Grumbles (former Secretary, Maryland Department of the Environment)

For more than 25 years, EPA and states have been using EPA's Community Multiscale Air Quality (CMAQ) Modeling System, a powerful computational tool for air quality management. CMAQ simultaneously models multiple air pollutants, including ozone, particulate matter, and a variety of air toxics to help air quality managers determine the best air quality management scenarios for their states and communities.

State agencies that control air pollution use CMAQ to develop and assess implementation actions needed to attain National Ambient Air Quality Standards (NAAQS) mandated by the Clean Air Act. States use the tool to identify sources of air quality problems and to assist in the design of effective strategies to reduce harmful air pollutants. Using data about land use, meteorology, and emissions, CMAQ provides detailed information about the concentrations of air pollutants in a given area for any specified emissions or air quality scenario. With information generated by CMAQ, states are able to examine the estimated impacts of different air quality policies.

The National Weather Service also uses the model to produce air quality forecasts twice daily, and the Centers for Disease Control and Prevention use CMAQ data in two community-focused tools that allow users to access county-specific air quality information on pollutants, such as ozone and particulate matter.

The CMAQ modeling system is publicly available, undergoes rigorous scientific peer-review and is used worldwide (in over 125 countries) for air quality assessments and research. The system brings together three kinds of models including meteorological models to represent atmospheric and weather activities; emission models to represent man-made and naturally occurring contributions to the atmosphere; and an air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions. The newest version of the model (CMAQ 5.4) was released in October 2022. An updated version of the model is expected to be publicly available in fall 2024.

AIR – SENSORS

Partner: Maricopa County (AZ) Air Quality Department
Challenge: Demonstrating the utility and challenges of using air sensors to investigate air quality issues in Phoenix, AZ
Resource: Reports, publications and presentations documenting the study and characterizing air sensor performance and air quality trends in Phoenix
Project Period: 2018 – 2021

Haze from air pollution in Phoenix, AZ. Inset: Sun damage to a PurpleAir sensor.

"The Maricopa County Air Quality Department was excited to work closely with EPA on this study. Developing an understanding of these new citizen science tools gives us the ability to help citizens put the data they are collecting into context. The data that were obtained in this study, and the expert analysis assistance provided by the EPA team, gave us a better understanding of the spatiotemporal patterns of $PM_{2.5}$. Furthermore, the knowledge gained on the use and limitations of these sensors will assist our agency with the future utilization of these affordable monitoring tools." – Ben Davis, Air Monitoring Division Manager, Maricopa County

A new generation of lower cost air sensors is increasingly being used by state, local and tribal agencies, researchers, participatory scientists, and others to supplement regulatory monitoring at the neighborhood level. However, air sensor performance and data quality can vary based on local conditions, such as temperature, relative humidity, and composition of particles. As a result, there is a need to understand how sensors behave in different environments when using them to study local air quality.

During the Phoenix as a Testbed for Air Quality Sensors (PTAQS) project, EPA collaborated with the Maricopa County Air Quality Department (MCAQD) to deploy a network of PurpleAir fine particulate matter ($PM_{2.5}$) sensors across Phoenix. In Phase I (November 2018 – July 2019), multiple PurpleAir sensors were placed alongside more expensive and sophisticated regulatory monitors at three sites to study long-term sensor performance and data quality in Phoenix's hot, dry and sunny environment. In Phase II (July 2019 – March 2021), PurpleAir and black carbon sensor packages were built and deployed at 20 non-regulatory sites to study air quality trends across the city. A mobile trailer with regulatory-grade $PM_{2.5}$ measurements was also transported between sites to validate sensor calibration methods. MCAQD provided important support by maintaining the sensor network, retrieving data, and sharing expertise on local air quality issues.

The PTAQS network was a great opportunity to understand air sensor performance in a new environment and answer specific air quality questions that have been challenging to address using the existing regulatory monitoring network alone. The work led to an increased density in observations that assisted interpolation of concentrations across the city, high time resolution data that helped visualize how pollutants move and how conditions can change during the day, additional supporting information for identifying exceptional events, and a greater understanding of how to correct and interpret data from air sensors.

Partners: Colorado Department of Public Health and Environment, Delaware Department of Natural Resources and Environmental Control, Georgia Environmental Protection Division, Oklahoma Department of Environmental Quality, Wisconsin Department of Natural Resources (DNR) and Maricopa County (AZ) Air Quality Department
Challenge: Harnessing advances and innovations in air sensor technology for protecting public health
Resource: Long-term performance evaluation of popular air sensor types at locations across the U.S.
Project Period: 2019 – 2021

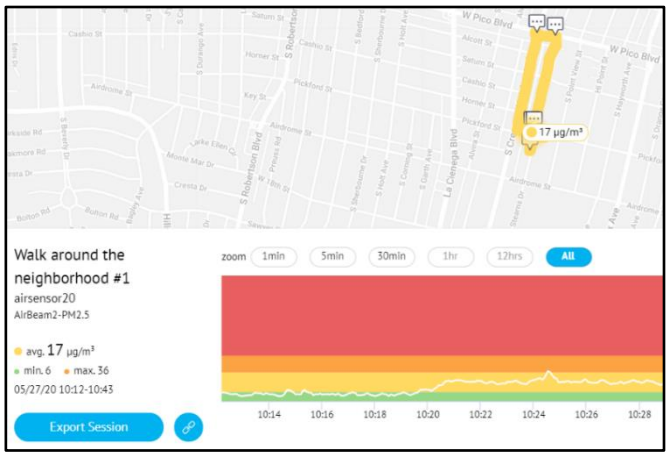
"As technology and public interest in air quality measurements advance, inexpensive sensors are fast becoming data crowd sourcing tools as well as community outreach resources. Research on the performance of sensors compared to regulatory sensors will be very valuable to states and communities as they look to use these sensors to expand air monitoring opportunities across the country." – Wisconsin DNR, former Environmental Management Division Administrator Darsi Foss

There is wide interest from air monitoring agencies, researchers, and community groups in deploying smaller, more portable air sensor technologies for community-scale air monitoring projects. First, air sensors need to be thoroughly evaluated in order to understand their limitations and data quality. Many sensor evaluations performed to date have evaluated sensors for short time periods in a single site or region. To be valuable at the local level, more information is needed about how sensors perform long-term and under a wide variety of meteorological conditions and pollutant concentrations.

EPA partnered with six air monitoring agencies across the United States to operate five air sensor types alongside standard regulatory monitors so that data could be compared. The commercially available sensors reported concentrations of one or more pollutants and featured variation in sensing elements, sampling techniques, data communication, size, and data correction and display. Data were collected between summer 2019 and spring 2021.The research team shared initial observations and findings with partners and presented results at scientific conferences and during an external EPA webinar in August 2022. In addition, results will be posted on the Air Sensor Toolbox using EPA's recommended Performance Evaluation Reporting Template and in peer-reviewed scientific journals in 2023. Most importantly, the project illustrates some of the important considerations that should be considered for planning community monitoring projects using this class of technology, including variations in design and performance, common points of failure, suggestions for maintaining sensors for long-term operation, and awareness of the similarities and differences between different sensors and regulatory monitors. Ultimately, the goal is to help manufacturers improve their products, users to choose appropriate sensors for their intended applications, and for air quality managers to advance air quality data collection and accuracy.

More information on this project and air sensor research can be found on the Air Sensor Toolbox.

Partner: Los Angeles Public Library (LAPL)
Challenge: Increasing community awareness of air quality and making air sensor technologies and educational resources more accessible
Resource: LAPL Air Sensor Loan Program
Project Period: 2019 – 2020



"Serving the largest city in a state threatened by more and more intense wildfires, Los Angeles Public Library is grateful for this important partnership with EPA. This critical and timely collaboration not only empowered our librarians with the knowledge needed to develop effective air quality educational programs, but also provided the library system with lower-cost air sensor loaning kits for patrons to check out for free. By combining information learned at library programs with firsthand experience of monitoring and interpreting air quality in and outside of their homes, Angelenos will be able to make informed decisions for their health and well-being." – Los Angeles Public Library Neighborhood Science Program Lead Vivienne Byrd

Air quality in the Los Angeles area has improved over the last four decades, but the area still struggles with air pollution, such as fine particulate matter ($PM_{2.5}$) which contributes to asthma, cardiovascular disease, and other health problems. $PM_{2.5}$, along with other air pollutants, is measured at a limited number of regulatory monitoring stations to determine air quality for the area. Communities have become interested in using new, lower-cost air sensors to measure air quality conditions at the neighborhood or street level.

From April 2019 to July 2020, EPA ORD, in collaboration with EPA Region 9 (Pacific Southwest) and the Los Angeles Public Library (LAPL), developed an air sensor loan program. In addition to books, library patrons can check out an air sensor device for free. As part of the program, EPA provided AirBeam2 sensor devices, which measure $PM_{2.5}$, and developed a number of educational resources. The resources included three hands-on lesson plans for exploring outdoor air quality, indoor air quality, and personal air pollution exposure with the public in classroom, group, and one-on-one settings. EPA also provided training to the librarians on the lesson plans and the use of the air sensors.

The LAPL air sensor loan program provides a unique opportunity for the public to access new, lower-cost sensor technologies for free while also learning about both air quality and the actions they can take to protect their health and the environment. Librarians will host workshops and classes using the resources developed to help participants use the air sensors and understand the data collected. The LAPL air sensor loan program concept was expanded in 2021 in collaboration with EPA Region 5 (Upper Midwest) and EPA Region 10 (Pacific Northwest). Those programs focused on tribal and rural communities and resulted in additional lesson plans. Since then, new air sensor loan programs have launched across the U.S.

To access introductory slide sets, instructional videos, five hands-on lesson plans, and a resource guide created in support of these air sensor loan programs, as well as other educational resources related to air sensors, visit the educational resources page on EPA's Air Sensor Toolbox. To access a best practices guide for starting an air sensor loan program and to see if an air sensor loan program serves your area, visit the air sensor loan programs page on EPA's Air Sensor Toolbox.

Partner: Louisville Metro Air Pollution Control District (LMAPCD)
Challenge: Need for a sensor system that can detect unpleasant smelling air toxics
Resource: Technology development and field implementation of novel air monitoring instrument
Project Period: 2018 – 2020

"The Louisville Metro Air Pollution Control District is currently working on a collaborative project with EPA using novel measurement technology – the oVET – to "sniff" and sample when elevated volatile organic compounds (VOCs) are detected. Investigating objectionable odors from VOCs in a complex airshed with multiple industrial sources is challenging. With nearby residences, being able to quickly identify and quantify VOCs would be a tremendous aid in odor complaint investigations." – Louisville Metro Air Pollution Control District, Interim Director Rachael Hamilton

The Rubbertown area in west Louisville, Kentucky, like many other urban areas, is challenged with significant air quality issues arising from the fugitive volatile organic compound (VOC) emissions released by multiple local industrial pollution sources. The VOC emissions released from these industrial facilities, including over 10 chemical facilities and a municipal wastewater treatment facility, have been contributing to elevated levels of air toxic and malodorous, or bad smelling, VOC compounds that can cause negative health effects on the nearby Rubbertown communities. Fugitive odorous emissions are highly variable in nature and are, therefore, particularly challenging to detect, yet they give rise to odor concerns and cause stress in affected communities.

EPA ORD researchers collaborated with the Louisville Metro Air Pollution Control District (LMAPCD) and EPA Region 4 (Southeast) to develop and demonstrate an innovative VOC sensor system to measure odor causing air toxic VOCs that are suspected of contributing to odor issues in the Rubbertown area. The new measurement technology—called an odor VOC Emissions Tracker (oVET)—was constructed and deployed by EPA ORD in Rubbertown in 2018-2020 with the support of LMAPCD and EPA Region 4. It combines several next-generation measurement approaches to detect and quantify fugitive odorous emissions near industrial facilities.

The project team conducted a field demonstration of the technology in Rubbertown to evaluate its ability to detect the source of odors in the ambient air. The oVET generated ambient measurements of odor causing air toxics coupled with real-time VOC sensor and wind readings. The measurements produced during the field effort are currently under review, and preliminary findings have been communicated to a wider audience in scientific meetings. The final results from this work are expected to provide the community and LMAPCD with actionable information on pollution sources contributing to odor issues in Rubbertown that can help to mitigate future odorous air toxic emissions.

Partners: Michigan Department of Environment, Great Lakes and Energy (EGLE); University of Illinois at Urbana-Champaign
Challenge: Inaccurate methods for quantifying landfill air emissions
Resource: Evaluating next generation emission measurement (NGEM) technologies as an alternative to current methods
Project Period: 2019 – Present

"Helping states understand the accuracy of new and innovative ways to monitor air emissions from landfills will help EGLE be able to better manage air quality in Michigan." – Michigan EGLE Air Quality Division, Assistant Director Jay Olaguer

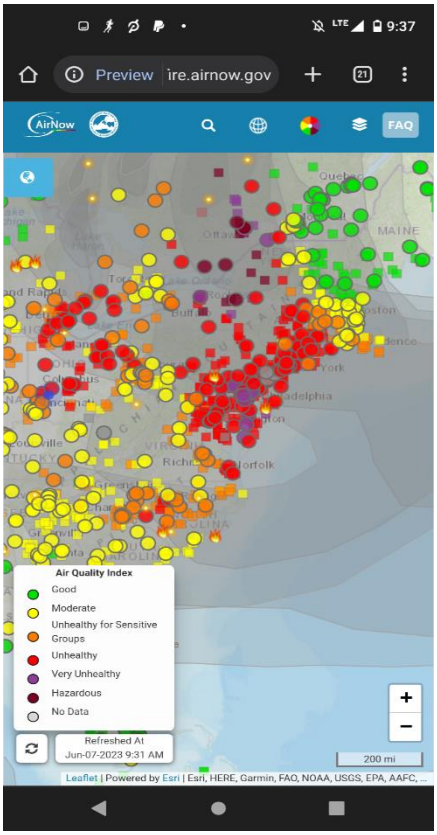
As of 2023, there are more than 2600 landfills in the US subject to Clean Air Act regulations requiring use of surface emission measurements (SEMs) and installation of gas capture and control systems. Since the regulation was published in 1996, there has been minimal updates to this rule in terms of use of next generation emission measurement (NGEM) technology for conducting SEMs and evaluating mitigation improvements through automatic tuning of the landfill gas (LFG) well field.

As waste in landfills decomposes, it produces emissions, including methane, nonmethane organic compounds, and hazardous air pollutants. This project evaluated an alternative (i.e., NGEM) approach for conducting SEMS at landfills using drone technology as conducted by Sniffer Robotics. This work resulted in development of an alternative measurement method that allows for routine use of the drone for conducting quarterly SEMs as required by the Clean Air Act. This method (OTM 51) is in routine use across the US as a result of the work conducted for EPA Region 5 and the state of Michigan.

In addition to demonstrating and deploying new method using drones for SEMs, EPA ORD researchers also worked with Carbon Mapper (https://carbonmapper.org/) to evaluate remote sensing data to determine compliance and enforcement of CAA regulations for landfills. Aircraft are used by Carbon Mapper and NASA to conduct regional survey of methane sources. Working with Region 5 and Michigan, EPA ORD researchers were able to investigate which landfills had higher emissions and where leaks are found. When landfill inspections occurred, it was possible to determine the root cause of the leaks and what was leading to high loss of fugitive methane and other air emissions. EPA ORD researchers also worked with Scientific Aviation to conduct independent validation of the Carbon Mapper approach (which quantifies point sources) versus emission measurements from Scientific Aviation that is quantifying total mass emissions (fugitive and point sources). Very good agreement was found, suggesting that point sources dominate emissions at landfills. Furthermore, it was found that landfills dominate emissions in some air basins based upon data from landfills in both EPA Region 5 and the southeastern US. The results have been submitted to Science in May 2023, and publication is expected in Spring 2024. EPA ORD researchers continue working with Carbon Mapper, NASA and others to identify landfills where near-term reductions are possible.

AIR – WILDFIRES AND PRESCRIBED BURNS

Partner: Northeast and Mid-Atlantic states, Tribes and localities impacted by Canadian wildfires
Challenge: Accessing air quality information during a cross-border wildfire crisis
Resource: AirNow Fire and Smoke Map, in collaboration with the U.S. Forest Service
Project Period: 2023



"With wildfire smoke having visible impacts in New Jersey and along the East Coast this year, ORD's work to make air quality and smoke data readily available through AirNow and the AirNow Fire and Smoke Map has been very valuable." – New Jersey Department of Environmental Protection Commissioner Shawn LaTourette

"This past summer, as much of the US has been impacted by the Canadian wildfire smoke, the EPA AirNow Fire and Smoke Map has been an invaluable tool for the New Jersey Department of Health. Such tools are instrumental in providing the agency with situational awareness about environmental conditions across the state that can affect health, which helps guide the development of timely and accurate public health messaging." – New Jersey Department of Health Acting Commissioner Dr. Kaitlan Baston

In June 2023, a large number of active wildfires in Canada, combined with southward wind transport patterns, resulted in smoke and haze blanketing the eastern and midwestern United States. During this time, the added data from air sensors in the AirNow Fire and Smoke Map proved vital for users nationwide. This added data was made possible by an earlier collaborative effort between EPA ORD scientists and staff in EPA's Office of Air Quality, Planning and Standards and the U.S. Forest Service. They developed a national calibration equation supporting the inclusion of PurpleAir sensor data in the Fire and Smoke Map, greatly enhancing the map's usefulness to state, tribal and local agencies. The publicly available, crowdsourced PurpleAir data provides supplemental air quality information in areas between regulatory monitors. With the growing wildfire crisis leading to increased exposures to smoke, state and local air quality agencies need more refined air quality data to effectively prepare and respond to smoke events. The growth of public data from air sensors has helped address this need.

The AirNow Fire and Smoke Map is one of the most accessed air quality tools for states and tribes as they work to prepare for and respond to wildfire smoke. On June 7, 2023, the AirNow Fire and Smoke Map received more than 1.3 million page views – nearly three times the previous high of roughly 0.48 million in August 2021.

Partner: Kansas Department of Health and Environment (KDHE)
Challenge: Understanding trade-offs associated with prairie rangeland burning
Resource: Multi-model framework and decision support tool in support of Kansas Flint Hills Smoke Management
Project Period: 2018 – Present

"Kansas Department of Health and Environment is excited and optimistic about the potential uses of this multi-model framework, including predicted spatial and temporal patterns of surface fuel loads, live biomass (forage), and soil moisture information that can be used to supplement our existing Flint Hills Smoke Management Plan modeling tool." – KDHE Division of Environment former Director John Mitchell

The Flint Hills ecoregion of eastern Kansas and northern Oklahoma is home to the largest (10,000 square miles) remaining contiguous natural grassland prairie in the U.S. Throughout the region, land managers frequently use controlled burns to sustain the natural prairie ecosystem from the encroachment of eastern Red Cedar and other woody species, and to enhance the quantity and quality of the grasses for cattle grazing. However, smoke from widespread prescribed spring burning can under certain conditions exceed air quality limits and impacted urban areas such as Kansas City, Topeka and Wichita.

To assist rangeland managers and local and state officials in better understanding the economic, ecological and human health trade-offs of rangeland burning in Flint Hills, EPA Region 7 (Midwest) and ORD are collaborating with KDHE to establish a user-friendly, multi-model framework for visualizing historical and hypothetical burning scenarios, including changes in the location, timing and frequency of rangeland burning practices. Part of this effort involves characterizing the emissions from the Flint Hills prescribed burning in both the spring and fall seasons. ORD has conducted aerial sampling with an instrumented, tethered aerostat as well as ground sampling to derive emission factors that characterize the amount and nature of the smoke. Tangible products of the research include computer-generated spatial and temporal maps of predicted changes in rangeland productivity and air quality. Stakeholders and decision makers can use these resources to identify best case scenarios for land management that strike a balance between the environmental, economic, and human health objectives of rural and urban communities.

Partners: Missoula City-County Health Department (MCCHD, MT) and Hoopa Valley Tribe (CA)
Challenge: Reducing indoor air exposures to wildfire smoke
Resource: *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events: First Public Review Draft*, in collaboration with the National Institute of Standards and Technology (NIST) and ASHRAE (formerly the American Society of Heating, Refrigerating and Air Conditioning Engineers)
Project Period: 2019 – Present


Goat Creek Fire, MT July 2017

"I'm SUPER excited for the ASHRAE document! Locally, we've found large, commercial spaces to be generally underprepared for wildfire smoke; the ASHRAE framework provides the foundation and expertise we need to address this gap in smoke-readiness. We are currently plotting how we can locally encourage HVAC technicians and building operators to engage with the material to help our community become better prepared for smoke events. It felt like Christmas when it came out!" – Missoula-City County Health Department, Air Quality Specialist Sarah Coefield

EPA ORD is working with local and tribal partners on a solutions-driven research effort to address reducing indoor air exposures to wildfire smoke. One of the concerns raised by partners in Missoula, Montana, was that they had no guidance to use when they talked with building owners about how to improve indoor air quality during wildfire smoke events.

ASHRAE is the organization that develops standards and guidance for the built environment, including ventilation and other practices affecting indoor air quality. Inspired by the need identified by Missoula partners, EPA ORD scientists began conversations with NIST about working with ASHRAE to address wildfire smoke in the indoor environment. Early in 2020, a proposal developed jointly by EPA and NIST was approved. By summer 2020, ASHRAE formed a committee to develop a guideline, *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events.* Several scientists from EPA and NIST are participating on the committee, along with representatives from industry and other government agencies in the U.S. and Canada.

Given the urgency of providing initial guidance, ASHRAE asked the new committee to work quickly to develop an interim document. The result was the publication of the short ASHRAE document—Planning Framework for Protecting Commercial Building Occupants from Smoke During Wildfire Events—in February 2021. This interim guidance was the first document to provide information to help owners and managers of commercial buildings, including schools, prepare for smoke related to wildfires or prescribed burning so that they can protect the health of people in their buildings.

ASHRAE released a draft of the full Guideline 44P titled "Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events: First Public Review Draft", for public comment in August of 2023. The ASHRAE committee is currently reviewing and addressing the public comments and anticipates the full guideline to be available in 2024. Additional information is available on EPA's Wildfires and Indoor Air Quality in Schools and Commercial Buildings webpage. EPA is conducting additional research activities to advance our understanding of indoor air quality during wildfire smoke events. Learn more.

Partners: Washington State Department of Health, North Carolina Department of Health and Human Services Division of Public Health and others
Challenge: Improving access to health risk communication among limited English proficiency populations
Resource: Smoke Sense mobile app with text translated into Spanish
Project Period: 2017 – 2024

"There is an urgent need to address research gaps and to prioritize practical solutions that can reduce smoke-related adverse health effects among agricultural workers. A large portion of the Pacific Northwest agricultural workforce is Spanish-speaking and at disproportionate risk of adverse occupational health effects from poor air quality during wildfire events. Growers have used the Smoke Sense app as part of their decision support to help reduce this exposure." – University of Washington School of Public Health, Pacific Northwest Agricultural Safety and Health Center, Outreach Director Edward Kasner PhD, MPH

Exposure to wildfire smoke is a community health issue that has been gaining the attention of public health professionals and organizations, especially in states where fires are frequently large and intense. Wildfire smoke has significant health implications for those near the fire, as well as for those living farther downwind. While these risks affect the population broadly, individuals with limited English proficiency are at increased risk of exposure due to limited access to health risk communication resources that provide clear information about wildfire smoke and the exposure reduction actions they can take.

The Smoke Sense citizen science project aims to increase awareness about the health risks associated with inhalation of wildfire smoke and actions individuals can take to reduce the amount of smoke they breathe. The Smoke Sense mobile app had over 44,000 participants. Through feedback from stakeholders, the Smoke Sense team learned that translating text in the app into Spanish would reduce a barrier for receiving information among individuals who speak Spanish and have limited English proficiency. Based on this feedback, the research team adapted the app's source code to accept translated text. The first language the app has been translated into was Spanish, allowing Spanish-speaking individuals to engage more fully. This effort reduced barriers for individuals with limited English proficiency by making available within the Smoke Sense app information about evolving environmental health threats and protective health behaviors. Since December 2024, the Smoke Sense app has been unavailable for use. Please visit AirNow for the latest wildfire smoke and air quality information.

Partners: State & local environmental and health agencies (AK, AZ, CA, CO, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY), regional clean air agencies, Western States Air Resources Council and interested tribes
Challenge: Addressing state, regional & local and tribal research needs related to wildland fires
Resource: EPA-hosted listening sessions with state & local agencies from western and neighboring states and Tribal representatives to discuss their research priorities and needs concerning wildland fires
Project Period: January – February 2022

"This convening was so important for highlighting our science needs to EPA on life and death wildfire issues, and to share knowledge among state colleagues facing the same challenges." – Oregon Health Authority, Environmental Public Health Section Manager Gabriela Goldfarb

"What I took away from listening to other Tribes was the frustration at not being allowed to burn in their traditional manner, and that there appears to be a disconnect between EPA's interest in smoke/air quality and Tribal interests in effects of fire on water and ecology and groundwater (used for drinking). I hope that listening to Tribal interests guides upcoming research. It was useful to know that mobile monitoring systems are being developed, and I hope Tribes are involved to ensure new systems fit their needs." – Chickaloon Native Village (Alaska) Environmental Program Manager Kendra Zamzow, PhD

Increasing fire activity has had significant impacts on the western states as well as Tribes. As EPA continues efforts to address the challenging questions associated with wildland fires and their impacts, it is imperative to ensure that we understand the greatest concerns of our partners in the states, Tribes and regions.

EPA ORD invited representatives from 14 western and neighboring state, regional & local environmental and health agencies, as well as Tribal nations to participate in a series of listening sessions held in January and February 2021. State, regional & local agencies and Tribes shared their top challenges and science needs related to wildland fires (including wildfires and prescribed burning) and smoke. Their input is of critical importance as we work together to better understand the impacts of wildland fires more fully on air quality, water quality and health, as well as how best to communicate to the public.

These localized perspectives, comments and feedback from the listening sessions were captured by EPA staff and used to inform implementation of ORD's wildland fire research program and development of ORD's Strategic Research Action Plans (FY23-26).

The listening sessions were also an opportunity to provide attendees with overviews of current EPA research on wildland fires and key resources available to support states, Tribes and communities. For more information, visit AirNow Fire and Smoke Map Pilot Project, Smoke Sense, Smoke Ready Toolbox for Wildfires, and Wildfire Smoke Guide. EPA ORD held follow-up webinars in early 2022 to summarize what we heard from these listening sessions, what we are currently doing to address the needs and challenges expressed by states, Tribes and local agencies, and how we plan to incorporate additional considerations in our Fiscal Year 2023-2026 research planning.

Partner: State, local and Tribal air organizations
Challenge: In many areas affected by wildfire smoke, air monitoring data may be limited or absent
Resource: EPA is loaning air monitoring technologies to help organizations assess smoke impacts and provide public health information with timely data
Project Period: September 2021 – Present

"Before WSMART, we only had monitoring for ozone near our area. Because of this, we would look on AIRNow, and it said our air quality was good though we were able to see smoke in the air. In 2022, we received four PM2.5 sensors from WSMART which gave us real-time data in our area and helped us distribute accurate information about smoke impacts to the tribal community." – Fallon Pauite-Shoshone Tribe's Environmental Protection Department Environmental Specialist Sonia Corleto

The growing threat of wildfires and related smoke impacts is a public health concern in the United States. In many areas affected by wildfire smoke, air monitoring data may be limited or absent. Supplemental measurement technologies can help air monitoring organizations gather timely data to assess smoke impacts and provide public health information.

To increase supplemental air monitoring data during wildfires, EPA ORD launched the Wildfire Smoke Air Monitoring Response Technology (WSMART) Pilot in September 2021. WSMART has made specific air monitoring technologies available for loan to state, local and Tribal air organizations. The current systems available upon request are two stationary sampling air sensor systems and a portable system called the Vehicle Add-On Mobile Monitoring System (VAMMS).

EPA loans the air measurement devices directly to state, local, and Tribal air organizations to support supplemental air monitoring in areas affected by wildfire smoke and with observational data coverage gaps. EPA also loans monitors to the Interagency Wildland Fire Air Quality Response Program for use by Air Resource Advisors (ARAs) who work with Incident Management Teams at major wildfires. ARAs coordinate with state, local, and Tribal organizations to share information regarding wildfire smoke conditions and coordinate public messaging.

Since the program's launch over 50 recipients have used WSMART monitoring technology to address the smoke impacts from over 30 wildfires across 12 states. The WSMART program has and continues to support air quality government organizations at the frontline of wildfire smoke response become better equipped to assess smoke conditions and protect public health during wildfires.

Eligible organizations can make requests for air monitoring equipment through the WSMART Pilot page.

CHEMICALS – ASSESSMENTS

Partner: Interstate Technology & Regulatory Council (ITRC)
Challenge: Need for improved understanding of the current science regarding microplastics
Resources: Microplastics Online Guidance Document, web-based training, and Microplastics Outreach Toolkit
Project Period: 2021 – 2024

"The Microplastics Toolkit provides materials that can be used to help explain microplastics to diverse audiences, from upper management to the general public. The toolkit will also provide resources regarding effective outreach strategies." – California DTSC Valerie Hanley (ITRC Microplastics Team Co-Lead)

Microplastics are tiny plastic pieces less than five millimeters in size which can be found in various sources. Microplastics can be categorized as primary (intentionally added or fit for use), such as in cosmetics and fertilizer pellets, or secondary (produced through the breakdown of larger macroplastics), such as from plastic packaging and fibers shed from clothing. Microplastics have been introduced to the environment over the last 50 years through their use in consumer products and industrial practices, as well as through plastic refuse, which has been broken down and entered the waste stream. Exposure to microplastics has the potential to harm wildlife, ecosystems, and human health by accumulating in the environment and entering the food chain.

The ITRC Microplastics Team was formed in 2021 and published its first resource in February 2023, an online Microplastics Guidance Document that provides readers with information on microplastics and the state of the applied science. EPA scientists participated on the team, providing their technical expertise, collaborating through discussions and meetings, and by providing written comments on draft ITRC materials. Written with the state regulator in mind, the technical guidance is also a useful tool for industry members and decision makers, covering topics such as sources and impacts of microplastics, environmental fate and transport, sampling and analysis, best practices for prevention and mitigation, and current policies and regulations.

