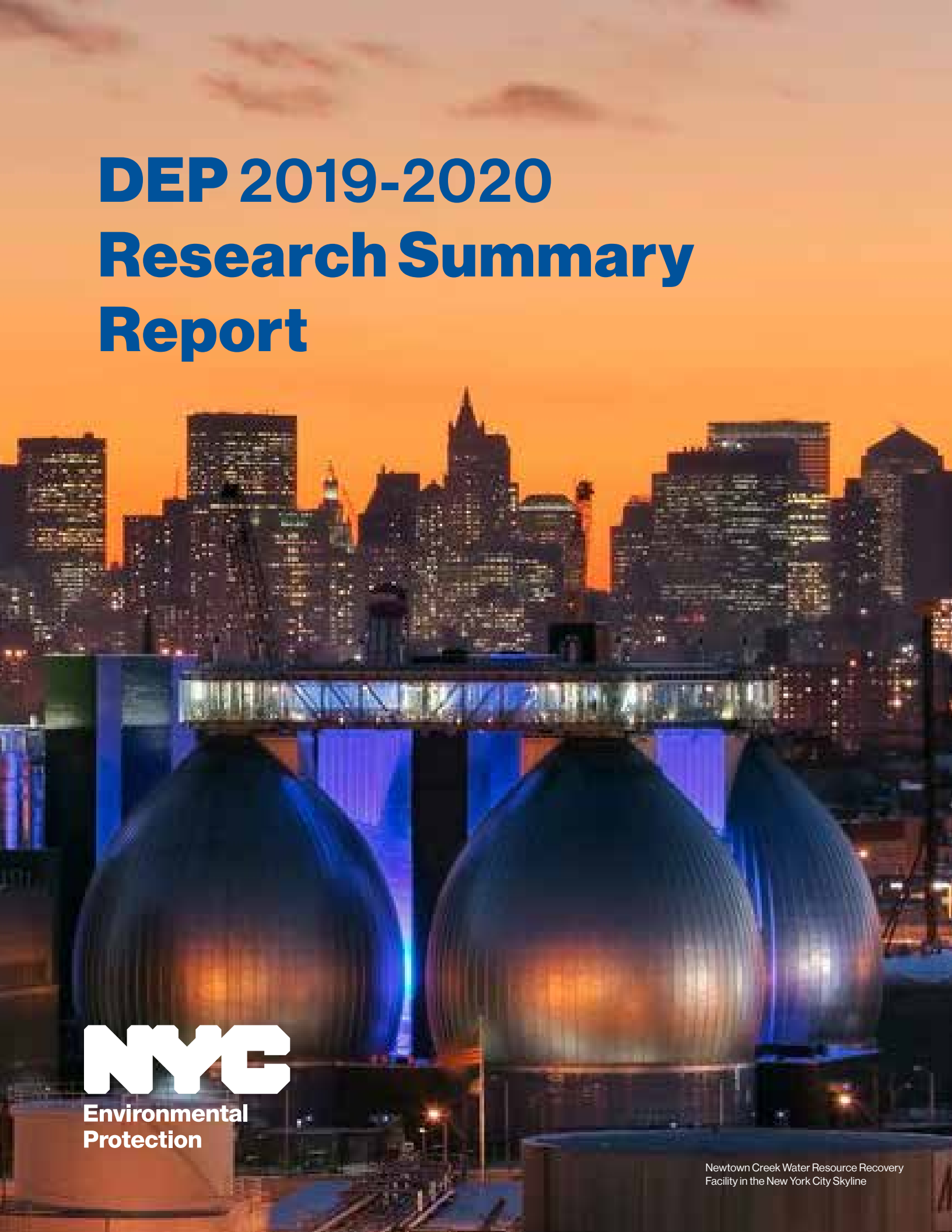
DEP 2019-2020 Research Summary Report



NYC Environmental Protection

Newtown Creek Water Resource Recovery Facility in the New York City Skyline

Dear Friends:

I am proud to share the 2019-2020 research summary, which outlines the considerable research efforts happening within the New York City Department of Environmental Protection.

My colleagues at DEP today are building on a long history of research and innovation that began more than a century ago when New York City built the world's greatest reservoir system, installed a vast network of pipes to deliver drinking water and collect wastewater, and implemented effective strategies to protect our waterways.

This report underscores the detailed work of our engineers, scientists and other experts who are exploring the methods and technologies that will be used in the future to protect the health and quality of life for everyone in our great city.

Their work is also diverse. Our scientists are using powerful computers to process huge amounts of data that will help us operate reservoirs, collect stormwater, and treat wastewater more efficiently. We are implementing new strategies to produce renewable energy from the sun, water and from human waste. DEP experts are researching the latest technologies to monitor noise, repair water and sewer mains, and protect our drinking water from potential contaminants.

Importantly, DEP scientists are also using advanced computer models to understand how climate change will affect our reservoir system, stormwater collection, and wastewater recovery in the future. Much of our work in the coming decades will happen in the context of a changing climate. We must use sound science to prepare for climate change, measure its effects, and combat them.

As you look through the pages of this report, I hope you will recognize the great skill and commitment of our DEP employees. The take great pride in in their work to serve their fellow New Yorkers – now and in the future.

Sincerely,

Vincent Sapienza, P.E.
Commissioner

Table of Contents

Commissioner Sapienza inspecting work progress of the Delaware bypass tunnel project.

2019-2020 Research Summary

The 2018 Strategic Plan: Enriching our Legacy outlined DEP's vision to remain a world-class water and wastewater utility while building a sustainable future. Our strategic plan included seven broad goals to advance our mission of enriching the environment and protecting public health for all New Yorkers by providing high-quality drinking water, managing wastewater and stormwater, and reducing air, noise, and hazardous materials pollution.

The 2018 strategic plan also builds on a tradition of long-term planning at DEP. Our focus on the future is reflected in Strategic Initiative 39, which challenges DEP to "Engage in cutting-edge research and influence national policymaking." This initiative outlines research priorities to help DEP meet regulatory mandates from our state and federal governments, capture the institutional knowledge of our expert employees, and apply the newest and best technologies to protect the environment and public health.

To ensure accountability to our ratepayers and other stakeholders, DEP convened representatives from our bureaus of Sustainability, Wastewater Treatment, Water and Sewer Operations, Water Supply, Engineering Design and Construction; and the Office of Energy and Resource Recovery Programs to implement and track the goals of Strategic Initiative 39. The 2019-2020 Research Summary catalogues the research conducted or completed since the strategic plan was published. Our efforts in 2019 and 2020 included work to optimize the quality of our drinking water and harbor water, maximize the efficiency of our resources (both people and dollars), prepare for the impacts of climate change, and minimize our greenhouse gas emissions.

DEP expanded its research efforts to support the strategic plan in several ways. First, research was catalogued in bureau-specific research agendas for each team – all of which is described in the subsequent chapters. In addition, the agency is procuring access to relevant research through a system that provides DEP employees access to scientific literature and data while adhering to copyright compliance. DEP has increased its engagement with The Water Research Foundation through workshops, scholarships, working groups, research proposals, and participation on the Board of Trustees and Project Advisory Committees. Taken together, these efforts set a strong foundation for our evidence-based approach to research.

The following report is a summary of the 2019 and 2020 research and the state of science within DEP. Projects are organized within four core subject areas: Environment, Innovation, Public Health, and Sustainability. Each is further broken down by research area to define the specific scientific discipline.

Figure 1: Research Framework

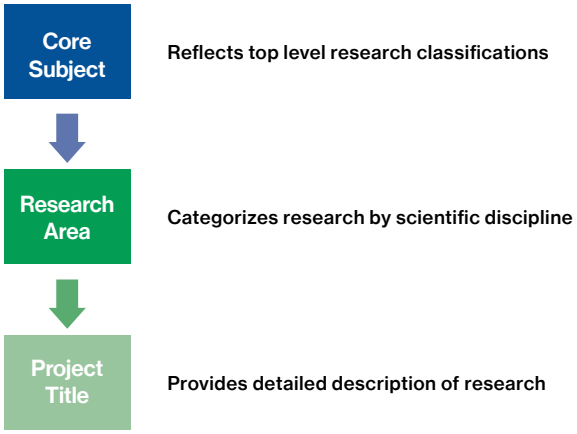


Figure 2: Research Projects Overview

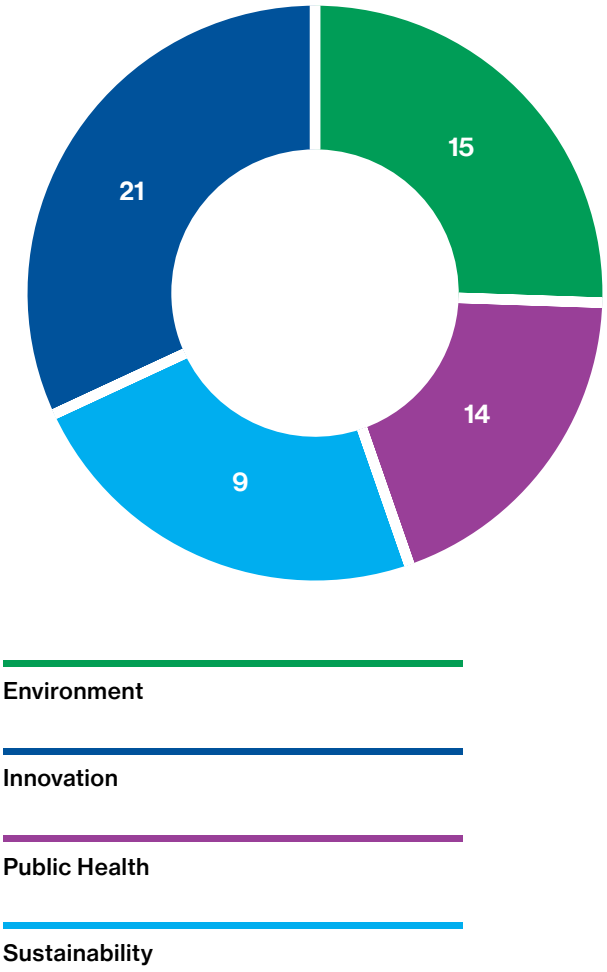
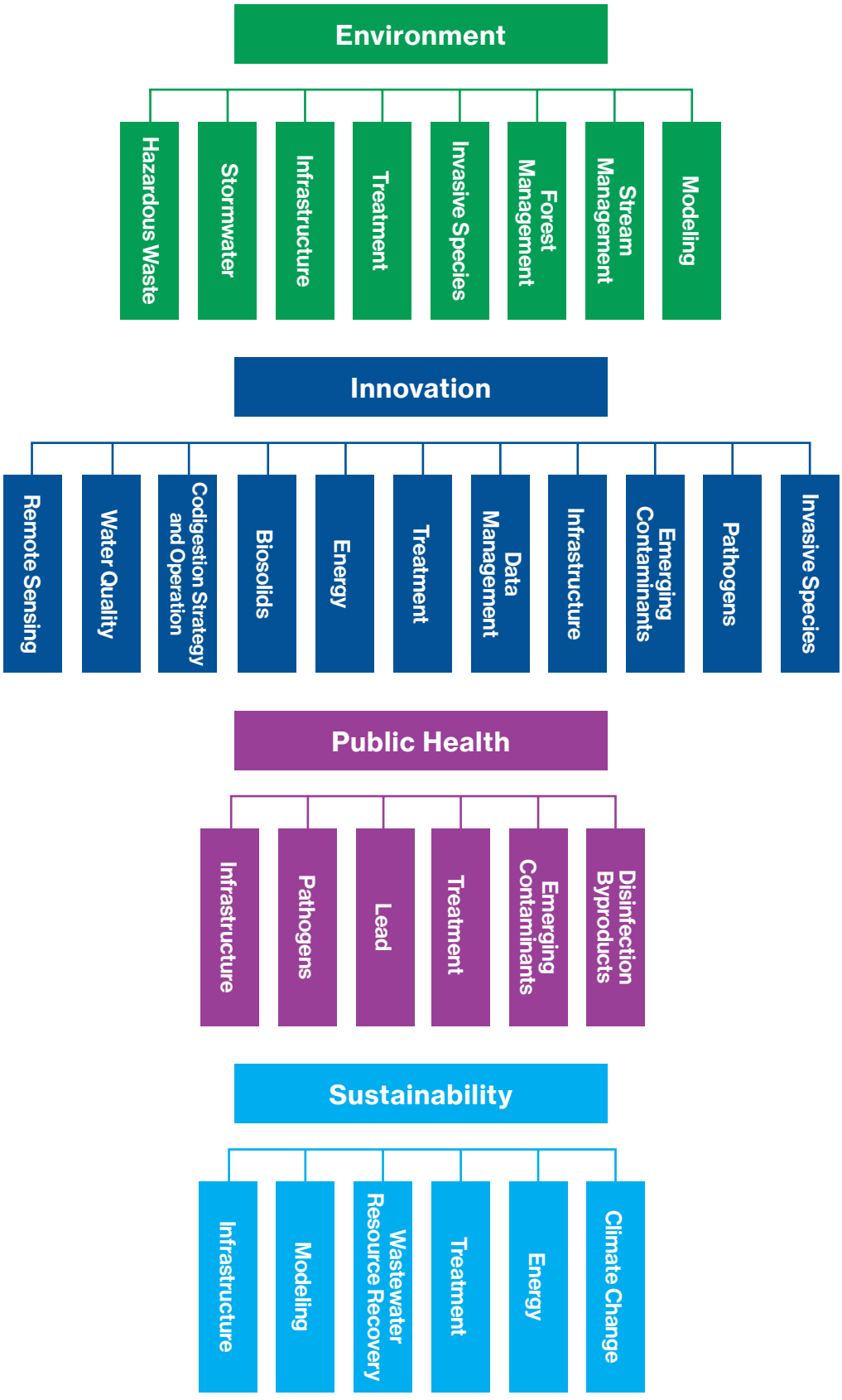
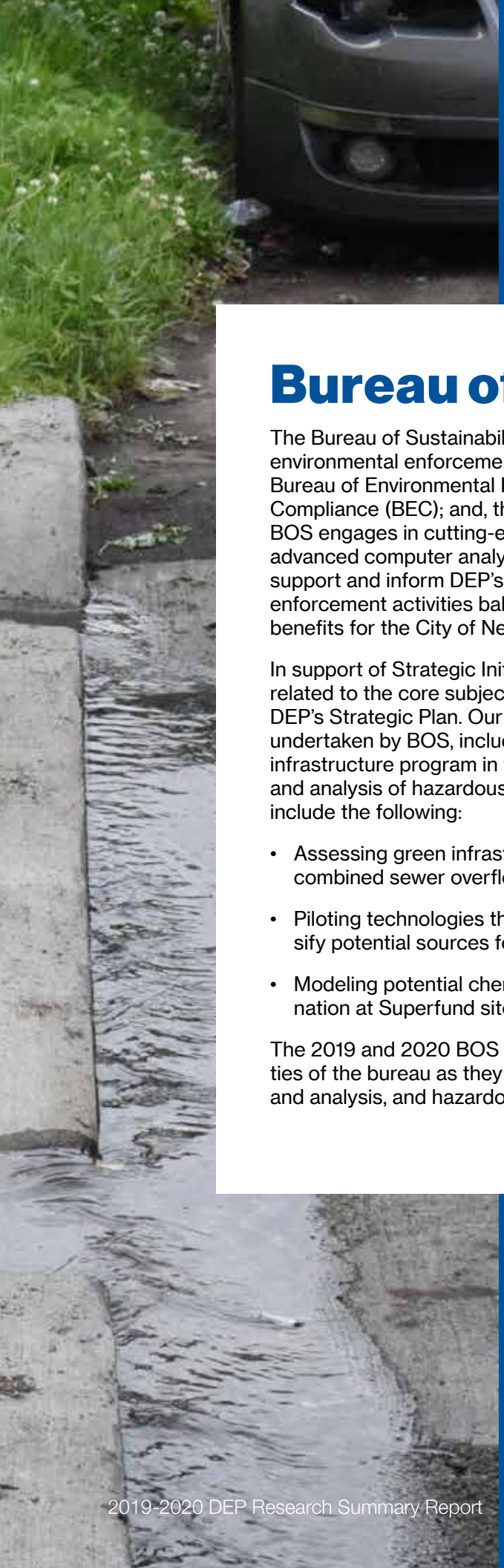


