Findings of the 2020 Biennial ERIS Survey on State Environmental Agency Research Needs

Introduction

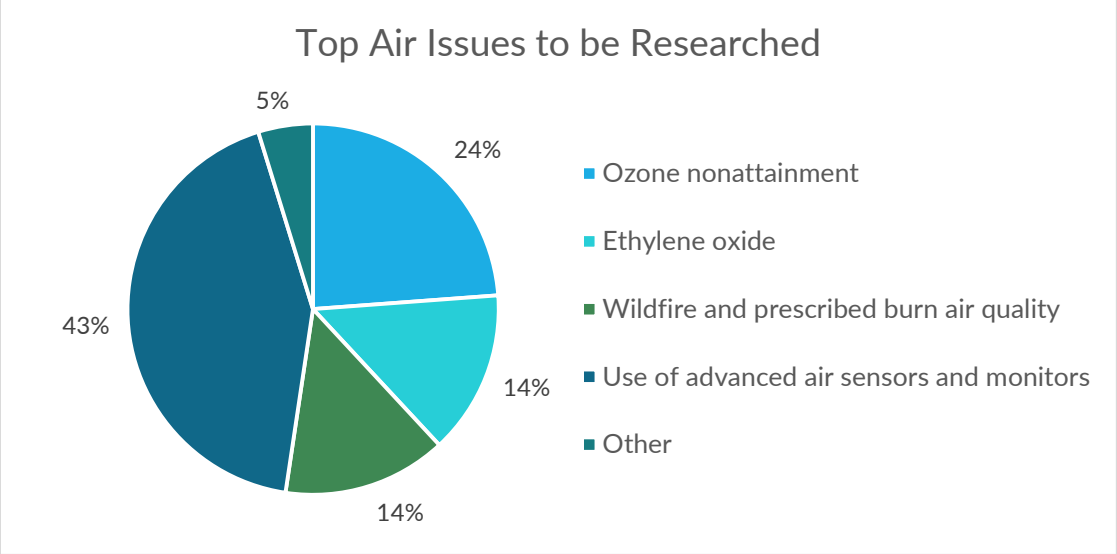
In August 2020, the Environmental Research Institute of the States (ERIS) conducted its fourth biennial survey of state environmental agency research needs. The results help ERIS identify the key research priorities of states to be conveyed to U.S. Environmental Protection Agency (EPA) Office of Research and Development and other federal partners.

This year's survey asked state environmental agency leaders to identify their top challenges and/or priorities requiring additional research in the areas of air quality, drinking water, water quality, waste and remediation, cross-media, and per- and polyfluoroalkyl substances (PFAS). In each category, respondents chose from among four to five options and had the opportunity to describe "other" challenges. Forty-three states and territories responded to the survey.

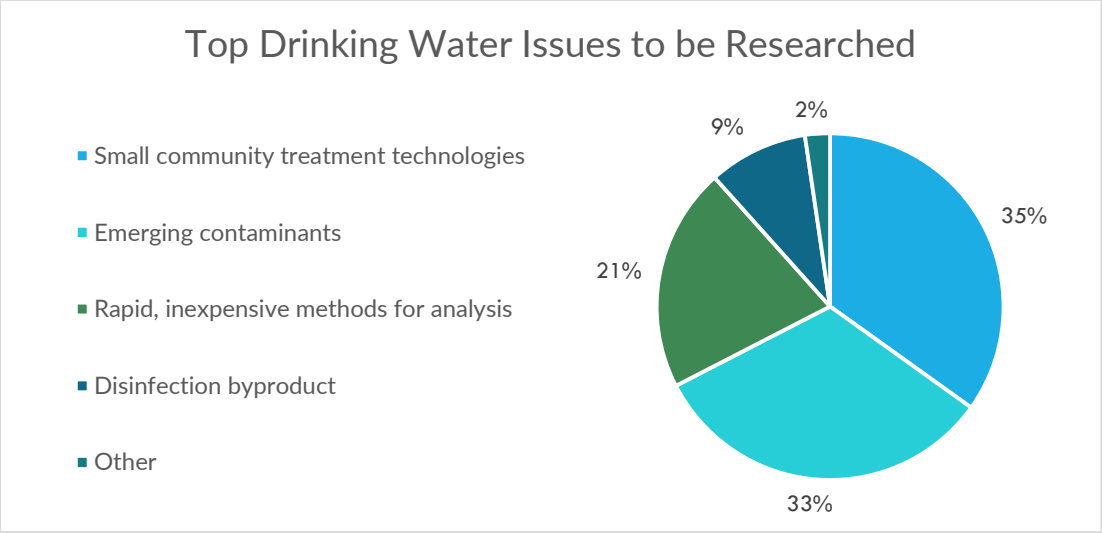
Throughout the fall, ECOS staff spoke with state environmental agency subject-matter experts to gather details on the research needs identified by their directors. Below is a compilation of the information gathered from the survey and of findings from follow-up conversations.

