2024-2025
RESEARCH AGENDA

Bureau of Water Supply

Catskill/Delaware watersheds during Autumn

NYC Environmental Protection

Rohit T. Aggarwala
Commissioner

Paul V. Rush, P.E.
Deputy Commissioner
Bureau of Water Supply

As we face new challenges, we remain committed to innovative thinking, building upon the New York City's water supply system's tradition of long-term planning. Over a century ago, our predecessors exemplified leadership by designing water supply and wastewater systems that still inspire us today. The Bureau of Water Supply's 2024-2025 Research Agenda highlights our intent to model that leadership as we explore new ways to manage challenges while protecting public health and the environment for millions of New Yorkers.

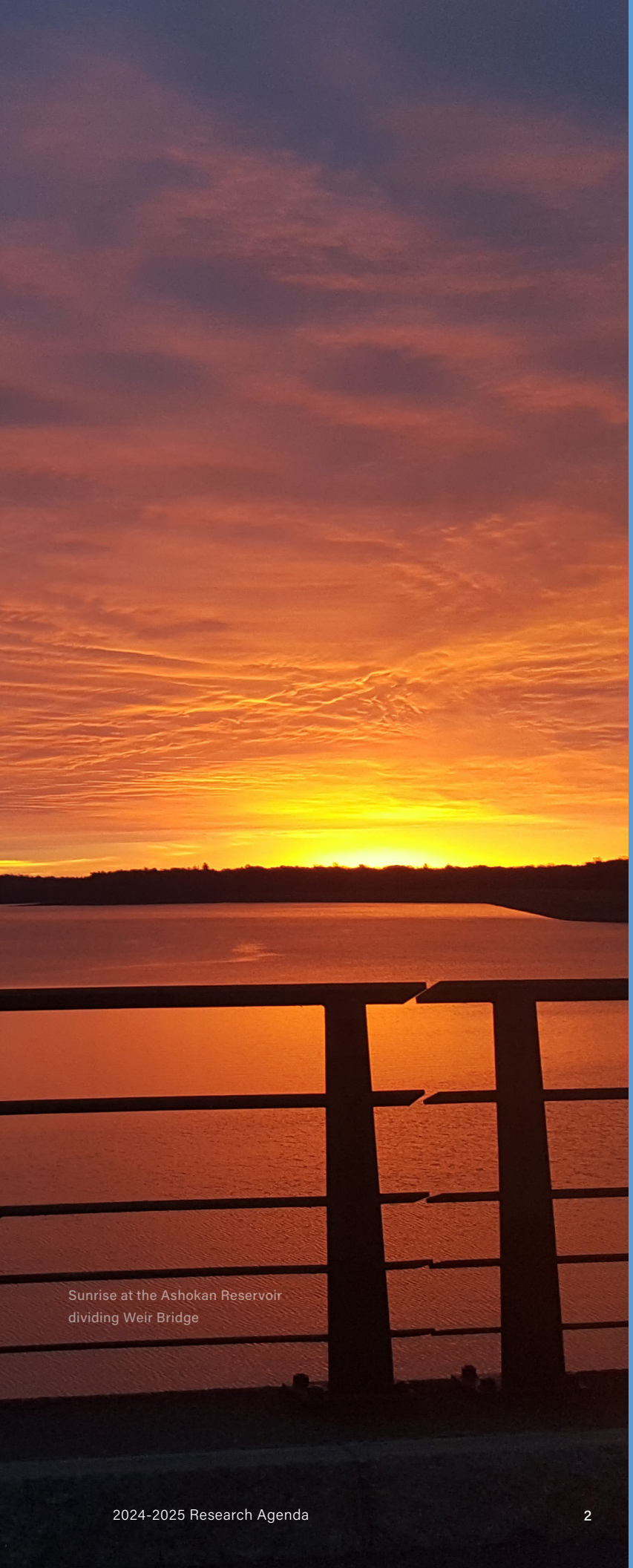
For the next two years, we will focus on developing strategies to respond to immediate regulatory and environmental challenges, including the Lead and Copper Rule Improvements, Microbial and Disinfection Byproduct Rule revisions, invasive species and emerging contaminants such as per- and polyfluoroalkyl substances. We will also continue to collaborate with our research partners to harvest data to refine models to better understand the ongoing effects of climate change.

Our work has evolved our two centuries, but our mission has remained constant. This document highlights the next steps for exploring critical research questions while ensuring the delivering a sufficient quantity of high-quality drinking water.

I am pleased to share the Bureau of Water Supply's 2024-2025 Research Agenda.

Sincerely,

Paul V. Rush, P.E., Deputy Commissioner



Sunrise at the Ashokan Reservoir dividing Weir Bridge

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INTRODUCTION

The New York City Department of Environmental Protection (DEP) continues to conduct innovative research while building on a tradition of long-term planning. Our continued focus on the future is reflected in the broad range of research taking place within the Bureau of Water Supply (BWS). A transformational approach to research is critical to meet the ever-changing regulatory landscape and water supply operational challenges. This 2024-2025 BWS Research Agenda provides a framework and context for the bureau's research in the coming years. As we look to the future, there are numerous factors influencing the bureau's near-term research: the United States Environmental Protection Agency's (EPA) Proposed Lead and Copper Rule Improvements (LCRI), the EPA's six-year review of microbial and disinfection byproduct rules, ongoing analysis on the effects of climate change, the proliferation of invasive species, taste and odor, and recent New York State and federal proposals regarding polyfluoroalkyl substances, all of which are directing the bureau's priorities.