Figure 3: Research Areas by Core Subject



Rain gardens near Hill Avenue and Cranford Avenue, Wakefield.



Bureau of Sustainability

The Bureau of Sustainability (BOS) is an interdisciplinary policy, planning, and environmental enforcement group composed of two bureaus and one office: the Bureau of Environmental Planning and Analysis (BEPA); the Bureau of Environmental Compliance (BEC); and, the Office of Superfund and Hazardous Materials Analysis. BOS engages in cutting-edge applied research that integrates artificial intelligence, advanced computer analysis and modeling, field studies and policy development to support and inform DEP's mission. BOS ensures that DEP's investments, policies and enforcement activities balance and maximize environmental, social, and economic benefits for the City of New York and our stakeholders.

In support of Strategic Initiative 39, BOS conducted research in 2019 and 2020 related to the core subjects of sustainability, innovation, and environment as part of DEP's Strategic Plan. Our ongoing research is part of larger programmatic initiatives undertaken by BOS, including, but not limited to, development of the largest green infrastructure program in the country, our response to 311 air and noise complaints, and analysis of hazardous waste contamination. Examples of BOS research projects include the following:

- Assessing green infrastructure technologies to manage stormwater and reduce combined sewer overflows.
- Piloting technologies that use artificial intelligence to monitor noise levels and classify potential sources for improved responses to noise complaints.
- Modeling potential chemicals of concern at large cleanup sites to analyze contamination at Superfund sites.

The 2019 and 2020 BOS research projects represent the broad-ranging responsibilities of the bureau as they relate to environmental compliance, environmental planning and analysis, and hazardous waste analysis.

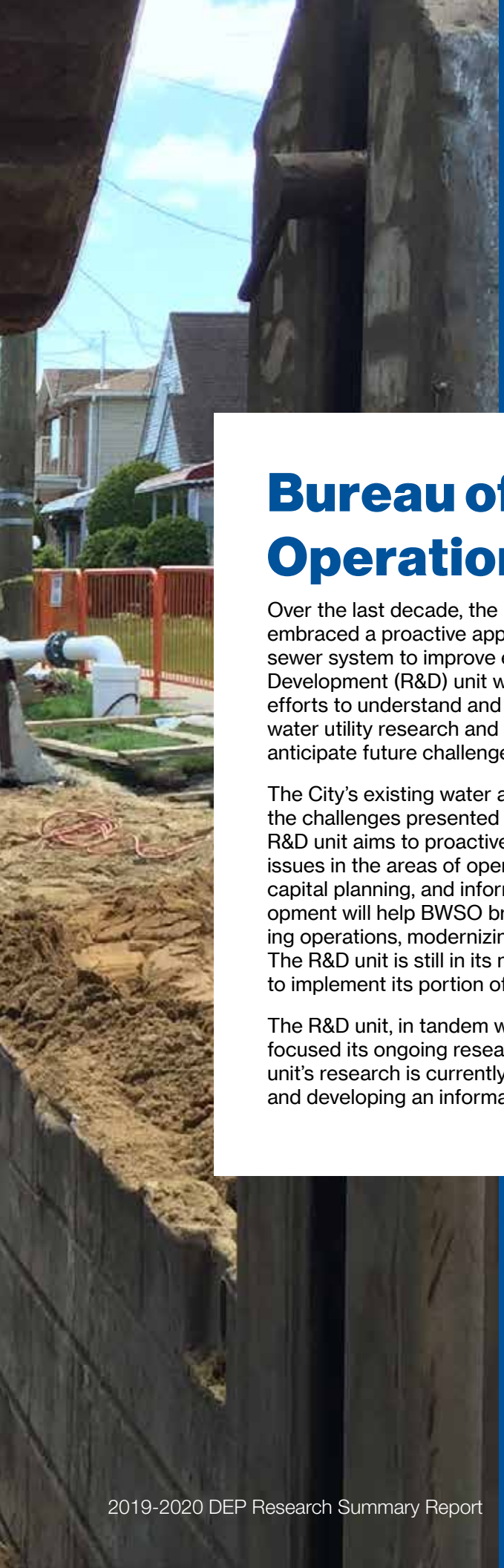
Digesters at Newtown Creek
Wastewater Resource Recovery Facility.

Bureau of Wastewater Treatment

The Bureau of Wastewater Treatment's (BWT) research priorities focus on sustainably meeting our core mission of protecting public health, while complying with regulatory mandates and stewardship goals by developing and demonstrating innovative conveyance and treatment technologies, configurations, and skillsets that are aligned with DEP's strategic plan.

BWT research is divided into three areas of focus: liquid conveyance and treatment, solids processing, and biogas treatment, and odor/air emissions. The three areas are interrelated within the wastewater treatment system at the level of facility design, process engineering, economics, regulatory compliance, and social impacts. BWT's tri-pronged approach addresses DEP's goals of advancing sustainability, public and environmental health, and innovation. The bureau continues to develop and update its portion of the research summary as it applies to innovations. It will explore next-generation technologies and techniques that are successful worldwide, adapting them to the NYC ecosystem and serving as a global leader in the industry.

Sewer upgrade project in Queens, NY.



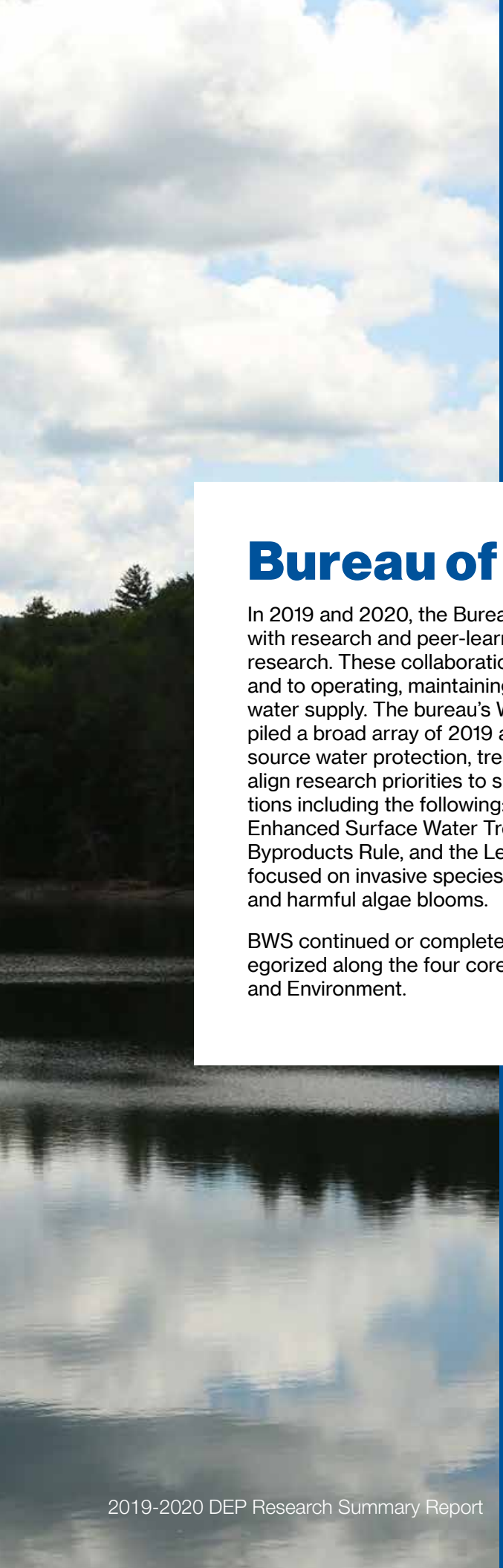
Bureau of Water and Sewer Operations

Over the last decade, the Bureau of Water and Sewer Operations (BWSO) has embraced a proactive approach to operating and maintaining the water and sewer system to improve efficiency. To achieve its goals, a BWSO Research and Development (R&D) unit was formed in 2019. The R&D unit will lead the bureau's efforts to understand and apply innovative technologies and state-of-the-industry water utility research and methods, as we strive to implement best practices and anticipate future challenges.

The City's existing water and sewer infrastructure requires novel thinking to bridge the challenges presented by the age, scale, and complexity of the system. The BWSO R&D unit aims to proactively assist the bureau in addressing current and emerging issues in the areas of operations, construction, permitting, drainage and modeling, capital planning, and information management. This approach to research and development will help BWSO bring the water and sewer systems into the future by improving operations, modernizing standard practices, and applying research in the field. The R&D unit is still in its nascent stage, but the unit will grow as the bureau continues to implement its portion of the DEP strategic plan.