Summary

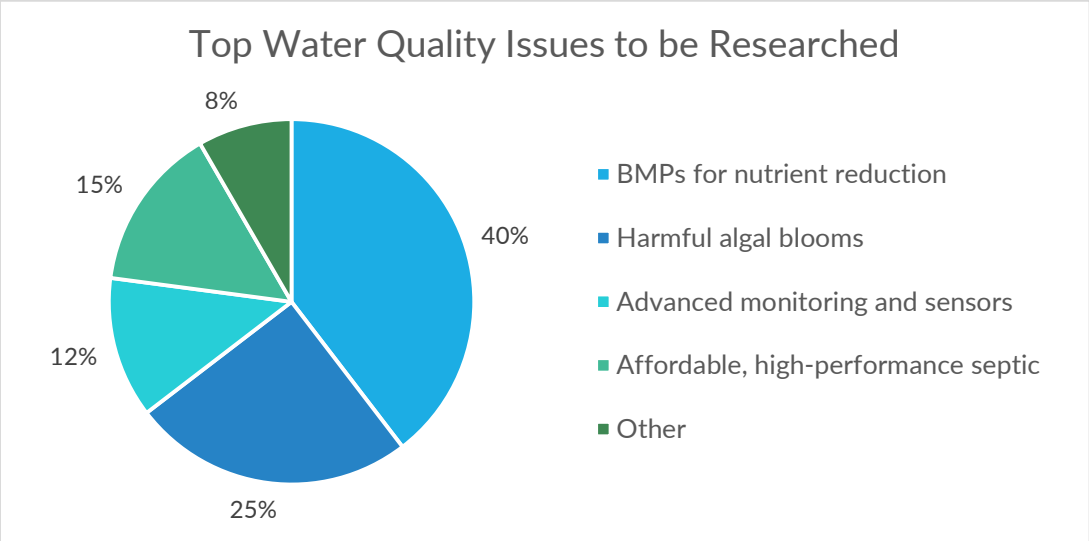
These pie charts reflect the percent of state agency leaders who identified each issue as a challenge and/or priority requiring additional research in specified environmental media. Each issue is explained in more detail following this summary.



The use of advanced air sensors and monitors is seen as the top air issue needing more research, with 43% of state environmental agency leaders selecting it as a top challenge and/or priority. That issue is followed by ozone nonattainment (24%); ethylene oxide and air quality around wildfires and prescribed burns (14% each); and "other" air issues (5%).