Dividing weir bridge, Ashokan Reservoir

Context

As BWS considers upcoming regulatory changes and emerging challenges associated with climate change, numerous research needs become evident. New and changing regulatory requirements for lead, microbial and disinfection byproducts (DBPs), and per- and polyfluoroalkyl substances (PFAS) – also called "forever chemicals" – are reflected in the bureau's research. Previous studies on these topics provide the bureau with a robust body of research from which to draw conclusions and refine new studies going forward.

A watershed climate change assessment is underway to study climate change impacts to the watershed, water quantity, and water quality characteristics of the City's drinking water supply reservoirs, develop advanced modeling tools to simulate and evaluate these impacts, and develop and evaluate climate adaptation strategies to ensure long-term water supply resiliency.

The assessment is timely, as we are already seeing the impacts of climate change: extreme rainfall events and periods of drought are becoming more frequent in New York City and the watersheds, along with increased temperatures throughout the region. Warming temperatures and extreme rainfall can affect reservoir chemistry and hydrology, and mobilize nutrients and turbidity, resulting in changes to water quality that include taste and odor issues. Current and projected changes in our regional climate also create opportunities for invasive species to proliferate and expand their range.

Numerous other studies are underway to examine a wide range of issues including but not limited to stream turbidity studies, emerging contaminants, Croton Filtration Plant treatment capacity, freshwater salinization, and models to assess nutrient loading in reservoirs. The small investment in our research provides the bureau with the institutional knowledge to collaborate effectively within DEP and partner with academic institutions and professional organizations to eliminate redundancies and optimize future spending.

Ashokan Reservoir west basin covered with snow

Framework

A standardized framework to organize research provides researchers with the ability to build upon previous studies and identify opportunities to collaborate. To that end, an inventory of all research planned, underway, and completed is maintained across several of the agency's bureaus, including BWS. This inventory is updated regularly and catalogues the agency's research by utilizing a flexible framework and hierarchy. Key to the inventory is a clear definition of what is classified as research. As such, all BWS research projects must meet one or more of the following for inclusion in the inventory:

- Answer a specific research question
- Test a hypothesis
- Validate new technology or practice
- Advance knowledge of a particular discipline or issue
- Generate questions for future research

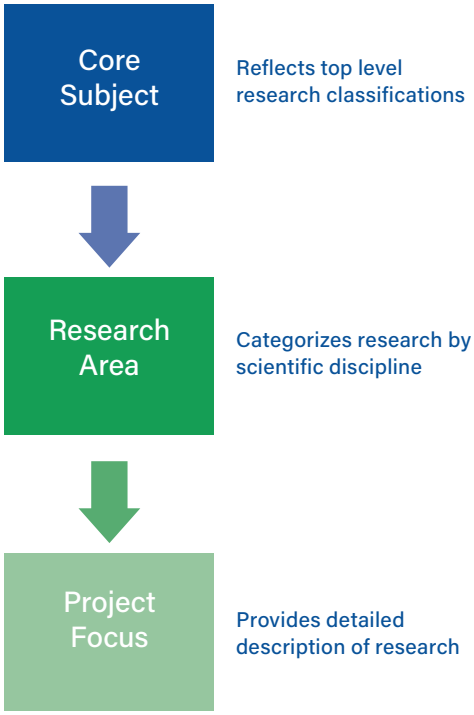
If a research project meets the above criteria, it is classified within four core subject areas that serve as a framework for research priorities moving forward:

Environment is inclusive of all studies pertaining to the interface of the natural environment with the water supply and includes terrestrial, aquatic, climatological, air, and water resources such as streams, lakes (reservoirs) and wetlands.

Innovation covers all new and emerging technologies, novel methods and strategies to better manage and operate the City's water supply, as well as studies and research pertaining to emerging challenges.

Public Health captures projects committed to ensuring safe, clean water is delivered to all users. It includes research related to water quality, treatment, and regulatory requirements.

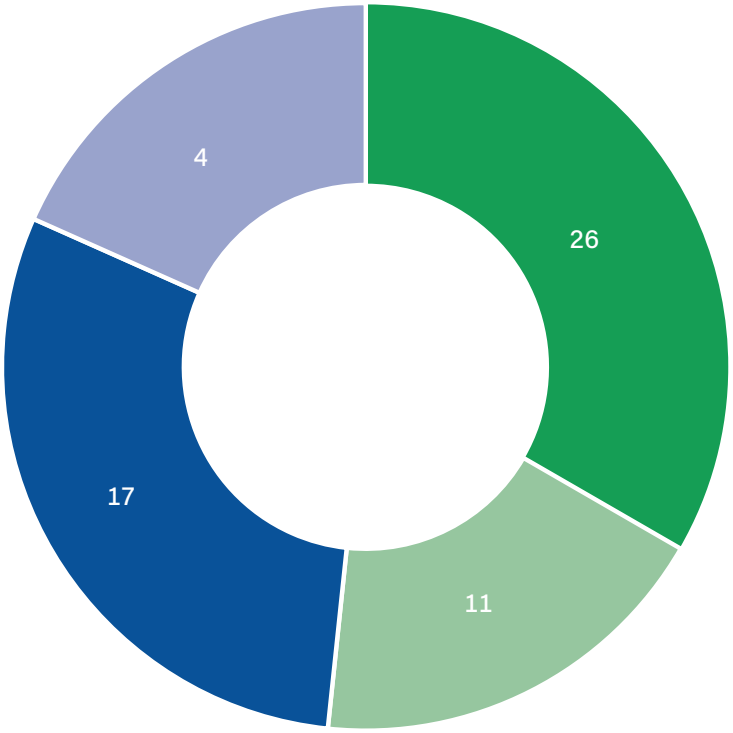
Figure 1: Research Framework



Sustainability includes opportunities for the water supply to be self-sustaining in the areas of energy, infrastructure, financing, and hydrology.