The R&D unit, in tandem with the bureau's Task Order Service Contract unit, has focused its ongoing research efforts on infrastructure and data management. The unit's research is currently focused on material properties, ease of installation, cost, and developing an information database.

Schoharie Reservoir



Bureau of Water Supply

In 2019 and 2020, the Bureau of Water Supply (BWS) increased its collaboration with research and peer-learning organizations to stay abreast of industry trends and research. These collaborations underscore the bureau's commitment to public health, and to operating, maintaining, and protecting the nation's largest municipal drinking water supply. The bureau's Water Quality and Innovation group coordinated and compiled a broad array of 2019 and 2020 research to address future challenges such as source water protection, treatment, water quality and operations. This will help BWS align research priorities to support compliance with current and emerging regulations including the following: the Filtration Avoidance Determination, the Long Term 2 Enhanced Surface Water Treatment Rule, the Stage 2 Disinfectant and Disinfection Byproducts Rule, and the Lead and Copper Rule Long-Term Revisions. BWS is also focused on invasive species, along with advancing innovative solutions to pathogens and harmful algae blooms.

BWS continued or completed numerous studies in 2019 and 2020, all of which are categorized along the four core subject areas of Sustainability, Innovation, Public Health, and Environment.

Upgrade work at 26th Ward Wastewater Resource Recovery Facility

Bureau of Engineering Design and Construction

The Bureau of Engineering Design and Construction (BEDC) continued to support DEP's capital program through sustainable design initiatives and scientific analysis of constructed works. Although BEDC does not engage in academic research, the bureau's sustainability section fulfills many research goals by implementing innovative and sustainable design practices.

Stormwater is a primary concern for DEP facilities, as it directly impacts DEP operations. The BEDC Sustainability Section is working to identify and select permeable paver products and concrete that can improve stormwater infiltration and retention with minimal maintenance requirements.

The bureau is also piloting new methods of reducing construction and demolition waste. These initiatives include working within and outside the agency to develop an extensive soil reuse program and identifying opportunities to replace virgin aggregate with crushed rock and concrete that can be generated on-site or sourced from New York City Department of Transportation.

To meet citywide goals for reducing energy consumption, BEDC is researching opportunities to reduce ventilation rates in non-occupied spaces, such as our 96 pumping stations. This effort has been shown to result in substantial energy savings.

BEDC's Laboratory Services Section is dedicated to providing technical assistance services to all DEP operating bureaus (water supply, water and sewer operations, and wastewater treatment) in the areas of material quality, materials selection, failure analysis, and field inspection. Researching materials will help BEDC ensure the utmost quality of each capital investment through quantitative analysis and implementation of the best materials for each project.

BEDC's In-House Design (IHD) division serves as the engineer of record for DEP's operating bureaus on designated capital projects by delivering contract documents, including drawings and specifications, and performing contractor supervision during construction. When appropriate, IHD investigates new technologies and evaluates their applicability on DEP projects. This helps DEP maintain its position as a world-class utility. One recent research project involved evaluation of pipe rehabilitation technologies to renew the life of an existing large-diameter pressurized pipeline, known as a force main. The objective of this study was to provide the same level of service as a new pipe, allowing the lined pipe to function safely and effectively for another 50-plus years, all while minimizing the need for excavation and disruption of plant operations. The alternatives investigated included carbon fiber-reinforced polymer lining, cured-in-place pipe lining, and slip lining, where a new pipe is inserted inside the old pipe.

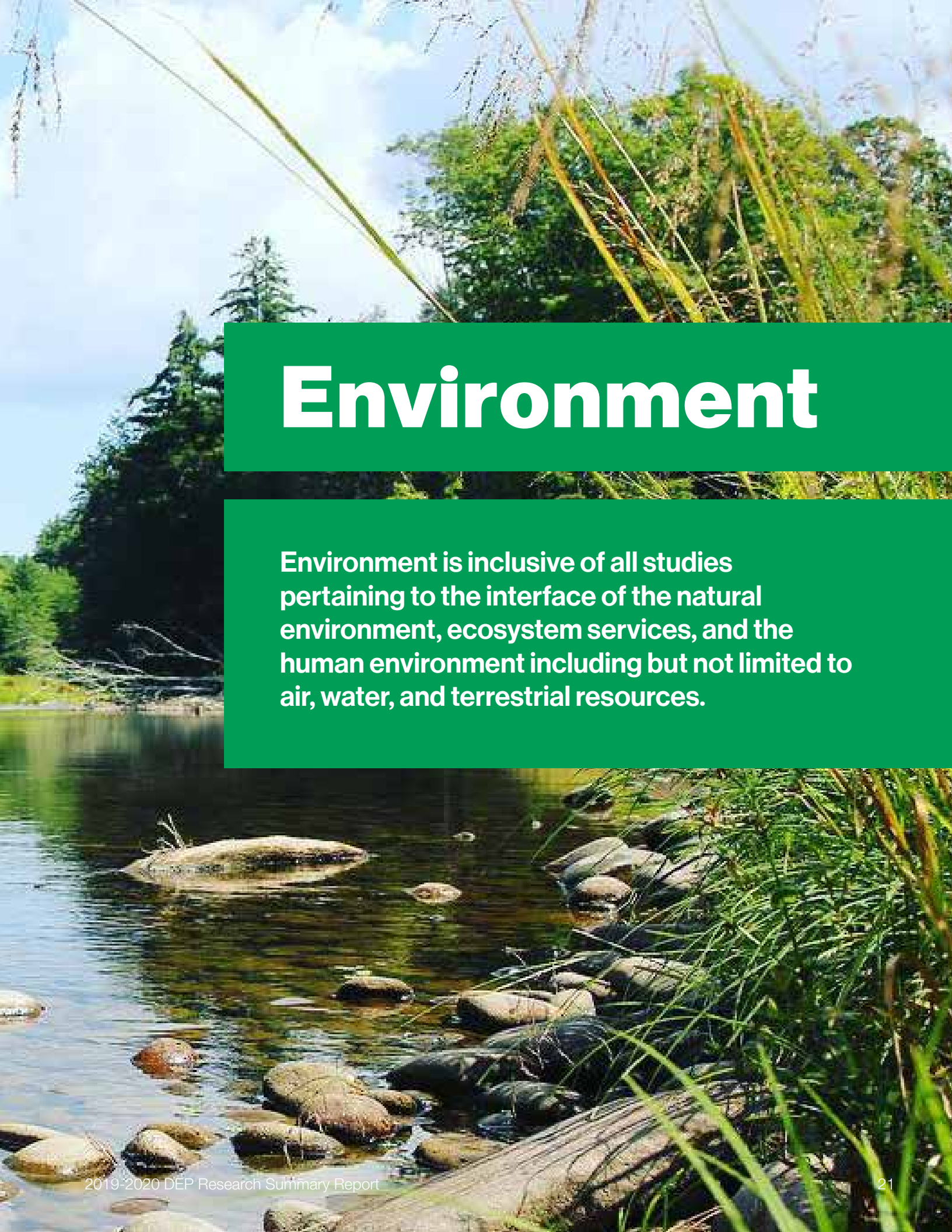
The BEDC Sustainability Section, Laboratory Services Section, and IHD continually look for new opportunities for sustainable design initiatives and scientific analysis to improve projects throughout DEP.

Solar panel array at Port Richmond
Wastewater Resource Recovery Facility

Office of Energy and Resource Recovery Programs

The Office of Energy and Resource Recovery Programs (Energy Office) is charting a path forward to transform DEP into a utility that leverages all its resources toward building a sustainable future. Most notably, the Energy Office commenced its three-year Energy and Carbon Neutrality Plan study in 2019. This study is an agency-wide collaboration that will define steps necessary to meet ambitious goals of achieving zero waste to landfills by 2030, and energy and carbon neutrality by 2050. In 2019 and 2020, the Energy Office continued research to further decrease fossil fuel-driven energy consumption and greenhouse gas emissions, while increasing resource recovery at DEP. In addition, the Energy Office also concluded its multi-year study of codigestion using pre-processed food scraps at the Newtown Creek Wastewater Resource Recovery Facility (WRRF). Based on the positive results of the study, the codigestion program will continue. The Energy Office's ongoing research digs deeper into specific topics around resource recovery and enhancement of renewable energy resources to achieve the goals of OneNYC by using DEP's Strategic Initiative 39 to guide and prioritize research.

Neversink River, Claryville, NY



Environment

Environment is inclusive of all studies pertaining to the interface of the natural environment, ecosystem services, and the human environment including but not limited to air, water, and terrestrial resources.

Stormwater > MS4 Monitoring Program

BEPA is coordinating the Municipal Separate Stormwater Sewer System (MS4) monitoring program to better understand the pollutant contribution from the MS4 area and its influence on water quality, as required by the City's MS4 permit. DEP is metering and sampling during wet weather at MS4 outfalls representative of six land use types within NYC: mixed; high-density residential; low-density residential; industrial; open space; and highway to assess the influence of land use on stormwater discharge and pollutant concentrations. Monitoring began in February 2019 and is expected to conclude in 2021. Chapter 10 of the NYC Stormwater Management Plan includes details on the MS4 Monitoring Program. For more information, please visit DEP's Municipal Separate Stormwater Sewer webpage.

Modeling > Development of Integrated Model and Graphical User Interface/Decision Support Tool for Long Island Sound

The United States Environmental Protection Agency (EPA) has awarded DEP $5.2M to develop an integrated model for Long Island Sound (LIS). The integrated model includes the development of a new hydrodynamic model component and new water quality model component. The new hydrodynamic model is intended to better understand and predict how wind, tide, salinity, river discharges and other factors affect water circulation within LIS. The new water quality model is intended to better understand the physical, chemical and biological processes that are influenced by nutrients and other constituents being discharged to LIS from point and non-point sources, and to use this understanding to predict how such discharges result in subsequent oxygen depletion in the LIS and affects living resources. The Graphical User Interface/Decision Support Tool being developed will enable DEP and other stakeholders to use the integrated model to run management scenarios. One example of this would be to predict the potential effects of climate change on water quality.

The work will be completed over a 4-5 year period and is intended to update and improve the model used to develop the 2000 total maximum daily load reduction for nitrogen. It is also intended to ensure that any new efforts imposed upon DEP and other LIS stakeholders in the future, as part of EPA's next generation nitrogen strategy, is based on the latest science and builds upon the extensive data collection efforts undertaken by various stakeholders in the two decades since the 2000 total maximum daily load nitrogen reduction requirements were finalized.

Rain garden research and development

Infrastructure > Research and Development for Green Infrastructure to Support Green Infrastructure Implementation

BEPA is conducting a comprehensive research and development program to assess green infrastructure (GI) technologies from design through construction and maintenance. The project builds upon previous GI monitoring activities and includes continuous monitoring, laboratory bench scale and field experiments and simulated runoff testing, as well as modeling for the purposes of quantifying a range of desired information for both stormwater performance and ecosystem services as co-benefits. Findings from the field activities to date show that the monitored GI practices are generally functioning as designed, with capacity for additional stormwater management through improved construction oversight and minor design modifications. Citywide modeling studies are also being conducted to evaluate the impact of GI at larger scales.

Hazardous Waste > Contaminant Modeling

Based on modeling work done for the Clean Water Act (i.e., Long Term Control Plans), BOS's Superfund group is developing models to track a wide suite of chemicals and their fate and transport in Newtown Creek. Inputs to the system include the East River, atmospheric deposition, private drainage, municipal inputs, groundwater, direct seeps of non-aqueous phase liquids (NAPL) and mixing/redistribution due to ebbulitive disruption of sediments. The chemical

Biofilter Pilot Unit

fate and transport models rely on years of work refining the point source and regional hydrodynamic models. The results of this model are used to help EPA make decisions and guide the Superfund process in assessing and remediating risks to human health and the environment.

Hazardous Waste > Measuring Impacts of Oil/ Non-Aqueous Phase Liquids

Tracking the inputs of specific chemicals of potential concern at large cleanup sites has often focused on point sources or large upstream and background sources. At the Gowanus Canal and Newtown Creek Superfund sites, another important input is NAPL from uncontrolled upland sites and legacy contamination from industrial activities. BOS's Superfund group has been leading work to assess and understand these compounds.