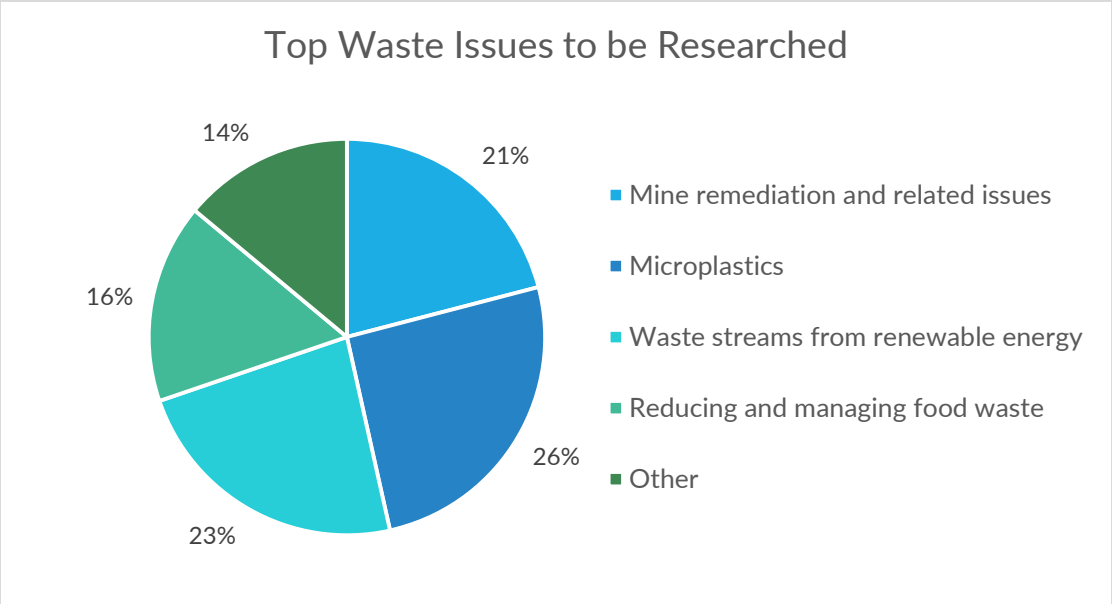


Treatment technologies for small communities are viewed as the top drinking water issue needing more research, with 35% of state environmental agency leaders selecting it as a top challenge and/or priority. That issue was closely followed by emerging contaminants (33%); rapid, inexpensive methods for analysis (21%); disinfection byproducts (9%); and "other" drinking water issues (2%).

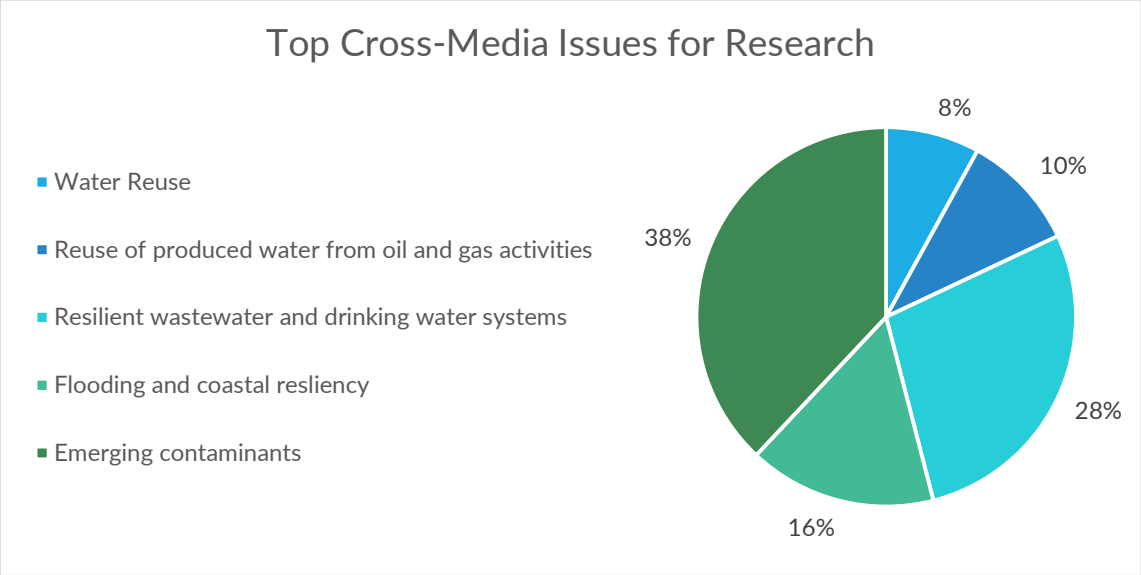


Best management practices for nutrient reduction are the top water quality issue needing more research, with 40% of state environmental agency leaders selecting it as a top challenge and/or priority. That issue was followed by harmful algal blooms (25%); affordable, high-performance

septic systems (15%); advanced monitoring, sensors, and technologies (12%), and "other" water quality issues (8%).