In June 2024, the team published its second resource, an Outreach Toolkit, to provide resources for environmental professionals to use in communicating microplastics issues to members of the public, scientists and regulators, and decision makers.

The Microplastics team continues to host a web-based training, which uses a conceptual site model to navigate microplastics in the environment and explore areas covered in the guidance document.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Addressing contaminants of emerging concern (CEC)
Resource: CEC Framework, web-based training
Project Period: 2021 – 2023

"The ITRC CEC Team is grateful to USEPA for its involvement in developing and reviewing its draft work products. This involvement will hopefully facilitate use of the ITRC CEC Guidance by the states and be conducive to informing a technically defensible and effective approach to evaluating CEC." – ITRC CEC Team Leaders Paula Panzino, AZ DEQ, and Vivek Mathrani, CA DTSC

Many states, territories and localities struggle with the challenge of addressing contaminants of emerging concern (CEC). According to the Interstate Regulatory and Technology Council, CEC refer to "substances and microorganisms including physical, chemical, biological, or radiological materials known or anticipated to be present in the environment, that may pose newly identified risks to human health or the environment." When CEC are encountered, there is often sparse or outdated information in the hazard, exposure, and fate and transport domains. There is no one given approach to how to handle CEC, and states, territories and localities may find it daunting to develop a monitoring and action-oriented program that can systematically prioritize and deal with them.

To address this challenge, ITRC assembled a Contaminants of Emerging Concern team, which published the CEC Framework in 2023. Since 2021, EPA scientists have supported the ITRC CEC Team by contributing expertise to support the development of fact sheets that can assist states, territories and localities in accessing resources to address CEC under their jurisdiction. These resources include approaches on monitoring programs and analytical methods, key information on toxicity, exposure, and fate and transport properties to help prioritize CEC, risk communication tools, and case studies.

ITRC training is available to present this entirely new framework for identification, prioritization, and communication of CEC. The first training was held early in 2024 and continues to host live courses.

Partner: Minnesota Department of Health (MDH)
Challenge: Identify and communicate the potential for hazardous chemicals
Resources: Software and computational tools to screen and prioritize chemicals to protect public health.
Project Period: 2019 – Present

"The software developed by EPA to assist our Toxics Free Kids program will be an integral part of our prioritization review process and will provide greater transparency and timeliness as we continue to provide Minnesotans with information about exposure to potentially hazardous chemicals. This software can do in minutes what would have taken us weeks to do manually and MDH is grateful for this partnership." –MDH Research Scientist David Bell

The Minnesota Department of Health (MDH) measures and evaluates the potential health risks of chemical exposures in the environment and in Minnesotans, especially children and pregnant people. EPA ORD and MDH are collaborating on two projects to develop computational tools to advance this work.

Project One: Protecting Minnesota's Children
The first project focuses on developing software which can be used by MN to prioritize chemicals which may pose more of a risk to children, as required by the MN Toxic Free Kids Act. MN's Toxic Free Kids (TFK) program identifies and communicates the potential for hazardous chemical exposures from consumer products to harm human health, particularly to vulnerable or susceptible populations.

To support the program, ORD developed a hazard and exposure comparison software to facilitate rapid and reproducible evaluations of chemicals for their potential risks to children and people who could become pregnant. The Chemical Prioritization software for the TFK program compares the relative hazards of multiple chemicals simultaneously via color coded scoring. In addition, it provides the underlying scoring based on MN's criteria which were used to assign the final scores and provides hyperlinks to more data for chemicals of interest to MDH.
The downloadable software is being used by the MDH TFK program to review and revise the Chemicals of High Concern list every three years and prioritize chemicals for consideration for their Priority Chemical List. The MDH uses these lists to communicate the potential hazard of these chemicals to the public through various communication mechanisms including reports that summarize these lists on their website and through community outreach. It is anticipated other states with similar legislation pertaining to children's health and chemical exposure may be interested in using this application.

Project Two: Screening Water for Chemicals of Concern
The second project focuses on developing an automated chemical exposure workflow for the MN Contaminants of Emerging Concern (CEC) program. MN's CEC program identifies chemicals in water that have no current regulatory standard yet may potentially pose a risk. Nominated chemicals undergo a screening-level evaluation and ranking based on exposure and toxicity potential. The CEC program currently evaluates exposure potential one chemical at a time using a standardized set of sources and procedures. ORD worked with MDH to develop an automated workflow that would enable rapid evaluation of thousands of chemicals using MDH's criteria.

MDH has evaluated the results of the CEC initiative automated workflow using a case study of 1,800 chemicals, including 82 chemicals already evaluated by MDH using its existing manual process. MDH found reasonably good agreement between the manual and automated workflows. This indicates that the automated workflow will be a useful tool to accelerate exposure screening evaluations and expand the number of chemicals assessed, freeing resources to complete the more complex aspects of exposure assessment. In addition, this allows for more efficient re-screening of previously evaluated chemicals to incorporate updated or newly available information. The automated workflow developed by EPA ORD greatly reduces the time and resources needed to identify higher priority water contaminants by eliminating much time-consuming data collection work.

Partner: National Tribal Toxics Council, National Tribal Science Council, Tribal Pesticide Program Council
Challenge: Understanding chemical exposures to Tribes and subsistence populations via seafood consumption
Resource: Conduct a systematic review on subsistence aquatic biota consumption in collaboration with Tribal partners
Project Period: 2019 – Present

"Historically we had as much fish as we needed to eat. Now our consumption is suppressed. We would eat more if we had more." – Lower Elwha Klallam Tribe Vice Chairman Russell N. Hepfer

Fishing and seafood consumption play an important role in the health, culture, and way of life for many subsistence populations. subsistence fishing populations include Tribes, fishers, and other populations who obtain most of their nutritional and caloric energy needs from consuming waterborne species (aquatic biota) such as fish and/or shellfish. Under the Toxic Substances Control Act (TSCA), EPA conducts chemical risk evaluations to determine whether a chemical substance presents an unreasonable risk to health or the environment. The 2016 Lautenberg Act amends TSCA and helps EPA further ensure the safety of chemicals while explicitly considering "potentially exposed susceptible subpopulations." Tribes have advocated to have subsistence exposure included in EPA risk assessments and have raised concerns that historically during TSCA reviews, EPA has missed important data on subsistence fish consumption that may have important implications for human health and the environment.

Given the opportunity to address this gap, in 2019 EPA ORD and the Office of Chemical Safety and Pollution Prevention (OCSPP) partnered with the National Tribal Toxics Council, the National Tribal Science Council and the Tribal Pesticide Program Council to conduct a systematic literature review of fish, seafood and other waterborne species. A systematic literature review examines available evidence using explicit and reproducible methods to systematically search, critically appraise, and synthesize information on a specific issue using strategies that reduce biases. EPA ORD researchers, OCSPP staff and Tribal partners, in collaboration with EPA Region 10, formed a workgroup to determine an appropriate systematic review approach. EPA provided training on systematic review processes and tools to help identify relevant references and organize them to facilitate the review of literature. This empowered tribal workgroup members to significantly contribute to the systematic review from the gathering of data to completing the full-text reference screenings.

An upcoming EPA report with results and collected data from this project will inform public health assessments and evaluations such as TSCA chemical evaluations or other human health risk assessments that include estimating exposures to environmental contaminants via consumption of fish or shellfish throughout the U.S.

Partners: California Environmental Protection Agency's (CalEPA) Department of Toxic Substances Control (DTSC) and Office of Environmental Health Hazard Assessment (OEHHA)
Challenge: Evaluating chemicals for health effects using data from new approach methods
Resource: New technologies, models, tools, data and other chemical information
Project Period: 2015 – Present

"California benefits significantly from our partnership with EPA ORD. We use data to provide valuable insight into how chemicals may cause toxicity, and we use their exposure modeling and monitoring for various state efforts including our work on safer consumer products. EPA ORD resources are helping us to make more informed decisions about the potential health effects of chemicals." – CalEPA former Secretary Matthew Rodriquez

CalEPA's DTSC and OEHHA are collaborating through a Memorandum of Understanding with EPA ORD to use New Approach Methods (NAMs) developed by our scientists to evaluate the potential health effects of chemicals. CA DTSC has been using these ORD data and models to inform risk assessments for certain pesticides. OEHAA has been using high-throughput screening data and exposure information generated by ORD to evaluate chemicals used in consumer products and found in drinking water. This data is publicly available on the Computational Toxicology (CompTox) Chemicals Dashboard and the Chemical Exposure Knowledgebase.

Specifically, DTSC is using ORD high-throughput chemical data in a Risk Characterization Document which is evaluating the risk to human health resulting from inhalation of the fumigant allyl isothiocyanate (AITC). The risk assessment process for AITC was initiated in 2018 due to its proposed use and based on evidence that it may cause reproductive toxicity, genotoxicity, and oncogenicity in animal studies. The risk assessment document was presented during a public meeting and finalized in April 2022.

In 2020, CalEPA's OEHHA used high-throughput screening (HTS) data from ORD to examine mechanisms of action of synthetic food dyes and included the data in a risk assessment. Using the data, they developed an approach to examining potential mechanisms of these synthetic food dyes. In 2021, OEHHA also used ORD high-throughput data on Perfluorooctanoic Acid (PFOAs) and Perfluorooctane Sulfonic Acid (PFOS) in drinking water. This data is used in the Public Health Goal (PHG) technical support documents which provide information on health effects from contaminants in California drinking water. PHGs published by OEHHA are used to establish primary drinking water standards. OEHHA also used high-throughput screening data to evaluate the potential carcinogenicity of acetaminophen, gentian violet and Perfluorooctane Sulfonic Acid (PFOS). This data is used in a Proposition 65 which requires the publication of a list of chemicals "known to the state" to cause cancer or reproductive toxicity. The Carcinogen Identification Committee (CIC) advises and assists OEHHA and adds chemicals to the Proposition 65 list of chemicals that cause cancer.

This collaboration is ongoing and the team is currently working on a research project focused on evaluating potential health and environmental effects of quaternary ammonium compounds (QACs or quats). Quats are a group of chemicals used for a variety of purposes, including as preservatives, surfactants, antistatic agents and as active ingredients for disinfectants and sanitizers. Quats have been shown to be highly effective at killing bacteria, fungi and viruses, including SARS-CoV-2, the virus that causes COVID-19, and are found in many common disinfectant products. In addition, ORD is providing a series of training webinars for DTSC staff on various computational toxicology and exposure online resources.

Partner: California Environmental Protection Agency's (CalEPA) Department of Toxic Substances Control (DTSC)
Challenge: To inform the identification of "Priority Products," California DTSC must understand the potential for exposures to chemicals contained in specific consumer products
Resource: Application of high-throughput human exposure models for thousands of chemical-product combinations
Project Period: 2017 – 2019

"The Safer Consumer Product regulations don't use quantitative risk assessment to prioritize product-chemical combinations as Priority Products. Instead, the regulatory criteria are exposure potential and hazard potential using a narrative standard. So, determining exposure is critical for our decision making. The Stochastic Human Exposure and Dose Simulation High Throughput (SHEDS-HT) model and product intake fraction modeling are valuable tools to help us assess exposure. CA DTSC can use SHEDS-HT to support the selection of Priority Product categories and accelerate our screening of chemicals in our work plan including flame retardants, antimicrobials, per- and polyfluoroalkyl substances (PFAS), and fragrances." – CalEPA DTSC Director Meredith Williams

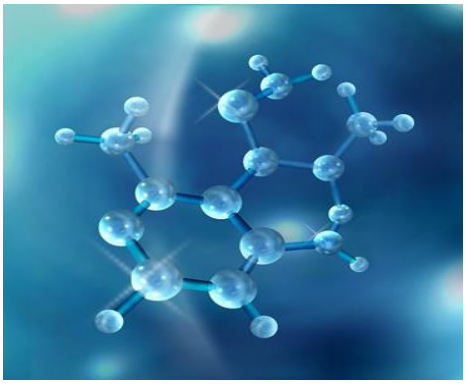
California DTSC's Safer Consumer Products program uses a multi-step process to reduce toxic chemicals in the products that consumers buy and use. It identifies specific products that contain potentially harmful chemicals and asks manufacturers if the chemical is chemical necessary and if there a safer alternative. DTSC identifies "Candidate Chemicals" which may pose a health hazard, and then identifies "Priority Products" in which they may occur. DTSC would like to consider potential human exposures associated with Candidate Chemicals when deciding which products are a priority. However, since measured exposure data are rarely available for all potential chemicals and products, exposure model predictions are needed.

EPA ORD's High-Throughput Stochastic Human Exposure and Dose Simulation Model (SHEDS-HT) is a population-based model of human exposure to chemicals in consumer products that can be used to meet this need. Inputs to SHEDS-HT include product compositions (i.e., chemical concentrations in various product types), human behavior patterns (e.g., frequency and amount of product use), chemical properties, and population characteristics. ORD has also developed a database of product chemical ingredient data called the Chemicals and Products Database (CPDat) by collecting and summarizing data on thousands of products from publicly- available data sources such as Material Safety Data Sheets and manufacturer ingredient lists. Using CPDat, ORD scientists performed SHEDS-HT simulations of the predicted exposures associated with thousands of chemical-consumer product combinations, including chemicals currently included on the DTSC Candidate Chemical List.

DTSC uses SHEDS-HT results to support selection of Priority Product categories and further prioritization or evaluation of products and chemicals. These activities have already directly supported California's Safer Consumer Products program. One example is California's assessment of non-occupational 1,4-Dioxane exposure from drinking water and product use.

For more information, visit the Rapid, Exposure and Dosimetry Webpage.

Partner: Minnesota Department of Health (MDH)
Challenge: Identify and communicate the potential for hazardous chemical that could be harmful to human health
Resource: Software and workflow development to prioritize chemicals for MN's Toxic Free Kids Program and screen for drinking water contaminants of concern
Project Period: 2018 – Present



"Minnesota has benefited greatly from this collaboration. It's provided us access to top-notch scientists at EPA, and their expertise in chemical screening and evaluation has been really helpful to our work." – MDH Environmental Health Division Director Tom Hogan

"Because of this collaboration we have new tools in our hands to help us perform exposure screening faster and more in depth than before. Ultimately we hope the collaboration will also bring us new tools for hazard screening and identifying chemicals of emerging concern that are relevant to Minnesota." – MDH Research Scientist Supervisor Sarah Fossen Johnson

"The software developed by EPA to assist our TFK program will be an integral part of our prioritization review process and will provide greater transparency and timeliness as we continue to provide Minnesotans with information about exposure to potentially hazardous chemicals. This software can do in minutes what would have taken us weeks to do manually and MDH is grateful for this partnership." – MDH Research Scientist David Bell

The Minnesota Department of Health (MDH) measures and evaluates the potential health risks of chemical exposures in the environment and in Minnesotans, especially pregnant people, and children. ORD and MDH are collaborating on two projects to develop computational tools. One project focuses on developing software which can be used by MN to prioritize chemicals which may pose more of a risk to children as required by the MN Toxic Free Kids Act. MN's Toxic Free Kids (TFK) program identifies and communicates the potential for hazardous chemical exposures from consumer products that could be harmful to human health, particularly to vulnerable or susceptible populations. The second project focuses on developing an automated chemical exposure workflow for the MN Contaminants of Emerging Concern (CEC) Program. MN's CEC program identifies chemicals in water that have no current regulatory standard yet may potentially pose a risk. Nominated chemicals undergo a screening-level evaluation and ranking based on exposure and toxicity potential. The CEC program currently evaluates exposure potential one chemical at a time using a standardized set of sources and procedures. ORD worked with the MDH to develop an automated workflow that would enable rapid evaluation of thousands of chemicals using MDH's criteria.

For the TFK program, ORD developed a hazard and exposure comparison software to facilitate rapid and reproducible evaluations of chemicals for their potential risks to children and people who could become pregnant. For the CEC Initiative, an automated workflow was developed that integrates relevant exposure data, including new approach methodologies (NAMs) exposure modeling and biomonitoring data.

The Chemical Prioritization software for the TFK program compares the relative hazards of multiple chemicals simultaneously via color coded scoring. In addition, it provides the underlying scoring based on MN's criteria which

were used to assign the final scores and provides hyperlinks to more data for chemicals of interest to MDH. This downloadable software is being used by the MDH TFK program to review and revise the Chemicals of High Concern list every three years and prioritize chemicals for consideration for their Priority Chemical List. The MDH uses these lists to communicate the potential hazard of these chemicals to the public through various communication mechanisms including reports that summarize these lists on their website and through community outreach. It is anticipated other states with similar legislation pertaining to children's health and chemical exposure may be interested in using this application.

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Partner: Minnesota Pollution Control Agency (MPCA)
Challenge: Evaluating risk of aquatic contaminants with minimal toxicity data
Resource: Extrapolation of species sensitivity and bioaccumulation to estimate potential impacts for contaminants of concern
Project Period: 2015 – Present

"EPA's variety of tools have been critical in developing aquatic toxicity profiles (ATPs) for contaminants detected across Minnesota. The MPCA uses EPA's estimation tools and databases to quickly obtain relevant information about contaminants that have only recently been detected in an aquatic environment. Prior to the development of these tools, information about contaminants has been limited or time-consuming to find. The profiles combine contaminant information such as fate in the environment, aquatic life toxicity, and endocrine activity to screen contaminants detected in Minnesota. The MPCA uses this information to communicate potential effects of the contaminants found in Minnesota and to identify pollution prevention opportunities for contaminants of highest concern." – MPCA John Linc Stine (former Commissioner)

EPA ORD scientists support ongoing efforts in Minnesota to characterize potential effects for a wide variety of contaminants for which there exists limited information. MPCA uses a suite of EPA tools – Estimation Programs Interface (EPI) Suite, ECOTOX, Web-ICE – to prioritize chemicals based on toxicity effects and hazard characterization. Using these tools, MPCA develops toxicity profiles to screen contaminants that have been detected in the state, and then uses those profiles to prioritize chemicals for further monitoring or pollution prevention opportunities. The profiles are also used as a communication tool that the public or agency decision makers can access to get an overview of the potential hazards associated with individual contaminants detected in Minnesota. Specific recommendations are made to ensure the appropriate considerations are factored into future monitoring efforts (e.g., some contaminants have greater seasonal or geographical inputs, and some contaminants are more likely to partition to sediment or biota, and those matrices are important to sample in addition to water). By assessing the characteristics of the contaminants, future monitoring can be more strategic and less costly, yielding the most relevant data for those contaminants of highest concern.

As an example, during the development of an aquatic toxicity profile for triclocarban (an antibacterial agent common in personal care products like soaps and lotions), MPCA used EPISUITE to demonstrate a high potential for bioaccumulation and environmental persistence. They then used ECOTOX to obtain available toxicity information, which was used as input into Web-ICE to determine that the compound had high acute toxicity to a diversity of taxa. The toxicity profile resulted in the designation of triclocarban as a high priority contaminant for monitoring in systems with effluent input, with focus on sediment monitoring due to the potential to accumulate, persist and cause toxicity in sediment. The use of ORD tools allows MPCA to prioritize chemicals for monitoring to ensure resources address the contaminants of greatest environmental concern.

Partners: Public health agencies of Arizona, Colorado, New Mexico and Utah; New Mexico Environment Department; New Mexico Environmental Public Health Tracking Program; New Mexico Department of Health Private Well Program
Challenge: Persistent environmental health disparities that are common to the four states such as heavy metal mixtures and well water concerns
Resource: Center for Native American Environmental Health Equity Research
Project Period: 2016 – 2021

"The Center's research results informed the work on exposure assessments to metals from private drinking water conducted among communities in the Four Corners' states regions; we look forward to continuing this beneficial exchange of technical expertise." – New Mexico State Epidemiologist Mike Landen, PhD

Many Native American communities are impacted by mine wastes and heavy metal contamination from abandoned mines. There is also community concern about how these contaminants impact human health and cultural practices. To help address these challenges, the EPA and NIH jointly funded the Center for Native American Environmental Health Equity Research from 2016 to 2021. (The Center had previously been funded with other grants including from NIH and continued funding since 2021 is being provided by NIH.)

The Center investigated various metals of concern (uranium, arsenic, manganese, mercury) and community- relevant metal mixtures in blood and urine samples obtained from community members. They also conducted mechanistic experimental studies to explore immunologic effects. The results of this research were presented at the *Four Corners States Biomonitoring Consortium* (4CSBC), organized by the state public health agencies of Arizona, Colorado, New Mexico and Utah. At the 2016 Annual 4CSBC Face-to-Face Meeting (September 28-30, 2016, Santa Fe, NM), the Center's Director presented and contributed to the discussion of biosample collection protocols (blood, urine). She applied the lessons learned in her Center's previous Navajo Birth Cohort Study (funded by NIH) and analysis of biomonitoring for metals exposure.

- Community Engaged Cumulative Risk Assessment of Exposure to Inorganic Well Water Contaminants, Crow Reservation, Montana (published 2018)

The Consortium developed three studies to investigate exposure and shared regional geophysical, cultural, economic, industrial, agricultural and political environment. For example, the consortium utilized the Center's findings as a starting point for a study by the Four Corners States Biomonitoring Collaborative entitled, "The private well drinking water and metals contamination study." A study undertaken by the New Mexico Biomonitoring Program included environmental sampling and assessment of water quality from domestic wells. They conducted laboratory analysis of well-water samples for arsenic, cadmium, manganese, mercury, selenium, and uranium. Testing of water from domestic wells helped to identify potential sources of excessive exposures to those metals. Through this project, participants and communities learned about their water quality and possible actions to control exposures. Ongoing efforts include investigating potential exposures to metals in drinking water across the state, investigating potential exposure to phthalates and other chemicals from the use of plastics and some consumer products, and chemicals used in some pesticides. At the local level, this collaborative project identified potential communities to include for monitoring, strengthened participant recruitment, and built collaborations with local governmental agencies and community coalitions in the recruitment and samples collection processes. The major impact of these efforts included developing states' capacity to conduct environmental exposure assessments through biomonitoring studies and investigating regional exposure concerns.

CHEMICALS – MERCURY

Partner: Minnesota Pollution Control Agency (MPCA)
Challenge: Addressing Beneficial Use Impairments through tracking and remediation of bioaccumulating contaminants
Resource: Modeling bioaccumulation of PCBs and mercury in fish
Project Period: 2017 – Present

"EPA ORD's Great Lakes Toxicology and Ecology Division has been instrumental in providing data, analytical expertise and guidance to support MPCA's efforts to remove Beneficial Use Impairments (BUI's) in the St. Louis River Area of Concern (AOC) in Duluth, MN and Superior, WI. This AOC is the largest and most complex of the 43 legacy pollution sites surrounding the Great Lakes in the U.S. and Canada. EPA's work on aquatic macrophyte models, bioaccumulative compounds in fish tissue, benthic invertebrate communities and spatial data sets has accelerated the implementation of our plan to complete all project work in the AOC by 2020 so that BUI's can be removed by the target date of 2025." – MPCA John Linc Stine (former Commissioner)

The St. Louis River is listed as a Great Lakes Area of Concern (AOC) under the Great Lakes Water Quality Agreement of 1987. This AOC has several Beneficial Use Impairments including loss of fish and wildlife habitat, excess loadings of sediment and nutrients, degradation of aquatic invertebrate communities (benthos), and restrictions on fish and wildlife consumption. MPCA conveyed a need to identify improvements and advance progress toward removing use impairments and eventual AOC delisting.

One of the critical impairments identified for this AOC is restriction of fish and wildlife consumption. Both Minnesota and Wisconsin have posted fish consumption advisories for the St. Louis River because fish have elevated mercury and polychlorinated biphenyl (PCBs) concentrations. Bioaccumulation of dioxins and furans in the Thomson and Scanlon reservoirs are also a concern for fish, wildlife and human health. MPCA identified the need to develop approaches to establish remediation targets for these and other bioaccumulating contaminants, and monitoring designs to track progress after sediment remediation has occurred.

EPA ORD researchers worked with state agency staff to develop a geospatial, habitat-based model of fish bioaccumulation of PCBs to help determine the extent of PCB contamination in the AOC. The model is being used to screen for contamination "hot spots," determine remediation targets for contamination, and develop monitoring plans for future assessments. ORD researchers also led a multi-federal/state agency team to apply cutting-edge chemical tracers to identify the source and pathways of mercury contamination in the AOC. The tracers are being applied to determine the role of legacy mercury contamination in the AOC, and aid in establishing a mercury-specific remedial target. Finally, once the remediation of dioxins and furans in the Thomson and Scanlon reservoir occurs, state agencies will implement a tracking approach developed by EPA ORD researchers to determine success of the activities.

CHEMICALS – PFAS

Partner: Iowa Department of Natural Resources (DNR)
Challenge: PFAS-contaminated stormwater in a detention pond
Resource: Treatment options for the contaminated water
Project Period: January – March 2023

"We truly appreciate the partnership between EPA ORD and the Iowa DNR. ORD's timely guidance was valuable and helped us to expedite the project and ensure a successful completion." – Iowa DNR Environmental Services Division Administrator Ed Tormey

In January 2023, fire fighters used an aqueous film forming foam (AFFF) containing PFAS to extinguish a fire in Marengo, Iowa. The foam entered the stormwater collection system, resulting in an estimated twelve million gallons of PFAS-contaminated stormwater being held in a basin.

The PFAS concentrations were determined to be above levels appropriate for discharge into the Iowa River that serves as a drinking water source for many downstream communities, including Iowa City. Iowa DNR contacted EPA ORD to request help identifying options for treating the contaminated water. ORD staff met with colleagues from Iowa DNR to discuss the appropriate technologies. ORD researchers then ran models to estimate the effectiveness of the technologies, the optimal flow rates needed, and the length of time it would take to treat the total volume of water. This led to discussions on how those technologies would be implemented in the field. ORD contacted technology vendors and had meetings with Iowa DNR and the vendors discussing treatment options and remediation costs.

Ultimately, Iowa DNR chose a vendor, and a granular activated carbon (GAC) treatment system was installed. By that time, due to additional rain and wastewater treatment plant discharge, the total volume of water to be treated was approximately 13 million gallons. The stormwater retention basin was sealed off and the successful treatment of the water was completed before the rainy season, with no PFAS being detected in the water discharged to the Iowa River. This was the first time in Iowa DNR history that a large-scale, portable package plant was utilized to treat PFAS-contaminated water.

Partner: North Carolina Department of Environment Quality (NC DEQ)
Challenge: GenX PFAS contamination in the Cape Fear River
Resource: Technical assistance for a one-mile-long soil cement barrier wall and associated seepage control structures
Project Period: 2022 – Present

"EPA ORD scientists provided valuable technical support to NC DEQ in our oversight of the facility's remediation measures to reduce the levels of GenX and other PFAS reaching the Cape Fear River. The support during the design, installation and testing have helped ensure that the barrier wall and treatment system address a significant source of PFAS exposure for communities along the Cape Fear River." – NC DEQ Secretary Elizabeth S. Biser

In 2017, the Cape Fear River, a public water source for Wilmington, North Carolina, was found to contain levels of concern for GenX compound of per- and polyfluoroalkyl substances (PFAS). State investigations determined that the unpermitted discharge of these hazardous chemicals into the Cape Fear River had come from the Chemours facility, a PFAS production site located near Fayetteville, NC.

In late 2022, EPA researchers, in collaboration with colleagues from EPA Region 4 (Southeast), began to assist the North Carolina Department of Environmental Quality (NC DEQ) in the remediation of GenX and other compounds from the Chemours chemical production facility that borders the Cape Fear River. EPA researchers provided technical support in reviewing the planning and construction of a one-mile-long underground soil cement barrier wall with associated seepage control structures, combined with a groundwater extraction and granulated activated carbon treatment system at the Chemours production site. These remediation components are designed to significantly reduce the PFAS levels going into the river through the containment and treatment of contaminated groundwater. NC DEQ also issued an NPDES permit for the groundwater treatment system. The permit contains technology-based effluent limitations that require the removal of greater than 99.9% of GenX and other PFAS compounds.

Agency scientists and the Region 4 team travelled to the site in April 2023 to meet with NC DEQ and observe the barrier wall installation and quality control testing. The completed barrier wall, seepage controls, and groundwater extraction system is designed to reduce the PFAS levels present in the Cape Fear Basin and protect the public drinking water that it supplies.

Partner: North Carolina Department of Environmental Quality, Cape Fear Public Utility Authority
Challenge: Removing PFAS from community drinking water with granular activated carbon
Project Period: 2017 – 2021

"EPA research has been extremely helpful to us in planning the startup operation of our GAC facility to reduce influent PFAS levels and meet various treatment goals. The Cape Fear Public Utility Authority (CFPUA) appreciates our partnership with EPA ORD in Cincinnati on the modeling of the GAC performance…it was very beneficial for our project and in communicating how our GAC facility will perform relative to EPA's proposed drinking water health advisories for PFAS." – CFPUA Deputy Executive Director Carel Vandermeyden

The Cape Fear Public Utility Authority (CFPUA) reached out to EPA ORD for help with plans to reduce PFAS from the community drinking water system, particularly with technical support for modeling pilot scale data. The partnership kicked off with a preliminary meeting held in Wilmington, NC with EPA Region 4 and the North Carolina Department of Environmental Quality. Since then, the partnership has led to a series of collaborative projects over several years. During this time, ORD researchers used data from two different long-term granular activated carbon (GAC) piloting exercises over multiple seasons. The pilot-scale data were fitted for 16 PFAS species and five commercial activated carbons using an EPA open-source pore and surface diffusion model that includes an automated parameter-fitting tool.

EPA's GAC model was then used to predict treatment effectiveness for different scenarios of interest to the utility. These included: how a particular full-scale design could handle fluctuating PFAS concentrations; how increased water demand or potential changes in prescribed treatment goals would affect treatment; and how different pretreatments or GAC choices might impact treatment effectiveness. The modeling also evaluated the optimal number of GAC contactors and their sizes. For all these analyses, uncertainty analyses were completed. Ultimately, what was learned supported the utility's decision to choose activated carbon and led to affordable, timely design and operational decisions that helped address the challenge of removing PFAS from the community drinking water system.