Gowanus Canal and Newtown Creek both have upstream parcels with NAPL seeps and spills observed on a frequent basis (e.g., oil refineries, former manufactured gas plants). Since NAPL floats and is redistributed via tide and wind, it is relatively common for a slick oil sheen to cover the entire surface of both waterbodies. Eventually, NAPL sheens break up and sink to the sediment bottoms of waterbodies, which can directly expose organisms to potentially harmful chemicals. Further, ebullition can mix and redistribute NAPL. As such, ebullition is also a contamination transfer mechanism. By developing specific devices to capture and measure contaminant flux and load, this information can be used to help guide the remediation and ensure a safe and successful clean up.

Treatment > Biological Odor Control Pilot Program

To reduce the operating cost and enhance the efficacy of odor control systems throughout DEP's facilities, BWT has worked with The City College of New York to design a pilot study of a BIOREM Skid Mounted SK-450 Biofilter at the Hunts Point WRRF. The pilot unit is a small scale, easy to deploy biological odor control system. Upon completion of the pilot installation, samples will be collected and characterized to determine the odor removal efficiency of the unit, estimate operating costs and ensure there are no exposure concerns for workers. BWT's goal is to apply the technology at various WRRFs to lower operating costs and eliminate the need for chemical-based odor control while addressing broader odor issues.

Modeling > Watershed Runoff and Nutrient Modeling

The Soil and Water Assessment Tool (SWAT) is a small watershed to river basin-scale model used to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. BWS has completed the application and validation of the SWAT model for the Cannonsville Reservoir watershed in the Catskill-Delaware System of the New York City Water Supply. Model application to the remaining West of Hudson watersheds is underway, and includes simulation of hydrology and water quality conditions such as nutrient and sediment loading. BWS's water quality modeling group has modified SWAT to include mechanisms to generate runoff that have been found to be important in West of Hudson watersheds. Over the next two years, modelers will develop and test enhancements to SWAT to allow simulation of dissolved organic compounds, quantified by dissolved organic carbon, as well as precursors of disinfection byproducts.

Stormwater > MS4 Floatables Loading Rate Study

A loading rate study is underway to determine the amount of trash and debris draining from MS4 areas to floatables-impaired waterbodies. This study will allow the City to estimate the volume of trash and debris discharged from MS4 drainage areas to floatables-impaired waterbodies.

The City's loading rate study is a hybrid approach that combines field monitoring with model analysis. The City will measure trash and debris discharged from 63 catch basins along 21 different categories. Each category will likely have a different loading rate because they represent differing combinations of catch basin attributes and catchment characteristics or unique land use types. After field monitoring data is normalized, the model can then be used to analyze loading rates in MS4 catch basins draining to a floatables-impaired waterbody based on real-world characteristics.

Stream Management > Esopus Creek Watershed Stream Turbidity and Sediment Research

BWS has partnered with United States Geological Survey (USGS) on a 10-year research project to determine whether stream restoration projects reduce stream turbidity and sediment load delivered to Ashokan Reservoir. The upper Esopus watershed stream turbidity and suspended-sediment research utilizes numerous inputs, including stream flow, turbidity, and sediment monitoring; source investigation methods, and stream restoration projects to inform and evaluate stream turbidity reduction efficacy

Stony Clove Creek Stream Management

across a range of spatial scales. The monitoring started in USGS water year 2017 and will continue through water year 2026. Final reporting is a November 2027 Filtration Avoidance Determination deliverable.

In 2019 and 2020, USGS continued monitoring turbidity at 29 monitoring stations in the Esopus watershed. Streamflow and suspended-sediment concentration were also measured at 13 of those sites. USGS also continued a pilot study on sediment fingerprinting as a source characterization technique. DEP continued mapping and monitoring stream erosion sediment sources in the Stony Clove watershed – the experimental sub-basin for stream restoration evaluation.

Two Filtration Avoidance Determination deliverable reports were produced in 2019: (1) Stony Clove Watershed Suspended Sediment and Turbidity Monitoring Study: Turbidity Reduction Project Nomination Report (January 2019); and (2) Upper Esopus Creek Watershed Turbidity/Suspended Sediment Monitoring Study: Biennial Status Report (March 2019). In addition, DEP also collaborated with researchers on a process-based and probabilistic-based modeling project to evaluate stream restoration project effectiveness in the Stony Clove watershed. A peer-reviewed journal manuscript is in development.

Stream Management > Catskill Mountain Bankfull Discharge and Hydraulic Geometry Regional Relationships

BWS is working to update regional regression relationships that predict bankfull streamflow and channel dimensions as a function of stream drainage area. The original project included 18 USGS stream gage reaches with sufficient conditions suitable for the study. The updated regression relationships now include 25 sites, increasing the options for further regionalization and stratification of the data for improved regression results. In 2019, DEP incorporated the revised data and regressions into an Excel workbook developed as a stream assessment and stream project design tool. The workbook includes metadata for all study sites, the study site data used for the regressions, 13 new regression relationships, and several supporting maps and appendices to assist the user in applying the regressions. The workbook was finalized in 2020.

Forest Management - deer exclusion area

In 2020, DEP started a second phase of updating the regional regression relationships to re-calibrate the two Schoharie Creek USGS monitoring sites and add a site for Town Brook in the West Branch Delaware River watershed. This phase is underway, with DEP is seeking written permission from streamside landowners to access properties for field work.

Forest Management > Deer Exclosure Study

Forest pests and pathogens in conjunction with invasive species and deer herbivory pose a significant threat to forest regeneration. BWS has been working with The Nature Conservancy (TNC) to understand forest condition and the interaction between invasive species and herbivory on forest regeneration through exclosure studies in the Ashokan basin.

In 2019, TNC and DEP collected data on tree seedling density, height, and richness to assess forest regeneration inside and outside deer exclosures to help measure deer impacts. Data were also collected on Japanese stiltgrass density and tree seedling abundance and height on experimental plots treated with Roundup in 2018 and untreated control plots to assess stiltgrass impacts to regeneration.

Further study of deer impacts was conducted using the AVID (Assessing Vegetation Impacts from Deer) protocol developed by Cornell Cooperative Extension. AVID is a rapid assessment methodology for evaluating deer impacts on forest regeneration. This protocol was used on four stands in the Ashokan basin. Data were collected from study plots in 2020 for analysis in 2021.

Invasive Species > Hemlock Woolly Adelgid Control

The hemlock woolly adelgid (HWA), an invasive, aphid-like insect that attacks North American hemlocks, has been identified in the City's West of Hudson watershed. BWS is currently conducting research to determine whether predatory species from the Pacific Northwest can be used as biocontrol agents to control HWA populations. Throughout 2019 and 2020, DEP continued collaborating on the Cornell Hemlock Initiative to establish populations of *Laricobius nigrinus* (beetle) and *Leucopis* spp. (silver fly) at several experimental release sites in the West of Hudson watershed.

Research continued in 2019 and 2020 with releases of *Leucopis* at Miller Hollow on Pepacton Reservoir and continued surveys to assess establishment at previous years' *Leucopis* spp. and *Laricobius nigrinus* release sites at Neversink, Schoharie, and Pepacton reservoirs. Cornell Hemlock Initiative also worked on stand health assessments and collected hemlock cones to be used for long-term seed banking through a New York State Department of Environmental Conservation-funded program.

Modeling > Ecohydrologic Modeling of Forested Watersheds

BWS is applying the Regional Hydro Ecologic Simulation System (RHESSys) model to two watersheds in the Neversink Reservoir drainage area. The model is being tested for its ability to accurately predict runoff and concentrations of dissolved nitrogen and phosphorus in these watersheds. Following testing, RHESSys may be scaled up to the entire Neversink Reservoir watershed. This research is conducted through collaboration between DEP modeling staff and post-doctoral researchers from the City University of New York.

RHESSys is a GIS-based, hydro-ecological modeling framework designed to simulate carbon, water, and nutrient fluxes. By combining a set of physically-based process models and a methodology for partitioning and parameterizing the landscape, RHESSys is capable of modeling the spatial distribution and spatio-temporal interactions between different processes at the watershed scale. The application and testing of RHESSys for small watersheds that drain to Neversink and Cannonsville reservoirs was completed in 2019.

Treatment > Flushing Bay CSORF Chlorination Pilot

As part of the Long Term Control Plan for Flushing Creek, DEP will implement full scale disinfection facilities for discharges to two outfalls to manage bacterial loadings into Flushing Creek. Disinfection will be accomplished through the implementation of a seasonal (May to October) chlorination/dechlorination system. DEP will pilot the use of sodium hypochlorite for chlorination to better understand the appropriate dose for the Flushing Creek sewershed, triggers for chlorination, and documentation of disinfection efficacy utilizing two fecal indicator bacteria: fecal coliform and *enterococcus*. In 2020, BWT worked with CCNY to develop the scope and preliminary experimental research proposal for this pilot. Concurrently, BWT developed design drawings for the pilot unit, and began work with BWT operations to plan optimal siting for the pilot unit.

Treatment > Alley Creek CSORF Ceramic Membrane Pilot

Alley Creek was specified under the 2012 Combined Sewer Overflow (CSO) Order to identify the CSO controls required to attain water quality standards consistent with the federal CSO Control Policy and related guidance. The proposed mechanism to achieve meaningful pathogen reduction was through a chlorination/dechlorination facility sited near the Alley Creek CSO Retention Facility. Because this method poses operational and performance concerns, DEP reviewed alternative technologies in 2019, and selected a novel, silicon carbide ceramic membrane technology to pilot at the Old Douglaston Pumping Station in spring 2020. BWT continued work on this pilot into 2020. Due to COVID-19, the pilot faced several setbacks due to supply chain delays and began in July 2020. BWT supervised the installation of the 13,000 gpd ceramic membrane filtration unit, which ran through December 2020. The evaluation of this technology was a collaborative effort with the BWT Division of RCI and Operations, as well as CCNY. Preliminary results demonstrated that the technology could be a viable alternative to chlorination/dechlorination, however significant work is remaining to address the concerns identified in the pilot study.

Flushing Bay

Alley Creek Drone Survey

Innovation

Innovation includes methods, resources, technologies, or processes that are novel in their use or application for the agency or industry.

Water Quality > Enhanced Source Tracking in Alley Creek - Drone Survey

BOS, in partnership with BWT, is exploring options for an enhanced source tracking of illicit discharges in Alley Creek. Direct observations and measures are difficult as there are accessibility issues created by the presence of wetlands, muddy conditions, and shallow waters at low tide. BWT had successfully eliminated many sources of illicit discharges, but this new effort incorporates modern technologies to build on those past efforts, including the use of drones.

Illicit discharges are typically warmer than the receiving waterbody and this temperature difference is captured by thermal sensors installed on the drone. The goal of a drone survey is to find areas with relative water temperature differences where BWT can investigate further for potential illicit discharges. BOS and BWT conducted a drone survey of Alley Creek in spring 2019, but the temperature data were inconsistent due to a sensor malfunction. DEP conducted another flyover in 2020 with a sensor that measures relative temperature data and identified a temperature anomaly that it determined to be groundwater discharge through laboratory analysis. Currently, DEP is planning to complete the drone flyover project in 2021.

Water Quality > Ribbed Mussel (Geukensia demissa) Pathogen Reduction Project

BEPA is conducting multi-objective research to mitigate the influence of pathogens derived from CSO events in marine surface waters. This consists of cultivating and deploying large ribbed mussel populations that will provide bacterial filtration of the Jamaica Bay and other water bodies. As part of this project, a literature review indicated that ribbed mussels (*Geukensia demissa*) are capable of filtering out particles as small as bacteria (less than 1 micron at varying levels of efficiency) from the water column. The bureau is also testing the ability of ribbed mussels to filter *E. coli* and other fecal coliform bacteria commonly found in the water after CSO events. The literature review, laboratory-based trials were completed in 2019, and the bureau is conducting mesocosm simulations. Field trials will be conducted in the final phase of the project.

Remote Sensing > NoiseAware Sensor Research

BEC is piloting noise level monitoring technology in residential areas to assist inspectors in responding more quickly to intermittent noises, especially commercial music and construction noise. The purpose of the pilot is to determine whether the technology is helpful to residents in areas that face chronic noise challenges. In 2019, BEC placed sensors throughout the city, including locations selected in partnership with the NYC Nightlight Agency.

DEP NYU partnered on noise monitoring technology.