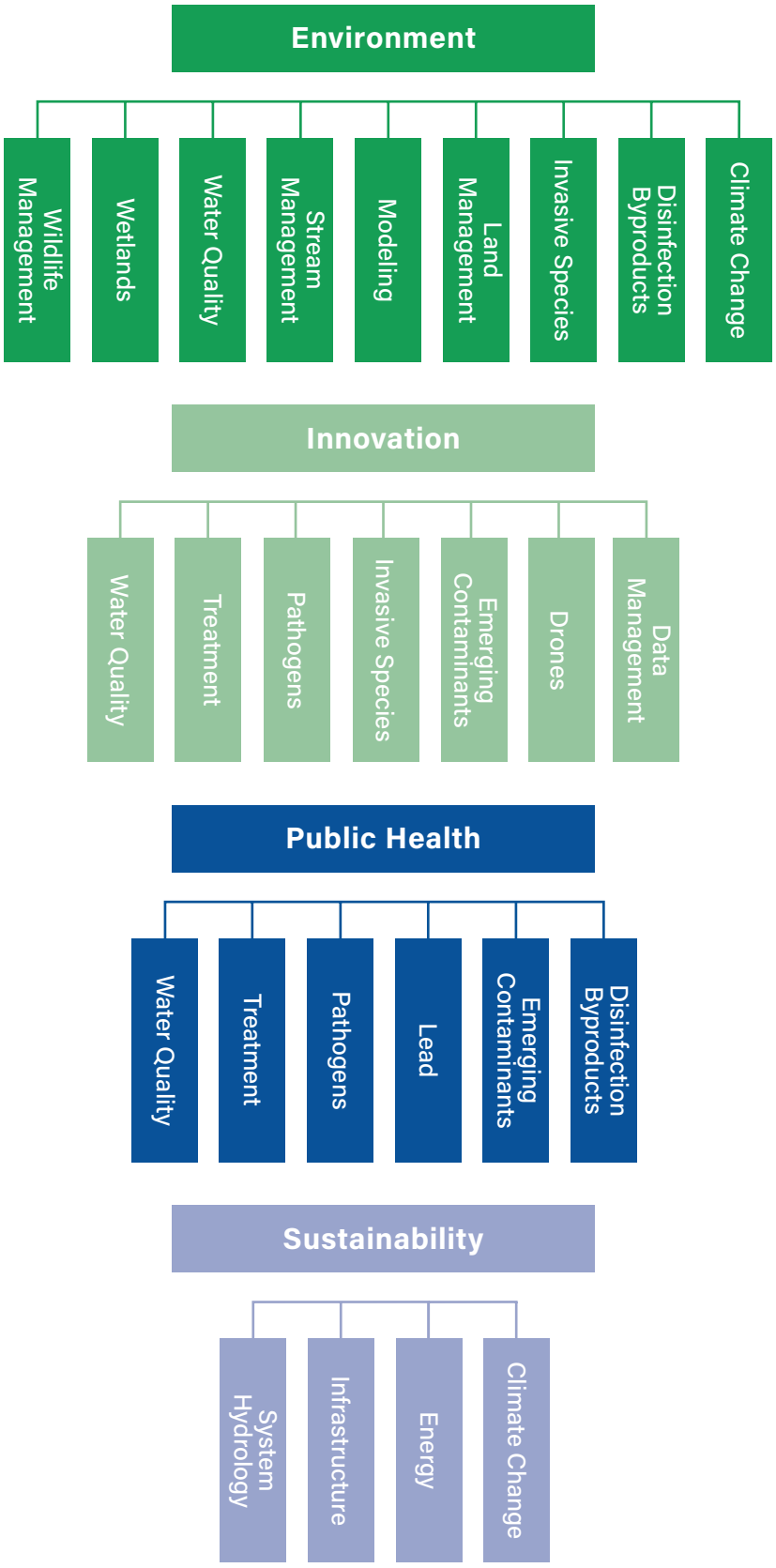
As of December 2023, BWS had 58 recently-completed, active, or planned research projects. Across the core subjects, the 2023 Research Inventory includes 18 research areas (Figure 3). A complete overview of BWS research is reflected in Appendices 1-4. Figures 2 and 3, below, show a high-level summary of the Bureau's existing research inventory.

Figure 2: Research Projects by Core Subject



DEP Sientist at
Kingston Laobratory

Figure 3: Research Areas by Core Subject



THE RESEARCH AGENDA

BWS is committed to excellence in watershed protection, water supply operations, and water quality, as demonstrated by engagement in innovative research and best practices on all issues related to water supply management. BWS's research is supported by a wide array of disciplines and administrative support, providing the workforce needed to stay at the forefront of the industry.

Bear Kill stream leads to Schoharie Reservoir

As we consider the challenges anticipated in the coming years, specific themes emerge as a result of climate change and regulatory requirements. Where the research inventory serves as a compendium of all research underway, the research agenda outlines research based on the most critical regulatory, environmental, and operational challenges facing BWS. Those challenges include, but are not limited to the following:

Public Health>Lead> Lead and Copper Rule Improvements

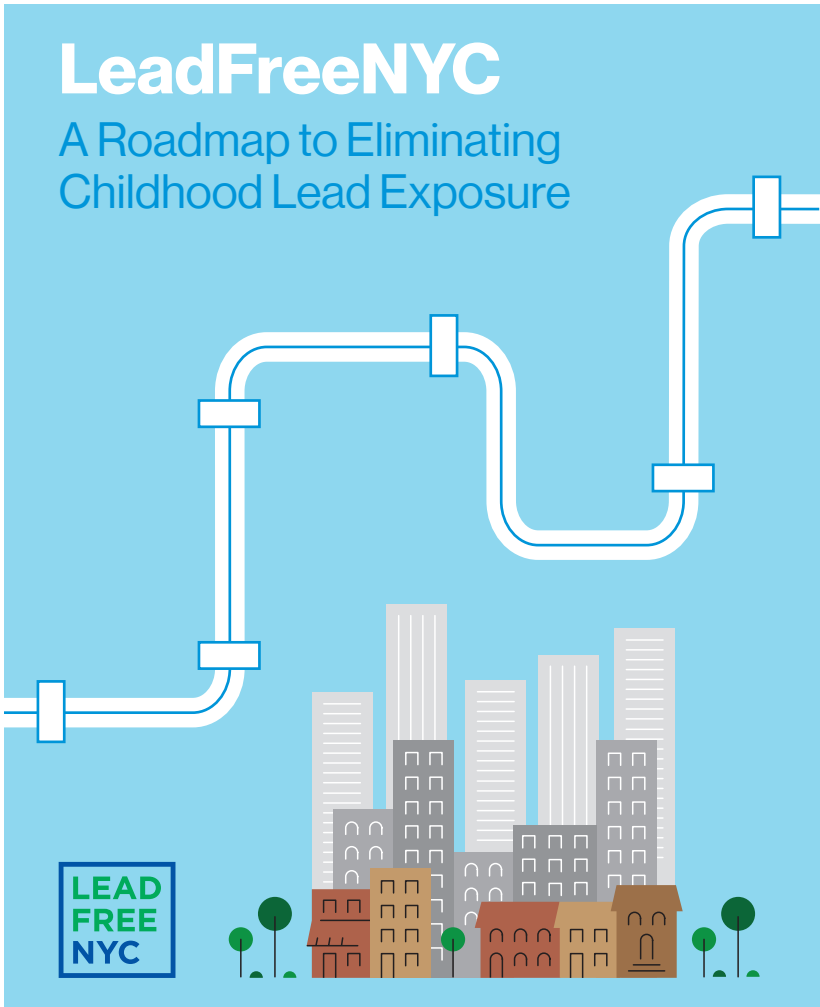
Lead is a harmful metal that can cause serious health problems. Lead is especially dangerous for children and pregnant people, but it can harm anyone. Lead is often found in old paint. Lead paint, and the dust it turns into, is the most commonly identified source of childhood lead exposure in New York City. The most commonly identified sources of lead exposure for adults who work in the construction industry are job-related. Pregnant adults are more likely to be exposed to non-occupational sources of lead, such as certain consumer products found to contain lead.

New York City's award-winning tap water is delivered lead-free through 7,000 miles of lead-free aqueducts, tunnels, and water mains in the city's water supply system. However, homes built prior to 1961 may have lead service lines (which connect to the city's water main in the street), and some homes, regardless of the year they were built, could have household plumbing and internal fixtures that contain lead.

On December 6, 2023, the proposed LCRI was published in the federal register by the EPA with a proposed effective date of October 16, 2024. The LCRI changes some of the requirements of the Lead and Copper Rule Revisions (LCRR) which has a compliance deadline of October 16, 2024 by moving most of the LCRR implementation deadlines out 3 years. These multi-faceted revisions impact numerous obligations, requirements, and activities associated with lead for water supplies. Most notably, the revisions call on utilities to comply with a lower Action Level, expand sampling, re-optimize corrosion control, update lead service line inventories, establish requirements and procedures for the replacement of lead service lines, and develop and implement a Lead Service Line Replacement Plan.

DEP has been fully engaged in at-the-tap lead monitoring and corrosion control since the 1990's and has been preparing for the implementation of the LCRR. In addition to regular compliance lead and copper monitoring, and the free residential at-the-tap lead testing program, DEP has been conducting a corrosion control optimization study since 2018.

In the coming years, DEP will finalize the Optimum Corrosion Control Study and Flushing Studies that were conducted during two Lead Service Line Replacement Pilot Programs (i.e., New York City Housing Authority and Grant program). As a result of the recently published LCRI, DEP is considering additional studies to advance our understanding of unanticipated consequences associated with additional corrosion control measures.



Environment and Public Health> Disinfection Byproducts> Stage 2 Disinfectant/Disinfection Byproducts Rule

The EPA has initiated the fourth six-year review of microbial and disinfection byproduct rules. At the time of this publication, the EPA was conducting analyses to further evaluate eight National Primary Drinking Water Regulations identified under the third Six-Year Review for potential regulatory revisions.

Chlorine, one of the disinfectants that DEP uses to treat bacteria and inactivate *Giardia* and viruses, can react with certain natural organic matter in the water to form disinfection byproducts including trihalomethanes, haloacetic acids, chlorite, and bromate. As with all federal regulations, BWS continues to advance research in this field to deliver source water that is low in natural organic matter while optimizing chlorination to meet all disinfection and residual requirements.

Specifically, BWS continues researching, analyzing, and developing models to understand and predict the natural organic matter that presages DPB formation. Field data were collected to facilitate a predictive fate and transport model of DBP precursors in Neversink Reservoir. In addition, a statistical approach to predict five haloacetic acids in Cannonsville and Neversink reservoirs was validated.

A final component of this effort is understanding how UV_{254} can be used as a surrogate for DBP precursors. UV_{254} is a measurement of the amount of light absorbed by organic compounds in a water sample and can be used as a proxy to predict DBPs in the water supply. To measure this throughout the West of Hudson watersheds, BWS has initiated a contract with the United States Geological Survey (USGS) to station sensors throughout the Catskill and Delaware watersheds. This will better link UV_{254} and DBP precursors at the reservoir inflows to watershed characteristics and will allow BWS to understand potential changes in organics attributed to land use and climate change. Once complete, the City's Operational Support Tool can be used to manage and reduce DBP formation and ensure our continued ability to maintain the Filtration Avoidance Determination (FAD).