Partner: Alaska Department of Environmental Conservation (ADEC)
Challenge: Contaminated site due to PFAS issues at Joint Base Elmendorf-Richardson
Resource: Technical support for site contamination in collaboration with the U.S. Air Force
Project Period: 2016 – Present

"EPA's collaboration with the ADEC and the Air Force on PFAS sampling and analytical methods is key to ensuring valid, defensible data are collected on these emerging contaminants that are being found in soil, groundwater and drinking water in Alaska and elsewhere across the country. Extremely low concentrations, in the parts per trillion levels, in drinking water may pose unacceptable health risks, thus, rigorous sampling and analytical methods are critical in ensuring people have clean drinking water." – ADEC former Commissioner Larry Hartig

With increased concern about the risk of per- and poly-fluorinated alkyl substances (PFAS) in drinking water, it is important to identify the source(s) of the contamination and manage/remediate the risk. To date, PFAS contamination has been observed at landfills, primary and secondary PFAS-related manufacturing sites, wastewater treatment plants, and emergency response and training sites where aqueous film forming foams (AFFF) were used for firefighting. The U.S. Department of Defense has identified hundreds of sites with potential AFFF contamination.

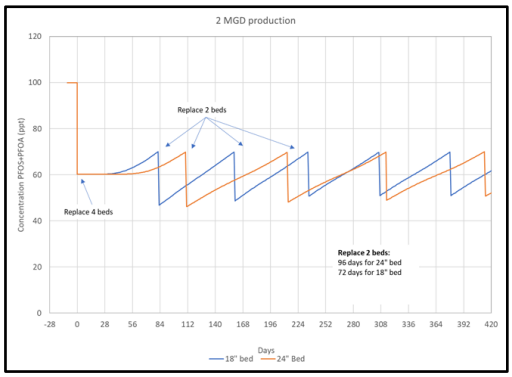
EPA ORD, in coordination with Region 10 (Pacific Northwest) and Region 5, is providing technical support for PFAS site characterization at Joint Base Elmendorf Richardson (JBER) in Anchorage. ORD previously provided a review of an Air Force work plan to collect groundwater and soil samples at JBER for PFAS analysis. ORD scientists observed the collection of groundwater samples by an Air Force contractor, visited locations where samples have been collected, and collected wastewater and creek samples. Region 5 scientists analyzed splits of some samples to evaluate the American Society for Testing and Materials (ASTM) analytical PFAS methods (ASTM 7968-14 and ASTM 7979-15, a preliminary version of SW-846 Method 8327). This sampling effort provided an opportunity to apply the ASTM methods to additional environmental matrices. In addition to the common PFAS analytes, samples were analyzed for PFAS precursors and transformation products. The analytical methods produced accurate and precise data for most analytes. Many groundwater locations contained PFOA and PFOS as well as other PFAS. The resulting data from EPA can be used to decide further site characterization priorities.

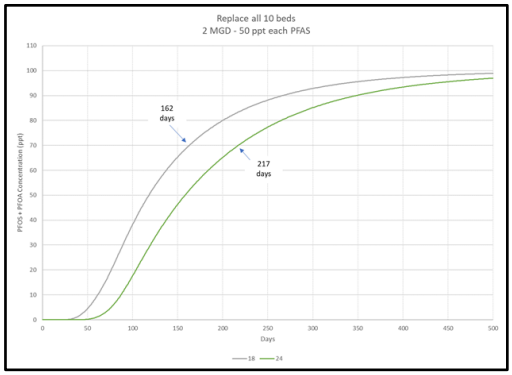
More information can be found on the Elmendorf Air Force Base and Fort Richardson Superfund site profiles.

Partner: Georgia Department of Natural Resources
Challenge: Understand effectiveness of granular activated carbon (GAC) for removing PFAS from a community drinking water system
Resource: Modeling and evaluating various design/operation configurations and lead/lag operations evaluations for GAC removal of PFAS
Project Period: 2020

"Georgia shout out to [EPA ORD] – the modeling analysis was very useful in helping Summerville develop their path forward!"
– Georgia DNR Watershed Compliance Program Manager Lewis Hays

The Georgia Department of Natural Resources and EPA Region 4 (Southeast) contacted EPA ORD seeking assistance on behalf of a Georgia community assessing the effectiveness of using granular activated carbon (GAC) for removing per- and polyfluoroalkyl substances (PFAS) from their drinking water. The community had sand filters that had been in service for years, and they were interested in replacing some or all of the sand with GAC to address PFAS removal.





In February 2020, ORD researchers modeled different local conditions to inform the choices the community was exploring. During these initial discussions, the objective was to understand how effective adding GAC to the current drinking water system would be for maintaining safe PFAS levels (EPA health advisory of PFOS + PFOA below 70 ng/ L) under the system's current production rates. This would then inform them as to whether they ultimately had to build a more robust system specifically set up for PFAS removal.

ORD provided actionable model results and consulted with their project partners from EPA Region 4 and the state on other technologies the utility could consider. The results of the modeling showed that GAC would likely provide PFAS removal at current treatment rates and provided some initial estimates for bed replacement intervals. This work highlighted that replacement of carbon in the current system could act as a stopgap measure to provide immediate treatment of PFAS to below the health advisory level, and it warranted an additional evaluation. Based on this work, the utility set up a confirmatory GAC test for evaluation.

Partner: Michigan Department of Environment, Great Lakes and Energy (EGLE)
Challenge: Understanding sources of PFAS from electroplating facilities
Resource: Sampling and analysis (both targeted and non-targeted) of PFAS in fume suppressants at electroplating facilities
Project Period: 2018 – 2020

"EGLE is grateful for the assistance provided by EPA Region 5 and ORD in investigating sources of PFOS. Their analysis demonstrated to chrome platers that the PFOS in their wastewater was not related to the PFAS in the fume suppressants that they currently use. Instead, the PFOS is likely the legacy from the previous generation of fume suppressants. This kind of information is invaluable to industries trying to reduce PFOS in their effluent to protect surface waters from these persistent pollutants." –Michigan PFAS Action Response Team (MPART) Executive Director Steve Sliver (retired)

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that include PFOA, PFOS, GenX and many other chemicals. There is evidence that exposure to PFAS can lead to adverse human health effects. Fume suppressants are commonly used by metal coating facilities to control air emissions and reduce worker exposure to hexavalent chromium, a known human carcinogen and inhalation hazard. While EPA required chrome platers to stop using PFOS-containing fume suppressants in chrome plating tanks in September 2015, some facilities that had stopped using PFOS-containing fume suppressants years ago were still discharging high concentrations of PFOS to sanitary sewers. These discharges caused municipal wastewater treatment plants to exceed state water quality standards. Exceedances continued even after extensive cleaning and disposal efforts. Industries and regulators were concerned that "PFOS-free" replacement products might still contain PFOS. To answer these questions, Michigan EGLE asked EPA ORD to conduct laboratory analysis of fume suppressant products and effluent from 11 Michigan chrome plating facilities to investigate PFAS.

EPA scientists used targeted and non-targeted analysis laboratory methods to identify and measure concentrations of PFAS in 12 fume suppressant samples and 11 effluent samples (collected prior to treatment for PFAS) from the chrome plating facilities. None of the currently used fume suppressants were found to contain detectable amounts of PFOS. In addition, none of the replacement products were found to contain PFOS precursors, which are specific PFAS that could break down into PFOS. In the targeted analysis, only one PFAS compound, 6:2 fluorotelomer sulfonates (FTS) was found in the currently used fume suppressants. Current discharges of PFOS are, therefore, assumed to be associated with historical use of PFOS-containing products.

EGLE used the information by provided by ORD to publish a report and conduct a successful webinar targeted toward the metal finishing industry to provide better understanding of sources of PFOS and how to reduce the amount of this pollutant released into the environment. EGLE has also shared this information with other state agencies as they work to address PFOS levels in their water systems.

Partner: New Jersey Department of Environmental Protection (DEP)
Challenge: Determining the scope of PFAS contamination
Resource: Water, soil and sediment analyses
Project Period: 2015 – Present

"EPA ORD's studies have provided critical information needed to develop PFAS human health risk assessments. In particular, we appreciate your foresight in initiating studies of PFNA several years before it was widely recognized as a potential concern. Also, we especially thank you for your ongoing willingness to share your knowledge of PFCs (perfluorinated compounds) in general, to answer all of our questions about your studies, and to continue working with us on identifying PFAS sources." – New Jersey DEP Research and Environmental Health, Division of Science, Gloria B. Post, PhD, DABT

A concern of New Jersey DEP is the ongoing presence of poly- and perfluoroalkyl substances (PFAS) in the drinking water resources of southwestern New Jersey. New Jersey DEP reached out to EPA ORD when they were faced with relatively high contaminant levels of a specific PFAS (perfluorononanoic acid, PFNA). New Jersey DEP continues to study the potential routes PFAS might be following in finding its way into these water resources. The chief questions are where the contamination is originating and whether it is getting into the water through direct discharge or through the air. The goals of this study are to confirm that PFAS contamination is occurring, establish specific PFAS source signatures, and evaluate the potential for impacts due to air deposition.

EPA ORD has provided nine data reports to NJ DEP since February 2019 identifying and quantifying PFAS in samples collected from various environmental media within the sampling area, including soils, vegetation, surface waters and groundwater wells. ORD analysis of results has shown promising methods for identifying source signatures and evaluating the effects of air deposition. For example, analysis of water and soil has found unique signatures of some manufactured PFAS and that by looking at the ratios of different PFAS, it is possible to identify a source signature that helps determine the contaminant's origin. Findings of the source identification project were published in the journal Science by EPA and NJDEP authors in June 2020. Results from a study on the effectiveness of point-of-entry granular activated carbon treatment for local residents was also published, in ES&T Letters.

New Jersey DEP has requested that ORD continue to work with them to analyze water, sediment, and soil samples for PFAS and their byproducts. NJDEP has recently conducted sampling at a manufacturing facility within the study area to continue investigations of the source of various PFAS. ORD will collaborate with New Jersey DEP to evaluate the data.

Partners: NC Department of Environmental Quality (DEQ), Cape Fear Public Utility Authority, Town of Pittsboro, Fayetteville, NC State Highway and Public Works Commission
Challenge: Mapping PFAS levels across an entire river basin
Resource: Methods development and laboratory analyses
Project Period: 2015 – Present

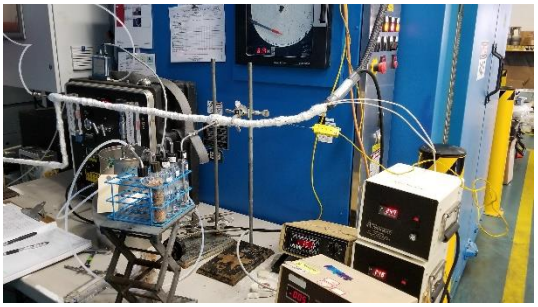
"We are extremely grateful for EPA ORD's work as we analyze these chemical compounds. EPA's analyses will be crucial to our efforts in protecting public health and the environment as we learn more about these emerging substances." – NC DEQ former Assistant Secretary Sheila Holman

Because of concerns about long-chain per- and polyfluoroalkyl substances (PFAS), which persist in the environment, their use began being phased out in 2006. In 2007, EPA ORD began a first-ever effort in the U.S. to map PFAS levels in an entire watershed, focusing on North Carolina's Cape Fear River Basin. This mapping effort demonstrated that there were multiple sources of many different PFAS throughout the basin, suggesting that since the basin is a major drinking water resource, it could potentially be responsible for human exposures to PFAS throughout the entire region. As part of this effort, EPA ORD also developed research-based methods to measure PFAS in drinking water and detect novel PFAS using high resolution mass spectrometry non-targeted analysis approaches.

EPA ORD's PFAS research in the Cape Fear Basin has continued to evolve. Having largely addressed PFAS wastewater discharge to the Cape Fear River, attention has turned toward air emissions, fate, transport, deposition, and resulting land and surface water contamination down wind of the Chemours plant. EPA ORD is working with Region 4 and NC DEQ to test and deploy air sampling methods including the application of non-targeted analysis to comprehensively characterize air emissions. NC DEQ is also sampling and making available rainwater for testing. This work is being done cooperatively with Chemours to evaluate air emissions control technology that they are considering. These efforts are expected to provide solutions for reducing exposures to these potentially hazardous chemicals.

Access EPA publications related to PFAS research in North Carolina.

Partner: New York State Department of Environmental Conservation (NYSDEC)
Challenge: Understanding VOC and air emissions from PTFE product manufacturing facilities
Resource: Sampling and analysis (both targeted and non-targeted) of air emissions from PTFE manufacturing facilities
Project Period: 2018 – 2020



"As PFAS are a significant concern, better understanding air emissions at a facility that uses PFAS to manufacture products is very helpful. Knowing what chemicals are emitted will help NYSDEC characterize PFAS emissions and determine the need for the installation of air pollution controls. Our collaborative work with EPA on this project was invaluable. " – NYSDEC Research Scientist Tom Gentile

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that include, among others, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), and GenX. There is evidence that exposure to PFAS can lead to adverse human health effects. PFOA is a PFAS that was widely used as a processing aid to manufacture nonstick coatings (polytetrafluoroethylene [PTFE]) and other fluoropolymers. PFAS manufacturing facilities may emit PFAS and other volatile organic compounds (VOCs) into the air.

At the request of the New York State Department of Environmental Conservation (NYSDEC), scientists from EPA's Office of Research and Development (ORD) conducted an independent study to qualitatively identify PFAS and PTFE thermal degradation products in air emissions at a manufacturing facility in New York State where bulk PTFE is molded and sintered.

ORD scientists collected air emission samples from the process exhaust at the industrial facility and used targeted and nontargeted laboratory analytical methods to qualitatively analyze the samples for VOCs, PTFE thermal degradation products, and water-soluble PFAS compounds. Investigating the potential presence of PFOA was the primary targeted measurement of interest. PFOA was determined to not be present in any of the process exhaust emissions measurements.

EPA shared a report of its study with NYSDEC. The information was also shared by NYSDEC with local elected officials and the public at a community meeting. The information helped NYSDEC characterize PFAS emissions from a PTFE manufacturing facility that processes raw PTFE powdered resins into final products. The qualitative analysis and other factors were used to assess the need for air pollution controls on this process operation.

Partner: Michigan PFAS Action Response Team (MPART)
Challenge: Limited understanding of technologies for the ultimate disposal of PFAS waste
Resource: Quarterly meetings with MPART members and EPA scientists to share the latest advances in PFAS destruction research and technologies
Project Period: 2020 – 2021

"We are pleased to partner with EPA ORD in identifying and evaluating treatment technologies that break the cycle of PFAS recirculating in the environment. This collaboration is an excellent opportunity to combine ORD's leading-edge technical research with the data being generated from Michigan's ongoing field work to address PFAS contamination and will help guide our collective efforts to identify and test the most effective treatment solutions." – MPART Executive Director Steve Sliver (retired)

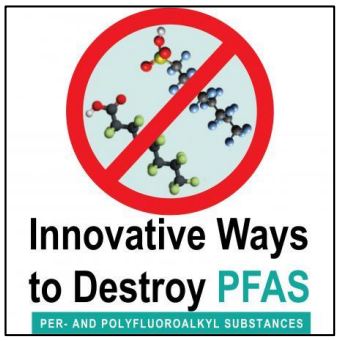
Per- and polyfluoroalkyl substances (PFAS) are a very large class of man-made chemicals that include PFOA, PFOS and GenX chemicals and are found in everyday items such as food packaging, non-stick stain repellent, waterproof products, and firefighting applications. PFAS can enter the environment through production or waste streams and can be very persistent in the environment and the human body. PFAS have many and varied pathways into waste streams, presenting challenges for ultimate disposal. Determining the appropriate method for ultimate disposal of PFAS wastes is a complex issue due to their volatility, solubility, and environmental mobility and persistence. EPA is currently considering multiple disposal techniques, including incineration and novel non-thermal ways, to effectively treat and dispose of PFAS waste.

From 2020 – 2021, EPA ORD and the Michigan PFAS Action Response Team (MPART) held regular meetings for MPART members and EPA ORD scientists to share the latest advances in PFAS destruction research and technologies. These calls helped align EPA's research programs with state needs related to PFAS. EPA ORD was pleased to partner with MPART and others on the Innovative Ways to Destroy PFAS Challenge to discover new non-thermal technologies and approaches that can remove PFAS in unused aqueous film forming foam (AFFF), without creating any harmful byproducts.

MPART is an interagency workgroup established in 2019 consisting of members from Michigan's Department of Environment, Great Lakes and Energy; Department of Health and Human Services; Department of Agriculture and Rural Development; Department of Natural Resources; Department of Transportation; Department of Licensing and Regulatory Affairs; and Department of Military and Veterans Affairs.

Learn more about EPA's research on PFAS.

Partners: Environmental Council of States (ECOS) and its research arm, the Environmental Research Institute of the States (ERIS)**;** Michigan Department of Environment, Great Lakes & Energy (EGLE); Colorado Department of Public Health & Environment (CDPHE)
Challenge: Discover novel non-thermal way(s) of destroying PFAS in concentrated firefighting foam
Resource: Crowdsourcing innovative solutions through the challenge.gov platform, in collaboration with U.S. Department of Defense's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP)
Project Period: 2020 – 2021



"The collective creativity and ingenuity of participants from diverse backgrounds is what makes challenges like this so successful. We hope rewarding the creators of these innovative concepts helps to make these technologies a reality so that federal, state, tribal, and local partners can safely destroy PFAS in firefighting foams." – Pennsylvania Department of Environmental Protection Patrick McDonnell (former Secretary and ECOS President)

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and to help make products stain-resistant, waterproof, and nonstick. Addressing and managing PFAS in the environment is one of the most pressing issues facing EPA, states, tribes and regions.

PFAS compounds are difficult to destroy because their unique chemical characteristics rely on very strong chemical bonds. EPA is investigating all methods of destroying PFAS. Incineration has been used to treat PFAS-contaminated media, and EPA scientists collaborated with the private sector to evaluate the effectiveness of thermal treatment technologies to completely destroy PFAS. EPA partnered with the U.S. Department of Defense, ECOS/ERIS, Michigan EGLE, and CDPHE in a challenge to identify a non-thermal way of destroying at least 99 percent of PFAS in concentrated aqueous film forming foam (AFFF), a type of firefighting foam, without creating any harmful byproducts. Although PFAS compounds can be found in various waste streams, the challenge was focused on unused AFFF.

The Innovative Ways to Destroy PFAS Challenge was launched in August 2020 and accepted applicants until November 2020. The Judging Panel, composed of EPA scientists, engineers and other technical experts, including subject matter experts from the partners for this Challenge, evaluated the submissions and announced winners in late spring 2021. The agency awarded $40K to the first-place winner and $10K to each of the second-place winners.

Learn more about EPA's research on PFAS.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Need for improved understanding of the current science regarding PFAS
Resource: Technical resources including fact sheets, a web-based technical and regulatory guidance document, and online training materials
Project Period: 2017 – Present

"As ITRC PFAS Team members, EPA staff continue to contribute valuable input and guidance to support the Team mission of developing materials that can be used by decision makers to address environmental challenges associated with PFAS contamination." – New Jersey DEP Sandra Goodrow and Vermont DEC Kristi Herzer (ITRC PFAS Team Leads)

Per- and polyfluoroalkyl substances (PFAS) are a large and complex class of anthropogenic compounds whose prevalence in the environment are an emerging, worldwide priority in environmental and human health. Some PFAS are environmentally persistent and bioaccumulative and may pose human health risks. There is a growing need for regulators, project managers, and other stakeholders to improve their understanding of the current science regarding PFAS.

The ITRC PFAS Team, formed in 2017, has prepared readily accessible materials to present PFAS information to stakeholders, regulators, and policy makers. The PFAS team represents a diverse cross-section of expertise and experience working on PFAS. In 2023, the team membership includes more than 50 active state, city and local representatives. State participation, including interested parties, comes from 44 states and the District of Columbia. The team membership also includes representatives from the federal government, academia, public and tribal stakeholders, consulting, industry, and international governments. EPA scientists participate on the team, providing their technical expertise, collaborating through discussions and meetings, and by providing written comments on draft ITRC PFAS materials. EPA has shared knowledge of emerging issues and research in a variety of topic areas, which is incorporated into many document sections: sampling and analysis; site characterization, fate and transport; occurrence in the environment; chemistry and naming conventions; physical and chemical properties; history and use; aqueous film-forming foam (AFFF); treatment; toxicity and risk assessment; and regulations and guidance. These materials can be used to foster development of a broad technical understanding necessary for informed and expedited decisions to address PFAS impacts to human health and the environment. The ITRC PFAS technical resource materials include:

- A series of fact sheets that synthesize key information for core subjects including fate and transport, sampling precautions, analytical methods and more. The newest fact sheet (published October 2022) includes information about Biosolids. Updated fact sheets are planned for September 2023. Eleven fact sheets have been posted in Spanish and five in Portuguese.
- A web-based technical and regulatory guidance document first published in 2020 presents a wide range of technical topics for PFAS, provides references to scientific literature and state and federal documents, and includes stakeholder points of view, technical challenges and uncertainties, and risk communication strategies. The document was updated in 2021, 2022, 2023, and small edits incorporated in August 2024.
- External Data Tables that compile key information on focused topics, including the PFAS Water and Soil Regulatory and Guidance Values table, the Aquatic Organism BAF table, and many others.

- Online training materials that convey the information presented in the technical and regulatory guidance document. Additionally, the team provided in-person and online training workshops to approximately 3,000 attendees from 2018 to 2020. In 2020 and 2021, the team launched a new training format and held 4 roundtable webinars on select PFAS topics. During 2022 and 2023 additional workshops and webinars were provided. In April 2023, PFAS team members presented a 90-minute, PFAS 101 webinar on the Clu-In platform an archive of which is available for viewing. In the Spring of 2024, the PFAS team launched a new training series titled PFAS Beyond the Basics, also through Clu-In. This series included five separate webinars on select PFAS topics, intended to expand beyond the curriculum presented in PFAS 101.

Partners: Environmental Council of the States (ECOS), Environmental Research Institute of the States (ERIS), Association of State and Territorial Health Officials (ASTHO) and member states, and Tribes
Challenge: Understand PFAS science & technology challenges in environmental media
Resource: State-Tribal-federal dialogue and presentations on evolving PFAS science
Project Period: 2017 – Present

"State-federal dialogue is critical to better understanding the science surrounding complex and multifaceted issues like PFAS. These calls are an example of the coordination necessary to foster research and technical capabilities." – ERIS Board member David Paylor (former Director of the Virginia Department of Environmental Quality)

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals that have been widely used for more than 60 years to make plastics, firefighting foams, and lubricants, and to help make products stain-resistant, waterproof, and nonstick. Addressing and managing PFAS in the environment is one of the most pressing issues facing EPA, states and regions.

EPA hosts a bimonthly call with the Environmental Council of the States (ECOS, the national association of state environmental agency leaders) and the Association of State and Territorial Health Officials (ASTHO, the national association of state and territorial chief health officials) and interested state and Tribal representatives on PFAS. These calls are an opportunity for EPA scientists and our state partners to share evolving PFAS science. Topics include analytical methods, human health and toxicity, site characterization, exposure, remediation, and treatment work. Both states and EPA present on a wide range of topics. More than 40 states regularly participate on these calls.

EPA ORD has gained a better understanding of the science needed to address real-world PFAS environmental challenges. This has helped us provide innovative and multidisciplinary research to underpin decisions and help develop science-based tools and resources that states and Tribes can use to protect human health and the environment. Joint efforts like our work with ECOS and ASTHO strengthen the alignment of EPA's scientific and technical capabilities with state needs and have better connected EPA and state scientists to help fill knowledge gaps. EPA scientists will continue to collaborate with our state and Tribal partners as PFAS research continues to expand.

For more information, please visit PFAS Resources for States and EPA's PFAS Research website.

Partners: Association of State and Territorial Health Officials (ASTHO), Environmental Council of the States (ECOS), and state environmental or health agencies (CO, IN, MI, MN, MO, NC, NH, NY, OH, OR, PA, UT and VT)
Challenge: Improve risk communication strategies for PFAS and harmful algal blooms
Resource: State-level case studies, tools, materials, and strategies for risk communication
Project Period: 2018 – 2019

"State health and environmental agencies are relied upon by the public to alert impacted communities of risks associated with waterborne contaminants, including PFAS and HABs. The way that these risks are messaged is important in gaining credibility and trust in our governmental partners, so it is important to frame the messages in a unified manner. This project provided a critical opportunity for several states to share how they have developed their health advisories and accompanying media releases, striking a balance between being transparent with known risks but also recognizing potential unknowns associated with the complex contaminant challenges." – ASTHO Health Security Vice President Meredith Allen, DrPH

Per- and polyfluoroalkyl substances (PFAS) and harmful algal blooms (HABs) are priority environmental issues for states. Proper risk communication is needed to inform the public of PFAS- and HABs-related issues without causing panic. There is also the balance of communicating what different health departments, environmental agencies, and water systems can and cannot do to address the issues. EPA partnered with the ASTHO and ECOS on a collaborative to highlight state-level risk communication of these PFAS and HABs, through our Memorandum of Agreement on environmental health.

In early 2018, ASTHO and ECOS interviewed health and environmental agency staff from 13 states about their risk communication strategies and lessons learned for either PFAS contamination or HABs. ASTHO and ECOS collected information on how selected states' health and environmental agencies have been addressing PFAS and HABs, including the wording of accompanying risk communication/health advisories and the methods used to communicate them to the public. ASTHO and ECOS compiled the findings to share with other states who are looking to update or create new advisories and supporting risk communication materials for their own jurisdictions.

In 2019, using lessons learned from the previous year's effort, ASTHO and ECOS compiled existing tools, materials, and strategies for PFAS risk communication. Known as the PFAS Risk Communications Hub, the goals were 1) to increase collaboration between state environmental and health managers, 2) increase accessibility of risk communication models for states and communities, and 3) improve public health through awareness of potential risks of contaminants of emerging concern.

- ECOS - Case Studies on State-Level Risk Communication of PFAS and HABs
- ECOS - PFAS Risk Communication Hub
- ASTHO – PFAS Risk Communication Hub

COMMUNITY RESOURCES

Partner: Environmental Council of the States (ECOS), Association of State and Territorial Health Officials (ASTHO), and Association of Fish and Wildlife Agencies (AFWA)
Challenge: Collaborating with state environmental, health, and fish & wildlife agencies to tackle environmental challenges
Resource: Webinars, workshop, Community of Practice
Project Period: 2021 – Present

"The Association of Fish and Wildlife Agencies (AFWA) values and appreciates the partnership with US EPA, the Environmental Council of the States (ECOS), and the Association of State and Territorial Health Officials (ASTHO) to raise awareness, expand collaboration, and support communication on One Health. EPA is serving an important role as a convenor to bring together practitioners across multiple sectors and disciplines to improve human, environmental and animal health." – Former AWFA President and Director of the Oregon Department of Fish and Wildlife Curt Melcher

One Health is a collaborative, multisectoral and trans-disciplinary approach—working at local, regional, national and global levels—to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment. Since 2021, EPA ORD has been collaborating with our state partners at the Association of Fish and Wildlife Agencies (AFWA), the Association of State and Territorial Health Officials (ASTHO), and the Environmental Council of the States (ECOS) to raise awareness of and promote the One Health framework to tackle environmental challenges.

EPA ORD and our state partners hosted two webinars and one workshop in 2021 to promote the One Health approach and to identify potential collaborative project ideas. The webinars served to discuss the importance of the One Health approach and the role of different environmental, health and animal professionals within the One Health framework. View recordings of the webinars here. The goal of the small workshop, held in December 2021, was to further explore One Health topics of interest to states and EPA with practitioners, build and enhance relationships between state environmental, health, and natural resource/fish and wildlife agencies, and identify potential One Health projects to collaborate on at both the state and national levels that will benefit states.

One idea that came out of the workshop was to host a quarterly One Health Community of Practice (CoP). EPA and our state partners kicked off the One Health CoP in 2022. The quarterly CoP has continued and is also open to our Tribal and federal partners. These meetings focus on the environmental pillar of One Health and missions that are relevant to EPA and our partners. EPA and our state partners held joint webinars to highlight all of the above mentioned One Health efforts and more in November 2022 and November 2023.

In 2023, ECOS and ASTHO developed four case studies of state agencies applying the One Health approach to tackle environmental challenges. The case studies include lead in Idaho, harmful algal blooms in New Jersey, fish tissue monitoring in Georgia, and PFAS in Wisconsin. Read the ASTHO One Health case studies. Read the ECOS One Health case studies.

Learn more about One Health at EPA.

Partner: California Energy Commission
Challenge: Population and land use projections to the year 2100 consistent with emissions storylines
Resource: Integrated Climate and Land Use Scenarios (ICLUS) version 2
Project Period: 2012 – 2019

"It is extraordinarily beneficial to climate planning in California to be able to rely on tools like ICLUS v2 to provide a federally-vetted baseline for coordinated climate assessment research." – California Natural Resources Agency, former Special Assistant for Climate Change JR De la Rosa

EPA ORD researchers developed national population, land use and impervious surface projections that the state of California used in its Third Climate Change Assessment. For the fourth assessment, the state used EPA's updated climate model, the Integrated Climate and Land Use Scenarios version 2 (ICLUS v2), as a basis for land use scenarios in California, with minor modifications as necessary. These scenarios were used across multi-disciplinary and multi- sectoral research that informs the Fourth Assessment.

ICLUS v2 uses the latest census, land use and land cover datasets to model population growth, residential housing changes, and commercial and industrial development nationally to the year 2100. Projections use information on fertility, mortality and international immigration rates that are consistent with global storylines (e.g., Shared Socioeconomic Pathways) used in climate change impacts, vulnerability and adaptation assessments. In addition, ICLUS v2 projections use information on domestic migration, including how future climate may make certain places more desirable. Combined with the addition of commercial and industrial land uses, the updated projections from ICLUS v2 helped the state of California better assess potential future impacts from climate change and prepare adaptation and mitigation responses.