Remote Sensing > New York University's Center for Urban Science + Progress

New York University's Center for Urban Science + Progress (CUSP) is in the early stages of developing a smart noise sensing technology with National Science Foundation funding and BEC technical input. The technology includes computer artificial intelligence analyzing sound recordings to identify potential sources. BEC noise inspectors are currently using the data from the smart noise sensing technology as a tool in addressing noise complaints. In 2019, BEC continued working with New York University, DOT, and the NYC Department of Design and Construction (DDC) to place remote noise sensors on light poles near construction sites. There are currently 60 sensors distributed throughout the city.

Treatment > Evaluation of Thermal Hydrolysis Process Effects on Biogas Production, Digestibility, Dewaterability

BWT is working to integrate a thermal hydrolysis process (using indirect heating via heat exchangers rather than direct heating by steam) with bench scale anaerobic digesters to demonstrate the potential benefits of moving to full scale operations. Benefits include: higher production of biogas for energy generation; improved sludge dewaterability, a higher solids loading rate, reduced digester volume and production of enhanced quality of biosolids. In 2019 BWT conducted a series of batch and bench-scale experiments to evaluate the effect of various combinations of temperatures and contact times on thermal hydrolysis, as well as the impact each hydrolysis level has on biodegradability or methane production potential. Data for the batch and bench-scale experiments was presented to the Technical Advisory Committee at a workshop held in March 2020. Due to the pandemic, limited experiments on dewaterability and gas composition at various temperatures for a post-digestion THP configuration have been ongoing since then.

Energy > ElectraTherm Demonstration at Port Richmond WRRF

BWT is working with ElectraTherm, the manufacturer of an Organic Rankine Cycle (ORC) system that uses low-grade heat from boilers to produce electricity. This one-year demonstration project will allow the Port Richmond WRRF to beneficially utilize its biogas during the summer, when typically the plant flares much of its biogas. Specifically, the ORC will utilize the thermal energy generated from biogas in boilers to provide power to the facility. At the end of this one-year demonstration, DEP has the option of retaining the ORC system and will also be able to assess the feasibility of this technology at additional facilities. This pilot project was fully funded by DEP's partner agency, the Department of Citywide Administrative Services. In 2019, the design was underway, and construction is slated to begin in 2021.

Biosolids > Characterization of BWT biosolids

In an effort to increase beneficial reuse of biosolids, the Energy Office will characterize the biosolids currently generated across the six WRRFs with dewatering capabilities by analyzing monthly samples. Expected to wrap up in 2021, the results will summarize nutrient value, carbon content, and selected historical and emerging compounds of concern across DEP's biosolids sources, as a precursor for further research as to the optimal beneficial use of this resource based on its characteristics.

Codigestion Strategy and Operation > Newtown Creek Wastewater Resource Recovery Food Waste Demonstration Project

In 2019, the Energy Office concluded a project that demonstrated the feasibility of post-consumer food waste collection paired with co-digestion at the Newtown Creek WRRF by modeling the costs and benefits associated with the program. The Energy Office partnered with Waste Management, the City of New York Department of Sanitation and New York City Department of Education to divert food waste into anaerobic digesters at Newtown Creek using pre-processing technology provided by Waste Management. Manhattan College studied the energy and nutrient content of the bioslurry provided by Waste Management as well as the optimum loading

Wards Island WRRF thickened sludge is fed to the bench scaled pressure cooker where the sludge undergoes thermal hydrolysis (left). The thermally hydrolyzed sludge is then fed into the bench scaled anaerobic digester (right). The digested sludge is then retrieved and characterized.

rate for co-digestion and biogas production and quality. The study demonstrated that the addition of food waste slurry produced additional biogas of higher quality, with no negative impacts on plant operations. In 2020, DEP transitioned this demonstration project into a permanent resource recovery project at Newtown Creek WRRF.

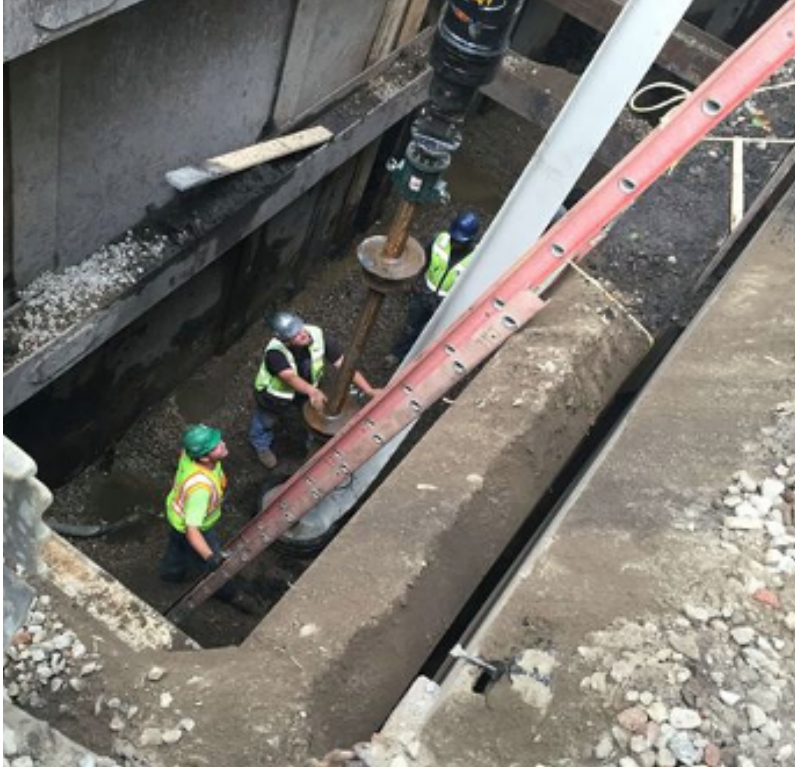
Infrastructure > CCFRPMP Viability for DEP Sewer Installations

The BWSO R&D unit is exploring alternative materials for sewer construction projects. This project is a case study to research new materials for 96-inch-diameter reinforced concrete pipes, which tend to be cost-prohibitive and difficult to transport and install. Based on recommendations from DDC, BWSO is researching the use of centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP) since it has inherent corrosion resistance and is lighter and therefore easier to transport. In 2020, DEP and DDC conducted test installations for the use of CCFRPMP in two projects in Queens for microtunneling and slip-lining applications. DDC and BWSO are also planning a pilot installation in large diameter (>72") sewers.

The BWSO R&D unit is compiling information on CCFRPMP, such as testing reports, material properties, and other previous applications, to verify if this material can be approved for standard sewer pipes and to develop specifications for its installation as a liner for sewer repair.

Data Management > DEP/DDC Pilot Information Database

Since May 2019, BWSO R&D and DDC collaborated to evaluate new technologies that could improve the planning, management, construction, and rehabilitation of the City's water and sewer system. This collaboration revealed that many of the technologies and products being proposed for evaluation have already been utilized by DDC on DEP construction projects in the past. To avoid redundant efforts in the future, BWSO initiated the creation of a pilot database that will encompass all alternative construction means and methods evaluated, piloted, or planned to be piloted by DEP and DDC. DDC has contributed project information and recommendations into the database. The database is currently in Excel format and continuously updated with new evaluated technologies. The next step is to put the database on a platform that is accessible and editable by both DEP and DDC at any time.



Installing DriveCast Helical Piles (DCP) at DEP work location.

Infrastructure > Evaluation of Various Innovative and Non-Standard Piles for Sewer/Water Main Installation Projects

In 2019-2020 BWSO R&D reviewed four non-standard piling methods including DriveCast Pile, Helical Pile, Drilled Displacement Pile, and Drilled-in Displacement Micropile for different construction sites.

DriveCast Pile is an innovative and a more environmentally friendly piling method and has several benefits compared with conventional continuous flight auger piles. Benefits include shorter construction duration, elimination of heavy equipment, reduced spoil disposal, and reduced impact on existing trees and the community. DEP and DDC approved 8-inch-shaft-diameter DriveCast Pile based on its sufficient load capacity. In addition, a conditional, site-specific approval was also granted for improved 4.5-inch-shaft diameter DriveCast Pile.

Helical piles were approved for use in project locations where Drivecast piles were unable to achieve the desired penetration depth and grout volume. Another new technology, drilled displacement pile, affords increased shear strength, improving the load capacity per unit length of the pile. In 2020, the use of drilled displacement pile in lieu of continuous flight auger piles was proposed for a Staten Island construction project. With this substitution, the number of piles was reduced, the pile spacing was increased, and the individual pile capacity was doubled from 20 tons to 40 tons.

Drilled-in Displacement Micropiles are another alternative to standard continuous flight auger piles that have no spoils, are more cost efficient, and can be installed in tight access and low overhead environments. In 2020, BWSO validated this technology as a substitution to continuous flight auger piles. BWSO is working with DDC to further improve QA/QC procedures for approval of non-standard pile requests.

Infrastructure > Implementation of a Radial Collection System to Alleviate Flooding in Southeast Queens

As part of BWSO's effort to address a flooding issue in Southeast Queens, a feasibility study was conducted to determine if a radial collection system could be a viable option to lower the groundwater table in the most affected areas. The modeling performed suggested that the concept may lower the groundwater table, but is dependent on numerous variables including slope, diameter, and slotting of the collection pipes, as well as the permeability of the soil. In 2019, groundwater elevations and water samples were collected from several monitoring wells to provide information for pilot study design and evaluate water disposal options. In 2020, these efforts were expanded upon and applied to begin design of a pilot small scale radial collection system. Installation of additional groundwater monitoring wells, surveying, groundwater modeling, collection of water quality samples and elevation data, and the preparation of system maintenance and monitoring plans are included in this pilot design.

Infrastructure > Consideration of Spray Applied Polyurethane and Heat Shrink Sleeves for Standard Trunk Water Main Coating Materials

BWSO and DDC are currently collaborating on updating the NYC DEP Standard Sewer and Water Main Specifications. This includes considering the use of spray applied polyurethane coating and heat shrink sleeves as coating materials for trunk water mains in the specification book. To evaluate these options, a contractor has been secured to perform a field application demonstration for both polyurethane spot repair and shrink sleeves to facilitate BWSO and DDC's evaluation and decision-making. Specific criteria to be evaluated include the durability of the polyurethane coating in the field, ability of field staff to perform quality spot repair, product life expectancy, and satisfactory corrosion protection for the pipe.

Infrastructure > Fiberglass Expansion Liner for Manhole Rehabilitation

BWSO is evaluating a new fiberglass expansion liner product for trenchless manhole rehabilitation. Continuously wound fiberglass strands are manufactured on a mandrel, cut lengthwise, and then compressed and positioned inside each other to fit in a manhole. This enables the expansion liner to be slid into position inside a manhole before it is released and expanded to fit securely in place. The concrete or brick walls are coated with high strength epoxy resins that fill voids and seal cracks, preparing the surface to receive the liner which expands when released and bonds to the epoxy. The next steps are to identify a suitable manhole for field installation and demonstration.

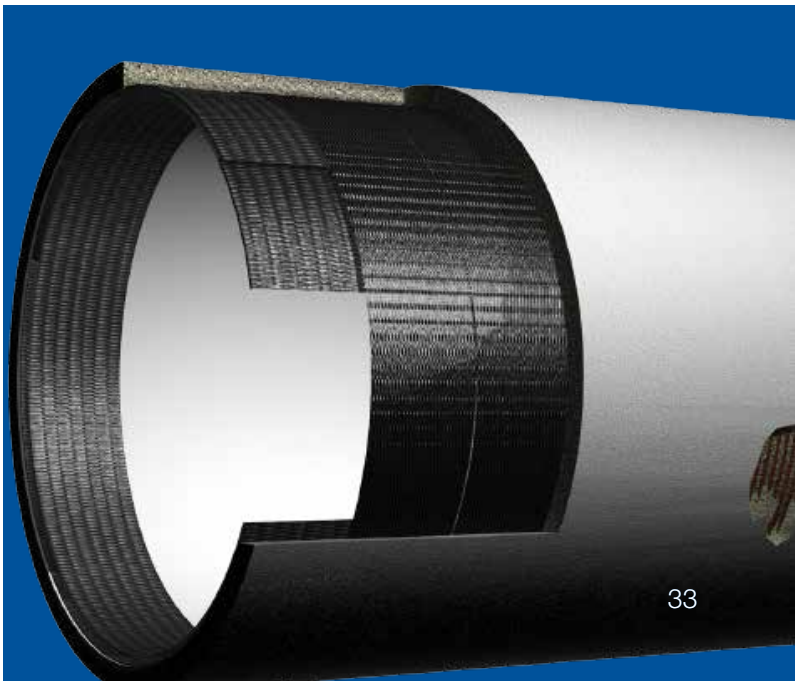
Infrastructure > Carbon Fiber System Lining for Water Main Rehabilitation

BWSO and DDC are planning to rehabilitate multiple trunk water mains in Brooklyn, near the Long Island Rail Road and other MTA facilities, where tunneling is restricted and open trenching cannot be used.