DEP scientist performing water quality testing, Kingston Laboratory

Environment>Climate> Climate Change Scenarios

BWS relies on a variety of models to inform daily operations and long-term planning. New and ongoing research is primarily two-fold: developing predictive models and forecasts and incorporating climate change scenarios.

To refine the bureau's responsiveness to weather conditions and support climate resiliency, several studies are planned to create and validate models used to forecast streamflow, extreme weather events, greenhouse gas emissions, and changes in the City's demand projections over time. Collectively, these studies will provide the modeling infrastructure needed to span daily water supply operations in tandem with the long-term forecasting to maintain the water supply for 8.5 million people in New York City and one million people in upstate counties.

The bureau is working on downscaling, bias-correcting, and disaggregating most recent Global Climate Models projections known as CMIP6 datasets. Additionally, BWS is developing methods to address under-representation of decadal scale variability in these projections.

The bureau uses two hydrologic models – the Soil and Water Assessment Tool (SWAT) and the Generalized Watershed Loading Function (GWLF). These tools are valuable modeling assets to predict changes in reservoir water quality and quantity based on projected weather conditions. The weather conditions driving SWAT and GWLF are climate change projections that consider various levels of greenhouse gas emissions.

BWS is also collaborating with the Bureau of Sustainability on an innovative approach to predicting long-term demand under various climate change scenarios. This work dovetails with the SWAT streamflow modeling to understand how droughts in an era of climate change will affect reliable water supply in the future.

Beginning in late 2023, the Watershed Agricultural Council, DEP, and Columbia University began research focusing on how future climate change scenarios are predicted to impact future agricultural production in the City's watersheds. These predictions will inform adaptation strategies to ensure that agricultural practices within the City's watersheds do not contribute to water quality degradation. This research will also tie in with BWS's existing models.

The nexus among each of these climate change considerations is the City's Operational Support Tool. The Operational Support Tool emulates the operation of the city's water supply using observed or modeled demand for water, streamflow and stream water quality. The Operational Support Tool will be driven by scenarios of streamflow and water demand under drought which will allow the bureau to assess and then adapt to risks imposed by climate change on the City's water supply. This effort will ensure the city has a safe and reliable source of water for decades to come.

Esopus Creek

Environment> Invasive Species

The naturally occurring ecosystems within the watershed provide services that maintain excellent water quality and underpin DEP's watershed protection programs and the FAD. If left unchecked, invasive species threaten to disrupt the ecological balance within the watersheds. They impact the ecosystem services we rely on for clean water and damage water supply infrastructure. Climate change is expanding the range of several invasive species and creating more favorable conditions for many other invasive species to become established.

BWS has developed relationships with numerous federal, state, and academic stakeholders and partners on emerging invasive species, and is using novel methods to prioritize, detect, and manage their populations. More specifically, BWS is working in partnership with Cornell University to utilize the introduction of a predator species (i.e., biocontrol) to manage hemlock woolly adelgid, *Adelges tsugae* (Annand), an aphid-like invasive insect that is attacking eastern hemlocks, a critical tree species in the watershed. Further research is needed to optimize establishment and success of these insect predators. Another biocontrol study in partnership with the United States Department of Agriculture targets the emerald ash borer *(Agrilus planipennis*), an invasive beetle that targets native ash trees, causing significant mortality.

Finally, BWS is actively managing an invasive aquatic plant identified in New Croton Reservoir – hydrilla (*Hydrilla verticillata*). Efforts are underway to control and hopefully eradicate hydrilla by applying fluridone, an approved herbicide. Research is on-going to assess the efficacy of this treatment targeting New Croton Reservoir, and the future of this program, and further research is needed to assess hydrilla's impact on water quality, taste, and odor.

Recently identified invasive species in the watershed include zebra mussels (*Dreissena polymorpha*), fish-hook water fleas (*Cercopagis pengoi*), and the spotted lanternfly (*Lycorma delicatula*). The zebra mussel was identified in Amawalk Reservoir and poses a significant threat to water supply infrastructure. Fish-hook water fleas were found in New Croton Reservoir and have the potential to disrupt lower trophic level dynamics. The spotted lanternfly is an emerging invasive species that threatens watershed facilities and forest health.

Hydrilla verticillata

Sustainability>Treatment> Croton Taste and Odor

The Croton Water Supply System's (Croton System) source water is treated at the Croton Water Filtration Plant, located in the Bronx, and is a critical component of the New York City water supply. As the City undertakes repairs to the Delaware Aqueduct and seeks to meet demand while buffering water availability during droughts, the Croton System plays a pivotal role in ensuring a sustainable water supply for all City residents. Essentially, the Croton System increases the flexibility of the water supply ensuring the City can respond to evolving effects of climate change, and creates redundancy to facilitate infrastructure improvements now, and for decades to come.

As the City utilizes the Croton System more frequently, emerging challenges, such as changes to taste and odor, must be addressed to ensure a sustainable water supply. The City has experienced episodic taste and odor events since the fall of 2018. Research and monitoring has identified two main taste and odor compounds of concern in the Croton System's source water, Geosmin and 2-Methylisoborneol. When these compounds are present in the drinking water, they can be detected by consumers at extremely low concentrations, leading to an increase in customer complaints.

BWS continues to monitor for taste and odor compounds on a regular basis to assist in managing the water supply and further understand the mechanism(s) causing increased concentrations in the source water. In addition, BWS convened an expert panel to provide guidance. The subject matter experts recommended DEP to first focus on identifying sources of taste and odor events, then use that information to build upon reservoir dynamics and develop predictive models for future events. As a result, a request for proposals (RFP) for research utilizing environmental DNA in order to identify sources of taste and odor compounds will be released in late 2025.