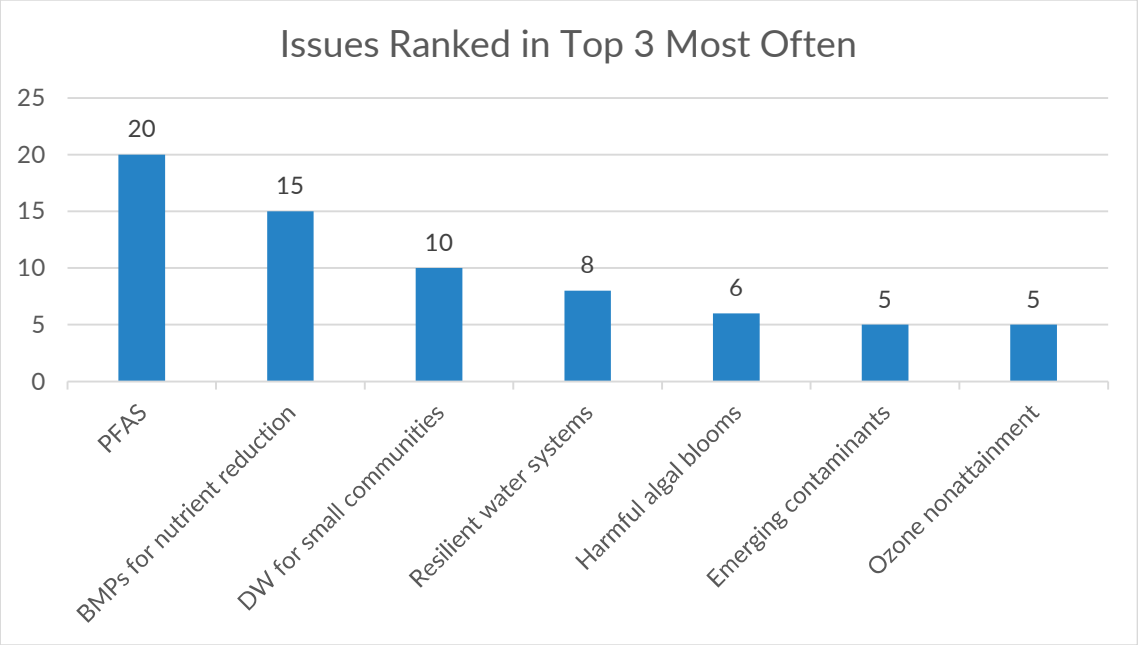
In the ranking of waste challenges requiring more research, microplastics top the list (26%), followed closely by waste streams from renewable energy (23%); mine remediation and related issues (21%); reducing and managing food waste (16%); and "other" waste issues (14%).



Emerging contaminants are viewed as the top cross-media issue needing more research, with 38% of state environmental agency leaders selecting it as a top challenge and/or priority. That issue was followed by resilient wastewater and drinking water systems (28%); flooding and coastal resiliency (16%); reuse of produced water from oil and gas activities (10%); and water reuse (8%).

As PFAS impacts numerous media, ECOS simply asked whether it was a state priority and what research would be most helpful. All 43 respondents said it was a priority, and identified research needs are described in the Details on PFAS Research Needs section.

At the end of the survey, 39 of the 43 respondents ranked their top three areas of research need across all environmental media. This bar graph below shows that PFAS, best management practices for nutrient reduction, and drinking water for small communities are the most critical areas requiring research assistance, followed by resilient water systems, harmful algal blooms, emerging contaminants in general, and ozone nonattainment.



Details on PFAS Research Needs

State environmental agencies would like EPA to research and provide information on the human health and ecological impacts of specific common PFAS compounds and to identify less-studied PFAS including replacement compounds that may present health risks. Specifically, states seek **human health, environmental, and ecological risk and impact research** such as:

- New and updated toxicity data;
- Biomagnification studies;
- Dermal and inhalation health effect studies;
- Land-applied biosolids impact research;
- Cumulative risk and effects of exposure to multiple PFAS research;
- Inhalation and dermal exposure risk assessments; and
- Toxicology data and quantification of exposure to PFAS in media beyond drinking water, including soil, air, fish, shellfish, and other foods.

States would also like EPA to provide more information and research related to the **fate and transport of PFAS** in the environment including:

- More data on PFAS persistence and movement in the environment;
- Fate and transport of PFAS via land application of biosolids;
- Migration of PFAS through waste mass at landfill and leachate from landfills;
- Incineration and managing disposal;
- Soil to groundwater transport and interactions; and
- Partitioning of PFAS compounds in surface water—what ends up in sediment and what stays in the water column in both freshwater and estuarine systems.

States identified additional **sampling and monitoring methods and techniques** that would be helpful including:

- Sensitive and affordable total organic fluorine test and test method;
- Standardized lab methods for more PFAS analytes in more environmental media including wastewater;
- Stack air emissions;
- Watershed characteristics and monitoring, including PFAS in fish; and
- "Fingerprinting" information for common PFAS products, industries, and activities.