Partners: Florida Department of Health (FDOH), University of Florida
Challenge: Effectively communicating technical guidance for safely remediating flooded homes
Resource: Risk communication tools to promote community resilience after flooding events, in collaboration with the Centers for Disease Control and Prevention (CDC), Agency for Toxic Substances and Disease Registry (ATSDR), Federal Emergency Management Agency (FEMA), U.S. Department of Housing and Urban Development (HUD), U.S. Office of Personnel Management (OPM), Louisiana State University, and the University of Missouri
Project Period: 2019 – Present

"Environmental health hazards such as mold, lead, asbestos and carbon monoxide associated with flooded homes present a unique and challenging problem for homeowners and renters in Florida and elsewhere. We believe this collaborative project will help folks to understand how to safely reduce risks to their health while restoring their homes and lives." – Florida DOH Bureau of Environmental Health Chief and State Toxicologist Kendra Goff, PhD, DABT, CPM, CEHP

Florida residents face health risks from flooding, including indoor air quality hazards in flooded homes. Every year, the Florida Department of Health (FDOH) and the University of Florida Institute of Food and Agricultural Sciences (UF IFAS) provide technical guidance on ways to safely clean up a flooded home. The existing resources are not widely utilized and can be challenging to understand. To better inform the public about risks—and actions they can take to reduce them—EPA is partnering with Florida DOH, UF IFAS, other federal agencies (CDC, ATSDR, FEMA, and HUD) and experts from Louisiana State University and the University of Missouri. Together, they are developing a strategically designed website that includes how-to videos, infographics, and other materials designed to inform the types of decisions flood survivors have to make about their homes and the social context in which they make those decisions.

EPA ORD, in collaboration with EPA Region 4 (Southeast), utilized human-centered design and disaster anthropology to create an innovative risk communication strategy to produce materials targeted to people impacted by flooding. To do so, EPA and partners interviewed residents of Florida and other states who had recently experienced flooding due to Hurricanes Dorian, Michael, and Irma. Based on what they learned, the researchers created a website tailored to homeowners, renters and volunteers working to fix up flooded homes.

The publicly available website is available at: www.epa.gov/flooded-homes. This resource will improve the resiliency of communities facing flood and other disasters involving water intrusion in their homes.

Partners: Massachusetts Bays National Estuary Partnership, Pennsylvania Department of Environmental Protection, Puerto Rico Department of Natural and Environmental Resources, Chesapeake Bay Program partners, Mobile Bay National Estuary Program
Challenge: Communicate potential social and economic benefits of ecosystem restoration projects
Resource: Technical support to link biological condition to ecosystem services
Project Period: 2023 – Present

"The Massachusetts Bays National Estuary Partnership has been fortunate to work with researchers in EPA's Office of Research and Development on multiple projects. The broad and deep expertise of the researchers there has enabled us to implement programs we would not have been able to tackle ourselves (like the Biological Condition Gradient). EPA scientists are committed to the practical side of science, helping us to realize improvements in local ecosystems, working alongside local decision makers." – Massachusetts Bays National Estuary Partnership Director Pam DiBona

Natural resource protection and restoration goals are often tied to "ecosystem services," the benefits people get from nature, such as fishing and other forms of subsistence and recreation. Yet the measurable data of these benefits are not often used to plan, implement, and monitor ecological restoration. Instead, the focus is usually on biological structure or ecological function, which fail to adequately communicate their potential social and economic benefits. State and local partners have expressed a priority need for ways to systematically characterize and measure ecosystem services to support their efforts to identify, maintain, and restore high quality natural resources. For example, EPA has been working with the Massachusetts Bays National Estuary Partnership (MassBays) to characterize biological condition of estuarine habitats, and to understand how conditions effect the availability of the ecosystem services these habitats provide, such as flood mitigation, fishing, and recreation. EPA researchers are working with partners to use information on biological condition and ecosystem services to identify and compare the potential benefits of different restoration options .. By having a clearer picture of the benefits of ecological restoration projects, MassBays partners expect growing community support for additional projects around Massachusetts Bay.

Many state and coastal programs use a Biological Condition Gradient (BCG) system—which characterizes conditions from "severely altered" to "natural condition"—to guide restoration targets for coastal and stream ecosystems. EPA researchers are working with partners to develop an ecosystem services analog to the BCG, the Ecosystem Services Gradient (ESG), that describes the potential range of ecosystem services along a gradient of biological condition. The process includes identifying the ecosystem services that are most relevant to stakeholders and the attributes of the biophysical condition that provide such services.

EPA researchers used the BCG/ESG approach with MassBays and their Science and Technical Advisory Committee (STAC) to set long-term habitat restoration targets for seagrass, salt marsh, and tidal flats, as well as to identify indicators of restoration progress that included not just acres of habitat, but measures of habitat quality and benefits. A more recent effort with MassBays and partners at the Massachusetts Division of Marine Fisheries applies both BCG and ecosystem services to set targets for restoration of diadromous fish – charismatic species that appeal to humans. This effort involves estuaries, rivers, spawning ponds and entire watersheds as well as many groups of stakeholders and beneficiaries. This research is being further applied as part of a pilot study in the Saugus River Watershed that will help partners better compare the effectiveness of restoration projects toward achieving beneficial use goals, and to communicate locally relevant benefits of restoration decisions to the public.

Our work with the State of Massachusetts shows how approaches that combine ecological and socioeconomic goals can lead to more effective, public-supported restoration targets that benefit both nature and people.

Partners: Citizen Schools, Duke Energy Initiative, Durham Children's Initiative, Durham Public Schools Science Alliance, NC Science Festival , NC Science Mathematics and Technology Education Center, NC State University Kenan Fellows Program for Teacher Leadership, Project PEACE, Research Triangle Cleantech Cluster Triangle Women in STEM, RTP Foundation, WakeEd Partnership
Challenge: Preparing the future environmental health workforce by providing STEM (science, technology, engineering and math) education, especially in K-12 schools with low-income populations
Resource: EPA's Community Engagement & STEM Education Program in Research Triangle Park (RTP), NC
Project Period: 2003 – Present

"EPA's Community Engagement and STEM Education Program in RTP has not only has been a source of ideas for our own outreach program improvement but also serves as a model STEM outreach organization in the region, because of its impactful work in schools, museums, and on-site for students of all ages through speed mentoring, job shadowing, and hands-on STEM activities."
– The Research Triangle Foundation, STEM in the Park Outreach Program Manager Sarah Council Windsor

EPA's Community Engagement & STEM Education Program (CE-STEM) communicates EPA science to K-12 and university students, to educators and to the public. CE-STEM outreach at schools, community events, and at EPA-RTP increases the public's knowledge of how protecting the environment protects human health. Most CE-STEM programming serves students at low-income schools (i.e., 50%+ free/reduced lunch) to help close the opportunity gap and build capacity for a more diverse workforce. CE-STEM also provides training and guidance to EPA regional offices and labs, as well as to U.S. embassies. CE-STEM was initiated in 2003 and typically reaches more than 25,000 people at 350 plus events, mostly in central NC, through the participation of more than 200 EPA-RTP employees. In March 2020, CE-STEM pivoted to providing programming via online platforms which expanding our geographic reach.

CE-STEM engages the public in protecting human health and the environment by:

- Establishing relationships with educators and local, regional, state, national and international stakeholders;
- Translating EPA science into hands-on activities and lessons for employees to use in the community;
- Recruiting and training EPA employees to educate K-12 students, college/university students and the public at school, community events and at EPA-RTP; and
- Building capacity for an educated, informed, diverse and inclusive pipeline of future EPA employees and environmental decision makers.

CE-STEM was awarded two US2020 STEM mentoring awards in 2017 – one for Excellence in Volunteer Experience, and a second for Volunteer Mobilization. The Excellence in Volunteer Experience Award recognizes STEM programs that provide high-quality, well-supported STEM activities for their volunteers, while the Volunteer Mobilization Award honors organizations that effectively engage their workforce to support youth-serving organizations. In 2019, the Research Triangle Cleantech Cluster recognized CE-STEM with the Diversity Initiative of the Year at their Cleantech Innovation Awards. In 2020, the program received the Research Triangle Cleantech Cluster Talent Initiative of the Year Award, as well as STEM RTP's Community Serving Organization of the Year Award.

Partner: Environmental Council of the States (ECOS), E-Enterprise Leadership Council (EELC), Association of Public Health Laboratories (APHL)
Challenge: Effectively using participatory science data in environmental decisions
Resource: Methods for using community and citizen science in EPA, state and Tribal environmental programs
Project Period: 2019 – Present

"State agencies appreciate working with EPA ORD on these community and citizen science case studies to increase effectiveness in gathering reliable air and water data to fill information gaps, monitor environmental changes, and assist in understanding conditions in underserved areas." – ECOS Executive Director Ben Grumbles (former Secretary of the Maryland Department of the Environment)

Participatory science is the involvement of the public in the scientific process, often in collaboration with professional scientists and institutions. It uses the collective strength of communities and the public to identify research questions, collect and analyze data, interpret results, make new discoveries, and develop technologies and applications to understand and solve problems. Often referred to as citizen or community science, EPA transitioned to the term "participatory science" in June 2022 to represent the most inclusive and accessible involvement of the public in the scientific process, especially for those who have been historically underrepresented in the field.

In October 2020, the Environmental Law Institute (ELI) released a report, supported by EPA, that highlights ways that participatory science is being adopted by state and Tribal environmental programs. The report includes case studies, best practices, and recommendations for EPA.

In 2021, EPA and Tribal members of the EELC prepared a Tribal participatory science paper that contains eight case studies, an overview of lessons learned, and recommendations for how EPA and other organizations can better support Tribal participatory science.

Also in 2021, EPA continued analysis and support of Tribal participatory science, and outreach and training opportunities with APHL and ELI with the announcement of EPA's Quality Assurance Handbook and Toolkit for Participatory Science. The Toolkit includes fact sheets, infographics, and on-line training video modules. A plain language orientation guide was developed to explain how to design participatory science projects so data collected can contribute to environmental decisions, including information on potential roles for state, Tribal, and local agencies to provide technical support and advice.

EPA held an interactive, multi-stakeholder workshop in 2021, co-sponsored with EELC, on improving data management for participatory science projects. An invited group of state, Tribal and EPA staff, as well as academic and NGO experts, discussed data management actions that support increased use of participatory science data in decision-making.

In June 2022, EPA issued the vision for participatory science. It describes EPA's vision for the strategic use of participatory science approaches in EPA's work. It will help guide EPA in the use of participatory science to increase the types and amount of data brought forth to inform scientific research, to enhance public engagement and

understanding, and to take actions to investigate and mitigate environmental problems.
In March 2023, EPA issued the Participatory Science Policy Guidelines and Checklist to help EPA staff and managers understand key requirements and design considerations for participatory science projects carried out by EPA. This document identifies existing policies that may be relevant to participatory science activities within EPA, including topics such as working with communities, citizen science statutory authorities, information quality guidelines, formal agreements, and many other legal and administrative requirements.

Also in 2023, in collaboration with the EELC, EPA hosted a "learn and share" meeting with states and Tribes to explore approaches to integrating and using data generated by volunteer scientists. During this exploratory meeting, attendees listened to four state case studies that examined how water and air data are used and then engaged in a discussion about best practices and lessons learned.

This year, EPA is working with the EELC to develop a strategy to improve the management and use of participatory science at EPA.

For more information visit:

- EPA's Participatory Science website
- StoryMap featuring examples of how EPA uses participatory science
- E-Enterprise webinar: Improving the Management and Use of Community Science Data

Partners: Environmental Council of the States (ECOS), Association of State and Territorial Health Officials (ASTHO)
Challenge: Protecting the public's health from environmental threats and hazards and advancing health and environmental equity for all
Resource: Tools, reports, workshops, and risk communication resources
Project Period: 2016 – Present

"ECOS values the relationships that we have built over the past [several] years with ASTHO and EPA as we have worked to address issues such as PFAS, lead, COVID-19, and wildfire smoke. With this amendment, we look forward to another five years of working towards our shared interests in advancing environmental and health equity for all citizens." – Pennsylvania Department of Environmental Protection Patrick McDonnell (former Secretary and past ECOS President)

"ASTHO is pleased to continue this important partnership, recognizing that our nation's environmental policies have a direct impact on public health and equity. The collaboration supports ASTHO's challenge to build healthy and resilient communities through a multiyear, national effort to promote community-led, place-based, cross-sector approaches to achieve better health. Working closely with our state and federal environmental allies is paramount to helping meet this challenge." – ASTHO Health Security Vice President Meredith Allen, DrPH

EPA entered into a formal Memorandum of Agreement (MOA) with ECOS (the national association of state environmental agency leaders) and ASTHO (the national association of state and territorial chief health officials) in 2016. The purpose of the MOA is to advance our shared mission to protect the public's health from environmental threats and hazards and to advance health and environmental equity for all. At the ECOS Spring Meeting in March 2021, EPA Administrator Michael Regan reaffirmed the agency's commitment to working collaboratively and cooperatively with the states to protect public health and the environment. He announced the extension of this MOA in his keynote address, reaffirming a partnership between EPA, ECOS and ASTHO to advance cooperative initiatives in pursuit of environmental health.

Under the MOA, EPA works with the coalitions to help develop tools, reports, workshops, meeting communications and other initiatives that will help protect public health from environmental threats.

During the past eight years, the MOA has served as a catalyst for EPA to work directly with environmental health experts in the states to identify emerging environmental health challenges, strategically design projects aimed directly at those challenges, and deliver the tools, models, and other research results that EPA and states need to reduce risks and improve public health. Example projects have targeted a wide range of environmental health challenges, including COVID-19, PFAS, harmful algal blooms (HABs), wildfire smoke, resiliency and complex disasters, and One Health.

See the below links to read the MOA and for more details on completed projects:

- EPA-ECOS-ASTHO Memorandum of Agreement (Amendment 1)
- Collaborative Projects with State Environmental Health Experts
- EPA-ECOS-ASTHO Annual Accomplishment Reports

COVID-19

Partner: University of North Carolina (UNC) Medical Center
Challenge: Urgent shortage of respirators caused by the emerging COVID-19 pandemic
Resource: Performance evaluation of sub-optimal and alternative respirators
Project Period: 2020 – 2022

"A true silver lining of the COVID pandemic is that it has created opportunities for scientists across different disciplines and backgrounds to work together to answer meaningful and practical questions with excellent science. Aerosol scientists from the US EPA and UNC Center for Environmental Medicine, Asthma, and Lung Biology worked closely with epidemiologists from UNC Hospitals to characterize the efficacy of face masks for reducing exposure to COVID-19. The EPA scientists were able to pivot quickly to address the needs of the Hospital because of the standing infrastructure and complementary expertise supported by the EPA-UNC Cooperative Agreement." – UNC-Chapel Hill Professor of Medicine William Bennett, PhD

"These kinds of studies exemplify the importance of the working relationship between academia and applied public health. This study will shed light on what has been one of the most challenging and disheartening aspects of the COVID pandemic. Comparative effectiveness of face coverings is an essential issue for our health care professionals and for the general public. And it is important to be clear that not everyone needs the same level of protection." – ASTHO Chief Medical Officer Marcus Plescia, MD MPH

In March 2020, UNC Hospital staff faced an urgent, acute shortage of disposable N95 respirators caused by a nationwide supply shortage coupled with a sharp increase in demand, the result of the emerging COVID 19 pandemic in the U.S. A broad variety of face coverings have been adopted, ranging from improvised and homemade designs to mass-produced disposable or reusable masks. However, little guidance or information exists on the comparative effectiveness of these face coverings.

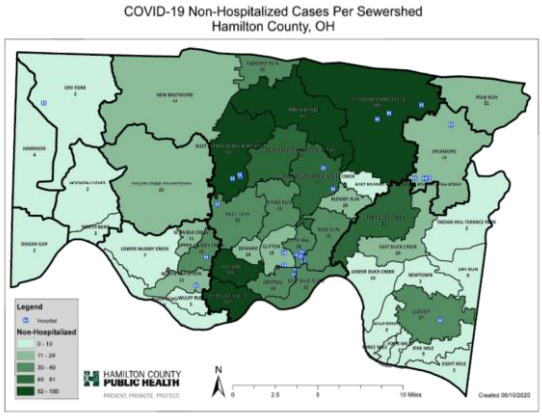
In response, hospital staff approached EPA researchers for assistance evaluating the performance of respirators that had been sterilized, were past their expiration date or mis-sized, as well as respirator alternatives from around the globe. In a series of studies, EPA ORD researchers evaluated nearly 30 different types of face coverings, as well as how their effectiveness was impacted by actions such as talking and bending, double masking, and by user characteristics such as facial hair.

This information can guide public health professionals in prioritizing the supply of available personal protective equipment during emergencies and will advance the understanding of factors and practices that influence the effectiveness of face coverings.

Related Publications:

- Filtration Efficiency of Hospital Face Mask Alternatives Available for Use During the COVID-19 Pandemic
- Evaluation of Cloth Masks and Modified Procedure Masks as Personal Protective Equipment for the Public During the COVID-19 Pandemic
- A novel method for the quantitative assessment of the fitted containment efficiency of face coverings
- Can disposable masks be worn more than once?
- Improvement in Fitted Filtration Efficiency of N95 Respirators with Escalating Instruction of the Wearer
- Research Letter: Fitted Filtration Efficiency of Double Masking During the COVID-19 Pandemic
- Assessing the effect of beard hair lengths on face masks used as personal protective equipment during the COVID-19 pandemic

Partners: Ohio Department of Health (DOH); Ohio EPA; Ohio Water Resources Center; Cincinnati Municipal Sewer District (MSD); Pickaway Correctional Institute (Orient, OH); Hamilton County Public Health; Cities of Batavia, Dayton, Hamilton, Marion, Portsmouth, and Springfield (OH)
Challenge: Understanding community infection rate of SARS-CoV-2
Resource: Monitoring levels of SARS-CoV-2 in sewage to assess community infection rate
Project Period: 2020 – 2022



"Our partnership with the US EPA has allowed us to broadly implement the innovative approach of collecting data from wastewater samples to prevent spread of COVID-19 across our state. Through this strong collaboration, we have been able to gain knowledge about the way the disease spreads, alert our communities about trends that could indicate cases are on the increase, help focus and prioritize testing and contact tracing resources, and serve as a model for other states." – Ohio Department of Health, Bureau of Environmental Health and Radiation Protection Assistant Chief Rebecca Fugitt

EPA researchers partnered with the state of Ohio on a project to better understand how sewer monitoring data can help them develop and evaluate a model on community infection rates for the presence of SARS-CoV-2 (the virus that causes COVID-19). In collaboration with Cincinnati MSD and Hamilton County Public Health, EPA researchers identified areas of high community infection rates and collected corresponding samples within the sewer network. These sub-sewersheds corresponded to the Hamilton County zip codes where there were noted increases in new cases of COVID-19. EPA researchers worked with the Hamilton County Public Health to compile known COVID-19 cases by sewersheds to identify monitoring sites and assist with relating the sewer signal to known infection rates in the community.

The initial pilot was later expanded into a state-level wastewater monitoring study, in collaboration with the Ohio Water Resources Center, Ohio EPA, and Ohio DOH. Network partners developed a list of sampling sites to capture Ohio's six major metropolitan areas, as well as approximately 40 smaller cities encompassing different counties and eight preparedness regions. EPA researchers focused on sampling sites from the southwest portion of the state, including Cincinnati, Dayton, Hamilton, Springfield, Batavia, and Portsmouth. Researchers analyzed and shared data with Ohio DOH for the new state wastewater surveillance dashboard. In spring of 2021, researchers supporting the Ohio Wastewater Monitoring Network, including EPA researchers, began using high-throughput sequencing techniques to track SARS-CoV-2 variants circulating in Ohio communities. This data is also available on Ohio's website and is updated weekly. In July of 2022, all wastewater sampling and analysis to support the Ohio Network transitioned from 8 analytical labs distributed throughout the state to the Ohio's public health lab. The state of Ohio continues to sample and track SARS-CoV-2, providing weekly updates to Ohio's dashboard and the National Wastewater Surveillance System maintained at the Center for Disease Control and Prevention, and is displayed as part of the COVID Data Tracker. Ohio's Wastewater Network is planning to expand monitoring for additional public health relevant microbes in Ohio wastewater, including influenza and respiratory syncytial virus. Several manuscripts have been published as a result of this collaboration. EPA researchers have also met with the states of Arkansas and North Carolina and the City of Burlington, VT, to discuss methodologies and best practices used in the Ohio monitoring pilot.

HABITAT

Partners: West Maui Ridge 2 Reef Initiative and U.S. Coral Reef Task Force
Challenge: Evaluating the use of the flocculant, chitosan, on Hawaiian stony corals
Resource: Laboratory research on Hawaiian corals
Project Period: 2020 – 2024

"We are so excited EPA's research team is working with us on this project. Their results will finally give us the critical insight needed to potentially unlock a tool that can settle out fine sediment, a pollutant responsible for significant loss of coral in West Maui. If found safe, we can move forward with developing applications for chitosan's use and break through our current technical limitations in improving nearshore water quality." – West Maui Ridge 2 Reef Initiative Tova Callender

The U.S. Coral Reef Task Force (USCRTF) is a multi-agency workforce of federal agencies, states, territories, commonwealths, and Freely Associated States formed to preserve and protect coral reef ecosystems. Members meet regularly to address needs and priorities of regions and/or concerns of specific reef habitats. Hawai'i's West Maui Watershed was identified by the USCRTF as a priority watershed requiring mitigation and restoration efforts to reduce land-based sources of pollution.

EPA ORD has largely focused its research efforts on Atlantic/Caribbean coral reefs with little to no emphasis on Hawai'i or Pacific coral. Listening to the needs of partners, the challenge was bridging the gap between ORD research and local concerns for Pacific, specifically Hawaiian coral reefs that are not only of environmental and ecological importance but have significant cultural value to native Hawaiians.
EPA scientist, Cheryl Hankins, collects coral at Sugar Beach, Maui.

ORD researchers, in collaboration with EPA Region 9 (Pacific Southwest), have taken steps to include investigations of Hawai'i corals in their current research. As of 2023, ORD now houses Hawaiian coral at the Gulf Ecosystem Measurement and Modeling Division's Coral Research Facility. Researchers there will expose Hawaiian corals to the flocculant chitosan to assess its impacts on growth. The results of the research will determine if the use of flocculant can be used in West Maui's watershed to be used as a management tool to reduce sediment exposure to West Maui's coral reefs.

The findings of this research support West Maui's Ridge 2 Reef Initiative, a coalition dedicated to address adverse impacts to West Maui's coral reefs. The research outcome will provide guidance on possible solutions to significantly reduce sediment and improve water quality not only on West Maui's coral reefs but other reef habitats around the world.

Partner: Florida Department of Environmental Protection and Florida Keys National Marine Sanctuary
Challenge: Evaluating effects of microplastics on Atlantic stony corals
Resource: Research on impacts of microplastics on coral growth
Project Period: 2017 – Present

"NOAA Florida Keys National Marine Sanctuary is pleased to support ongoing research efforts by EPA into microplastics, as this critical work directly supports the sanctuary's goal to improve understanding and condition of sanctuary resources. Information gained from EPA's efforts will guide management decisions to reduce threats to sensitive resources, such as stony corals." – Joanne Delaney, Resource Protection and Permit Coordinator, CPC, Inc. in support of Florida Keys National Marine Sanctuary

Acropora cervicornis (staghorn coral) that has ingested orange microplastic.

Microplastics are small plastics (<5mm) that are found in all aquatic habitats. As they spend time in the water, a biofilm is created on the surface of the microplastic which can include micro-organisms and/or chemical pollutants. This biofilm decreases the buoyancy of the microplastic causing it to sink, where they can be ingested by corals—filter feeders that indiscriminately pluck tiny particles out of the water.

EPA researchers are conducting laboratory studies to determine the size of microplastics that corals can ingest and determine if microplastics are retained once ingested. Additionally, the researchers varied the time of microplastic exposures to determine the long- and short term effects on growth. Additional research was conducted by collecting coral and water samples from Florida's coral reef to determine the abundance of microplastics. Agency researchers continue to work to determine thresholds values which will not impact coral.

The results of the research have greatly improved our knowledge on how corals actively ingest microplastic. Though corals ingest a wide range of microplastic sizes, coral will also egest (spit out) the majority of microplastics ingested. Even though coral retain a small portion of microplastics, repeated ingestion could impact coral by blocking their digestion tract preventing coral from ingesting food. Additionally, the energy required to egest microplastics could lead to decreased growth rates and impact to reproduction. Not only do microplastics potential harm coral due to physical impacts, but hazardous biofilms could also expose coral to harmful pollutants.

Partner organizations can use the findings from this research to know the potential and actual risks of microplastics on coral. The data will also assist with determining potential sources of microplastic pollution. It is expected that partner organizations would use research findings to implement improved management applications to minimize microplastic exposure to coral.

Partner: Pensacola and Perdido Bays Estuary Program
Challenge: Monitoring the health of the estuary
Resource: Technical support for the development and implementation of a probabilistic monitoring framework
Project Period: 2020 – Present

Hidden Gems: One of the many waterways within Pensacola Bay and Perdido Bay estuaries where people can connect with nature.

"Completing an intensification of the Condition Assessment Survey within the Pensacola and Perdido Bay watersheds would not have been possible without the technical, field, and facility support provided by EPA ORD's Gulf Ecosystem Measurement and Modeling Division (GEMMD). As a result, local natural resource management decisions are and will be informed by survey results. The Pensacola & Perdido Bays Estuary Program is grateful for our partnership with GEMMD, and we look forward to continued collaboration in the years ahead." — Pensacola & Perdido Bays Estuary Program Executive Director Matt J. Posner

In 2018, EPA awarded Escambia County, Florida a $2-million cooperative agreement under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies (RESTORE) of the Gulf Coast Act to establish the non-regulatory, place-based Pensacola and Perdido Bays Estuary Program (PPBEP). Through a coalition of local, state, and federal stakeholders from two states, two watersheds, four counties and five municipalities, the PPBEP fosters partnerships and coordinates efforts to collaboratively achieve publicly identified goals and objectives to restore and conserve the environment and the economy of the Pensacola and Perdido Bay region.

To assist the PPBEP in implementing a coordinated long-term environmental monitoring program, ORD researchers, in collaboration with Region 4 worked with the PPBEP team to develop and implement a probabilistic sampling strategy using protocols established under EPA's National Coastal Condition Assessment (NCCA). Water, sediment and fish measurements and samples were taken and analyzed for pollutant, toxicity, and biological characteristics. EPA staff provided the technical support for the survey design, training, field logistics and sample collection. The results produced from the 2021 sampling event will serve as a baseline for the PPBEP to monitor progress in restoring and maintaining the resilience of the Pensacola and Perdido Bays and the community benefits derived from healthy productive estuaries.

The 2021 PPBEP coastal assessment partnership team representing the Pensacola and Perdido Bays Estuary Program; EPA Gulf Breeze, FL and Region 4-Athens, GA; Escambia County, FL; Florida Fish and Wildlife Conservation Commission; and EPA Office of Water (not pictured).

Learn more about the Pensacola and Perdido Bays Estuary Program.

Partners: City of Superior (WI) Parks, Recreation, and Forestry; Wisconsin Department of Natural Resources (DNR); St. Louis River Area of Concern; Lake Superior National Estuarine Research Reserve; University of Minnesota-Duluth Natural Resources Research
Challenge: The contamination of Pickle Pond by runoff and invasive plants
Resource: EPA's Remediation to Restoration to Revitalization (R2R2R) approach to improve Pickle Pond for the benefit of the local community
Project Period: 2022 – Present

"Environmental stressors and restricted access have impacted public interests in the Pickle Pond for more than 130 years. The Wisconsin DNR is extremely grateful for the efforts of the ORD to evaluate the pond's ecological health and human connections to it before and after the construction of the restoration project. We are excited by the opportunity to see the restoration efforts bear fruit and the application of good science to evaluate changes in the condition and use of the site. EPA has been a great partner and their assistance in reaching the community through signs posted at the site and by hosting a website with project information and updates has played an important role in the success of this collaboration." – Wisconsin DNR Project Manager Joe Graham

The origin of Pickle Pond in Superior, Wisconsin dates back to the 1800s when a railroad construction project cut it off from the rest of Barker's Bay. Isolated and sheltered from the larger bay, it became a unique area in the lower estuary that provides a habitat to both native plants and wildlife. However, it did not endure as a healthy ecosystem. Over the years, contamination from diverted sewage and runoff from the increasingly urban surrounding watershed have significantly reduce the water quality of Pickle Pond.

Researchers from EPA's Great Lakes Toxicology and Exposure Laboratory study the benefits of coastal wetlands restoration in the urban Great Lakes Estuary, including Pickle Pond which is considered an Area of Concern. The studies revealed Pickle Pond provided an ideal opportunity to expand the EPA's understanding of how the local human community would respond to the restoration of a recreational coastal wetland area. It is the first of the Remediation to Restoration to Revitalization (R2R2R) projects planned which incorporates community engagement both pre- and post-restoration. Researchers have been and will continue conducting intercept surveys to understand how visitors' experiences at the site change during and after the project. In early 2022, EPA researchers began collaborating with the City of Superior and the Wisconsin Department of Natural Resources to design a project plan for restoration.

In May 2023, remediation actions started, beginning with dredging to remove contamination and deepen the pond to enhance the fish habitat. In addition, abandoned railroad tracks are being removed from the causeway to prevent continuing rust and other related contaminants from reaching the pond through runoff.

In addition to improving conditions for fish, the work will enhance the coastal habitat for native vegetation and improve connectivity between the pond and the St. Louis River Estuary. It is also projected that stormwater inputs to

the pond will be reduced and trails, water access, and wildlife/scenic viewing locations may be created, all either as part of the project or by partner organizations after the initial project is complete.

The R2R2R methods used in the Pickle Pond project will create benefits for local communities—both human and wildlife—with direct links to the river estuary. What the research team and their partners learn will also inform future planning efforts and improve the evaluation of project goals for future restoration projects in the St. Louis River Estuary.