The expert panel also recommended copper sulfate application as an in-reservoir treatment for the immediate near term. As a result, the bureau is piloting treatments at four reservoirs in the Croton System, studying the effectiveness of treatment on algae growth and their production of taste and odor compounds. Further study is needed to understand the specific organisms that may be producing these compounds, and why they are producing these compounds at certain times of the year.

The Croton Water Filtration Plant

Public Health>Emerging Contaminants>PFAS

There are two groups of emerging contaminants under careful consideration. In 2023, the EPA proposed legally-enforceable National Primary Drinking Water Regulations for six per- and polyfluoroalkyl substances, collectively referred to as PFAS. In addition, the New York State Department of Health has proposed notification levels for 23 PFAS compounds, and the New York State Drinking Water Quality Council approved these recommendations in November 2023.

While PFAS have not been detected in water leaving Kensico Reservoir using currently-approved analytical techniques, BWS, in anticipation of increasingly stringent future drinking water regulations, is taking a proactive approach to evaluating risks associated with these compounds. The New York City Water Board has dedicated funding for a study to conduct a desktop analysis of water quality data and historic records to identify potential sources of PFAS within the Kensico Reservoir's watershed, and to identify information needs and next steps. Issuance of a request for proposals is anticipated in early 2024.

All NYC drinking water remains compliant with current regulations. BWS has an established and ongoing monitoring program for all required PFAS compounds that complies with EPA methods and has not had any detections in the Catskill/Delaware source water or finished water entry into distribution. In addition, BWS modifies analytical methods as directed by the EPA and State agencies.

DEP Scientist at the Kingston Laboratory

RESEARCH SPOTLIGHT: ZEBRA MUSSELS

Since the 1990s, BWS has monitored for the presence of zebra mussels, as they can have significant ecological and water quality impacts. They were identified in three consecutive reservoirs in the Croton System – Amawalk, Muscoot, and New Croton – between 2021 and 2022. The mussels were transported to Amawalk Reservoir via the Muscoot River from Lake Mahopac, a private, unregulated lake in the watershed.

Zebra mussels are known biofoulers and can clog water supply infrastructure like intakes, pipes, and valves, resulting in flow reductions and increased physical deterioration. They can also cause or exacerbate water quality issues such as harmful algal blooms, the presence of taste and odor compounds, and natural organic matter.

Unfortunately, zebra mussels have the potential to impact water supply infrastructure and the Croton System's water chemistry parameters (calcium, pH, and alkalinity) support moderate to high zebra mussel populations. While the basic biology of the zebra mussels is understood, targeted surveys are underway to understand the site-specific phenology of this mollusk in New Croton Reservoir.

BWS has increased monitoring in the Croton System and is incorporating recommendations and next steps identified by subject matter experts at a workshop focused on zebra mussels. Based on this guidance, the Mollusk Monitoring Group is developing a program to combat this invasive species. In addition, BWS has ongoing best management practices that include public education, steam cleaning all boats and watercraft before they enter reservoirs, issuing permits, and tracking boats.

Zebra Mussel

DEP Scientist diving to search for zebra mussels in New Croton Reservoir

ACCOMPLISHMENTS

Commissioner Aggarwala with Bureau of Water Supply scientists collecting samples at Ashokan Reservoir

Defining Research Areas

As the research inventory continues to grow, new and emerging issues have been identified. One such issue is to define each research area currently in use before clarifying and consolidating areas with significant overlap. This effort was initiated in 2022 and completed in 2023.

BWS created the Research Advisory Council (RAC) to establish and manage a research process and act as a forum to communicate and support research initiatives. The RAC is a staff-level group with representation from all directorates. In this role, they served as the lead to develop definitions for over 30 research areas.

Collaborations

DEP expanded its research efforts in several ways. First, DEP has increased its engagement with The Water Research Foundation through workshops, scholarships, working groups, research proposals, and participation on the Board of Trustees, Research Advisory Council, and Project Advisory Committees. The agency is also strengthening its relationships with academic partners in two ways: partnerships and direct funding via Town+Gown.

Cardiff University

BWS continued to collaborate with researchers from Cardiff University who have been helping water utilities in the United Kingdom study taste and odor issues. In 2022, Cardiff University was awarded an Engineering and Physical Sciences Research Council grant for four university researchers to visit DEP and demonstrate both field and lab Environmental DNA (eDNA) analyses to BWS staff.

Cardiff University has been developing genomic methods of analysis that determine not only the presence of algal species, but also their ability to produce certain taste and odor compounds. Environmental DNA is organismal DNA that can be found in the environment. It originates from cellular material shed by organisms through skin, excrement, etc., into aquatic or terrestrial environments that can be sampled and monitored using new molecular methods.

BWS and Cardiff University conducted field and lab work in 2022 utilizing a specific type of field analysis using eDNA filters, coupled with two types of analysis. The first uses next generation sequencing to determine relative abundance of species presence in order to track changes in the algal communities over time. An additional analysis that uses ribonucleic acid (RNA), a nucleic acid present in all living cells. RNA determines what portion of the cells present can produce the taste and odor compounds Geosmin and 2-Methylisoborneol.

The results of this eDNA analysis provided the bureau with useful information regarding the relative abundance of bacterial species present in the samples collected at eight locations across New Croton and Muscoot reservoirs. These findings were used to develop a scope of work for a large-scale study in the Croton System.

Field Ecology class visit to Ashokan wetlands mitigation site

Virginia Tech

BWS is coordinating with Virginia Tech on a Smart One Water program through the National Science Foundation. The goal of the proposed Smart One Water Engineering Research Center is to advance measurement and decision support technologies for adaptive management of engineered and natural water systems driven by societal needs for resilience, sustainability, and social justice.

Recent natural disasters, cyber-security breaches, and aging infrastructure failures are a reminder that natural, technological, and anthropogenic hazards have great impacts on our society and economy. Smart One Water seeks to create a system of systems approach to integrate cyber-social-environmental components of water resources management.