States seek **PFAS management, treatment, and cleanup techniques** including:

- Technologies for treating drinking water, groundwater, soil and biosolids;
- Cost-effective treatments for smaller water systems and for multiple PFAS;
- Effectiveness analysis of various granular activated carbon (GAC) media for longevity and slope conditions;
- Pilot studies or other data on ion exchange versus. GAC;
- Additional research and information on incineration of PFAS and PFAS-containing sewage sludge to ensure destruction and safe air emissions;

- Summary information on storage, treatment, and disposal options for various PFAS waste streams including efficacy, design, and construction standards, and applicability criteria;
- Information on prevention, management, and remediation of PFAS in leachate plumes at landfills;
- Information on PFAS impacts to soil and water from pelletized biosolids including options for management of pelletized biosolids other than incineration if they are a PFAS-contamination risk;
- Information on treating PFAS at wastewater treatment facilities at a production scale with consistent results;
- Information on sources of PFAS including data on unsafe limits of PFAS in products; and
- Assistance identifying safe, less-toxic alternatives.

States would like EPA to provide more assistance with PFAS **risk communication**.

Details on Air Quality Research Needs

States would like **new air sensors and air sensor information** including:

- Low-cost, field-robust particulate matter (PM) 10 sensors;
- Fully correlated and tested sulfur dioxide (SO_2) sensors;
- Sensors for ground-level formaldehyde;
- Low-cost sensors for wildfires;
- Better sensors for low concentrations of ethylene oxide;
- Better, low-cost sensors for hydrogen sulfide (H_2S) and other odorous compounds;
- Real-time or near real-time, sensitive, low-cost volatile organic compound (VOC) monitors for ambient air;
- More low-cost monitors for air toxics like polycyclic aromatic hydrocarbons and hazardous air pollutants;
- Sensors for measuring and monitoring aero allergens;
- Sensors for environmental justice areas and areas with high concentrations of industry;
- Information on how low-cost sensors perform and deteriorate over time; and
- Algorithms/correction factors for low-cost gaseous sensors to match regulatory monitors.

States identified additional **ozone research** that would be helpful including:

- Formation ozone over large bodies of water during the day that later comes on shore;
- The role of transport in local ozone levels across the country;
- The conditions that cause ozone levels to be driven by VOCs versus nitrogen oxides (NOx);
- Emissions inventory information for mobile sources, minor sources, oil and gas sources, and agricultural burning; and
- Sources, transport, and chemical composition of VOCs in ozone nonattainment areas.

States would like **ethylene oxide research** including:

- The environmental fate and transport of ethylene oxide;
- Improved standardized test method for low concentrations;
- Background levels, other sources, and their contributions to atmospheric concentrations;
- Direct measurement of fugitive emissions during transport of ethylene oxide; and
- Off-gassing following sterilization, especially after equipment leaves a sterilization facility.

States seek additional **wildland fires and prescribed burns research** and information including:

- Health effects of different smoke exposures such as long-term low-level exposure versus short-term high-level exposure, very high-level exposure from large fires, and cumulative effects of multiple exposure events;
- Health effects of wildfire PM 2.5 versus more typical PM 2.5;
- Development of emissions factors for pile burning, and small grass prairie burns;
- Differing chemical constituents of smoke from the burning of developed areas;

- Differing effects of wildfires on PM 2.5 and ozone concentrations;
- Effectiveness of different filters and clean air spaces;
- Models for the effects of multiple wildfires, many prescribed burns, or agricultural burns;
- Longer-term smoke forecasting; and
- Linking satellite smoke data to ground-level ozone across the country.

States identified **air modeling** work that would be useful including:

- Additional ozone modeling to address stagnant conditions in mountain valleys, especially with wintertime ozone chemistry;
- Additional ozone modeling to address the shorelines of major waterbodies;
- Fine-tuning models including Comprehensive Air Quality Model with Extensions (CAMX) to address local meteorology and soil parameters;
- Motor Vehicle Emission Simulator (MOVE) model updates as soon as possible for ozone state implementation plans due in 2021; and
- Additional training of state modelers on the use of various models.

States would like additional **air quality research** including:

- The fate and transport of atmospheric formaldehyde;
- Understanding and measuring cumulative effects of air pollutants;
- Sources of ammonia and NOx;
- The relationship between concentrations of nitrogen dioxide, SO_2, and ammonia in the atmosphere;
- Using more satellite data to identify and measure air pollutants;
- In-field/on-stack efficacy of VOC emissions controls;
- The co-benefits of clean energy on air quality;
- Landfill H_2S and odorous compounds emissions to understand a recent increase in community complaints; and
- Industrial hemp emissions from the fields during growth and from facilities during drying and cannabidiol (CBD) extraction.