Partner: Connecticut Agricultural Experiment Station (New Haven, CT)
Challenge: Protecting New England bees from potential impacts of exposures to pesticides used in plant nurseries
Resource: Case studies characterizing potential hazards to bees associated with the consumption of pesticide contaminated pollen
Project Period: 2017 – 2020

"This collaborative research project with the US EPA allowed us to continue and expand the research of the Connecticut Agricultural Experiment Station with the ornamental nursery industry in Connecticut – the largest agricultural industry by value in the state, and one of the largest in the region. Through this research, we have been able to quantify levels of exposure of honey bees to pesticides in pollen under realistic nursery conditions, and to identify insecticides such as acetamiprid that are not likely to pose a hazard to bee health at the levels of exposure we have found in the field." – Connecticut Agricultural Experiment Station Entomologist Kimberly Stoner, PhD

EPA Region 1 (New England) has identified the protection of bees and other pollinators from pesticide risk as a regional research priority. The area is home to a thriving horticulture industry, including large plant nurseries and greenhouse operations. Currently, there is little data on how pesticide use in these operations might impact local bee populations.

To address this knowledge gap, EPA ORD researchers, in collaboration with EPA Region 1, partnered with the Connecticut Agricultural Experiment Station in New Haven, CT, to design studies to provide information on: 1) the types and quantities of pesticides found in pollen harvested by honey bees in New England plant nurseries, 2) the types of plants that honey bees forage on in New England plant nurseries, and 3) the effects that chronic dietary exposure of the pesticide acetamiprid (a neonicotinoid purported to be less toxic to bees) has on bumble bee microcolony development and productivity under laboratory conditions. Bumble bees are under-studied and little information is available about the effects of exposure to acetamiprid on these bees.

Research results to date suggest that neonicotinoids play a smaller role in the toxicity associated with the contaminated pollen than initially anticipated. Additionally, there is evidence that chronic dietary exposure to acetamiprid has the potential to impact bumble bee microcolony development and productivity, but only at concentrations higher than environmental concentrations that would be achieved when following label rates. Additional studies conducted under field conditions are necessary to better understand the potential consequences of exposure to acetamiprid on bumble bees.

Partner: Escambia County (Florida) Natural Resources Management Department, Water Quality and Land Management Division
Challenge: Evaluating sediment habitat quality in an urban estuary to inform sediment remediation activities
Resource: Technical support to assess sediment habitat quality using novel remote sensing technologies
Project Period: 2019 – Present

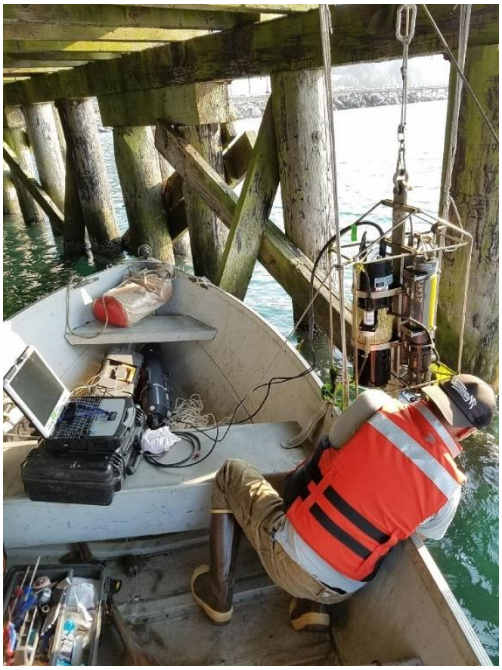
"Bayou Chico has long supported commerce and industry in the greater Pensacola area with many examples dating back over 150 years. Among other goals, the Bayou Chico Sediment Remediation Project seeks to restore fish and wildlife habitat within the bayou. Escambia County has recently partnered with EPA ORD to document existing conditions within the Bayou Chico benthic community. Not only did the survey allow for rapid collection of the ecological information needed to support the sediment remediation project, but it also provided a great opportunity for EPA researchers to gain valuable information about the performance of the SPI (Sediment Profile Imaging) equipment within the mucky bayou sediments. EPA's presence here along the northern Gulf Coast continues to be big factor in furthering our understanding of the Pensacola and Perdido Bay estuaries. We look forward to a continued partnership with EPA working to restore Bayou Chico, and hopefully many more projects to come." – Escambia County Natural Resources Management Department, Water Quality & Land Management Division Brent Wipf

Bayou Chico in Escambia County, Florida, is an urban estuary considered one of the most historically contaminated water bodies in the state. Despite recent efforts to improve surface water quality, sediments remain impacted by fecal coliform bacteria, excess nutrients, and legacy contaminants, including heavy metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs). Escambia County is developing a sediment remediation plan for Bayou Chico. Understanding the distribution of soft sediments and benthic (bottom) habitat condition will assist the County in these planning activities.

EPA ORD scientists, in collaboration with EPA Region 4 Gulf of Mexico Division, deployed the Sediment Profile Imaging (SPI) camera system in Bayou Chico in December 2019. The SPI system is a rapid sampling technology that captures images of cross-sectional views of the sediment—both water interface and subsurface features. These images are used to make qualitative and quantitative measurements on the biological, chemical, and physical character of sediments. Escambia County identified over 30 stations scattered throughout the Bayou to be surveyed. Image analysis is now underway. Sediment and biological features that can be identified in the imagery will be evaluated to identify possible relationships between these measures and known stress gradients in the Bayou.

In addition to evaluating the Bayou's benthic habitat quality, this collaborative work provided researchers the opportunity to test the effectiveness of recent modifications to the SPI camera frame to accommodate sampling in soft sediments. This ultimately improves ORD's scientific capabilities in the future. An understanding of current sediment habitat characteristics and benthic habitat condition through this SPI assessment will assist the County in planning for sediment remediation and restoration activities in Bayou Chico.

Partners: Oregon Department of Environmental Quality and Tillamook Estuaries Partnership (TEP)
Challenge: Acidification in estuaries threatening shellfish fisheries
Resource: Providing science to support the states in assessing impacts of coastal acidification
Project Period: 2017 – Present



"ORD scientists have collaborated with TEP and local partners to address global issues like [Ocean Acidification and Hypoxia] at a local level, making our communities and economies less vulnerable to future challenges and changes. Together, we are working to protect species that rely on the estuaries for their survival, including oysters, Dungeness crabs and threatened coho salmon." – Tillamook Estuaries Partnership Executive Director Kristi Foster. PhD

Increasing acidification of offshore ocean waters is threatening recreational and commercial fisheries. Governors of California, Oregon, and Washington have joined with stakeholders (state, tribal, federal, watershed councils, the aquaculture industry, and universities) through the Pacific Coast Collaborative to develop coordinated solutions to address the adverse effects of ocean acidification. In Oregon, the Oregon Coast Ocean Acidification and Hypoxia Workgroup formed to advance recommendations from the Collaborative. Oregon DEQ invited EPA scientists to be members of the Ocean Acidification and Hypoxia Technical Workgroup (link to workgroup) The workgroup is assisting Oregon DEQ to develop ocean acidification and marine dissolved oxygen assessment methodologies (link to report) for future Clean Water Act integrated reports.

In addition to participating in the interagency workgroups, EPA scientists are conducting research on how excess nutrients contribute to the acidification of estuarine waters. They are exploring the use of seagrass meadows as a resource to help reduce the effects of acidification to shellfish and developing a coastal acidification indicator for the National Coastal Condition Assessment. Since 2017, Agency scientists, in collaboration with the Tillamook Estuaries Partnership, have been monitoring coastal acidification in the Tillamook Estuary. Data from the monitoring effort have already contributed to two publications (and several others in the works): 1) a paper comparing coastal acidification across National Estuary Program sites and (2) an EPA report focused on challenges and solutions associated with monitoring acidification in estuaries. The research is being conducted at EPA's Pacific Coastal Ecology Laboratory in Newport, OR and in Tillamook Bay—the site of Oregon's largest inshore shellfisheries. The results of this research will provide state agencies with tools to reduce the causes and effects of acidification in Pacific Northwest estuaries, thereby enhancing the environment and economies that depend on the shellfisheries.

Partners: Maryland Department of Natural Resources (MDDNR), West Virginia Division of Natural Resources (WVDNR), California Department of Fish and Wildlife (CADFW), California Department of Water Resources (CADWR), California State Water Reclamation Control Board (CASWRCB)
Challenge: Accurate and sensitive methods to detect hard-to-find endangered species
Resource: Environmental DNA (eDNA) for inventory and monitoring of imperiled species in collaboration with the U.S. Fish and Wildlife Service (USFWS) Pennsylvania Field Office, and the University of Kentucky Department of Forestry
Project Period: 2017 – Present

"The development and validation of the eDNA methodology will profoundly change how aquatic populations are monitored and significantly improve the ability to conserve and recover rare aquatic species." – WVDNR Wildlife Diversity Biologist Janet Clayton

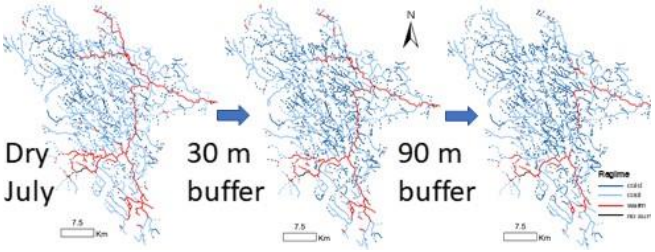
Conservation and management of endangered species require being able to locate populations and determine their distribution in the environment. However, classical monitoring approaches may overlook or underestimate species presence. Because living organisms constantly shed DNA into the environment, environmental DNA (eDNA) may offer an efficient, more sensitive, and non-invasive solution for detecting endangered species at low abundances and can be readily obtained from environmental samples (e.g., water, soil) instead of thru capture of whole organisms. Because each organism's DNA contains a unique genetic code, eDNA can be used for precise taxonomic identification. The non-invasive nature of eDNA surveillance reduces stress, harm, and spread of disease to the species of interest.

To provide support to various state agencies and in collaboration with EPA Region 3 (Mid-Atlantic), EPA Region 9 (Pacific Southwest), the U.S. Fish and Wildlife Service (USFWS) Pennsylvania Field Office, and the University of Kentucky Department of Forestry, ORD scientist developed eDNA tools and assessed the capability of eDNA to determine distribution and relative abundance of species of concern. This included the federally-listed dwarf wedgemussel (*Alasmidonta heterodon*) within the Chesapeake and Potomac drainage basins in Maryland. Multiple ongoing research are also targeting various salamander species in KY streams, several imperiled freshwater mussels (Northern riffleshell, Snuffbox, Brook and Green floaters) in WV, PA, and MD, and other listed species in the Sacramento river (Delta smelt) and Vernal pools (Fairy shrimp) in the Central Valley, CA.

These studies demonstrate how eDNA can be an effective tool for determining species occupancy at low abundances or limited biomass. For example, in our dwarf wedgemussel eDNA was detected in water samples from all Maryland streams known to support the species including streams with relatively low abundan*ces.* Innovative techniques like eDNA surveillance can be incorporated into the species conservation management toolbox as an efficient and cost-effective means for state agencies to inventory and monitor imperiled species occupancy, to guide more localized traditional monitoring efforts, and to inform habitat suitability studies for species reintroduction programs.

Partner: Houlton Band of Maliseet Tribe (Maine/New Brunswick)
Challenge: Identifying cold water refuge areas for brook trout and Atlantic salmon in the Meduxnekeag subwatershed on the Maine/New Brunswick border, as well as potential restoration actions to improve coldwater habitat
Resource: A fine-resolution spatial statistical (SSN) stream temperature model and an evaluation of the coldwater refuge distribution
Project Period: 2019 – 2020

"EPA ORD's temperature modeling for the Meduxnekeag watershed has been eye opening, both for our understanding of the potential impacts of climate change on our goal of restoring and sustaining cold water fisheries and migratory fish and for identifying opportunities to mitigate those impacts in a strategic and targeted way. This understanding has helped us prioritize next steps, like our ongoing effort to find ways to work with farmers in the watershed on increasing riparian buffers in active farmland." – Houlton Band of Maliseet Indians, Environmental Planner Sharri Venno



An international memorandum of understanding is in place between the Maliseet Tribe and the U.S. and Canadian federal governments with a goal of supporting habitat restoration in the transboundary Wolastoq (Saint John River) watershed for coldwater fisheries. A primary concern are Atlantic salmon populations, which are severely threatened overall and extirpated in portions of the watershed. Protection and restoration of habitat for coldwater fisheries requires knowledge of the distribution of thermal regimes within the watershed during the hottest portion of the summer with low baseflows.

In response to a request for technical assistance from the Maliseet, EPA researchers worked with the tribe to develop a fine resolution stream temperature model for the Meduxnekeag subwatershed that could be used to evaluate how the distribution of coldwater habitat varied between wet and dry years and simulate the effects of restoring riparian buffers. The model indicated that the mainstem of the Meduxnekeag provides only warm water habitat during July to August and that headwater tributaries are critical for providing cool- and cold-water habitat during times of thermal stress. The fraction of cool- and coldwater stream reaches could be expanded by restoring forested riparian buffers, with greatest benefit achieved with 30-meter width buffers as compared to wider buffers. During extremely dry years, little coldwater habitat remains and additional instream restoration practices may be required for mitigation. The Maliseet Tribe is using these results to guide their restoration activities in the Meduxnekeag and to support grant applications for those activities. Results have been published and shared with the Meduxnekeag working group coordinated by EPA Region 1 (New England) and composed of Tribal, U.S. and Canadian federal and provincial agencies.

HOMELAND SECURITY

Partner: Kentucky Department for Environmental Protection, Division of Water and Department of Public Health
Challenge: Providing clean, safe water following natural disasters
Resource: Water-On-Wheels Mobile Emergency Water Treatment System (WOW Cart)
Project Period: 2020 – Present

"Water everywhere and non-drinkable. During the 2022 Eastern Kentucky flooding event, the WOW carts provided crucial relief for first responders and residents during this horrific event." – KY Dept. of Health Readiness Response Coordinator David Carney

Recovery following a natural or man-made disaster such as a flood or accident often requires an emergency supply of safe, potable water. Bottled water is typically the first choice. However, long-term dependence on bottled water creates plastic bottle waste and in large or extended recoveries, using bottled water for bathing, sanitation and laundry is impractical. Mobile water treatment can significantly reduce the volume and cost of water to be transported.

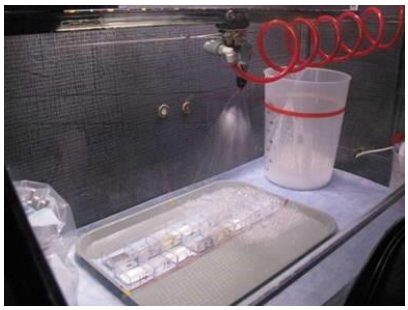
EPA ORD, in partnership with WaterStep, developed and patented the affordable and versatile Water-On-Wheels Mobile Emergency Water Treatment System (WOW Cart). The system is about the size of a shopping cart, is configured with multiple treatment technologies (filtration, carbon, UV and chlorination), can run on a variety of power sources (AC, DC and solar), and makes liquid bleach on site. The easy-to-operate technology makes quick training of first responders, community leaders, water system operators, and volunteer organizations possible, and it can be dispatched ahead of predicted natural events to facilities such as hospitals.

The WOW Cart has already been successfully used to help Kentucky communities in the aftermath of disaster:

- In December 2021, a deadly tornado devastated communities in Western Kentucky, knocking out power for days and placing thousands of customers served by the water utility under a Boil Water Order. A WOW Cart was set-up at the Graves County Health Department, in conjunction with the Kentucky Department of Public Health, to provide first responders with showers and safe drinking water. A second WOW Cart supplied safe water to a food relief organization that prepared thousands of free meals each day that were distributed from a mobile kitchen.
- In August 2022, deadly flooding occurred in Eastern Kentucky and the public water supply was lost for weeks. Working with state agencies, WaterStep and the Kentucky Rural Water Association were able to set up four WOW carts in the communities of Hazard, Buckhorn and Mayking. The WOW Carts supplied potable water and disinfectant for food facilities, mobile showers, laundry trucks, and displaced people.

Efforts are underway to pre-position up to 18 WOW Carts across the state of Kentucky, through an emergency response network of trained water system operators, engineers and volunteers. WaterStep is in discussions with the state of Kentucky to develop pre-approval for emergency mobile water treatment systems and the testing and monitoring requirements to assure the water is safe to drink.

Partners: Indiana State Department of Health; Massachusetts Department of Environmental Protection and Massachusetts Department of Fire Services; Michigan Department of Health and Human Services, Michigan State Police Forensic Science Division and Western Wayne County (MI) Hazmat Team
Challenge: Remediation of indoor fentanyl contamination
Resource: Decontaminant testing to effectively degrade fentanyl and its analogs
Project Period: 2020 – 2024



"EPA's Office of Research and Development's (ORD) bench-scale fentanyl decontamination research on surface decontamination options and personal protective gear decontamination will help the Michigan Department of Health and Human Services (MDHHS) develop Clandestine Drug Lab Cleanup Guidance for fentanyl. The ORD research also helps MDHHS understand by-products that may be formed as a result of degradation of fentanyl during the surface decontamination process. The ORD research team has been a valuable resource and continues to assist the MDHHS team as we make informed, science-based decisions and assess decontamination approaches." – MDHHS Environmental Assessment and ATSDR Unit Manager Andrea Keatley

Fentanyl, a drug typically used in healthcare settings to manage pain, has been increasingly used illegally to enhance other opioid drugs due to its inexpensive production cost and higher potency. As the popularity of fentanyl rises, so does the potential for contamination of indoor environments, which poses exposure risks to first responders. In most cases, a lack of awareness of the need and methods to decontaminate premises where fentanyl was found presents risks for re-entry or re-occupancy.

To address this challenge, EPA developed a fact sheet in 2018 that provides local, state and county hazmat partners with the most pertinent information needed for a safe response to opioid contaminated sites. In 2019, EPA ORD researchers, with input from regional on-scene coordinators, tested multiple off-the-shelf, easy-to-access products for their ability to decontaminate fentanyl and its analogs, including on multiple common materials found in buildings such as glass, laminate and wood. Results show the best methods to be a spray application of several decontamination solutions—peracetic acid, hydrogen peroxide, and pH adjusted solution containing hypochlorite—followed by a one-hour contact time.

Additionally, EPA ORD studied methods for cleaning personal protective equipment (PPE), such as Tyvek suits, hazmat suits, firefighter turnout gear, and neoprene gloves, worn by first responders. Decontamination of these materials needs to occur in a shorter timeframe, only 1-5 minutes, as compared to the materials in the home. Research showed that solutions containing peracetic acid are highly effective in degrading fentanyl in only a couple of minutes. This initial research will be used to scale up efforts to address a larger scale decontamination application and establishing effective operational procedures that will minimize additional hazards. Further research will also address materials that are more difficult to decontaminate, such as those that are porous, and fumigation methods for more complex contamination scenarios.

Results of this research will inform federal, state, tribal and local agencies on the requirements for safely entering, decontaminating, and eventually clearing indoor environments contaminated with fentanyl. A technical brief summarizing decontamination testing conditions, efficacies and protocols was published in 2022 for responders.

SUPERFUND AND CONTAMINATED SITE REMEDIATION

Partner: Virginia Department of Environmental Quality (DEQ)
Challenge: Assessing conditions at Bristol Landfill to determine the potential source of local odors
Resource: Technical expertise and support in reviewing and examining data and action plans
Project Period: 2022

Left: Hot gas escaping from a landfill gas collection well. Right: A geyser of hot liquid from deep within the landfill. Source: City of Bristol, VA.

"The Bristol Landfill is an unusually complex facility that necessitated a holistic approach to resolve issues affecting the community. DEQ and our expert panel appreciate the input from ORD scientists on the recommendations to address landfill temperature and odor concerns in Bristol." – Virginia DEQ Director Mike Rolband

In 2022, residents in Bristol, VA and Bristol, TN were complaining of odors suspected of originating from the Bristol Landfill, a likely culprit given the visible geysers of gas and leachate (landfill wastewater) as well as steaming chimneys observed from the landfill and its quarry sidewalls. Some gas collection wells installed to control landfill gas exhibited higher than normal temperatures, indicating the potential presence of heat-generating (exothermic) reactions that can have significant detrimental impacts to landfill operations, including foul-smelling emissions. To address these issues, the Virginia DEQ assembled an expert panel to review temperature and composition data from landfill gas wells and leachate composition. The expert panel was composed of professionals from academia, the public, and private sector, all with experience in evaluating elevated temperature landfills. Using data from the Bristol Landfill, they developed a plan to get address the facility's elevated gas well temperatures.

EPA ORD in collaboration with EPA Region 3 (Mid-Atlantic) attended the expert panel meeting from March 21-22, 2022 as an observer. Based on a request from their Region 3 colleagues, ORD experts reviewed the documents provided at the meeting, and the subsequent recommendations of the panel to address local concerns about the landfill. EPA Region 3 provided ORD's input to both VA DEQ and the city of Bristol, VA.

Based on that partnership, the panel's recommendations—including temporarily ceasing disposal operations, covering and closing the site, enhancing the existing gas collection system, and closely monitoring the most impacted areas of the landfill—were put into action. The closure will reduce residents' exposure to landfill gas and provide opportunities for the city to regain control and prevent offsite emissions before a possible re-opening in a few years.

Partner: City of Rockford, Illinois Planning and Development Committee
Challenge: Revitalizing and reinvesting de-industrialized, underserved South Main Corridor neighborhood
Resource: Comprehensive Health Impact Assessment (HIA) that incorporates community priorities, analyzes potential health impacts, and provides strategies to maximize benefits and minimize impacts
Project Period: 2020 – Present

"Once complete, the Colman Yards development will serve as a focal point for arts, culture, and community gathering for Southwest Rockford and all members of our community. The City has partnered with US EPA for two decades to make this development a reality. In addition to the Framework plan, US EPA Brownfields Assessment, Cleanup, and Revolving Loan Funds were heavily relied upon to address onsite contamination. Colman Yards would not be a reality without the collaboration of US EPA." – City of Rockford, IL Brownfields Redevelopment Specialist Robert Wilhelmi

Brownfields, a declining infrastructure, and a history of manufacturing have become major physical and mental health concerns to the City of Rockford, Illinois, especially with over one-third of the City's population currently living below the poverty level. Communities like the ones in Rockford, who are recovering from de-industrialization and financial disinvestment, are often beset by a number of factors that could negatively affect their health. The City of Rockford recruited EPA to help assess conditions and inform revitalization plans that could simultaneously address both environmental concerns (contaminated air, water and land) and socioeconomic conditions (employment, education and access to health care).

EPA ORD, in collaboration with the EPA Region 5, worked with the City of Rockford to conduct a Health Impact Assessment (HIA) that analyzed how to perform neighborhood revitalization in a way that maximizes health benefits for residents. During this partnership, the HIA focused on avoiding gentrification and negative social consequences for community members while seeking to preserve cultural values and improve quality of life and public health. The six determinants of health focused on throughout the HIA included: 1) housing, 2) neighborhood and built environment, 3) parks and greenspace, 4) crime and safety, 5) employment and economy, and 6) social and cultural well-being. The HIA provided more than 80 strategies across social, economic, and environmental sectors to maximize the positive effects of revitalization, resulting in several positive developments.

In July 2023, an exciting agreement was approved by the city's Planning and Development Committee to redevelop the 26-acre Barber Colman Complex, which will result in an accrued population increase of 2,710 people and an accrued employed increase of 2,784 jobs over the next seven years. The complex, which has been sitting abandoned for 22 years, will undergo historical rehabilitation, new construction, hundreds of new multi-family units, commercial space, public green spaces, and an activated riverfront.

As a result of its success, this HIA has demonstrated that collaborative decision-making can increase the vibrancy and overall health of communities across the country.

Partners: Oregon Department of Environmental Quality (DEQ)
Challenge: Legacy heavy metal soil contamination from past mining activity
Resource: Prescription for soil amendments to enhance revegetation
Project Period: 2017 – Present

"EPA researchers developed a prescription for amending contaminated mine tailings at the Formosa Mine Superfund Site to support the establishment and growth of vegetation where none was growing due to contamination. The research work is providing a site-specific biochar formula suited for the site conditions. Not only is this a significant scientific contribution that will prevent the offsite movement of contaminants at the site, help facilitate the removal of this site from the NPL and support long-term cleanup, but this kind of technology will be useful at numerous other contaminated sites across Oregon." – Oregon DEQ Hydrogeologist Bryn Thoms

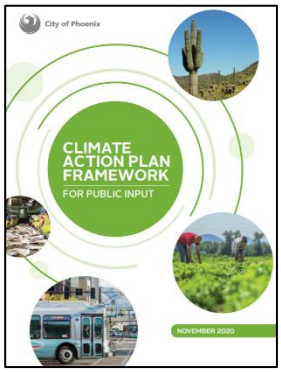
Past mining activities in the United States have left a legacy of soil and mining residues contaminated with heavy metals. Before plant growth can reach levels adequate enough to stabilize the soil, the bioavailability (absorption of the contaminants into living tissue) and acid levels generated by waste rock need to be reduced. EPA's Superfund program oversees cleanup of these sites. However, with limited resources, the highest priority for remediation goes to the most hazardous sites. In the meantime, many sites receive little or no attention. Often simple steps such as establishment of plant cover can reduce wind and water erosion of contaminated waste materials and the subsequent contamination of downslope receiving waters.

Of special concern is the Formosa Mine Superfund Site in south-central Oregon. This mine has a large area of tailings where it is difficult to establish vegetation. EPA ORD and Region 10 (Pacific Northwest) and the U.S. Department of Agriculture's Agriculture Research Service partnered to develop new techniques to assist in this cleanup. These techniques use soil amendments that adjust the pH, absorb heavy metals, and provide nutrients essential for plant establishment and growth. By creating a favorable rooting environment with amendments, plants can get established and protect the site from wind and water erosion, preventing the movement of contaminated soil.

The amendments used at the formosa mine include lime for neutralizing acidity and raising soil pH; biosolids (organic matter recovered from a sewage treatment process and used as fertilizer to supply carbon and nutrients for plant growth); and biochar (a charcoal-like material made by heating waste wood in the absence of oxygen to sorb metals, lower soil bulk density, and improve water infiltration and retention).

Results show that with these amendments the conditions for plant establishment and growth at the Formosa Mine dramatically improved. Douglas fir trees and herbaceous plants grew in amended tailings. Without amendments, the tailings are barren and do not support plants. Tree mortality was observed because surface runoff from unamended tailings overcame the acid neutralizing effectiveness of the lime and soil pH dropped, causing tree mortality. This suggests that all exposed waste rock and tailings need to receive amendments, including sufficient lime to neutralize residual acidity to prevent this from occuring in the future especially in downslope positions. Monitoring is also important as lime and biosolids may need to be reapplied occasionally to support long-term plant health. Other mine sites can use these types of amendment combinations and prescriptions to improve contaminated or degraded soils to establish plants and support their growth. Over time plants will improve soil health and prevent flow of heavy metals downstream from these mine sites.

Partners: City of Phoenix; Arizona Department of Environmental Quality (DEQ)
Challenge: Community vulnerability to contaminated sites and waste facilities due to climate change and extreme events
Resources: Suite of indicators and hazards maps
Project Period: 2017 – 2022



"The City of Phoenix used [ORD's] extreme heat indicators and maps in their 2021 Climate Action Plan (CAP) and related presentations to the public. ORD's social vulnerability indicators may be used to assist with equitable decision-making as they relate to heat and water resilience in the CAP. The City's Office of Homeland Security and Emergency Response may also use, as feasible, the indicators and maps for hazard mitigation planning." – City of Phoenix Rosanne Albright

The City of Phoenix was concerned about the current and future effects of rising temperatures and drier conditions on their communities, particularly as they relate to the risks associated with nearby contaminated sites. With their eyes set on an inclusive and equitable climate action plan, the City pursued a roadmap for advancing climate resiliency and making more informed decisions.

EPA ORD, in collaboration with EPA Region 9 (Pacific Southwest), partnered with the City of Phoenix and Arizona DEQ to find the most relevant data, build a suite of indicators and hazard maps, and create useful outreach and communication materials to share as part of the plan and more broadly with other regions and municipalities.

The project ultimately produced community and contaminated site indicators and hazard maps in partnership with the City of Phoenix, Maricopa County, and Arizona DEQ. The results have benefitted the City of Phoenix by providing: 1) a greater understanding of the type and magnitude of hazardous sites in the project area, 2) maps that could be used for emergency preparedness and response, 3) scenarios that mapped extreme heat, drought, wildfire and flooding, and 4) the characteristics of the population, particularly those most vulnerable.

Resources/Articles:

- EPA Research Website
- Fact sheet: A Handbook to Assist with Planning for Extreme Climate Events When You Have Contaminated Sites and Waste Facilities in Your Community
- U.S. EPA. Handbook on Indicators of Community Vulnerability to Extreme Events: Considering Sites and Waste Management Facilities
- Building resilience to extreme weather events in Phoenix: Considering contaminated sites and disadvantaged communities
- Assessing community vulnerability to extreme events in the presence of contaminated sites and waste management facilities: An indicator approach
- Assessing Community Vulnerability to Pollutant Releases Due to Extreme Events

Partner: Florida Department of Environmental Protection, City of Jacksonville
Challenge: Assess the fraction of arsenic that is bioavailable in contaminated creek sediment
Resource: Validation of EPA method to assess arsenic bioavailability in aquatic environments and investigation of bacterial communities in sediment as potential indicators of bioaccessibility
Project Period: 2018 – 2020

"The Fairfax St. Wood Treaters Superfund Site is a great example of partners working together successfully. It was a collaborative effort in all aspects of the cleanup, including review of the sediment sampling data for Moncrief Creek." – Florida DEP Project Manager Miranda McClure

Heavy metal contamination of soils is a pervasive problem that is a source of significant human health and ecological risk. Bioaccessibility describes the portion of a heavy metal in contaminated media (soil/sediment, water, air) available to be taken up by the ecosystem. It is an important consideration when assessing ecological risk of contaminated sites. Methods to measure the bioaccessibility of arsenic (As), which was widely used in the past as a wood preservative, do not take into account aquatic sediments. This research was undertaken to determine 1) if EPA Method 1340, an *in vitro* bioaccessibility assay (IVBA) developed for lead (Pb) and arsenic (As) in soils, can be used to assess As in creek sediments and 2) if there is a relationship between bioaccessible As and sediment bacterial communities that would be useful for risk assessments.