As part of the next phase of this program, Virginia Tech is using the Delaware River Basin as a test bed, along with Biscayne Bay in Florida and the Upper Colorado River Basin states. In 2022, BWS staff participated in the two-day Future of Water Summit, which brought together utility managers, engineers, data experts, and federal officials in furtherance of a Smart One Water paradigm.

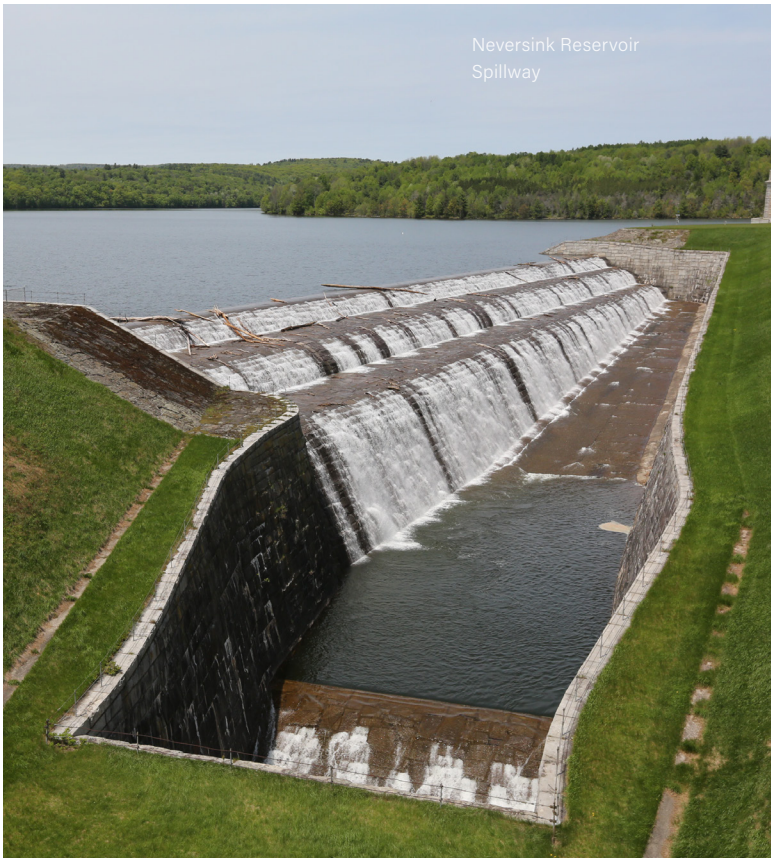
Postdoctoral Research

The research partnership between BWS and the City University of New York (CUNY) was formed to provide support to the bureau in the form of development, testing, and application of water quality models, and related compilation and analysis of data. This support is designed to help achieve two goals as specified in the City's Revised 2017 FAD: (1) evaluation of the effectiveness between and within watershed management programs implemented through the FAD and Memorandum of Agreement on maintenance and improvement of water quality, and (2) continuation of model development and application to project the effects of climate change on water supply quantity and quality. Current research in support of this requirement includes DBP formation, climate modeling, and septic and wastewater nutrient loading.

In 2022 and 2023, BWS and CUNY continued efforts to develop improved hydrological scenarios for NYC water supply system resiliency studies. A correction method was applied because the Global Climate Models underestimated the magnitudes of multi-year precipitation extremes, resulting in an inaccurate estimation of the magnitudes of extremes in future scenarios.

The University of Massachusetts, under contract with CUNY and DEP, sampled four storm events in Neversink watershed and these data will help towards building a predictive fate and transport model of DBP precursors for Neversink Reservoir.

The bureau also validated a two-component, simple statistical approach to predict the formation potentials of five haloacetic acids and total trihalomethanes in inflows to Cannonsville and Neversink Reservoirs. The statistical approaches used streamflow, total phosphorus, and soil temperature along with UV_{254} as a surrogate for DBP precursors. In addition, work began to develop empirical models to predict dissolved organic carbon export from the six West of Hudson reservoir watersheds and an investigation related to water quality impact of septic systems and wastewater treatment plants in two East of Hudson reservoir watersheds – Amawalk and Boyds Corner.



Neversink Reservoir Spillway

In 2024, improvements to the Amawalk and Boyds Corner watershed models will be carried out to refine the nutrient load contributions, and models will be developed for the rest of the East of Hudson watershed. The bureau will also continue to develop future extreme precipitation scenarios that will serve as input to the system operations model and evaluate the resiliency of the system to potential future drought and rainfall extremes as well as continue to monitor organics related to DBP in Neversink watershed.

USGS

In 2022 and 2023, USGS maintained sixty stream gaging stations throughout the watersheds of the water supply. This includes turbidity sampling in the Lower Esopus Creek. BWS uses data from stream gages for several tasks: to meet stream flow requirements, make operational decisions such as reservoir releases to meet reservoir Conditional Seasonal Storage Objectives, initialize the City's Operational Support Tool, support New York State Department of Environmental Conservation releases to meet thermal targets in rivers below the reservoirs, and track the performance of hydrologic forecasts.

In addition, USGS continued collaboration with DEP's Stream Management Program on the 10-year Upper Esopus Creek watershed turbidity monitoring study. USGS operates and maintains 29 stream monitoring stations in the Upper Esopus Creek watershed dedicated to this study to examine factors driving and influencing turbidity production impacting the Ashokan Reservoir. In addition to the monitoring data acquisition and analysis, USGS continues to evaluate the impact of stream turbidity reduction projects on measurably reducing turbidity from the reach to reservoir basin scale, implement a suspended sediment fingerprinting investigation to associate geologic sources with suspended sediment, and conduct bedload sediment measurements.