States seek **technical assistance** to:

- Use data from the Photochemical Assessment Monitoring Stations (PAMS) Network;
- Develop regional air quality data to help states better understand trends;
- Simplify exceptional event reporting; and
- Develop a database that allows use of community-based monitoring as a screening tool.

States request **communications assistance** on multiple air-related topics including:

- Comparisons between and uses of regulator monitors versus low-cost monitors;
- Similarities and differences in what a one-time instantaneous reading indicates compared to longer-term averages or trends;
- Ethylene oxide risk communication; and
- Risk communication around air pollution including pollutants not visible to the naked eye.

Details on Drinking Water Research Needs

States identified **drinking water treatment challenges** on which they would like additional research including:

- Updated technical standards for GAC to address emerging contaminants;
- Low-cost nitrate treatment options for small systems;
- Alternative disinfection methods like ozone and ultraviolet and how to scale them;
- Options to address disinfection byproducts for small systems;
- Low-cost options to comply with the new Lead and Copper Rule;
- Low-cost arsenic treatment technologies;
- Options to address Legionella and dicyclopentadiene;
- Information on treating harmful algal blooms (HABs) including how to optimize removal and manage byproducts;
- Management options for source water with naturally occurring organics that can be oxidized into brominated disinfection byproducts;
- Information on how to design cost-effective systems to address the water chemistry and contaminants unique to each drinking water system; and
- Surface water monitoring and treatment options for PFAS to keep it out of the system.

States ask that EPA lead or participate in a collaborative effort to **set standards for, review, and validate or certify treatment technologies**. The former Environmental Technology Verification program and current National Sanitation Foundation (NSF) work were identified as examples of the work that should be conducted for all drinking water treatment technologies.

States seek additional research and information on **drinking water monitoring** including:

- Inexpensive HABs early warning systems;
- Comparison of the effectiveness of HABs monitoring and analysis techniques;
- Improved rapid, economical testing methods for emerging contaminants such as manganese, PFAS, and cyanobacteria;
- Simple, affordable, environmentally friendly ways to monitor arsenic and nitrate; and
- Assessment of microbial water quality and distribution systems in buildings.

States would like research on the causes of **disinfection byproducts (DBP) exceedances in consecutive systems** and what actions the purchasing systems can take to reduce DBP issues.

States also would like additional **drinking water and public health research** including:

- More information on the contribution of drinking water to total manganese exposure and its adverse health effects;
- Nutrient fate and transport modeling for nitrate contamination in drinking water;
- More studies on corrosion control, especially for copper;
- Information on managing corrosion control for blended sources that may be treated using differing methods; and

- Research to understand the effect of using a mix of phosphate and orthophosphate products in a water supply.

States request assistance **communicating health impacts and relative risks** of disinfection byproducts to the public.

Details on Water Quality Research Needs

States would like **water quality modeling** work to including:

- Research to expand the applicability of nutrient reduction best management practice models for the Chesapeake Bay beyond the one watershed;
- Studies on nutrient reduction best management practices (BMPs) in various soil types to improve modeling;
- Improving the Spatially Referenced Regression on Watershed Attributes (SPARROW) model for stormwater to provide better predictions;
- More research on the Bayesian model to explain regional differences of lake nutrients;
- Developing a model to predict septic system impacts on waterbody nutrient levels; and
- Ongoing updates to storm models for changing probably maximum precipitation, intensity-duration-frequency, etc.

States also would like research to develop **standard evaluation methods** for the efficiency and effectiveness of nutrient treatment devices.

States seek research and information on **nutrient management** including:

- Edge-of-field measurements such as pounds of nitrogen reduced per year to provide information on effectiveness of different BMPs in varying soil types and climates;
- BMP performance in different situations including on irrigated fields and at golf courses;
- Identification of the most effective BMPs for animal agriculture under varying soil and climate conditions;
- Effectiveness of saturated buffers including edge-of-field infiltration trenches and tile-drainage systems for water-level control;
- Demonstration of local impact of individual actions while also tying them to longer-term effects on larger waterbodies/watershed;
- Measurement of nitrogen conversion and removal in a soil column and its subsequent movement to groundwater and surface water;
- Surface water and groundwater nutrient loading from Concentrated Animal Feeding Operations (CAFOs) and septic systems;
- Watershed scale impacts of timber harvesting on nutrient exports, especially nitrate; and
- Better nutrient source identification at a watershed scale.