DDC suggested a carbon fiber system (CFS) lining material. CFS is a high strength, thin composite stand-alone pipe, or mesh, capable of resisting high operating pressures and external loads. A CFS liner can be inserted into an existing pipe or shaft (pipe-in-pipe) and fixed in place by an epoxy or resin. An installed CFS liner restores functional capacity to the existing pipe, with minimal reduction in pipe diameter and without excavating the pipe.

BWSO is developing a plan to test this lining system in an emergency construction location prior to the start of DDC's construction, and is also researching this product for future projects.

3D Model of Carbon Fiber System (CFS) Liner (Source: Structural Group Inc.)



Hydrilla is an invasive weed that comes from Asia. It grows aggressively in water, forming dense mats that crowd out native plants, harm fish habitats, and interfere with boating, fishing and other types of recreation.

Infrastructure > Geopolymer Lining Pilot Study

BWSO R&D evaluated a pipe-lining product made of a high-performance, fiber-reinforced geopolymer mortar. This geopolymer liner is spray applied to deteriorated sewer pipes and manholes to create a new structural pipe. Its potential advantages over traditional gunite methods include greater structural integrity, corrosion resistance, and longevity, as well as faster cure times. The pilot application of the geopolymer in a deteriorated sewer pipe began in 2020. Gunite and geopolymer were applied to adjacent manhole runs in the same sewer line, allowing for a side-by-side comparison of the products under the same conditions. Samples of the geopolymer lining product were also collected to perform laboratory tests for its compressive, flexural and bond strengths. BWSO will revisit the pilot location to observe how the liner performs over time and then create a research report documenting the findings. The material will be considered for inclusion into the DEP Standard Specifications if it proves to be a viable alternative to gunite.

Invasive Species > Evaluate eDNA As a Tool for Surveying Aquatic Invasive Plants

Environmental DNA (eDNA) is DNA present in the environment that can be amplified and sequenced to survey for aquatic invasive plants in a water body. eDNA is a developing and promising technology that that may allow more rapid surveying of multiple waterbodies. . BWS, the American Museum of Natural History, and the Catskill Regional Invasive Species Partnership collaborated in testing the use of eDNA in the Ashokan, Schoharie, Rondout, Neversink and Pepacton reservoirs in 2018 and 2019 to survey for aquatic invasive plants, especially *Hydrilla*.

In response to four potential positive results for *Hydrilla* in 2018, two rounds of resampling were conducted in June and October 2019. eDNA was then sequenced using metabarcoding to survey for a suite of species and quantitative polymerase chain reaction to test specifically for *Hydrilla*. Thirty sites in the West of Hudson reservoirs were sampled to confirm or refute the 2018 results. Several small watershed ponds where aerial photography indicated thick aquatic vegetation growth late in the season (indicative of *Hydrilla*) were also sampled. Reservoir sampling concentrated on locations near the putative positive 2018 samples. No conclusive evidence of *Hydrilla* was found in the 2019 samples. The final report was received from American Museum of Natural History in 2019.

Pathogens > Canine Pollution Detection

BWS has a decades-long legacy of conducting microbial source tracking in the tributaries to the Kensico Reservoir in an effort to identify potential sources of illicit discharges, failing septic systems, or broken sewer lines. Results from past studies have shown the presence of genetic markers that are indicative of human waste. BWS personnel have conducted several investigations to locate sources of contamination, and in one case identified a broken sewer line, which was subsequently repaired. While successful, this effort was time intensive.

To explore other options, BWS piloted the use of canines for detection of sewage and/or septic discharges in the Kensico watershed. Canine sewage detection methods are a complimentary tool to traditional methods such as laboratory testing and with the added benefit of rapid detection of point source pollution. In 2019, a field investigation using a scenting canine was conducted to canvass multiple sites in the Kensico watershed that were suspected of having illicit discharges. Samples were collected and analyzed using traditional methods to compare with the canine results. Results from the study highlighted several areas of interest for follow up, and future canine work is in the planning stage.

Water Quality > Microbial Source Tracking in Alley Creek

BOS, BWT, and USGS partnered to identify the source(s) and relative host contribution of bacterial contamination in Alley Creek using microbial source tracking of Bacteroides and chemical analyses. The study is designed to evaluate fecal contamination sources to Alley Creek seasonally and spatially, during both wet and dry weather conditions, and based on tidal influence. Surface water, groundwater, and sediment samples will be collected for analysis. Additional analysis for viruses that infect bacteria and pharmaceuticals will also be run for samples with human or canine markers. Sampling began in August 2020 and is expected to conclude in 2021. The final report is expected in late 2022.

Canine Pollution Detection Team

Emerging Contaminants > Ultrasonic Algae Control

Widespread regional and national concern over increased harmful algal blooms has prompted additional research into monitoring and mitigation approaches. Although there are many treatment alternatives available, non-chemical treatment options of algal blooms are specifically attractive for water supply operations.

The 2020 deployment of the ultrasonic platform on Croton Falls Reservoir was conducted as a continuation of a 2018 pilot study to determine the effectiveness of this technology in preventing and mitigating algal blooms. Equipment malfunctions during 2018 and 2019 warranted a third study season to effectively evaluate the technology. As was observed in 2018 and 2019, there was no significant difference in water quality at the control or treatment sites in terms of chemical or biological parameters. Algal production at the testing site has proven to be beyond the control capability of this particular ultrasonic buoy platform.

While this technology remains of interest to the DEP, no further study will be undertaken in Croton Falls. DEP will evaluate other locations that may be of interest and will request appropriate permits as needed based on study locations.

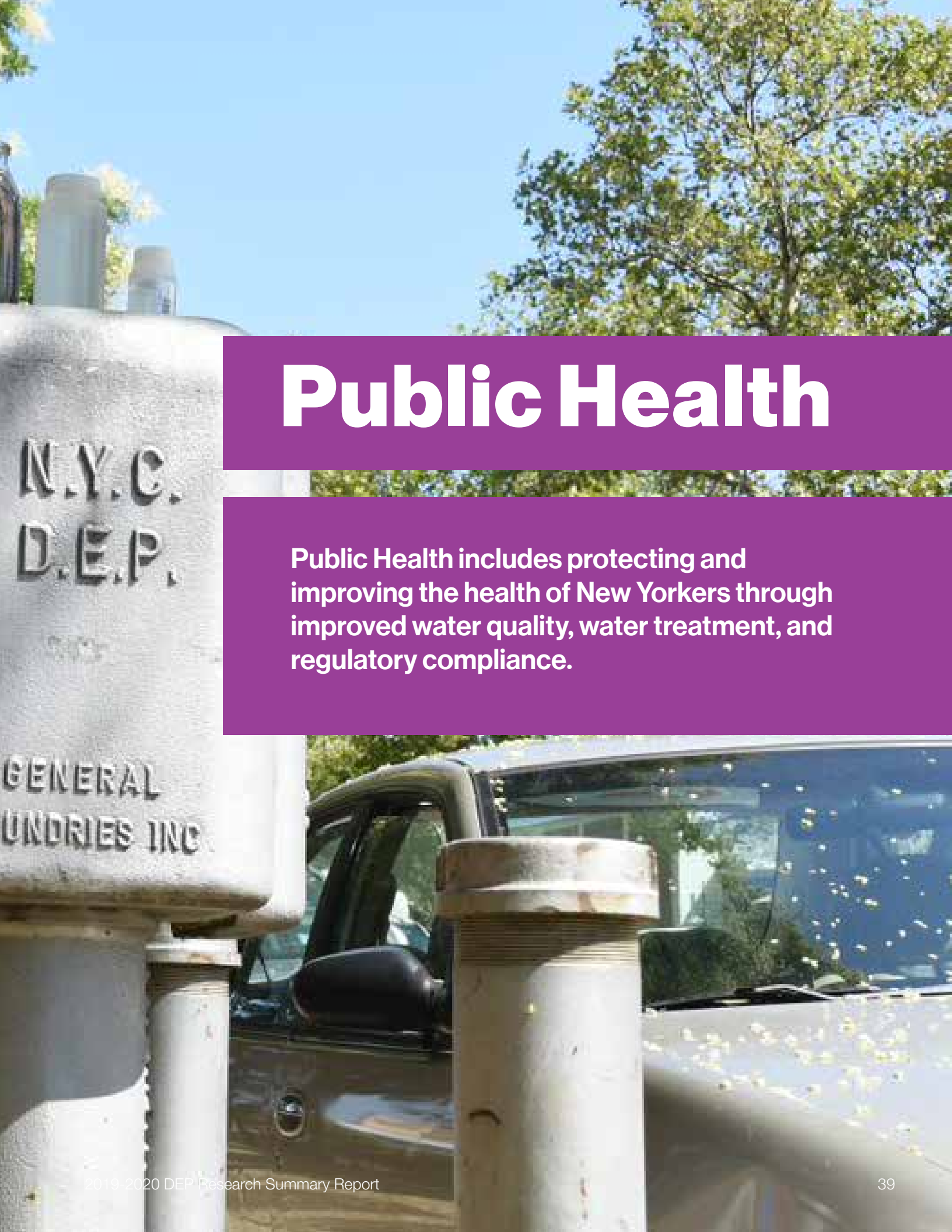
Treatment > Implementation of an Alternative Struvite Control Method

In an effort to reduce chemical consumption and reduce the detrimental effect of struvite precipitation on structures and equipment, BWT is upgrading all its struvite control system switching from ferric chloride to a polymer dispersant. This change reduces the direct cost of chemicals for struvite control by at least 60%. Additionally, it could reduce or completely eliminate the use of magnesium hydroxide in the downstream separate centrate treatment. In October 2020, the Wards Island facility was upgraded, and has been operating with dispersant polymer since. BWT is in the process of upgrading two other facilities, Hunts Point and Bowery Bay, with work at three additional facilities scheduled for late 2021 and early 2022. The design and construction work will be performed entirely using in-house resources.

Deploying the Ultrasonic Algae Control Platform

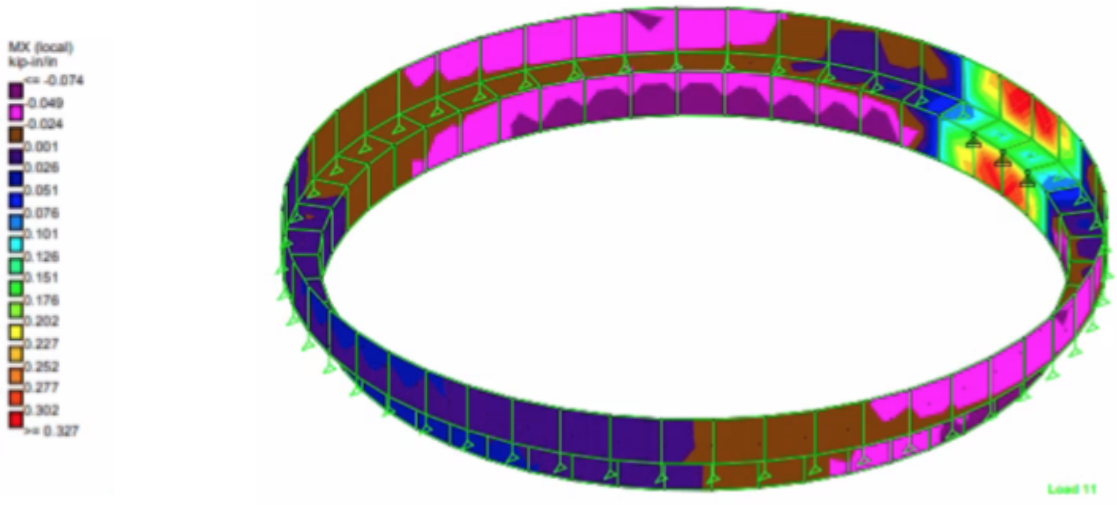
Deploying the Ultrasonic Algae Control Platform

DEP scientist collecting drinking water samples



Public Health

Public Health includes protecting and improving the health of New Yorkers through improved water quality, water treatment, and regulatory compliance.