EPA ORD, in collaboration with EPA Region 4 (Southeast), collected *As*-contaminated sediments from the on-site retention pond and along a creek near the Fairfax Street Wood Treaters facility, which had become a Superfund site. Elevated levels of As in the pond and creek were detected. Once detected, the pond and creek sediments were subjected to the IVBA, a *Hyalella azteca* sediment toxicity test, and analysis of bacterial community composition using molecular biological and statistical methods.

Total As ranged from 2 – 52 ppm, with 29 – 95% being bioaccessible. Arsenic bioaccessibility appeared inversely related to total As concentration. There was no statistically significant difference in percent bioaccessible As whether the sediments were dried, as prescribed for the soil IVBA, or left wet—suggesting the soil IVBA Method 1340 is suitable for sediment analyses. The results showed that an IVBA for As in sediments and bacterial community analyses could both be developed for ecological risk assessments. The results from sampling Moncrief Creek helped also helped to show As in the sediments did not pose an ecological risk.

Partners: Colorado Department of Public Health and Environment, Utah Department of Environmental Quality, Utah Geological Survey, and the Ute Mountain Ute Tribe in Utah.
Challenge: Identifying locations of metals loading to surface water from impacted mine pools, groundwater, and surface water
Resource: High resolution temperature and conductivity sensor networks along key stream sections, in collaboration with the U.S. Geological Survey (USGS)
Project Period: 2018 – Present

"With data and monitoring available through the sensor network, we have been better able to understand mine drainage across sites and make informed decisions about where to conduct remediation or additional analysis." – Colorado Department of Public Health and Environment, Remedial Project Manager Mark Rudolph

More than 500,000 abandoned mines found in the U.S.—particularly in western states—present risks to surface water, groundwater, and human and ecological health due to the volume and toxic nature of the waste produced at these sites. They also present challenges to those tasked with addressing related public health risks and leading environmental cleanup efforts, primarily EPA, states and tribes. Mining sites make up a significant portion of the national Superfund site portfolio in these states.

Mine drainage refers to any surface water or groundwater that drains from an active or abandoned mining operation. The impact of such drainage on water quality can range from minimal, leaving it similar to a natural state, to severely degraded. Polluted mine drainage can be extremely acidic and often consists of high concentrations of toxic, heavy metals. The more acidic the water, the more likely it is to be harmful to living organisms. Measuring the ecosystem health of surrounding surface water has historically involved limited sampling, providing only a snapshot of conditions that can quickly change.

EPA ORD, in collaboration with EPA Region 8 (Mountains and Plains), and with help from other partners, deployed a dense network of sensors that provide accurate water quality measurements on a continual basis. USGS provided equipment and assisted with deployment, data collection and interpretation using fiber optic distributed temperature sensing.

Colorado Department of Public Health and Environment, other state partners and remedial project managers were able to share results of specific sites, lessons learned, and provide additional support using these technologies. Best practices were captured and shared with key partners to improve strategies and lower costs associated with these mitigation efforts.

EPA researchers and their partners are now applying what they learned from developing and deploying the sensor networks to update conceptual site models and advance the understanding of the interactions of mine pools, shallow groundwater, and surface water, even across large, diverse mining districts. This work is helping managers better target mine sites for high resolution site characterization and optimize remediation system design an operation,

significantly reducing costs to federal, state and tribal partners. Data sets and successful deployments have resulted in using these and similar technologies at other mining sites in Colorado including Colorado Smelter, Nelson Tunnel and Standard Mine Superfund Sites.

Partner: Louisiana Department of Environmental Quality (DEQ)
Challenge: Contaminated groundwater from former battery demolition site entering neighborhood creek
Resource: Technical assistance and characterization studies for mitigating off-site acid and heavy metal impacts
Project Period: 2004 – Present

"The permeable reactive barrier wall allows us to be protective of the waters of Selsers Creek. ORD's assistance with the testing of the wall was essential. Our collaboration with our federal partner was key to completing this mission at Delatte Metals Superfund site, and we continue to cooperate with EPA and ORD on other issues at this site." – Louisiana DEQ former Secretary Chuck Carr Brown, PhD

Past activities at the Delatte Metals Superfund site in Ponchatoula, Louisiana, involving processing spent lead-acid batteries and smelted lead plates have resulted in significant contamination of groundwater. Contaminants include sulfuric acid, lead, cadmium and nickel. The site borders a large creek that runs adjacent to a residential neighborhood. In order to mitigate impacts to the creek, a permeable reactive barrier (PRB), consisting of limestone and composted cow manure, was installed parallel to the creek to intercept the impacted groundwater and both neutralize the sulfuric acid and remove the heavy metals prior to entry of the groundwater into the creek.

EPA ORD has been working with the Louisiana DEQ and EPA Region 6 (South Central) to evaluate the long-term performance of the PRB in preventing discharge of contaminants into the creek. Monitoring and evaluation—involving groundwater sampling for metals and geochemical parameters, hydraulic conductivity and flux measurements, and PRB core analysis—are being used to assess performance and identify potential issues impacting long-term performance.

The PRB has performed well for over 14 years with performance monitoring scheduled to continue in coordination with the Louisiana DEQ and EPA Region 6. The sulfuric acid is being fully neutralized, and metals are being effectively removed (e.g., Pb from 100 µg/L upgradient to <0.09 µg/L within the PRB and Cd from 66 µg/L to <0.07 µg/L). Observed gradual changes in geochemical parameter measurements suggest, as expected, that the effectiveness of the PRB will have a finite lifetime. Louisiana DEQ and EPA ORD will continue to monitor PRB effectiveness to determine if contaminant levels decrease to safe levels, sparing the cost of replacement.

Partners: Massachusetts Department of Environmental Protection (MassDEP), Massachusetts Development Finance Agency (MassDevelopment)
Challenge: Defining the extent and nature of contaminant impact to groundwater and a recreational lake from a landfill at the Former Fort Devens; providing technical analysis of viable alternatives to stop contaminant impacts to off-site public and private properties
Resource: Applying novel methods for detailed assessment of groundwater and contaminant movement in a complex setting, in collaboration with the U.S. Army
Project Period: 2014 – Present

"EPA ORD's involvement has been essential to the ongoing development of a groundwater model that can be used to support a remedy modification. Because of the technical complexity and importance of this project, it is doubtful that the results from the model could be accepted by the state without EPA ORD's participation." –MassDEP, Devens Project Manager David Chaffin

The former Fort Devens made use of an onsite landfill for solid waste generated during several decades of operations. The landfill was not equipped with a system to prevent release of landfill leachate into the underlying aquifer. The resulting contaminated groundwater has since moved beyond the base property, impacting an adjacent recreational lake (Plow Shop Pond) and the aquifer underlying the Town of Ayer, MA.

EPA ORD, in collaboration with EPA Region 1 (New England) and the U.S. Army, implemented a monitoring program during 2005-2008 to clearly define the location and nature of impact to Plow Shop Pond.
This established that contaminated groundwater entering the lake was caused by leachate migration from the eastern edge of the landfill, causing contamination of lake sediment and water.

The multi-year effort included installation of supplemental monitoring locations and collection of detailed chemistry data to define the source of arsenic contamination observed in the lake. Confirmation that the landfill was the source of contamination led to construction in 2013 of a hydraulic barrier wall to prevent plume discharge to the lake and removal of contaminated sediments. The U.S. Army is conducting an assessment during 2024 to confirm performance of the barrier wall. EPA ORD will conduct a final round of groundwater sampling during Fall 2024 from the supplemental monitoring locations to support the remedy performance assessment. Continued work will evaluate the success of the interim groundwater remedy installed at the northern edge of the landfill and allow stakeholders to select a permanent solution to address contamination impacting groundwater under the Town of Ayer, MA.

More information can be found on the Fort Devens Superfund Site profile.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Suitable groundwater remediation technologies at the South Municipal Supply Well Superfund Site
Resource: Technology transfer and technical support for permeable reactive barrier & thermal remediation
Project Period: 2009 – Present

"*EPA ORD personnel have provided invaluable technical support to the South Municipal Well governmentteam.*"
– NHDES Waste Management Division, KennethRichards

The South Municipal Water Supply Well Superfund Site located in Peterborough, New Hampshire, includes the New Hampshire Ball Bearings (NHBB) property, adjacent wetlands, commercial/residential properties, and the South Municipal Water Supply Well. Installed in 1952, the South Well provided water to Peterborough for nearly 30 years. In 1982, concentrations of volatile organic compounds were detected in the South Well at levels above 100 parts per billion and use of the well discontinued. Initial groundwater and soil cleanup actions at the site included in-situ vacuum extraction and groundwater pump-and-treat using air stripping and carbon adsorption. In 2010, revised groundwater remedies were initiated to include a combination of two treatment technologies: 1) thermal remediation within targeted source areas, and 2) in-situ groundwater treatment using a zero-valent iron permeable reactive barrier (PRB).

NHDES and EPA Region 1 (New England) first requested EPA ORD technical assistance in 2009 for information on innovative remediation technologies, including thermal, enhanced bioremediation, and PRB applications. Technology transfer efforts by ORD personnel resulted in recommendations on bench-scale studies, site characterization and monitoring requirements, and implementation of the thermal and PRB remedies. In 2014, the PRB was installed along the alignment of the former Boston & Maine Railroad (B&M) line to intercept and treat groundwater contaminants emanating from the eastern NHBB property line. Thermal remediation using Electrical Resistance Heating technology was completed in 2016. Approximately 5,000 pounds of tetrachloroethylene (PCE) were removed from the subsurface. ORD personnel continued to provide technical assistance to the NHDES and EPA Region 1 teams by helping to determine the effectiveness of the thermal and PRB remedies, and in determining the location of other source areas that require treatment.

Groundwater data show that the original PRB failed to meet specified treatment criteria. A new PRB has been designed and installed. Current ORD technical support efforts include assistance in interpreting site groundwater data; recommendations on pilot study designs for characterizing groundwater flow and enhanced biodegradation potential.

More additional can be found on the South Municipal Supply Well Superfund Site profile.

Partner: New Hampshire Department of Environmental Services (NHDES)
Challenge: Suitable technologies to remediate waste oils and chlorinated solvents at the Beede Waste Oil Superfund Site
Resource: Technology transfer of Steam Enhanced Extraction and technical support for thermal remediation of waste oils
Project Period: 2007 – Present

"US EPA ORD personnel have provided invaluable technical support to the Beede Waste Oil government team." – NHDES Waste Management Division Ken Richards

The Beede Waste Oil Superfund Site is located in Plaistow, NH within a predominantly residential area. Prior commercial operations at the site, which began in 1926, included storage and distribution of fuel oil and recycling of used oil. Spills, leaks from storage tanks, and discharges to lagoons on the site created subsurface plumes of light nonaqueous phase liquids (LNAPL) that contained a wide variety of petroleum hydrocarbons, polychlorinated biphenyls (PCBs), and chlorinated solvents. The Record of Decision (ROD) chose soil vapor extraction to remediate the smear zone of LNAPL, with a contingency for thermal enhancements if it was determined during the design stage that this was needed in order to meet the site soil cleanup goals. The ROD also included a groundwater extraction system to extract the downgradient dissolved phase plume.

In 2007, NHDES and EPA Region 1 (New England) requested EPA ORD technical assistance to aid in determining if a thermal enhancement to the groundwater extraction system would be required to meet soil cleanup goals, and if so, which of the thermal technologies would be most applicable to this site. In addition, ORD personnel provided technical support on delineation of the area to be treated using thermal remediation.

In 2010, ORD completed a bench scale treatability study that demonstrated that steam injection remediation of the soils was capable of reducing contaminant concentrations to meet the cleanup criteria. Subsequently, Steam Enhanced Extraction (SEE) was chosen as the remediation technique for the two LNAPL-contaminated areas that were delineated by the site characterization activities. From 2015 to 2016, SEE was used to successfully meet the soil cleanup criteria in the Phase 1 area, with the injection of 28.7 million pounds of steam and the recovery of more than 150,000 pounds of contaminants. In late 2018, steam injection was initiated in the Phase 2 treatment area, and this portion of the remediation was completed in the Fall of 2019 with the attainment of the soil cleanup goals. Approximately 66.3 million pounds of steam were injected in the Phase 2 area, and 177,300 pounds of contaminants were recovered.

More information can be found on the Beede Waste Oil Superfund Site profile.

Partners: New Mexico Environment Department (NMED), New Mexico Tech, University of Iowa, and Ohio State University
Challenge: Environmental sampling and assessment of local waterways and sediments following Gold King Mine Spill
Resource: Center for Native American Environmental Health Equity Research
Project Period: 2015 – 2021

"ORD's support of the Center for Native American Environmental Health Equity Research has helped NMED reach out to and coordinate with Navajo Nation communities that were affected by the Gold King Mine spill." – NMED Chief Scientist Dennis McQuillan

In 2015, about 3 million gallons of contaminated wastewater from the Gold King Mine spilled into the Animas River impacting several tribes and states. Following the spill, a team of researchers from the University of New Mexico Center for Native Environmental Health Equity Research and New Mexico Tech, in collaboration with the New Mexico Environment Department (NMED), performed a sampling trip collecting water and sediment samples from Silverton, CO to Farmington, NM. The results obtained from this work were presented at the Environmental Conditions of the Animas and San Juan Watersheds conference (Farmington, NM; May 17-18, 2016) which was co-organized by their collaborator from NMED and other staff from the New Mexico Water Resources Institute and institutions from the state of New Mexico.

As a result of this work, the Center, in collaboration with NMED, the University of Iowa, and The Ohio State University, initiated an investigation of the mineral phases and metal release by microbiological activity from sediments collected along the Animas River after the spill which impacted the Navajo Nation. Additionally, NMED has utilized the information generated by the Center to propose a long-term monitoring program that has been partially funded by EPA.

- Post Gold King Mine Spill Investigation of Metal Stability in Water and Sediments of the Animas River Watershed (published 2016, research with NIH funding)
- Gold King Mine Water Spill Long-Term Monitoring Plan (published 2017)

The EPA ORD-supported Center for Native American Environmental Health Equity Research, jointly funded by EPA (2016-2021) and NIH, was established to address pervasive environmental health disparities. The Center's work continues with funding from NIH, and the primary focus is biomedical and environmental research and Native-focused community engagement. The research team aims to expand their understanding of mixed-metal toxicity and enhance confidence in the characteristics of the metal exposures and the populations that influence the generalizability of the results.

Partner: Washington State Department of Ecology
Challenge: Upper Columbia River contaminated site
Resource: Technical support for remedial investigation/feasibility study
Project Period: 2018 – Present

"Washington is addressing surface soil legacy smelter-emission impacts across a range of communities and settings spanning the state. The assessment of state-of-the-art, minimally disruptive exposure reduction surface treatment technologies for rural-residential and rural tribal-use settings common to the upper Columbia River Valley is a fundamental step toward identifying long- term cleanup measures. ORD's participation is highly valued to ensure honest assessment, input and multi-disciplinary scientific oversight." – Washington State Department of Ecology, Toxics Cleanup Program, Upper Columbia River Site Project Coordinator John Roland

EPA ORD, in coordination with Region 10 (Pacific Northwest), is providing technical support for the Upper Columbia River (UCR) Valley Superfund Site's remedial investigation/feasibility study. EPA ORD is a member of the UCR Soil Amendment Technologies Evaluation Study technical team established through the interaction of the Coleville Confederated Tribes, Washington State Department of Ecology, Teck Resources Limited, Ramboll Environ and EPA Region 10. EPA ORD is engaged as a third-party to provide an unbiased, scientific assessment of, and expertise on, soil amendment alternatives for soil lead and associated metals in the UCR area. Amendment alternatives being evaluated include phosphate, magnesium oxides, ECOBOND®, compost, biochar and other widely accepted treatment options for lead in soil.

EPA has provided input on potential alternative treatments for the site and provided input on testing that could be done to predict treatment suitability/effectiveness at the site. EPA ORD also participates in site meetings and teleconferences with the region, state and potentially responsible party to discuss the site soils and alternative soil remediation approaches.

For more information, go to the Upper Columbia River Remedial Investigation and Feasibility Study webpage. Active field research efforts have concluded during the summer of 2023 and a manuscript is currently in development.

Partner: Idaho Department of Fish and Game (IDFG), Washington State Department of Ecology
Challenge: Development of a passive remediation alternative at the Bunker Hill Superfund Site (Lane Marsh)
Resource: Technical Investigation
Project Period: 2015 – Present

"Abundant natural resources and clean functioning ecosystems are highly valued by local and regional residents and a huge part of why we choose to live here. The IDFG is committed to restoring healthy and productive ecosystems in the lower basin. We are happy to have been able to support and partner with EPA ORD in the effort to find new, innovative, and cost-effective approaches to the wildland contamination problems we face there." – IDFG Regional Wildlife Habitat Biologist David Leptich

"The Washington State Department of Ecology appreciates ORD's involvement in the Bunker Hill Superfund Site. The tools being developed by ORD will not only ensure that lakes and marshes receive appropriate cleanups and reduce contaminant transport into Washington, but also may assist us in determining the best remedial strategies at our own cleanup sites." – Washington State Department of Ecology, Toxics Cleanup Program Hydrogeologist Sandra Treccani

The Lower Coeur d'Alene River Basin in northern Idaho and eastern Washington is an active habitat for migratory birds (including the Canadian Tundra Swan) and part of the Bunker Hill Superfund Site, a former lead refining and smelting facility. Historical and ongoing transport of contaminated sediment to floodplains, marshes and side lakes from the Bunker Hill site has resulted in annual acute lead toxicity of migratory birds that utilize the surrounding wetlands for feeding during migration. The concentration of lead in some sediments is so elevated that acute effects of lead toxicity are seen within as little as a two-week period. The loss of bird life has also resulted in reduced use of the river basin for recreational activities. The historical release of contaminated materials has led to the contamination of more than 18,000 acres of prime water fowl habitat. The size and scope of the sediment contamination prohibits the use and application of traditional remediation practices at this site, including sediment removal. A passive treatment option that reduces the potential for biological uptake of lead is required. EPA ORD is collaborating with state partners to develop a passive soil amendment option that would reduce bioaccessible lead concentrations in wildlife.

EPA ORD in collaboration with Region 10 (Pacific Northwest) have conducted an initial site investigation to evaluate geochemical cycles, contaminant distribution and chemical speciation of lead throughout Lane Marsh. This information was used to develop laboratory conditions for bench scale studies evaluating the performance of sediment amendments to reduce lead bioavailability. Research is ongoing as scientists begin selecting specific materials for field trials.

ORD's partners will use the results of the bench scale testing and field trials to determine the best options for passive remediation efforts. In addition, the potential for remedy selection based upon existing geochemical properties and contaminant speciation will be employed at other locations within the Lower Coeur d'Alene Basin. Successful identification and deployment of affordable and effective passive sediment remediation technologies will ultimately result in a reduction of bioavailable lead improving the ecosystem by protecting migratory birds and subsequently revitalizing recreational activities in the Lower Basin.

More information can be found on the Bunker Hill Superfund Site profile.

Partner: Interstate Technology and Regulatory Council (ITRC)
Challenge: Need for specialized technical and risk assessment training
Resource: ITRC online training webinars and in-person training
Project Period: 2015 – Present

"The experience and knowledge of EPA scientists were essential to the success of this important training used by state risk assessors and others to address complex challenges at contaminated sites." – California Department of Toxic Substances Control, Senior Toxicologist Claudio Sorrentino

"The ITRC risk training is more robust as a result of our partnership with EPA experts on this effort." – South Dakota Department of Environment and Natural Resources, Engineering Specialist John McVey

In 2015, EPA ORD partnered with ITRC, a program of the Environmental Research Institute of the States, to develop specialized training for state risk assessors responsible for the cleanup of chemicals released into the environment. Based on feedback from EPA's Risk Assessment and Training Experience (RATE) program, ORD scientists reached out to ITRC and proposed that ITRC create training modules on the harmonization of risk assessment approaches across state regulators. EPA experts provided materials developed for its RATE program for the ITRC effort. These materials provide up-to-date and comprehensive training for human health risk assessment, ranging from beginner to expert classes.

The ITRC team of approximately 75 representatives from various environmental sectors completed a comprehensive web-based training module entitled, *Decision Making at Contaminated Sites: Issues and Options in Human Health Risk Assessment*. ORD scientists provided expert technical support as needed along the development processes and extensive peer reviews before release of the final product. More than 2,700 people have taken the online course and the associated guidance document is available to download.

A continuing partner with EPA ORD, ITRC has developed numerous documents and training over the last year. Within the last year, ITRC has published six technical guidance documents, ranging from traditional remedial topics (Hydrocarbons Site Management) to emerging contaminants (Microplastics, PFAS) and Environmental Data Management. ORD scientists participate on ITRC project teams in both the development and review of ITRC products. ITRC expanded its training program in 2023, with over 20 internet-based training courses scheduled so far, including new courses on Environmental Data Management and Microplastics.

WASTE AND MATERIALS MANAGEMENT

Partner: Ohio Environmental Protection Agency (EPA)
Challenge: Elevated temperatures at a municipal landfill
Resource: Ongoing site visits, reports and technical expertise
Project Period: 2022 – Present

"EPA's Office of Research and Development (ORD) has reviewed numerous documents and visited elevated temperature landfills with our staff. Ohio EPA appreciates the expertise provided by ORD to support the technical review of the landfill operator's request to continue filling activities in the affected area." – Ohio EPA Environmental Manager Michelle Ackenhausen

Elevated temperature landfills are municipal solid waste (MSW) landfills that have experienced unusual subsurface reactions that raise the internal temperature and produce odorous landfill gas. The temperatures are usually above regulatory thresholds and can negatively affect the normal biodegradation process, and so they require additional monitoring to ensure the reaction does not spread or increase in intensity without notice. The odors are a nuisance to neighbors, and the wastewater the reactions generate is more difficult and expensive to treat. Therefore, both landfill operators and regulators must spend more time monitoring these areas to ensure protection of human health and the environment.

EPA ORD provided advisory assistance to Ohio EPA during a joint visit to an elevated temperature landfill where the management company proposed to continue and expand operations in previously capped areas that had reverted to normal temperatures. If approved, this would be the first time that a landfill would be allowed to resume normal disposal practices in a previously impacted area. The operator proposed a 10-month pilot study on a small portion of the total affected area. ORD and Ohio EPA posed questions to the operator, made comments about the proposal, and suggested items for future discussion. ORD plans to continue assisting Ohio EPA as the operator's revised plans are reviewed.

Partner: Rural Alaskan Communities via Solid Waste Alaska Taskforce
Challenge: Helping Alaska villages prevent contamination by efficiently backhauling waste
Resource: EPA developed an iOS application that collects live tracking data to ship waste from rural communities to final disposal destinations
Project Period: 2020 – 2022

"It is our hope that the work here can be applied to situations that other underserved communities of need face, multiplying the benefits of this outstanding partnership." – Zender Environmental Health and Research Group, Executive Director Lynn Zender

Under a unique exception to the Resource Conservation and Recovery Act, many rural Alaska communities rely on unlined landfills to dispose of waste due to their remote locations. This approach is not appropriate for discarding hazardous waste, which can pose health and environmental risks when improperly disposed. Therefore, the waste must be transported long-distance to recycling destinations, a task that is often both expensive and logistically difficult. Over the past five years, EPA Region 10 (Pacific Northwest) has partnered with the Solid Waste Alaska Taskforce (SWAT), a joint collaboration between the state of Alaska, Alaska Native Tribal Health Consortium, Kawerak Inc, and Zender Environmental Health and Research Group, to develop a household hazardous waste backhaul service program, called Backhaul Alaska, to serve 160 communities located off of the national highway system.

In March 2020, EPA ORD in collaboration with Region 10, was requested to support the Backhaul Alaska Program's logistical efforts. The program was started as a pilot among 25 communities who needed a technology capable of scaling up the service statewide. One of the lingering challenges in the program was to develop a tool capable of supporting the removal of hazardous waste from rural Alaska. The tool would be used by communities in rural Alaska to log hazardous waste inventories in harsh environmental conditions. Central to all of this is tracking the materials—where they are from, where they are going, how they are packaged, how much of each type there are, and multiple other features. ORD used its prior experience developing similar tools for post-disaster events to quickly identify viable options for managing transportation and recycling logistics.

In just a few months, researchers enhanced the ESRI ArcGIS Survey123 program by integrating a barcode creator and an interactive dashboard. This allowed for seamless coordination with the program's inventory management and control procedures. SWAT was rolled out this tool to over 16 diverse communities, gathering initial inventories and obtaining feedback from field participants. Leveraging this feedback, EPA ORD fine-tuned the application for future backhaul events. The comprehensive framework and software were officially transitioned to SWAT in 2022.

Partner: California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA)
Challenge: Addressing safety concerns of tire crumb rubber used in synthetic turf fields and playgrounds
Resource: Research for improved exposure assessment in collaboration with the Centers for Disease Control and Prevention (CDC) and the U.S. Consumer Products Safety Commission (CPSC)
Project Period: 2016 – 2024

"The U.S. EPA study complements and strengthens what we are doing in California. Consultations with the U.S. EPA scientists benefit our project team and help to improve the quality of the California synthetic turf study."
– CalEPA OEHHA Senior Toxicologist Patty Wong, PhD

EPA ORD collaborated with the CDC's National Center for Environmental Health and Agency for Toxic Substances and Disease Registry (ATSDR) and the CPSC to study key environmental and human health questions. To address the concerns that have been raised about the potential health risks from playing on synthetic turf fields containing tire crumb rubber, a Federal Research Action Plan was launched in 2016 to investigate potential human health implications. The Federal Research Action Plan has four parts: a literature review and data gaps analysis, outreach with key stakeholders, tire crumb rubber characterization research, and human exposure characterization research. This research, now complete, serves to provide a better understanding of the chemicals found in tire crumb rubber and the potential exposures that field users may experience by using these fields.

EPA and CDC/ATSDR have reported research findings in two parts. Part 1 communicates the research objectives, methods, results and findings for the tire crumb rubber characterization research (i.e., what is in the material). Part 2 reports data to characterize potential human exposures to the chemicals found in the tire crumb rubber material while using synthetic turf fields and includes results from a biomonitoring study conducted by CDC/ATSDR to investigate potential exposure to constituents in tire crumb rubber infill. CPSC has conducted separate research on playgrounds. These research activities and the resulting findings do not provide an assessment of the risks associated with playing on or contact with the recycled tire crumb rubber used for synthetic turf fields. Instead, these research results provide an understanding of the potential for human exposure and should inform future risk assessments. Researchers at CalEPA OEHHA are also completing research aimed at reducing data gaps for tire crumb rubber constituents and human exposures. The federal research team regularly consulted with OEHHA scientists to discuss how the two studies could be mutually informative. Information was shared between EPA and OEHHA through a Materials Cooperative Research and Development Agreement (MCRADA). The federal and state researchers have implemented methods and approaches that where feasible produced comparable data. This effectively expanded the overall U.S. research sample size and will provide additional insight into potential exposure variability. There are also important differences between the federal and OEHHA studies that provide complementary data for improved exposure assessment. EPA and OEHHA research staff have also jointly participated in sessions on tire crumb research at several international scientific conferences including the 2018 International Society of Exposure Science (ISES)-International Society for Environmental Epidemiology (ISEE) Ancillary Workshop on *Translating Research on Recycled Tire Crumb Rubber: Opportunities for International Cooperation* in Ottawa, Canada.

WATER – DRINKING WATER

Partners: Michigan Department of Environment, Great Lakes, and Energy (EGLE), Michigan Department of Health and Human Services (DHHS)
Challenge: Helping Benton Harbor residents know the importance of using water filters to reduce lead in their drinking water
Resource: Field research and technical support
Project Period: 2021

"The results of EPA's Benton Harbor filter study were a key component in informing the public health on what steps they could take to protect their families from lead in drinking water." – Michigan EGLE Liesl Clark (former Director)

In the fall of 2021, the state of Michigan was responding to a continuing challenge of increased levels of lead, which is toxic to humans, in the city of Benton Harbor's water system. In response, the Michigan DHHS began providing the Berrien County Health Department with water filters to distribute to residents of the city. Two types of filters were distributed—pitchers and faucet-mounted, point-of-use (POU). Both types were certified by NSF/ANSI 53 for lead reduction to reduce the level of lead in tap water.

To support the state's response and to address concerns raised in a Safe Drinking Water Act petition filed on behalf of the residents of Benton Harbor, EPA's Office of Water requested that ORD conduct a filter effectiveness study. EPA ORD researchers designed the study to address two major concerns: 1) lead levels in some residences exceeded the certified capacity of the filters, 150 parts per billion (ppb), and 2) lead nanoparticles small enough to pass through the filters might be forming in the water.

ORD scientists worked closely with EPA Region 5 (Midwest), Michigan EGLE and Michigan DHHS to develop a drinking water sampling protocol to evaluate NSF/ANSI 53 certified water filters in the city of Benton Harbor. They also collected additional water samples to identify lead sources in the community and determine if lead nanoparticles were forming.

A joint team of representatives from ORD, EPA Region 5, Michigan EGLE and DHHS was rapidly deployed to the city to conduct door-to-door water sampling, water filter installation, and education. The team initially operated out of Benton Harbor's water treatment plant and later moved to one of the local community colleges. The team worked with local organizations to identify residences to be sampled. From November 9 to December 17, 2021, EPA was on the ground in Benton Harbor collecting and couriering water samples to EPA's Chicago Regional Laboratory where they were analyzed for lead and other water quality parameters.

A total of 307 properly operated and certified filtered water samples (from 199 locations) were collected and 100% of the filters performed as they were certified, meaning that all filtered water samples had lead concentrations of 5 ppb or less. Ninety percent of the filtered water samples were below the 0.5 ppb laboratory reporting limit for lead, and none of the filtered water samples contained lead greater than 2.5 ppb. These results confirmed that the filters are effective in removing lead in Benton Harbor drinking water.

The information that ORD provided was crucial for helping Michigan EGLE and DHHS make decisions and provide citizens with the best possible information about the importance of using certified filters to reduce lead concentrations in their drinking water to protect themselves and their families. This rapid and comprehensive response to local and state concerns is a reflection of EPA's commitment to ensuring that everyone has access to clean drinking water.

EPA continues to support the Benton Harbor public water system and Michigan state agencies to ensure access to safe drinking water for the Benton Harbor community, and more information about this response can be found here: https://www.epa.gov/mi/benton-harbor-drinking-water.