States identified research and information on **HABs** that would be useful including:

- Identifying the best options for detecting and monitoring HABs besides chlorophyll such as biota, cell counts, toxin levels, and qPCR;
- Modifying the Cyanobacteria Assessment Network (CYAN) mobile application to expand its use to smaller waterbodies, to predict shoreline conditions, and to tie spectral data to phytocyan cell counts;
- Tracking the movement of blooms due to prevailing winds;
- Identifying drivers of benthic algae HABs besides nutrients;

- Understanding toxin production, persistence, and fate and transport through groundwater;
- Improving predictors and indicators of toxic blooms and their level of toxicity;
- Developing standard laboratory analyses and recreational toxicity values for other toxins including saxitoxin and anatoxin;
- Determining the effectiveness, safety, scalability, ecosystem impacts, and long-term effects of various HABs treatments including copper sulfate and peroxide;
- Identifying HABs triggers besides excess nutrients such as lake stratification, total phosphorous concentration, increased temperatures, droughts, flashier rains, wildfire runoff, and milfoil;
- Developing best practices for using advanced technologies such as unmanned aerial vehicles to conduct environmental surveillance for HABs formation; and
- Developing a central hub on use and effectiveness of treatments and BMPs for HABs.

States ask that EPA support research to develop **affordable, low-maintenance, advanced septic systems** that provide for use in challenging conditions including in cold weather, on small lots, and in tight clay, tundra, frozen soils, and soil that does not percolate well.

States also request the development of a user-friendly **septic system performance evaluation database** that helps users identify the best options for varying conditions or specific needs such as meeting water quality standards or secondary treatment standards at the end of the pipe, and includes information such as the annualized costs and NSF testing.

In addition, states seek work related to **septic systems** that:

- Identifies septic effluent limits need for performance targets to reach groundwater goals;
- Calculates the equivalency of one traditional system to multiple advanced systems; and
- Indicates system failure like high-tech approaches to tank temperature measurement.

States would like new or better ways to **monitor for stormwater impacts and water pollutants** including ocean acidification, near-shore/coastal acidification, bacteria, and microplastics. They would also like better testing methods to use related to multisector general permits for industrial stormwater as identified in a National Academies report.

States seek additional **stormwater pollution research** to:

- Identify the differing effects pollutant concentrations in the first flush versus later runoff;
- Allow for better bacteria source identification;
- Study the interaction of bacteria, phosphorous, and nitrogen;
- Identify BMPs for specific pollutants in stormwater runoff;
- Study methods to keep road surface pollutants from migrating to surface waters; and
- Develop rapid testing methods for metals that are not hindered by stormwater interferences and allow for comparison to surface water quality standards.

States would like other **water quality research** to:

- Allow for the development of technology-based effluent limits for PFAS compounds, 1,4-dioxane, and other emerging contaminants;
- Quantify the relative public health and environmental impacts of various water pollutants; and
- Identify how to use drones or satellite images to map eel grass and sea grass beds.

Details of Waste Research Needs

States would like additional research and information on **mine remediation challenges** including**:**

- Additional studies of options for management of contaminated soils such as in situ treatment;
- Options for passive water treatment without long-term operating and maintenance obligations;
- Water quality impacts from mines including acid mine drainage; and
- Best practices for inventorying and prioritizing abandoned mine lands.

States seek additional **microplastics research** including:

- Fate and transport of microplastics including possible pathways for contamination of various media;
- Information on the chemicals in and attached to the microplastics;
- Impacts of microplastics on public health and ecological systems from both the plastics themselves and chemicals that they absorb or become attached to;
- Best practices for material handling and spill containment;
- Options for removing microplastics from water, solid waste, and other media;
- Information to assist with source identification of microplastics; and
- Comparison of environmental impacts of microplastics and microbeads versus other plastics.

States seek research and information to help them manage **renewable energy waste streams** including:

- Best management, recycling, and disposal options for wind turbines or some components, especially the blades as they are so large;
- Studies on the chemicals present in solar panels;
- Best management, recycling, and disposal options for solar panels;
- Studies of the potential hazards of lithium ion batteries and other high-density power sources;
- Best management, recycling, and disposal options for the new generation of batteries; and
- Studies to identify electronics recycling options and value.