USGS is also studying the influence of leaks from the Rondout Pressure Tunnel, a portion of the Catskill Aqueduct that runs below Rondout Creek in Ulster County. Field visits by DEP identified possible leaks and a review of historical drilling documents and geologic records supported this concern. USGS established a groundwater monitoring network of 31 sites, observing changes over time and under various Catskill Aqueduct operational scenarios. The study confirmed a hydraulic connection between monitoring wells and the Rondout Pressure Tunnel. BWS is currently preparing to perform interim repairs related to the leaks in the Rondout Pressure Tunnel.

In 2024, BWS will be working with the USGS to expand our partnership to include monitoring of DPB formation potential (DBPfp) and to elucidate the sources of DBPfp in the water

Benthic macroinvertebrate sampling in the West Branch Neversink River

supply. BWS will also begin a new phase of the collaborative research related to turbidity which will include development of suspended sediment budgets and sediment connectivity modeling in Stony Clove Creek and Woodland Valley, conduct geophysical investigations to map and model the presence of potential connectivity with glacial legacy sediment, and produce a final study Scientific Investigation Report covering the full 10-year study that will serve as a FAD milestone deliverable in late 2027.

In June 2024, BWS will enter the last phase of multi-year project to repair the Delaware Aqueduct, the longest tunnel in the world. DEP will connect a newly constructed 2.5-mile bypass tunnel in Orange County and Dutchess County, New York to the existing Delaware Aqueduct, permanently conveying water around a leak under the Hudson River. The leaks in Wawarsing, NY will be repaired. In preparation for the Wawarsing repairs, USGS will monitor local wells, two of which will be connected to the USGS website by telemetry.

Town + Gown

Created in 2009-2010, Town+Gown is a city-wide university-community partnership program, coordinated by the New York City Department of Design and Construction. Town+Gown brings academics and practitioners together to create actionable knowledge in the built environment. Under the terms of the consortium contract, BWS can issue RFPs for research initiatives.

Cornell University

The hemlock woolly adelgid is an invasive, aphid-like insect that attacks North American hemlocks, and has been identified in much of the City's watershed. BWS contracted with Cornell University in 2022 to determine how effective predatory insect species from the Pacific Northwest can be when used as biocontrol agents to control hemlock woolly adelgid populations. In 2023, DEP continued collaborating on the Cornell Hemlock Initiative to establish populations of silver fly (*Leucotaraxis* spp.) at one experimental release sites in the West of Hudson watershed. Populations are being monitored for signs of successful reproduction.

Workshops

Taste and Odor

The Water Research Foundation organized a Taste and Odor Expert Panel Workshop in May 2022. The panel recommended DEP first focus on identifying sources of taste and odor, then using this information to build upon reservoir dynamics and develop predictive models for future events. Findings from this workshop were used to develop a scope of work for a large-scale study in the Croton System that utilizes eDNA to identify sources of taste and odor compounds.

As a result, Water Innovation & Research is developing a Town+Gown RFP slated for release in late 2025.

Zebra Mussels

With Zebra mussels established in the East of Hudson watershed, BWS coordinated with the Water Research Foundation to convene a zebra mussel workshop in White Plains, New York in June 2023. Numerous experts convened for the two-day workshop to discuss next steps, identify risks, propose treatment and/or mitigation, and make recommendations on how best to develop a comprehensive approach to zebra mussel control. The Water Research Foundation prepared a report with recommendations and next steps, and the Bureau is incorporating this guidance into Zebra mussel management.

White woolly ovisacs on an eastern hemlock branch.

photo credit: New York Department of Environmental Conservation

NEXT STEPS

Robotic buoy at
Rondout Reservoir

Innovation

Several of DEP's utility peers are finding ways to engage their workforce and supply chains through new and novel technologies, processes, and services to deliver high-quality, safe drinking water to their customers. These water utilities have adopted new strategies using an innovation program framework within their standard business model, reaping benefits such as enhanced operational performance, cost savings, and employee engagement. To remain at the forefront of the drinking water industry, BWS is establishing an Innovation Program that will adopt key elements of successful innovation programs from other drinking water utilities.

Water Innovation & Research (WIR) staff have been holding discussions with some of the largest water utilities in the nation about their longstanding innovation programs. WIR has borrowed from the lessons learned by our utility peers and developed a framework for an innovation program that fits the needs of the bureau. The framework includes the development of a mission statement which will focus on assisting BWS directorates with the conception, design, and implementation of new and novel business practices that enhance the efficiency and engagement of BWS employees in delivering high-quality drinking water to the City's consumers.

The program mission is necessarily broad as innovation applies to all reaches of BWS, from the science and engineering efforts we lead and perform, to the management policies and procedures affecting the quality of our work life and direction of our workforce. As the program evolves, it is WIR's hope that the Innovation Program can help BWS remain at the forefront of the water industry while making BWS a productive and rewarding place to work.

Deputy Commissioner Paul Rush presenting at the 2023 Bureau of Water Supply Conference

A Regional-scale Assessment of Nutrient Loading for NYC Watersheds

The bureau issued a Town+Gown RFP in December 2023 to study patterns (e.g., seasonal, annual) and trends (i.e., change through time) in watershed nutrients like nitrogen and phosphorus throughout the City's watersheds. Applying a nutrient export approach by using watershed models and anthropogenic nutrient input toolboxes coupled with results from trend analysis will allow BWS to describe the potential causes of observed nutrient trends in the NYC watersheds.

Ultimately, this research will help understand where the greatest areas and types of nutrients are located and how nutrient loads to reservoirs have changed over time. It will also provide insight into the influence and interaction of City watershed protection programs and climatological change, and provide guidance for future watershed protection program planning. Research is anticipated to begin in late 2024.

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