Partners: City of Poughkeepsie, NY and U.S. Virgin Islands Water and Power Authority
Challenge: Assessing Resilience of Drinking Water Systems to Natural Disaster
Resource: Water Network Tool for Resilience (WNTR)
Project Period: 2017 – 2022

Figure 1: Damage following earthquake, including broken pipes.

"In 2017 EPA researchers conducted a computer modeling of our water usage to determine impact of supply deficiencies and distribution breaks. Their effort was instrumental in showing our Water Board where our risks are and was valuable in preparation of budget to address concerns identified." – Poughkeepsie Water Treatment Facility, Plant Administrator Randy Alstadt

The prototype Water Network Tool for Resilience (WNTR) is an open-source resource designed to analyze a wide range of water distribution network failure and recovery scenarios and help users prioritize resilience enhancing actions. It can be used to estimate potential damage, understand how infrastructure damage would occur over time, evaluate preparedness strategies, prioritize response actions, and identify worst case scenarios, efficient repair strategies, and best practices for maintenance and operations. EPA researchers and EPA Region 2 collaborated with partners on two case studies to use WNTR to advance resilience—one with the City and Town of Poughkeepsie, NY, and the other with the U.S. Virgin Islands (USVI) Water and Power Authority.

In 2017, EPA researchers and partners began working with the City and Town of Poughkeepsie, NY, to investigate the resilience of their drinking water system. Using WNTR, they assessed a scenario involving the loss of source water to their treatment plant due to frozen intake pipes, drought, saltwater intrusion, or other events. Water utility decision makers were interested in evaluating how long they could supply water and what approaches, such as reducing usage, could effectively extend that timeframe. Researchers also assisted Poughkeepsie with analyzing how breaks in critical distribution pipes could affect firefighting capability. The resulting analysis was shared with the city, who proposed to use the results to plan for and justify the costs of system upgrades that would enhance resilience over the long-term.

In May 2020, the Naval Postgraduate School (NPS) approached EPA to partner in their resilience study of the USVI Water and Power Authority (WAPA), which supplies drinking water to the St. Croix, St. Thomas, and St. John islands. Using WNTR, EPA ORD researchers simulated four-week power outage scenarios, similar to those caused by hurricanes. NPS brought expertise in electrical power resilience, and together we addressed interdependencies between water and power systems. The results will be used by the utility to develop a hazard mitigation and resilience plan to address future hurricanes. Information from the analyses was shared with the utilities and journal articles detailing the approach were published (Poughkeepsie and USVI). These community applications demonstrate how WNTR can be used to identify utility vulnerabilities and offer specific resilience improvements to match different disaster scenarios, as well as structure capital investment plans.

Partners: Association of State Drinking Water Administrators (ASDWA) and other state contributors
Challenge: Providing information, technical assistance, and training to small drinking water systems
Resource: Webinars, workshops and workgroup to address challenges and treatment solutions for small systems
Project Period: 2003 – Present

"ASDWA is pleased to partner with EPA in the sharing of resources and organizing opportunities that bring together the drinking water sector. During an era of rapid regulatory movement, it is imperative for the advancement of public health protection that the water industry works in tandem to learn from each other and share ideas through our partnership that encompasses all levels of government." – ASDWA Senior Policy Analyst Kevin Letterly

EPA's ORD and Office of Water, in partnership with ASDWA, host a free annual workshop to provide in-depth information and training on various solutions and strategies for handling small drinking water system challenges. Because they tend to have fewer resources than larger systems, small systems can face enormous challenges in consistently providing safe and reliable drinking water. For 20 years, the workshop has brought together professionals from states and territories, Tribes, federal agencies, academia, NGOs, local agencies, system owners and operators, and others to share the latest information, resources, and training needed to help in building systems capacity and sustainably and with providing equitable access to drinking water. The 2024 workshop attracted 242 attendees including 143 state/territory environmental and health agencies from 40 states and Guam. Access past workshop recordings.

As an extension of the annual workshop, EPA's ORD and Office of Water began hosting a monthly webinar series in 2015 that is targeted to state/territory agencies, Tribes, and water utilities on challenges and treatment solutions for small water systems. In 2023, the series attracted 13,000+ attendees, including representatives of 54 Tribal Nations and of 166 state/territory agencies from all 50 states, DC, and 5 U.S. territories. Presenters are typically from EPA and the states to help encourage communication between EPA and the states and between the states themselves. Beginning in 2023, ASDWA is now partnering with EPA on this series. Access the webinar series schedule, registration, and past recordings.

Both the workshop and webinar series allow EPA to communicate directly with the states to provide training, including continuing education contact hours, and foster collaboration and dissemination of information. This, in turn, provides them with information and resources needed to communicate the latest scientific advancements and current guidance to their small systems. These forums also provide EPA invaluable information on the problems that states are currently encountering in their day-to-day interactions with their small systems. With this increased awareness, ORD experts can then modify their research to solve real-world problems that small systems are experiencing.

WATER – NUTRIENTS

Partner: Interstate Technology & Regulatory Council (ITRC)
Challenge: Strategies for Preventing and Managing Cyanobacterial Blooms
Resources: Online Guidance Documents, web-based training, and educational video, Learn to Identify Cyanobacteria Blooms
Project Period: 2019 – 2023

"The HCBs team is an ITRC success story demonstrating how state and federal agencies including EPA working with invested stakeholders and local governments can develop guidance on strategies and approaches to respond and manage an environmental impact. The training is delivered by multiple state agency representatives sharing experiences and knowledge to inform a larger audience about this growing freshwater impact." – H&M Environmental, LLC Nicole Henderson

Cyanobacteria are microscopic organisms that can produce toxins (cyanotoxins) that can cause illness or death in humans and animals. Harmful cyanobacterial blooms (HCBs) can also impair drinking water sources, recreational uses, fisheries, and property values. HCBs can occur in freshwater and marine environments and can be influenced by various factors such as nutrient loading, temperature, light, water flow, and climate change.

The ITRC HCB Team has conducted extensive research and review of the current scientific literature and state-of-the-art practices for HCB prevention and management and created two guidance documents to help stakeholders prevent and manage HCBs in different aquatic settings. In 2021, ITRC published Strategies for Preventing and Managing Harmful Cyanobacterial Blooms (HCB-1), which focuses on strategies for planktonic HCBs, which are cyanobacteria that float in the water column. The second document, Strategies for Preventing and Managing Benthic Harmful Cyanobacterial Blooms (HCB-2), was published in 2022 and focuses on benthic HCBs, which are cyanobacteria that grow on the bottom or attached to surfaces. Both documents provide tools, guides, and other resources to help users select appropriate monitoring, field screening, sampling and analytical methods, laboratory testing, prevention and management strategies, communication, and nutrient reduction approaches for their water bodies.

The ITRC HCB Team has also developed online training sessions to accompany the guidance documents. The training sessions review key information found in the two ITRC HCB guidance documents including an overview of the cyanobacteria biology, ecology, and toxicity, and the ITRC framework for HCB prevention and management. These sessions also demonstrate how to use the interactive tools and visual guides in the guidance documents and showcase examples of successful HCB projects from multiple states.

In 2024, ITRC developed a HCB Resource Guide to promote all the various products available.

Partners: Barnstable Clean Water Coalition (BCWC); Massachusetts Alternative Septic System Test Center; the Town of Barnstable, Massachusetts; and the Massachusetts Department of Environmental Protection (MassDEP)
Challenge: Evaluating non-traditional approaches for reducing excess nutrients entering Cape Cod's coastal waters
Resource: Nutrients Solutions-Driven Research Pilot – neighborhood-scale demonstration of innovative/alternative septic systems in Cape Cod, in collaboration with U.S. Geological Survey (USGS) and The Nature Conservancy
Project Period: 2018 – Present

"We've all heard the saying, 'If you want to go fast, go alone. If you want to go far, go together.' At the core of this proverb is the idea of partnership. Stellar results in business and in life usually have partnerships at their foundation, which has proven to be the case for BCWC's work in the Three Bays watershed. We were introduced to EPA ORD about four years ago at a fortuitous moment. EPA ORD was launching a program they call 'translational science,' where they work on a significant environmental challenge and look to partner with stakeholders to develop real-world solutions. For BCWC this has meant that our team has the opportunity to spend hundreds of hours working with the experts at EPA ORD to understand the nutrient pollution problem. We are working together on multiple approaches to reduce nutrient overload—one of the most significant problems for our Cape Cod waterways." – Barnstable Clean Water Coalition Executive Director Zee Crocker

EPA is collaborating with partners and stakeholders in the Cape Cod region to explore ways of reducing the amount of nutrients, specifically nitrogen, in coastal watersheds. Excess nutrients from human activities are an increasingly serious threat to water resources as they degrade water quality and contribute to algae blooms, low dissolved oxygen, loss of habitat and species diversity and, in extreme cases, fish kills.

Enhanced innovative alternative (IA) septic systems can remove much of the nitrogen in wastewater before it enters groundwater and connected surface waters such as ponds, streams, and estuaries. As new designs are developed, system installation and monitoring are needed to evaluate real-world performance before they are considered for broader use. EPA, in collaboration with USGS, is partnering with BCWC, the Massachusetts Alternative Septic System Test Center, MassDEP, and the Town of Barnstable to implement a neighborhood-scale demonstration of enhanced IA septic systems.

Goals of the demonstration project include quantifying nitrogen reduction and cost-effectiveness of the enhanced IA systems, evaluating how clustering these systems impacts nitrogen in groundwater nitrogen, and communicating lessons learned to local, state, regional and federal partners in watersheds similarly compromised by legacy septic systems.

More information is available on the Innovative/Alternative Septic Systems webpage.

Partner: Clermont and Brown County (OH) Soil & Water Conservation Districts, Clermont County Office of Environmental Quality, Clermont County Water Division, Ohio EPA, Ohio Department of Agriculture/National Resources Conservation Service, Ohio Department of Natural Resources
Challenge: Managing excessive nutrient runoff into East Fork Lake (Lake Harsha), which is causing harmful algal blooms
Resource: East Fork Watershed Cooperative—a collaboration between local, state and federal entities including the U.S. Army Corp of Engineers (USACE), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service—and The Nature Conservancy
Project Period: 2010 – Present

"This partnership has made a huge difference in what we've been able to do at the local level. The research and expertise involved in the Cooperative has made things possible that we would never have been able to do on our own." – Clermont County Soil and Water District Administrator John McManus

Excessive nutrient runoff in East Fork Lake in southwestern Ohio causes harmful algal blooms (HABs). These HABs in turn can produce cyanotoxins, which are harmful to human health and can compromise drinking water safety. EPA ORD along with several federal, state and local agencies collaborated to form the East Fork Watershed Cooperative to address this issue.

This multiagency cooperative, led by EPA ORD staff, leverages resources to help demonstrate how to better protect water quality in the watershed. EPA provides technical support and guidance, runs watershed simulation models, provides expert review, assists USACE in monitoring water quality, participates in statewide HAB modeling efforts with USGS, and supports the state of Ohio on nutrient Total Maximum Daily Load (TMDL) implementation in the East Fork.

The short-term goal of the cooperative is to provide early warning and efficient treatment plans for the toxic algae problem in Lake Harsha. Their long-term goal is to eliminate the algae problem by reducing runoff from nonpoint sources.

More information on the East Fork Watershed Cooperative (EFWCoop) webpage.

Partners: Oregon Department of Environmental Quality (DEQ); Oregon Department of Agriculture
Challenge: Improve surface and groundwater nitrate contamination from agriculture
Resource: Collaborating with farmers to assess the effectiveness of fertilizer best management practices
Project Period: 2017 – 2022

"EPA ORD scientists have made significant contributions to the monitoring program in the southern Willamette Valley Groundwater Management Area. Their technical expertise has enhanced analyses of complex hydrological systems, as well as informed Oregon DEQ synthesis of multi-scale factors impacting nitrate concentrations in the southern Willamette Valley." – Oregon DEQ Joni Hammond (former Acting Director)

Groundwater nitrate contamination affects thousands of households in the Southern Willamette Valley Groundwater Management Area (GWMA) in Oregon. To reduce non-point source loading of nitrogen to groundwater and surface water, successful approaches are needed within affected communities to integrate science, outreach and management efforts. A partnership was formed that brings together commercial farmers, Oregon Department of Agriculture, soil and water conservation districts and EPA to assess the current state of groundwater in the Valley, and to evaluate best practices in fertilizer management.

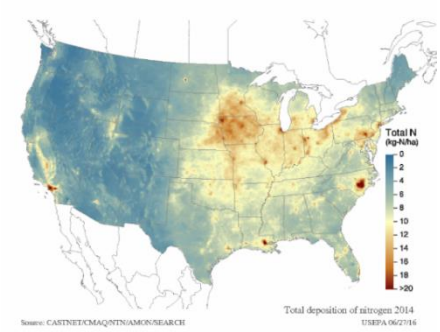
In this collaborative project, scientists measured nitrate leaching from 14 fields in the Valley. They shared the data with farmers and discussed best practices for fertilizer application that would reduce the leaching. Scientists documented the effectiveness of these practices on their fields and now are seeing positive results for less nitrate leaching in some fields. This work was published in Nutrient Cycling in Agroecosystems.

EPA ORD scientists also recently published a study of deep soil leaching and storage within a corn crop in the Valley. ORD scientists learned that approximately 29% of nitrogen inputs leached below 3 m in the soil, while 27% was stored within the soil. Deeper soil storage is less accessible to future crops and leaves a legacy that allows groundwater nitrate contamination to persist. Understanding the long-term role of this soil storage is key for both agricultural sustainability and water quality.

In addition, EPA ORD scientists have provided stable isotopic analyses to identify the causes of high temporal nutrient variability within local wells. These efforts have helped illuminate complex groundwater-surface water interactions and greatly improved Oregon DEQ's monitoring program for the groundwater management area. This works has been published and ORD efforts helped to reduce potential new inputs of nitrate into the groundwater system and understand the complex dynamics of groundwater in general.

EPA ORD scientists also worked with Oregon Department of Environmental Quality and Oregon State University Extension to produce a story map and a data dashboard about the GWMA that allows the community to learn about well water nitrate sources, issues and progress in the GWMA.

Partners: Delaware Department of Agriculture, DC Department of Energy & Environment, Maryland Department of the Environment, Virginia Department of Environmental Quality, West Virginia Department of Environmental Protection
Challenge: Estimating the impact of atmospheric deposition on nutrient loading in Chesapeake Bay
Resource: Improved models for calculating historic and predicting future atmospheric deposition of nitrogen
Project Period: 2015 – Present



"Science-based decision-making is at the core of the Chesapeake Bay Program Partnership and ORD's work to update the CMAQ airshed model provided the partnership with a better understanding of past progress and well as future opportunities for reducing atmospheric sources of pollution." – Maryland Department of the Environment, Water and Science Administration Director Lee Currey

The Chesapeake Bay watershed includes parts of six states and the District of Columbia and is home to over 18 million people. It provides over $100 billion annually in economic benefits. However, the growth in industry, population, and agriculture in the watershed has degraded water quality, with much of the decline attributed to excessive nutrient loading.

Consequently, in 2010, a Total Maximum Daily Load (TMDL) was established to reduce nutrient loading to the Chesapeake Bay watershed. Atmospheric deposition is among the largest pathways of nitrogen loading to the watershed, and the individual and combined impacts of climate and emissions changes on nitrogen loading from NH_x and NO_x to the watershed had not been well assessed.

Working in collaboration with the EPA Region 3 (Mid-Atlantic) Chesapeake Bay Program, EPA ORD scientists developed a consistent long term emissions dataset (Foley et al. 2023) and tailored the Community Multiscale Air Quality (CMAQ) modeling system (Hood et al. 2021) so that it could be used to estimate atmospheric nitrogen deposition for historical (2002 – 2019), and future (2035, 2050) scenarios projected using the GCAM USA model including planned reductions, state greenhouse gas targets, and a NetZero greenhouse gas emissions by 2050 target. The work was conducted to assist partner states and watershed managers.

ORD scientists have developed a set of annual North American emissions data for multiple air pollutants across 18 broad source categories for 2002 through 2019. The emissions datasets are designed to support regional air quality modeling for a wide variety of human health and ecological applications. The data were developed to support simulations of the CMAQ model but can also be used by other regional scale air quality models. The emissions data are one component of EPA's Air Quality Time Series Project which also includes air quality modeling inputs and outputs for the Conterminous US. The nitrogen deposition estimates generated are being used in the development of the Phase 7 version of the Chesapeake Bay Model and will be widely distributed among the federal, state, local and academic Chesapeake Bay Program research partners as they consider options for reducing nutrient loading.

Read the peer-reviewed publications:

- The Chesapeake Bay program modeling system: Overview and recommendations for future development
- 2002–2017 anthropogenic emissions data for air quality modeling over the United States
- Long-term regional trends of nitrogen and sulfur deposition in the United States from 2002 to 2017

WATER – QUALITY

Partner: Ohio Environmental Protection Agency (Ohio EPA) and the Great Lakes National Program Office (GLNPO)
Challenge: Remediation and restoration of Great Lakes Areas of Concern (AOCs)
Resource: Technical and sampling support in partnership with the Ohio EPA, GLNPO, U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration
Project Period: 2019 – Present

"ORD has provided valuable technical support for several Maumee AOC projects. ORD provided technical, sampling and report writing support in late 2021 for the purpose of collecting and evaluating multiple lines of evidence – chemical, physical, and biological – to define contaminated sediment management areas." – Ohio EPA Environmental Specialist Lynn Ackerson

Ohio EPA is implementing several projects in the Maumee AOC in northwest Ohio. The projects are funded by the Great Lakes Restoration Initiative (GLRI), which is designed to protect and restore the chemical, physical and biological integrity of the Great Lakes Basin ecosystem. Completion of these projects and demonstration of chemical and biological improvements will contribute to the removal of Beneficial Use Impairments in this AOC. Since 2019, a technical work group focused on characterizing sediments in Swan Creek and the Lower Maumee River to support these projects and collaborate on developing a data gap sampling plan, field sampling, and report writing to support identification and remediation of contaminated sediments. In addition, the ORD-led team of federal partners have provided support for Ottawa River remedy effectiveness studies and Otter Creek remedy and restoration effectiveness studies.

EPA ORD scientists have assisted with various studies, such as the Swan Creek and Maumee River final sediment characterization reports and feasibility studies and the Otter Creek remedy effectiveness studies including non-federal sponsor led mussel mitigation. Overall, EPA ORD's technical and sampling support from site and baseline characterization, remedy and restoration effectiveness studies, and report writing is fundamental to supporting the Maumee AOC in addressing Beneficial Use Impairments.

Partner: City of Ada (OK), Chickasaw Nation, Oklahoma Water Resources Board, East Central University-Oka' Institute, U.S. Geological Survey
Challenge: Enhancing limited local groundwater supplies
Resource: Investigating the impacts of Managed Aquifer Recharge (MAR) on groundwater quality/quantity
Project Period: 2020 – Present

"Enhanced (or managed) aquifer recharge represents a process, once scientifically proven, that will provide a practical solution to rising demand for additional water resources, and potentially a definitive resource management approach to aquifer sustainability." – Chickasaw Nation's Natural Resources Office Director Kris Patton

In south central Oklahoma, the Arbuckle-Simpson Aquifer is a critical water source which is increasingly being stressed by growing water demands and shifting weather patterns. The aquifer, a store of groundwater within the underground rock layers, is the primary source of drinking water for tens of thousands of people, including the Chickasaw Nation. Additionally, the aquifer provides water for agriculture, mining and other industries. It is also the source of many springs, lakes and rivers—providing important recreational and tourism resources to the area. The aquifer is designated as a "sole-source aquifer," a recognition that there are no reasonably available alternative drinking water sources. The aquifer relies solely on precipitation to recharge the groundwater supply, as no other water source enters the aquifer.

The challenge of studying groundwater, however, is that it is not readily observable, like a stream or lake. Scientists from EPA ORD have been working with federal, Tribal, state and academic partners, including the City of Ada, Oklahoma and the Chickasaw Nation, whose headquarters are in Ada, to understand the impacts of human activities (like pumping water from the aquifer) on the aquifer's water quality and quantity. EPA and its partners are also conducting research to understand the geological controls on groundwater flow, its underground "plumbing system." Scientists have developed conceptual models of how rainfall percolates through the ground to recharge the aquifer. To check these models, they have installed monitoring wells, water autosamplers, soil water sensors, and weirs at a site within the aquifer to measure changes in water levels and water quality. Other EPA research includes electrical resistivity imaging to map the subsurface to "see" the apparent water movement through the subsurface, and changes with the use of enhanced aquifer recharge (EAR) approaches. EAR uses small dams and weirs to capture water from significant rainfall events, allowing it to infiltrate into the ground, rather than run off the surface.

The studies EPA scientists are conducting and the concepts and the techniques they are using at the Arbuckle-Simpson Aquifer can be applied in other aquifers facing similar resource management issues. This research will inform the City of Ada, EPA regions, states and other partners of the risks and potential impacts to groundwater quality from the use of EAR in rural settings to recharge aquifers. This research will allow water managers to establish initial best management practices and policies on the use and maintenance of EAR systems; and identify the types of characterization and monitoring necessary for the implementation and long-term monitoring and maintenance at MAR sites.

Partner: DC Department of Energy & Environment (DOEE)
Challenge: Application of advanced monitoring technologies to characterize fecal pollution sources in regulated MS4 dischargers in Washington, DC
Resource: Field research, technical support, and laboratory training
Project Period: 2019 – 2024

"For many years, DOEE has been restoring DC's streams and major waterways with the goal of achieving fishable and swimmable status. A major hurdle has been high levels of microbial contamination that impair waterways via raw sewage overflows, leaky pipes, illicit discharges, and wildlife/domestic pet excrements. The first step towards controlling and mitigating microbial contamination is to identify the sources. Through a valuable partnership with EPA, DOEE has conducted an extensive field study to track microbial pollution in headwater streams of the Anacostia River. Once field collected samples are analyzed by EPA ORD, results will assist DOEE in developing focused control and mitigation strategies. This will help us get one step closer towards achieving fishable and swimmable status in DC's waterways."
– DC DOEE Water Quality Division, Environmental Scientist Amir Sharifi, PhD

More than 80% of the United States population resides in areas with municipal separate storm sewer systems (MS4) resulting in over 7,500 communities with the responsibility to develop, implement and mitigate stormwater management programs. Urban stormwater can contain disease causing pathogens and other pollutants and is a leading cause of surface water impairment in the U.S. Genetic technologies are now available that can help characterize key source(s) of fecal pollution in stormwater discharges helping to provide communities with more cost-effective, focused remediation, and prevention strategies.

EPA ORD, in collaboration with EPA Region 3 (Mid-Atlantic) and the Office of Water, partnered with the DC DOEE to conduct a field research study to evaluate the use of genetic fecal source identification technologies for MS4 outfall pollutant characterization in the DC area. In addition, EPA ORD is provided technical support and training to DOEE staff to promote the local use of these methods for future stormwater management efforts.

EPA ORD technical support and training helped educate local stormwater managers and facilitate the use of advanced monitoring technologies in the District. Field study results provided DOEE with important information to improve stormwater management. In addition, findings served as a foundation for the development of a strategic MS4 monitoring approach used by DOEE and other stakeholders. to address future stormwater management challenges.

The study is summarized in a presentation titled Fecal Source Characterization of Urban Municipal Stormwater Outfall 'Wet' and 'Dry' Weather Discharges and resulted in two scientific publications (Diedrich *et al.* 2023; Shanks *et al.* 2024).

Partner: New Mexico Environmental Department (NMED)
Challenge: Develop water quality assessment methods for highly altered systems, such as the middle Rio Grande
Resource: Integrated and organized existing physical, chemical, and biological data to develop and calibrate models for both fish and benthic macroinvertebrate communities based on the Biological Condition Gradient (BCG) approach and technical expertise
Project Period: 2018 – 2020

"The Biological Condition Gradient models developed with EPA and an interdisciplinary team of experts are a leap forward for water quality protection of the middle Rio Grande. We look forward to continued collaboration with EPA in developing new methods to protect New Mexico's water resources." – New Mexico Environment Department Water Protection Division Director Rebecca Roose

A lack of defined numerical thresholds limits the ability of the state of New Mexico to sustain, restore and protect non-wadeable rivers in the state, a major source of water for most of the state's population. In addition, because these rivers have been greatly altered from their original conditions, "minimally disturbed" reference waters do not exist for determining threshold assessments.

To address these challenges, EPA researchers, in collaboration with EPA Region 6 (South Central), NMED, Tetra Tech, and a panel of fish and macroinvertebrate experts from a number of organizations and universities, developed a suite of Biological Condition Gradient (BCG) models for fish and benthic macroinvertebrate communities of the middle Rio Grande, which is habitat for the threatened and endangered Rio Grande silvery minnow. The BCG provided the state with a tool to evaluate biological expectations over a range of stressor conditions within the middle Rio Grande.

EPA ORD, in collaboration with EPA Region 6, Tetra Tech and NMED, using data from EPA's National Aquatic Resource Surveys, also found the BCG models to be potentially applicable to other sandy-bottomed rivers in the southwestern United States. With this development, other states in the intermountain region are interested in using the models for their sandy-bottomed strams.

NMED uses the BCG models to develop quantitative thresholds of biological condition to evaluate the level of impairment from stressors such as excess nutrients and sediments in the middle section of the Rio Grande. Similar thresholds may be developed for other non-wadeable, sandy-bottomed rivers within the state.

Partners: Washington State Department of Natural Resources, Washington State Department of Ecology, Nisqually Land Trust, Nisqually Tribe
Challenge: Improve watershed condition for salmon recovery, clean drinking water and other ecosystem services
Resource: EPA watershed restoration planning tools (VELMA, Penumbra) and technical support
Project Period: 2015 – 2022

"Guided by sophisticated new modeling from EPA ORD's Western Ecology Division in Corvallis, combined with modeling used by the Nisqually Tribe for salmon recovery, the community forest's management team will selectively thin the property's timber stands to encourage old-growth forest characteristics and increase stream flow during the fall spawning season."
– Nisqually Land Trust, Executive Director Joe Kane

Intensive forest management in the Pacific Northwest during the past century has emphasized clearcutting on short harvest intervals (40-50 years). This highly profitable practice has converted the region's vast pre- settlement old-growth forests to young forest landscapes. This has fundamentally changed the functioning forest watersheds and their capacity to sustainably provide essential ecosystem services (nature's benefits) for local and downstream communities. Provisioning of drinking water, flood protection, fish and wildlife habitat, and recreational and cultural opportunities have been significantly degraded in many places.

Indicative of these widespread changes, Puget Sound salmon populations have declined sharply from historic levels. For example, 22 of at least 37 Chinook populations are now extinct, and many other species are listed as endangered. Communities, tribes and state agencies (Departments of Natural Resources and Ecology) are now collaborating throughout the region to implement salmon recovery plans that aim to restore hydrological and ecological processes critical to salmon recovery, and more broadly, to the functioning of entire watersheds and the ecosystem services they provide. A prime example is the Nisqually Community Forest (NCF), a novel collaboration of communities in southern Puget Sound aimed at acquiring private forest industry lands from willing sellers. The NCF is a working forest owned and managed for the benefit of local communities.

EPA ORD has developed and transferred modeling tools to NCF to support their salmon-recovery planning in the Mashel River watershed, a once prime salmon producing sub-basin of the Nisqually River. NCF staff are currently using EPA's Visualizing Ecosystem Land Management Assessments (VELMA) watershed simulator to quantify long-term effects of alternative management and climate scenarios on key salmon habitat and water quality variables. A key NCF goal is to design sustainable management plans that emphasize forest thinning and robust riparian buffers, a strategy shown by VELMA simulations to restore greater summer stream flows favorable to salmon spawning. Other ongoing NCF projects using VELMA include prioritization of land acquisitions, community-based best management practices and long-term management strategies.

Additional Resources:

- Read about EPA's 2022 PISCES award recognizing the Nisqually Indian Tribe leadership in this work.
- Access the keynote presentation describing this project titled How Visualizing Ecosystem Land Management
- Assessments (VELMA) modeling quantifies co-benefits and tradeoffs in Community Forest management.
- Read the report titled Transferability and Utility of Practical Strategies for Community Decision Making: Results from a Coordinated Case Study Assessment.

WATER – SOURCE AND RECREATIONAL PROTECTION

Partners: Local and regional beach managers across states that border the Great Lakes, as well as other states
Challenge: Predicting water quality at beaches
Resource: Virtual Beach software
Project Period: 2007 – Present

"This reliable, predictive water quality model is key to protecting health and promoting recreational enjoyment of our beaches. The model provides same-day public notifications of beach conditions at a lower cost than traditional monitoring. Communities that use Virtual Beach can dedicate more of their resources to locating and correcting sources of contamination and improving local beaches. The (Wisconsin DNR's) partnership with EPA in the development of this practical scientific tool offers a great pay off." – Wisconsin DNR former Secretary Cathy Stepp

To protect public health, beach managers need to continually assess the level of potentially harmful microbes (primarily bacteria) in the water. However, traditional culture-based testing methods can take 24 hours to get results – preventing same-day, proactive beach closures and leaving many recreational swimmers open to sickness or infection, or potentially close a beach needlessly and incur economic losses. EPA's Virtual Beach software offers a solution.

Virtual Beach facilitates efforts to support the local economy while protecting the health of residents. Virtual beach is used to assist in advisory issuances in the Great Lakes states and to forecast water conditions in numerous locations in Illinois, Indiana, Maryland, Michigan, Minnesota, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, and Wisconsin. In recent years, the software has been used for modeling water quality at water intake pipes (due to harmful algal bloom concerns) and shellfish harvesting areas (fecal coliform of typical concern) along the southern Atlantic coast.

An updated, web-based version of Virtual Beach is currently being developed. It will provide cutting-edge analytical tools, like ensemble modeling using a variety of machine-learning algorithms, as well as methods for handling non-detects and missing data, to maximize the predictive accuracy of water quality models while not over-fitting the training data which leads to poorer predictions. This package will be a general analytical tool that can be used for a large variety of site-specific modeling questions, e.g., at recreational beach sites, shellfish harvesting areas, or public drinking water intake locations.