States would like research and information to help them **reduce and manage food waste** including:

- Information on environmentally preferable practices for managing food waste;
- Research on anaerobic digestion including whether it can be environmentally and economically beneficial, and where it should be in the waste management hierarchy;
- Performance of anaerobic digesters under varying conditions including: differing feedstocks, digester characteristics, co-digestion versus stand alone digestion, and management of digestate;

- Research on the performance and impact of mechanical de-packaging processes for various food waste management processes;
- Information on microplastic contamination in composting and anaerobic digesters;
- Research on the impact of compostable food packaging on composting and resulting compost; and
- Research on PFAS contamination in compost streams through sources such as food packaging, etc.

States seek additional modeling and information related to **life cycle analysis** including:

- Expansion of the sustainable materials management prioritization tool with more materials; and
- Models for identifying the environmental impacts of different management options for common products.

States would like research on **contamination of recycling streams** with toxics and best practices for managing this contamination.

States would like EPA to **expand the Waste Reduction Model (WARM)** to include source reduction and reuse data as well as open access economic factor modeling.

States ask EPA to **update the Integrated Risk Information System (IRIS) database** with the latest information on ethylbenzene and hexavalent chromium.

States would like research and information on the environmental and public health impacts of **land application of biosolids** from varying sources such as paper mills and agriculture.

States seek additional research on the state of solid waste facilities that are set to complete **post-closure care** including any continuing environmental and public health risks.

Details of Cross-Media Research Needs

States would like more information and research on **flooding and coastal resiliency** including:

- Models to more accurately predict the impacts of sea level rise on flooding in local communities;
- Models that allow for projection of changing precipitation events on the local/smaller geographic scale;
- Research on the amount of carbon sequestered through various water quality and water habitat restoration projects;
- Information on where living shorelines are most effective and protective from erosion; and
- Research on best practices for preventing flooding and increasing coastal resiliency in the face of coastal development, sea level rise, and frequent intense rain events.

States seek more information and research on developing **resilient wastewater and drinking water infrastructure and treatment systems** including:

- Information on how to harden systems and parts of systems as small as water lines to withstand natural disasters such as flooding, hurricanes, and fires;
- Information on how Leadership in Energy and Environmental Design (LEED) and nature-based solutions such as green roofs and rain barrels reduce the energy footprint at wastewater facilities; and
- Research on resiliency during pandemics or other health emergencies that ensures drinking water and wastewater are appropriately treated.

States would like research and information related to **water reuse** including:

- Additional information on direct potable reuse including treatment standards and environmental benefits;
- Research on whether reuse impacts contaminant levels including PFAS and pharmaceuticals;
- Information on treatment technologies and their effectiveness in various water reuse scenarios;
- Modeling of stormwater flows to estimate the amount available for reuse;
- Information on options for decentralized water reuse or water reuse in small communities that may not have traditional sewer systems;
- Research into requirements for stormwater capture and reuse for dry wells and injection; and
- Modeling to identify best areas for infiltration for groundwater recharge.

States also would like research and information on the **reuse of produced water** from oil and gas operations including:

- Ecological and human health risks associated with discharge of treated produced water into the environment;

- Options for environmentally sound treatment and reuse of produced water for purposes outside the oil and gas sector;
- Research on the chemical constituents found in produced water and their toxicity; and
- Information on technologies and their efficacy to treat produced water to be fit for uses from agriculture to drinking water.

States seek more research and information on the **prevalence and toxicity of chemicals of emerging concern** including:

- Action around PFAS (as described in the PFAS details and other media sections);
- More and clearer health studies on 1,4-dioxane, manganese, and inadvertent polychlorinated biphenyls (PCBs);
- Research on harmful algal blooms, including on cyanotoxins for which EPA does not have health advisories;
- Information on how to prioritize and get ahead of future emerging contaminants, especially as it pertains to grouping contaminants, safer products, upstream products uses and fate and transport modeling, and identifying nationwide issues when states that deal with different manufacturers;
- Managing basic constituents and cross-referencing studies on a regional basis with states to determine whether chemical replacements are better or worse than existing options; and
- Expanding upon and making publicly available EPA tools (e.g., the hazards alternatives assessment dashboard, functional use database, and chemical and products database) so that states can integrate and cite them in their work.