Finite Element Analysis Model of a manhole extension ring under traffic loading

Infrastructure > Analysis and Design of Extension Rings for Manhole Covers

Analysis was performed on all variations of DEP and Department of Transportation (DOT) manhole extension rings to ensure that they can withstand standard traffic loading. BWSO performed structural strength and traffic loading analysis on the existing ring designs. A new ring was also designed, with a smaller rise to mitigate the elevation difference between the manhole cover and the pavement. This analysis supported a cast iron ring with a 1.75-inch-high rise. DEP also performed analysis on a new aluminum ring design. Since cast iron is a heavy material, a lighter weight aluminum ring would be easier to transport and maneuver in the field. The analysis concluded that the aluminum ring also meets the traffic loading requirements and passes the force analysis.

Disinfection Byproducts > Reservoir and Watershed Modeling and Research for Disinfection Byproduct Precursors

BWS is working to expand an existing dissolved organic carbon (DOC) model to include additional disinfection byproduct (DBP) precursors to simulate the export, fate and transport of DOC and DBP precursors and consider the impact of watershed protection and climate change for the West of Hudson watersheds. As an alternative to direct simulation of DBP precursors in watershed and reservoirs, BWS is also investigating simulation of an optical surrogate, or proxy, for precursors. Because analysis of data collected to date indicates that UV254 may be a good proxy for precursors, BWS is developing a model to simulate the fate and transport of UV254 in Cannonsville and Neversink reservoirs.

Emerging Contaminants > Emerging Contaminant Research

BWS monitors for emerging contaminants within the NYC watershed and distribution system. In 2019, the parameters studied included those listed in the 3rd and 4th Unregulated Contaminant Monitoring Rules, as well as various pharmaceutical and personal care protection products (PPCP). The PPCPs and related compounds in the NYC Water Supply have been investigated in the past and include prescription and over-the-counter drugs, fragrances, disinfectants, sunscreen, preservatives, and surfactants. The EPA uses the Unregulated Contaminant Monitoring Rules to collect data for contaminants that are suspected to be present in drinking water and do not have health-based standards set under the Safe Drinking Water Act.

Treatment > Adenosine Triphosphate Testing of Granular Activated Carbon

The Croton Filter Plant has shifted the filtration system to granular activated carbon (GAC). GAC consists of irregular shaped carbon particles that can vary in size, but are typically no larger than 5 millimeters. One of the characteristics of GAC is its ability to grow a diverse community of microbes on the grain surface. These microbes have the ability to remove a wide range of contaminants from drinking water and can markedly extend the active lifetime of the GAC. Adenosine triphosphate testing measures the development of this biological activity and optimizes the GAC's capacity and life-cycle. DEP piloted the use of this testing in 2020.

Treatment > Maximizing Treatment Effectiveness at Croton Filter Plant

In natural waters, the organic constituents targeted for filtration have a negative charge. In order to effectively filter drinking water, the Croton Filtration Plant utilizes a series of treatments to neutralize it. This is achieved through the addition of positively charged metals like aluminum compounds that help create particles large enough to be lifted by dissolved air flotation and then filtered in the treatment process. Research is underway to study the effectiveness of using zeta potential – the measure of the overall charge in water – to ensure effective chemical treatment. Testing is underway to measure the zeta potential against the current treatment process for use as a baseline measurement. In 2021, zeta potential will be used to measure the effectiveness of polyaluminum chloride in lieu of the current compounds to identify whether there is an opportunity to improve filtration at the plant.

Treatment > Source Water Selection – New Croton Water Quality Index

BWS is developing a water quality index to identify and optimize withdrawals from source water reservoirs. The water quality index is created by scoring numerous water quality parameters to create an index that succinctly conveys overall water quality in a single number. The Catskill, Delaware, and Croton systems each have unique indices based upon the parameters evaluated and incorporated into the index. For example, the Catskill and Delaware water quality index evaluates parameters such as turbidity and UV254 data to aid selection of the highest quality source water for distribution. The Croton water quality index evaluates a suite of parameters that aid in the selection of the optimal location and depth to withdraw water from New Croton Reservoir to meet treatment efficacy and efficiency at the Croton Filtration Plant.

Treatment > Croton Filter Plant Distribution to City Tunnel 2

With the construction of a connection between the Croton Filter Plant and City Tunnel Number 2, research is underway to understand the maximum flow that can be distributed throughout the water supply system at different times of the year. This value will be developed by evaluating the role of temperature, pH, and free chlorine residual at different times of the year and under various flow scenarios. The result will provide BWS with the information needed to meet water quality requirements for inactivation and disinfection as the new operational configuration is brought online.

Croton Water Filtration Plant

Lead > Lead Premise Plumbing Studies

During a DEP review of tapping records for city-owned infrastructure in 2018, a number of single-family homes owned by the New York City Housing Authority (NYCHA) were identified as possibly having lead service lines (LSLs). These homes were inspected, and those with confirmed LSLs had those lines replaced by DEP in coordination with NYCHA. To better understand the impacts of LSL replacements on lead concentrations in premise plumbing, DEP provided residents with lead test kids for sampling between 30 and 90 days after the LSL replacements. Results indicated that flushing may not be needed for more than a month, but DEP plans to continue to evaluate the impact of flushing post-LSL replacement. This effort will be conducted under the New York State grant-funded LSL Replacement Program that DEP is managing. The program has the capacity to replace LSLs at up to 300 eligible low income homes. At the close of 2020, approximately 60 LSLs had been replaced.

Lead > Evaluation of Optimizing Corrosion Control in the New York City Water Supply

DEP is studying the impact of increasing the orthophosphate (PO_4) dose in a limited, isolated area of the Bronx in City Island. The PO_4 operating dose in City Island was initially raised from 2 to 3 mg/L in August 2019 and continued as such into 2020. The impact of the increased dose is being evaluated by collecting samples from two pipes loops installed at a BWT pump station on City Island, and profile samples collected from private homes on City Island under different doses, source waters, and water temperatures. The study has completed profiles based on Catskill watershed and Delaware watershed water samples, and Croton watershed profiles are slated for 2021.

In addition, data from water quality instrumentation on City Island is continuously monitored for PO_4, specific conductivity, turbidity, temperature, pH, and chlorine residual levels. Also included in the study is a third pipe loop in Queens, which is being used as a control as it is not receiving an increased PO_4 dose or change in source water.

Lead > Lead Scale Analysis

BWS performed lead scale analysis on six lead service lines harvested from the NYC distribution system to better understand the makeup of the scale forming in pipes within the distribution system. This research allowed DEP to understand the morphology, chemical composition, and crystalline structure of lead scales which impacts the potential for lead release. The analyses were conducted at the State University of New York at Buffalo via X-ray diffraction, field emission scanning electron microscope with energy-dispersive X-ray spectrometry, and energy-dispersive spectrometry.

City Island Lead Pipe Loop Study

Pathogens > *Cryptosporidium* analysis of Wildlife Excrement Samples

To maintain an understanding of potential pathogen sources within the NYC watershed, BWS continued mammal and bird excrement collection and pathogen analyses to identify the prevalence of *Cryptosporidium* oocysts in a variety of wildlife species throughout the watershed and at Hillview Reservoir. Samples collected by the BWS Wildlife Studies Section by means of trapping, roadkill collections, and surface collection were identified. Scat samples from these animals were catalogued and shipped on ice by the Watershed Impact and Pathogen Assessment team to the Centers for Disease Control and Prevention laboratory in Atlanta, Georgia for analysis.

Thirteen wildlife scat samples were submitted from the upstate watershed in 2020, and 29 scat samples were sent from the Hillview area. Samples were analyzed by Polymerase Chain Reaction in order to detect the presence of any *Cryptosporidium* species in the wildlife samples. In 2019, most cases (>92%) of wildlife samples were negative for *Cryptosporidium*. Animals that tested positive included two eastern gray squirrels (*Sciurus carolinensis*), and one each of raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*) and a mouse (*Peromyscus* spp.). Less samples were collected and analyzed in 2020 due to COVID-19 and the subsequent shut-down of certain analyses by the CDC. As a result, most data remain pending; however, animals that have tested positive so far include an opossum (*Didelphis virginiana*), a coyote (*Canis latrans*) and a white-tailed deer (*Odocoileus virginiana*).

Disinfection Byproducts > DBP Formation Potential in Watershed Sources

BWS is conducting research in the Neversink and Cannonsville watersheds to evaluate potential proxy measurements for DBP precursors to support water supply operations and water quality modeling efforts. Samples from major stream inputs, along with reservoirs and reservoir diversions, are being analyzed for total trihalomethane formation potential, haloacetic acid formation potential and potential proxy analytes. The proxy analytes include total and dissolved organic carbon, UV254, fluorescent dissolved organic matter, S::CAN multi-spectral absorbance, *chlorophyll a* and *phycocyanin*.

The study, which includes a combination of laboratory, field and robotic monitoring, will assist BWS in developing a water quality index and models to optimize the quality of water being delivered to the City.

Pathogen monitoring at East Branch Delawere River

DEP sceientist conducting SARS CoV-2 testing at the Newtown Creek Microbiology Laboratory

Pathogens > Legionella Monitoring in NYC Phase 2

BWS conducted a second yearlong joint study with NYCDOHMH in 2019 to continue monitoring for Legionella in the NYC distribution system. Samples were collected from 281 sites during this period, and each site was sampled once during the study period with the exception of a site located on Warren Street, between West Broadway and Greenwich Street, in Manhattan (Site 31850). This location was sampled monthly due to recurring positive Legionella detections during Phase I of the study, conducted in 2018.

In 2019 and 2020, this work allowed DEP to establish baseline data for *Legionella* at all Revised Total Coliform Rule compliance sites City-wide, and to continue evaluating the Legiolert testing method. The study also permitted DEP to expand the library of *Legionella* isolates from the NYC distribution system, to assess seasonality at the Warren Street location, and to develop a tool box of potential actions for responding to future positive results.

Pathogens > Wastewater Based Epidemiology: SARS CoV-2 Monitoring

In August 2020, DEP's BWT joined scores of utilities nationwide to monitor levels of the virus that causes COVID-19 in untreated wastewater. With significant help from our academic partners at CUNY and NYU, he Newtown Creek WRRF microbiology lab set up monitoring procedures in a very short timeframe using a testing method that looks at viral RNA. This was a significant achievement, as it represents the implementation of the very first molecular biology method in this laboratory. To date, the Newtown Creek microbiology lab has analyzed hundreds of samples from DEP WRRFs, as well as from Westchester County, Plattsburgh, NY, and BWS upstate. Since August 2020, DEP has reported data on the City's 14 WRRFs to the NYCDOHMH for their public health monitoring, and has participated in several national initiatives on the important area of wastewater-based epidemiology (e.g., Association of Public Health Laboratories' guidance documents for laboratories getting started on wastewater-based epidemiology for SARS-CoV-2RNA).

Organic chemistry testing at
Distribution Laboratory in Queens

Green roof at The New School in Manhattan, NY. A recipient of a DEP Green Infrastructure Grant which helped to fund the installation.

Sustainability

Sustainability includes opportunities to be self-sustaining in the areas of energy, infrastructure, financing, and hydrology, in addition to efforts to improve quality of life through water conservation, preparing for extreme weather and climate change, and understanding the water-energy nexus.