Partners: Depts. of Environmental Protection (KY, MA, ME, NJ, PA and WV); Depts. of Environmental Management (AL and RI); CT Dept. of Energy & Environmental Protection; DE Dept. of Natural Resources and Environmental Control; Depts. of Natural Resources (GA, MD and Red Lake Nation (tribal)); MA Dept. of Fish & Game; NH Dept. of Environmental Services; Depts. of Environmental Conservation (NY and VT); Depts. of Environmental Quality (NC and VA); SC Dept. of Health & Environmental Control; TN Dept. of Environment & Conservation; VA Dept. of Game and Inland Fisheries; Susquehanna River Basin Commission; TN Valley Authority
Challenge: Develop a baseline monitoring network to detect long-term trends
Resource: Technical support to states and tribes through workshops and stream monitoring network development, in collaboration with the U.S. Forest Service and the U.S. Geological Survey
Project Period: 2012 – Present

"As an interstate agency, the Susquehanna River Basin Commission (SRBC) certainly recognizes the value of the regional partnership EPA has assembled to address the need for collecting the data necessary for detecting changes to water quality and aquatic life communities over time, especially as it relates to any regional trends that may result from climate change effects. The establishment of an effective regional network is a bigger task than any single agency can undertake given the resources involved, and EPA's staff provided the needed leadership to establish and guide the partnership, as well as the scientific expertise on the study methods for characterizing any future changing conditions." – SRBC Executive Director Andrew Dehoff

EPA ORD is working with regional offices, states, tribes, river basin commissions and other entities to establish Regional Monitoring Networks (RMNs) for freshwater wadeable streams. The objectives of the RMNs are to collect long-term biological, thermal, hydrologic, physical habitat and water chemistry data to document baseline conditions across sites and detect long-term changes. Consistent methods are being used to increase the comparability of data, minimize biases and variability, and ensure that the data meet data quality objectives. Continuous sensors are being employed when possible. RMN surveys build on existing state and tribal bioassessment efforts with annual sampling of a limited number of sites that can be pooled at a regional level.

Pooling data enables more robust regional analyses and improves the ability to detect trends over shorter time periods. The collaborations across states, tribes and other entities resulted in the development of RMNs, some of which have collected data since 2012. Recently, EPA Regions 1, 2, 3 and 5, in coordination with their states and tribes, began developing RMNs for lakes and wetlands with the same objectives as the stream RMNs. EPA is also working to expand the Wetland RMN in Regions 1, 2, 3, and 5 and continues to develop the Flow Photo Explorer in collaboration with USGS, adding imagery from different stream types as well as lakes and wetlands. Additionally, EPA is working on an Interagency Agreement with the National Park Service to conduct thermal tolerance analyses for their data in their Eastern Region.

RMN data can be used for many purposes, over short and long-term timeframes. These applications include informing water quality and biological criteria development and protection planning priorities, refining lists of biological, thermal and hydrologic indicators, and detecting trends in commonly used water quality and biological indicators. The RMN data also are important for detecting climate change effects in the context of biomonitoring. There are a number of climate change projections that are relevant to aquatic life condition, including increasing temperatures and changing frequency and magnitude of extreme precipitation events and frequency of summer low flow events. Managers will be able to use the monitoring data to help inform adaptive management. Read the final report on *Regional Monitoring Networks (RMNs) to Detect Changing Baselines in Freshwater Wadeable Streams.*

Partners: Ohio River Valley Water Sanitation Commission (ORSANCO), an interstate commission representing 8 states (Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia), US Army Corps of Engineers, USGS, and the Delaware River Basin Commission.
Challenge: Providing information to water utilities that will inform operating decisions and minimize impacts on water users resulting from spills and extreme low flows as a result of climate change within U.S. waterways and coastal estuaries.
Resource: River Spill model in collaboration with Global Quality Corp.
Project Period: 2016 – Present

"The River Spill model has been used on several recent spills on the Ohio river and has predicted the actual times and concentrations very well. If accurate spill and river condition data is fed into the River Spill model, the model seems to accurately predict the resulting conditions downstream."
– ORSANCO Technical Program Manager Sam Dinkins

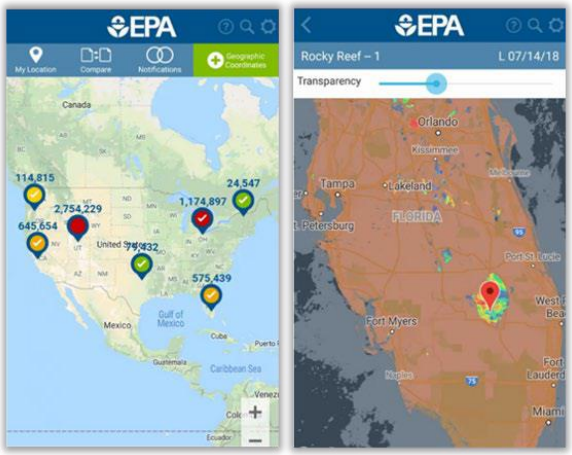
There are 25,000 navigable miles of inland waterways within the contiguous U.S., which transport an estimated 630 million tons of commodities valued at $73 billion annually. There are also hundreds of drinking water intakes that supply drinking water to 66% of American water consumers. Spills within U.S. waterways can threaten safe drinking water supplies, fire protection, commerce, and critical navigation activities.

Given this challenge, EPA ORD researchers developed a web-based advanced River Spill Modeling System (RSMS) software that enables accurate two-dimensional modeling of spills in rivers. RSMS helps utilities decide if they should close their intake, add additional treatment, or access alternative water supplies, if available, while the worst of the spill plume passes. RSMS uses real time and predicted river flows and velocities collected and distributed by the U.S. Geological Survey and the U.S. Army Corps of Engineers, and it can be run in a web-browser on a computer or handheld device. RSMS captures the effect of dead-zones along the river-banks and leverages real-time river data updates. That functionality is not available elsewhere in the Federal government. RSMS uses the Lagrangian numerical modeling approach and that avoids the fake dispersion effects seen in all other models that use the Eulerian numerical modeling approach. The ability to avoid "numerical dispersion" is critical for estimating the plume leading edge, trailing edge travel time, and peak contaminant concentration to support the intake shut-off related decision-making.

RSMS has been used by ORSANCO on spills that occur on the Ohio River and its tributary system for many years. The results indicate good correlation between the model and actual spill conditions. RSMS was used successfully by ORSANCO to model the East Palestine spill. Global Quality Corp. has provided cloud-based hosting and technical support for RSMS. RSMS is also being adapted to work on other river systems such as the Delaware River and the Des Moines River.

Future enhancements to the River Spill Model include adding layers of GIS data such as bridge crossings, pipeline crossings, real-time barge traffic, and locations of oil and chemical refineries.

Partners: State environmental agencies or health departments
Challenge: Support the environmental management and public use of U.S. lakes and reservoirs by providing a capability of detecting and quantifying cyanobacteria harmful algal blooms using satellite data records
Resource: Satellite-derived measures of cyanobacteria, software and training in collaboration with the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Geological Survey (USGS)
Project Period: Sentinel-3 satellite 2015 – 2023, Sentinel-2 satellite 2024+



"The images we've been receiving through the CyAN project have been tremendously helpful to the Utah DEQ Division of Water Quality (DWQ), providing the foundation for a wide range of useful outputs. It allows DWQ to better target field sampling and more efficiently use our limited resources to protect public health. Finally, images are easily shared with response agencies as a useful visual communication aid." – Utah Department of Environmental Quality, DWQ Standards & Technical Services Section Manager Benjamin Holcomb

Cyanobacteria blooms are an environmental and human health problem across the U.S. They are capable of producing toxins, odors, and surface scum that threaten the health of humans and animals, the quality of drinking water supplies, and the ecosystems in which they develop. Improving the detection process would help state environmental and health agencies better determine whether to post public advisories to protect aquatic and human health.

The Cyanobacteria Assessment Network (CyAN) project is a multi-agency effort among EPA, NASA, NOAA, and USGS to develop an indicator system using historical and current satellite data to quantify the temporal frequency, spatial extent, and magnitude of blooms in U.S. lakes. CyAN is providing daily and weekly cyanobacteria monitoring data to state environmental and health departments from the European Space Agency Sentinel-3 satellite, training opportunities, and software applications. As part of the CyAN project, EPA developed the CyAN app and CyANWeb, easy-to-use and customizable applications that provide access to algal bloom satellite data for over 2,000 of the largest lakes and reservoirs across the United States. Annual metrics that quantify the spatial extent, temporal frequency and occurrence as well as the original satellite data are publicly available through EnviroAtlas, Report on the Environment, and NASA's Ocean Color Web. These interfaces help local, state, and tribal water quality managers make faster and better-informed management decisions related to cyanobacterial blooms. During the CyAN app and webapp development, many partner states listed above participated in beta testing.

The original project concludes in 2023 and will transition in 2024 toward applying higher resolution Sentinel-2 Multi-Spectral Imager that can provide measures of chlorophyll in more than 270,000 lakes and all estuaries, adding US Army Corps of Engineers as a fifth federal partner. While the Sentinel-3 portion of the project will conclude, the data will continue to be made publicly available and reprocessed annually. CyAN will continue to engage states for feedback and testing.

WATER – STORMWATER

Partner: Ouachita River Valley Association, Cities of Monroe/West Monroe and Ouachita Parish (LA)
Challenge: Quantifying the true benefits of the Ouachita River ecosystem
Resource: Ecosystem services assessment, based on quantifying domains of human well-being, as a method for linking the ecosystem services provided by the Ouachita River to community priorities
Project Period: 2017 – 2020

"This study will be the first step in putting a true value on the Ouachita River….Currently, the Army Corps of Engineers only recognizes a river's value based on its transport tonnage….The Ouachita River is a source of potable water for the region or is a receiving body for the hundreds of commercial and public discharges into the river. This economic impact study will present the Ouachita River's true value, aiding in our efforts to obtain funding for all aspects of the river." – Ouachita River Valley Association Randy Denmon

While the Ouachita River offers economic, infrastructure and natural benefits to surrounding communities, the region and its cities, Ouachita Parish includes some of the most flood-affected areas in Louisiana. Waterways across the nation, including the Ouachita, are also facing reduced funding for river maintenance and bank stabilization. Resulting floods affect ecosystem services that provide recreational and economic benefits to rural areas. With decision support from EPA, the cities of Monroe and West Monroe explored ways to enhance community resiliency in the face of historic flooding along the Ouachita River.

EPA ORD, in partnership with the EPA Region 6 (South Central), convened a series of workshops in 2018 and 2019 for 35 participants representing federal agencies, community stakeholder groups, state and local government agencies, and universities. Together, these stakeholders prioritized flood mitigation projects along the Ouachita River that were expected to have the greatest benefit to human well-being. Their work was framed by EPA's Human Well Being Index, which helped participants evaluate the specific ecosystem goods and services the Ouachita River offers their community (such as water supply, storm-water discharge, and navigational, recreational, and educational opportunities). The project results were published in a report that now serves as a planning roadmap for flood resilience along the Ouachita River and a decision-making guide for federal, state, and local officials. Future phases of the work will determine the resilience outcomes of the selected projects as the community enjoys improved ecosystem goods and services and improved resilience against future floods.

Partners: Proctor Creek Watershed (in Atlanta, GA) residents and stakeholders
Challenge: Develop an easy-to-use resource that addresses community-identified concerns in the watershed
Resource: Interactive, online tool that provides environmental resources and important watershed information
Project Period: 2017 – 2020

"For years, Proctor Creek residents have elevated community concerns about environmental and health challenges in the watershed and invested decades of sweat equity to address those concerns. This Story Map helps to tell some of that story by centering both historical and ongoing challenges that have, in the past, and continue to plague the watershed today. Perhaps more importantly, it also offers tools that community members can pursue, in collaboration, with government and other stakeholders to help achieve a swimmable, fishable, playable Proctor Creek and a restored community and people." – West Atlanta Watershed Alliance, Co-Founder and Board Chairperson Na 'Taki Osborne-Jelks

Proctor Creek is an impaired waterway in Atlanta that experiences several overlapping environmental issues. The watershed has been troubled by frequent flooding, erosion, stormwater runoff, and pollution from illegal dumping. In addition, sewer overflows from the city's combined sewer system, which terminates in pipes that mix sewage and rainwater runoff with those from its sewage-only sanitary sewer system, have impacted the creek.

Beginning in 2017, EPA ORD researchers collaborated with EPA Region 4 (Southeast) to engage with residents and stakeholders in Proctor Creek to identify and address community concerns related to the local environment. A major outcome of the collaboration was the development of The Proctor Creek Watershed Story Map—an easy-to-use, interactive online tool that combines maps with narrative text, images, and multimedia content. Users can use the Story Map to explore concerns—such as flooding and water quality, urban heat islands, mosquitoes, and health—in the context of the potential for green infrastructure to provide solutions. Green infrastructure is a practice that uses plants, soils, and other natural features to manage wet weather impacts and reduce and treat stormwater at its source. Using green infrastructure can reduce a community's exposure to harmful substances and conditions, such as water pollution, flooding, air pollution, and heat. Green infrastructure can also provide opportunity for recreation and physical activity, improve safety, and promote community identity and a sense of well-being.

Since its release in 2020, the Story Map has been used to help community members engage as stewards of their watershed. The tool provides information and resources that the community can use to: 1) gain a better understanding of flooding, urban heat islands, mosquitoes, and green infrastructure and their impacts on health; 2) support efforts to address these issues within the watershed; 3) advocate for green infrastructure and health; and 4) help inform future decisions around green infrastructure, including areas in the Proctor Creek community that may benefit most from green infrastructure practices.

Read the fact sheet and news release on the Proctor Creek Story Map.

Partners: Minnesota Department of Health; University of Minnesota
Challenge: Obtaining water quality data and best technologies for informing processing and treating stormwater reuse
Resource: Water quality assessments of stormwater harvested for landscaping and agricultural irrigation near four midwestern towns
Project Period: 2019 – 2020

"This project will help Minnesota to keep moving forward with stormwater reuse as a tool to conserve water resources and improve surface water quality while protecting public health."
– Minnesota Department of Health, Engineer Anita Anderson

There is limited data to determine the suitability of stormwater for direct reuse in surface irrigation systems, either on a commercial or residential scale. In locations with limited infiltration capacity or stressed water supplies, water reuse can conserve resources and benefit surface water quality. However, it is also important to ensure that reuse projects are implemented in ways that protect human health and the environment.

EPA ORD, in collaboration with the Region 5 (Great Lakes) and the Minnesota Department of Health, planned and implemented stormwater sampling events to determine water quality impacts on irrigation and agricultural stormwater reuse. Specifically, stormwater samples were collected in Chicago, IL; Cincinnati, OH; Cleveland, OH; and Minneapolis, MN, in August 2019 for physical, chemical and microbial indicators and in October 2020 for pathogen samples. Samples were collected from various collection areas including 1) rooftop water collection tanks, 2) permeable pavement catch basins, 3) mixed use (roofs, parking lots) urban underground cisterns and storage tanks, and 4) mixed use (roofs, vegetated lands) suburban ponds and farm wetlands. Reuse site characteristics of interest include age, tributary area, land use, end-use of water, size and type of storage, and type of treatment (e.g., sediment screens, filtration, chlorination, ultraviolet disinfection).

The research provided relevant information on the extent of physical, chemical and microbial contamination of reuse waters and the effectiveness of filtration and disinfection technologies to reduce public health risks.

WATER – WASTEWATER/WATER REUSE

Partners: State of California and San Francisco Public Utilities Commission (SFPUC)
Challenge: Providing sufficient, quality water to meet increasing demands
Resource: Assessment modeling for introduction of novel water reuse technologies
Project Period: 2017 – Present

"SFPUC values the support EPA ORD provides to both SFPUC and the NBRC. Their research is targeted and relevant to the needs of the decentralized water systems community, and their unbiased and engaged expertise is an extremely valuable part of the guidance and recommendations we produce."
– SFPUC, Director of Water Resources Paula Kehoe

Climate change stressors (e.g., drought, sea level inundation, flooding) and challenges in maintaining centralized water infrastructure has led to increasing development of new approaches to water systems coupling reuse and decentralization. Cities and states need to provide clear guidance on treatment requirements for these new treatment systems, as well as better understand the most cost-effective, sustainable approaches for implementation of decentralized water reuse. The San Francisco Public Utilities Commission (SFPUC) leads an effort to implement decentralized non-potable water systems that involves a group of stakeholders from across the country, including a range of water utilities (Austin, Denver, Los Angeles, Portland, Seattle and Washington, DC) and public health departments (California, Colorado, Hawaii, Minnesota, Washington and New York City).

EPA ORD is assisting the efforts of this group, called the National Blue Ribbon Commission on Onsite Water Systems (NBRC), by developing and assessing the risk-based log reduction targets related to fit-for-purpose water use. Initial ORD research directly supported a 2017 report by the NBRC, and continued refinements in ORD risk modeling are reflected in a 2023 NRBC update. In April 2024, ORD collaborated with the NBRC and the WateReuse Association to develop and conduct a summit which included over 40 presenters and 200 attendees from across the country to share experiences associated with implementing onsite water reuse systems. One outcome of the summit was an action plan for accelerating the adoption of onsite water systems These documents, as well as others generated by the NRBC, can be found at: https://www.epa.gov/waterreuse/onsite-non-potable-water-reuse-resources

ORD work also involves assessment of the life cycle costs, and potential environmental (particularly energy) and human health impacts, of onsite water systems. This work provides state and various utilities and public health departments with a system-level approach and framework to quantitatively evaluate the tradeoffs that exist among alternative processes and identify which configuration delivers a robust and sustainable water system design. This includes an on-line tool for conducting these life cycle analyses for buildings of various sizes at any zip code in the continental US.

More information on EPA's research on non-potable water reuse can be found at: https://www.epa.gov/water-research/onsite-non-potable-water-reuse-research.

Partners: NC Department of Environmental Quality, City of Charlotte, City of Raleigh
Challenge: Acceptance of bio-contaminated wastewater by Publicly Owned Treatment Works (POTWs)
Resource: Technical support around pathogens in wastewater infrastructure
Project Period: 2014 – Present

"The question of how wastewater plants deal with bio- contaminated waste needs to be addressed before a potential health emergency surfaces. EPA's proactive work to assist wastewater operators before the next emergency occurs is not only prudent, but critical in order to protect public health." – NC DEQ former Assistant Secretary Sheila Holman

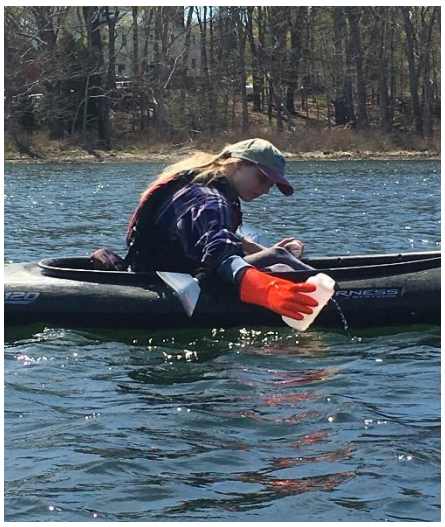
In October 2014, EPA held a forum on high consequence pathogens in wastewater infrastructure for state and POTW representatives. The forum focused on providing recommendations, technical information, and potential solutions to the wastewater industry, particularly for emergencies.

The forum was organized around the following questions: How do we deal with wastewater contaminated with biological agents such as *Bacillus anthracis* or Ebola virus? What is needed/required for utilities to accept bio-contaminated wastewaters? What sorts of tests, protocols and regulatory guidance are needed? What is needed for permit authorities in NC to guide/allow utilities to accept these wastes? How should these (tests, protocols, and regulatory guidance) be designed or implemented? Who should design and evaluate these? Are there other "simpler" tests and protocols? What is needed to address concerns and issues raised by the public, wastewater workers and operators? What are the data gaps and what type of research is needed?

As a result of this forum, EPA and the Water Environment Research Foundation (currently known as the Water Research Foundation) held a national workshop on this topic in 2016. In turn, this led to several research projects being planned and implemented to address the key research gaps and needs brought up in the workshop. Read the published report from the 2016 workshop titled *Collaborative Workshop on Handling, Management, and Treatment of High-Consequence Biocontaminated Wastewater by Water Resource Recovery Facilities.*

Since then, EPA is investigating data needs that, if filled, would assist wastewater plant operators in making decisions about whether and how to accept wastewater contaminated with high consequence pathogens (e.g. anthrax bacteria, Ebola virus) during an emergency. EPA is also in the process of performing research projects to address needs associated with POTW acceptance of wastewater potentially contaminated with such pathogens.

Partner: Town of North Kingstown (RI) Departments of Water and Public Works
Challenge: Assessing the impact of sewering on coastal water quality
Resource: Technical support in collaboration with the U.S. Geological Survey (USGS)
Project Period: 2018 – 2024



"The town of North Kingstown's main village, Wickford, is a densely settled area on the coast with many houses built between 1780 to 1830. Although direct discharges to the water and most of the cesspool systems have been eliminated, rising sea level and older, inefficient septic systems continue to impact the receiving waters. Sanitary sewers to the business district of the village are being installed. The town needs help persuading residents of the need to extend sewers to the residential areas. The analysis and assessment by the EPA showing improvement of the water quality would really drive the importance of sewers." – North Kingstown Town Engineer N. Kim Wiegand, PE

Many areas rely on septic systems installed at individual homes and businesses to treat most of their wastewater. These systems were designed primarily to remove harmful bacteria, and most allow the bulk of the nutrients, especially nitrogen, in the waste to flow via groundwater into streams, ponds or coastal waters where they can cause problems such as low dissolved oxygen (which can harm fish populations) and nuisance or harmful algae blooms. To solve this problem, many coastal communities are installing sewers to intercept, treat and discharge the waste to less sensitive areas. These projects are expensive for taxpayers and few studies have documented the beneficial effect of sewering on water quality in the receiving waters, which is of interest to communities that invest in them.

Wickford, a small village in North Kingstown, RI, is in the process of installing sewers and hoping to secure and maintain support for their project within the community. EPA ORD researchers have sampled the waters around the town since early 2018, measuring nutrients, dissolved oxygen and several tracers of wastewater and in a collaboration with EPA Region 1 (New England) and USGS starting in 2020, mapping and modeling groundwater and associated nutrient flow into the cove system around Wickford. While it is too early to assess if water quality is improving, EPA ORD and its partners are creating a baseline for comparison after the sewering is finished. EPA ORD is working with the Town of North Kingstown to document the progress of the sewering and remediation of water quality problems in the coves surrounding Wickford (e.g., algae covering cove bottoms and low dissolved oxygen conditions, particularly at night during the summer), and to develop educational materials about the impact of nutrients on coastal waters and the impact of sewering in the coves around Wickford. Eventually the town will use the generated data to determine if sewering has improved local water quality and demonstrate to residents how their investment is paying off in terms of local environmental improvement.

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Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

MARYLAND

Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)
Environmental DNA (eDNA) for species inventory (CA, KY, MD, WV)
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)
Atmospheric deposition of nitrogen (DE, DC, MD, VA, WV)

MASSACHUSETTS

Determining extent of contaminant impacts
Evaluating non-traditional approaches for reducing excess nutrients entering Cape Cod's coastal waters
Technical support to identify and quantify ecosystem services (AL, MA, PA, PR)
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)
Decontaminant testing to effectively degrade fentanyl and its analogs (IN, MA, MI)

MICHIGAN

Using water filters to reduce lead in drinking water
Evaluating next generation emission measurement technologies to quantify landfill air emissions

Sampling and analysis of PFAS in fume suppressants at electroplating facilities
Sharing latest advances in PFAS destruction research and technologies
Lake Michigan's ozone formation and transport (IL, IN, MI, MN, OH, WI)
Crowdsourcing innovative solutions for non-thermal way(s) to destroy PFAS in concentrated firefighting foam (CO, MI, all states)
Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)
Decontaminant testing to effectively degrade fentanyl and its analogs (IN, MA, MI)

MINNESOTA

Screening and prioritizing chemicals to protect public health
Tapping data from the latest innovations in toxicology to advance chemical risk assessments
Evaluating risk of aquatic contaminants
Modeling bioaccumulation of PCBs and mercury in fish
Remediation to Restoration to Revitalization (R2R2R) to improve Pickle Pond (MN, WI)
Lake Michigan's ozone formation and transport (IL, IN, MI, MN, OH, WI)
Obtaining water quality data to inform processing and treating stormwater reuse (MN, OH)
Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)

MISSISSIPPI

MISSOURI

MONTANA

Planning framework for protecting commercial building occupants from smoke during wildfire events

NEBRASKA

NEVADA

NEW HAMPSHIRE

Suitable groundwater remediation
Thermal remediation of waste oils
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

NEW JERSEY

Determining scope of PFAS contamination
AirNow Fire and Smoke Map (Northeast and Mid-Atlantic states)
Exploring the cause of persistent high ozone in the New York City region (CT, NJ, NY)
Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

NEW MEXICO

Gold King Mine Spill local waterways/sediments sampling

Development of Biological Condition Gradient models to advance assessment of non-wadeable rivers

Persistent environmental health disparities research (AZ, CO, NM, UT)

NEW YORK

Understanding VOC and air emissions from PTFE product manufacturing facilities

Exploring the cause of persistent high ozone in the New York City region (CT, NJ, NY)

Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)

Applications of the Water Network Tool for Resilience to assess drinking water systems' resiliency to natural disasters (NY, VI)

Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)

NORTH CAROLINA

GenX PFAS contamination in the Cape Fear River

Removing PFAS from community drinking water with granular activated carbon

Mapping PFAS levels

Science, Technology, Engineering, and Math (STEM) education

Evaluating filtering and disinfection efficiency of various face coverings

Acceptance of bio-contaminated wastewater

Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NC, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

Smoke Sense mobile app translated into Spanish (NC, WA)

NORTH DAKOTA

OHIO

Remediation and restoration of Great Lakes Areas of Concern

Elevated temperatures at a municipal landfill

Monitoring levels of SARS-CoV-2 in sewage to assess community infection rate

Managing excessive nutrient runoff causing HABs

Lake Michigan's ozone formation and transport (IL, IN, MI, MN, OH, WI)

Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)

River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)

Obtaining water quality data to inform processing and treating stormwater reuse (MN, OH)

OKLAHOMA

Impacts of Enhanced Aquifer Recharge (EAR) on groundwater quality and quantity

Long-term performance evaluation of popular air sensor types at locations across the U.S. (AZ, CO, DE, GA, OK, WI)

OREGON

Heavy metal soil contamination from past mining activity

Coastal acidification effects on fisheries

Water nitrate contamination

PENNSYLVANIA

Technical support to identify and quantify ecosystem services (AL, MA, PA, PR)

Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)

PUERTO RICO

Technical support to identify and quantify ecosystem services (AL, MA, PA, PR)

RHODE ISLAND

Assessing the impact of sewering on coastal water quality

Exploring the cause of persistent high ozone in the New York City region (CT, NJ, NY, RI)

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

SOUTH CAROLINA

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

SOUTH DAKOTA

TENNESSEE

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

TEXAS

UTAH

Emissions measurement methods (UT, CO, WV)

Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)

Persistent environmental health disparities research (AZ, CO, NM, UT)

VERMONT

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

VIRGIN ISLANDS

Applications of the Water Network Tool for Resilience to assess drinking water systems' resiliency to natural disasters (NY, VI)

VIRGINIA

Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)

Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)

River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)
Atmospheric deposition of nitrogen (DE, DC, MD, VA, WV)

WASHINGTON

Chemical exposures via seafood consumption
Remedial investigation/feasibility study technical support
Watershed condition improvements
Passive remediation alternative (ID, WA)
Smoke Sense mobile app translated into Spanish (NC, WA)

WEST VIRGINIA

Emissions measurement methods (UT, CO, WV)
Environmental DNA (eDNA) for species inventory (CA, KY, MD, WV)
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)
River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)
Atmospheric deposition of nitrogen (DE, DC, MD, VA, WV)

WISCONSIN

Remediation to Restoration to Revitalization (R2R2R) to improve Pickle Pond (MN, WI)
Lake Michigan's ozone formation and transport (IL, IN, MI, MN, OH, WI)
Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)
Long-term performance evaluation of popular air sensor types at locations across the U.S. (AZ, CO, DE, GA, OK, WI)

WYOMING

MJLTISTATE

AirNow Fire and Smoke Map (Northeast and Mid-Atlantic states)
Exploring the cause of persistent high ozone in the New York City region (CT, NJ, NY, RI)
Lake Michigan's ozone formation and transport (IL, IN, MI, MN, OH, WI)
Emissions measurement methods (UT, CO, WV)
Reducing harmful air pollutants (CA, GA, MD, NC, NJ, NY, UT, VA)
Listening sessions with state, local, and tribal representatives to discuss research needs concerning wildland fires (AK, AZ, CA, CO, ID, MT, ND, NM, NV, OR, SD, UT, WA, WY)
Persistent environmental health disparities research (AZ, CO, NM, UT)
Environmental DNA (eDNA) for species inventory (CA, KY, MD, WV)
Predicting water quality at beaches (IL, IN, MI, MN, NY, OH, PA, WI)
Stream monitoring network (AL, CT, DE, GA, KY, MA, MD, ME, NV, NH, NJ, NY, PA, RI, SC, TN, VA, VT, WV)
River Spill model (IL, IN, KY, NY, OH, PA, VA, WV)
Satellite derived measures of cyanobacteria (AR, AZ, CA, CO, FL, ID, IO, KS, KY, LA, MO, ND, NY, OH, OR,

PA, RI, SC, SD, TN, UT, VT, WA, WI and WY)

Atmospheric deposition of nitrogen (DE, DC, MD, VA, WV)

Wildfire Smoke Air Monitoring Response Technology Pilot (multistate)

ALL STATES

Resources and education for preventing and managing cyanobacterial blooms

One Health collaborations with state environmental, health, and fish & wildlife agencies

Resources and education for understanding microplastics

Addressing contaminants of emerging concern

Crowdsourcing innovative solutions for non-thermal way(s) to destroy PFAS in concentrated firefighting foam

State-federal dialogue and presentations on evolving PFAS science

Collaborative projects with state environmental health experts

Risk assessment training

Resources for small drinking water systems

Need for improved understanding of the current science regarding PFAS

Improving the value of participatory science data in environmental decisions