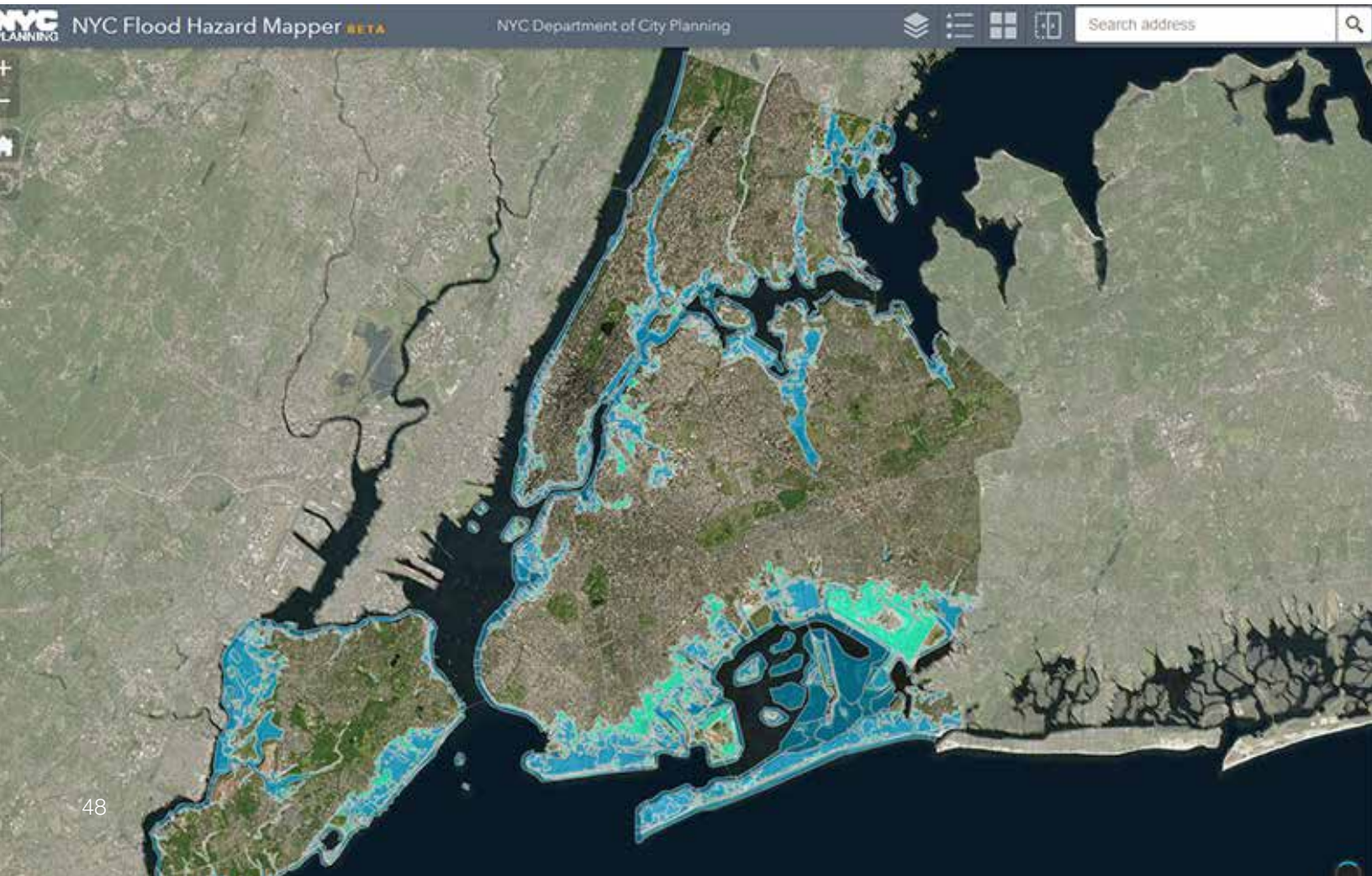
Climate Change > Citywide Stormwater Resiliency Planning

In 2018, BOS initiated a stormwater resiliency study with the Mayor's Office of Resiliency to model flood-prone areas under different storm scenarios and with current and future climate projections. Local Law 127 of 2018 requires the City to provide maps of areas most vulnerable to flooding, and to develop a mitigation plan that reflects existing and potential future approaches through green, and green-gray hybrid stormwater management solutions. Accordingly, DEP and the Mayor's Office of Resiliency will be developing a plan that utilizes the flood maps and builds upon the City's existing efforts and projects incorporating operational and structural approaches. BOS is also working to leverage similar efforts such as those undertaken by the cities of San Francisco, Atlanta, and Copenhagen to apply lessons learned. In 2019, BOS continued to refine flood maps by enhancing the level of drainage system level information to produce more accurate estimates of potential flood extent and depth.

Modeling > Water Demand and Wastewater Flow Projections

The Integrated Water Management group in BEPA is developing updated short- and long-term water demand projections in consultation with BWS to statistically characterize trends in water use patterns by user class, sectors, and geographic regions. The Integrated Water Management group will also consider the influence of climatic and socio-demographic factors that shape short- and long-term demand trends when updating the projections. Additionally, BEPA is developing updated dry weather wastewater flow projections by drainage area, sewershed, and/or sub-sewershed to empirically connect water demand and wastewater flow projections and translate water demand forecasts to projected wastewater flows. In 2019, BEPA developed a forecasting framework, which will be used for the development of the water demand forecast model. The forecasting framework centers around the disaggregation of water-use data, as well as the socioeconomic and other variables that can be used to explain variability in water use. BEPA also worked to gather and clean the large automated meter reading consumption datasets that are the basis for the updated water demand and wastewater flow projections.

NYC Flood Hazard Mapper



Infrastructure > Rezoning Infrastructure Planning Analysis Support

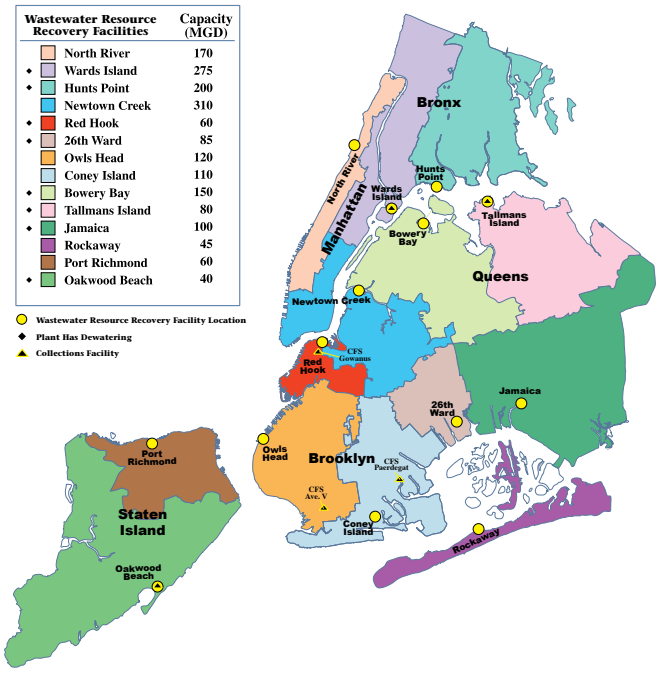
BOS is working to develop a method for analyzing potential impacts on the sewer system from rezoning to better understand how much development can be supported by DEP infrastructure before capital improvements are necessary. This analysis is especially important in light of the City's need for neighborhood rezonings related to affordable housing. There is a need to assess the effect of proposed growth on infrastructure capacity and develop a uniform approach to support sustainable growth. In 2019, DEP initiated the analysis via a citywide methodology to evaluate capacity and conducted a neighborhood analysis of the Gowanus Rezoning area.

Wastewater Resource Recovery > Evaluation of Magnesium Hydroxide for Struvite Control and Alkalinity Supplementation

The overall objectives of the proposed study are to assess and demonstrate the effectiveness of magnesium hydroxide, to minimize the concentration of phosphate by enhancing struvite precipitation in anaerobic digested sludge while simultaneously supplementing its alkalinity to satisfy potential demands by downstream treatment processes. In 2020, BWT's academic partners conducted Phase 1 of the study. The aim of Phase 1 was to characterize the digested sludge and centrate from the Wards Island WRRF, confirm the solubility of magnesium hydroxide in sludge as a function of dose and contact time using different batch tests, and assess the phosphate removal performance in batch reactors.

Energy > Characterizing, Categorizing, and Communicating Next-Generation Nutrient Removal Processes for Resource Efficiency

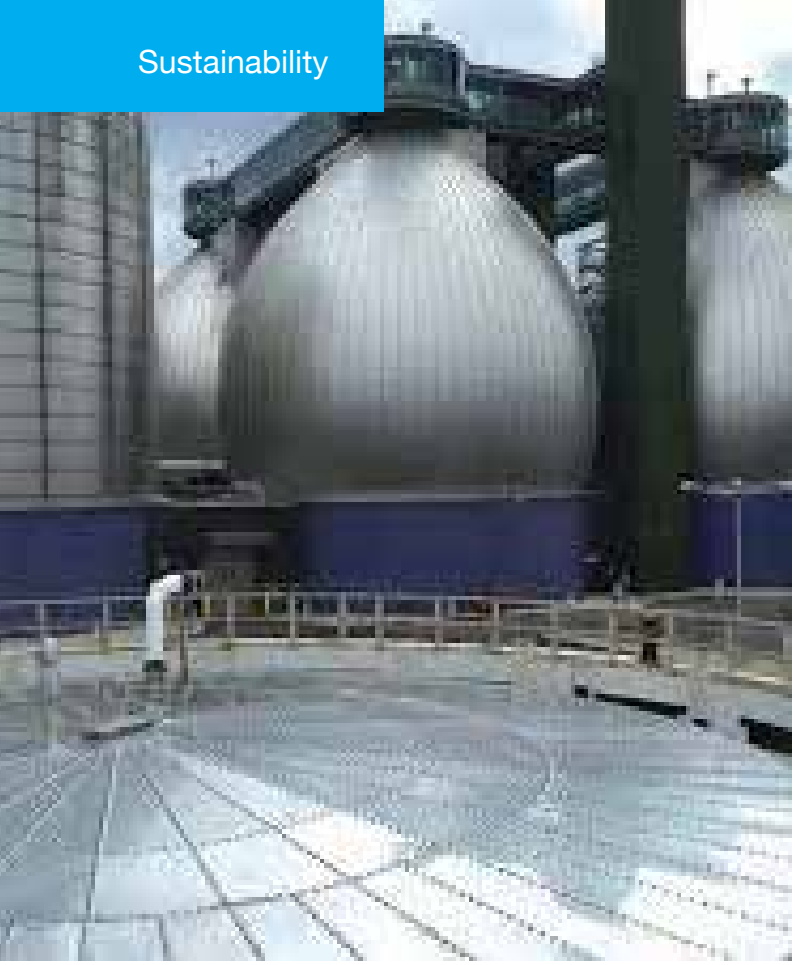
In 2019 and 2020 DEP collaborated with The Water Research Foundation and Stanford to conduct a comprehensive overview of nutrient technologies, associated indicators, and potential future research areas. The goal of this project is to inform research and development in the area of efficiency optimization for nutrient removal. This work culminated in 2020 with a collaboration workshop on next generation nutrient removal technologies. This workshop was organized by DEP and Stanford and hosted at the Newtown Creek WWRF. Held over 1 day, the workshop provided an opportunity for engineers, operators, and academic professionals to come together, engage with presentations by leading speakers on emerging technologies and case studies, and participate in group discussion. A final report was issued to The Water Research Foundation in July 2020, which provided a comprehensive overview of nutrient technologies, summarizing common metrics and classifying technologies to facilitate technology comparison, and identifying research questions.



New York City drainage areas and Wastewater Resource Recovery facilities

Energy > DEP Energy and Carbon Neutrality Plan

DEP's Energy and Carbon Neutrality Plan is a three-year effort that will develop a roadmap achieving energy and carbon neutrality by 2050. The project is comprised of five major tasks and deliverables: (1) an Energy Neutrality Plan for the 14 in-City WRRFs, including five conceptual designs for innovative energy efficiency and renewable energy systems that will be replicable at multiple locations; (2) a Solids Handling and Biosolids Beneficial Use and Residuals Optimization Plan for both the upstate and in-City WRRFs; (3) a DEP-wide Energy and Carbon Neutrality Plan, including an 80% reduction in greenhouse gas emissions, and a 20% reduction in energy usage; (4) an Energy, GHG, and Biosolids Management Scenario Modelling Tool and data management support; and (5) a report on highly innovative, fringe technologies related to energy, GHG emissions, and biosolids beneficial use that DEP could demonstrate. In late 2019, DEP's project partners were on-boarded. Throughout 2020, the team undertook several first-ever analyses for DEP, such as food waste co-digestion capacity system-wide, solar PV potential over process tanks, hydropower potential from effluent outfalls, and thermal energy recovery from wastewater. The project is expected to proceed through 2022.



Food waste storage tank and digester eggs at the Newtown Creek Water Resource Recovery Facility.

Climate Change > Climate Data and Analysis Modeling

BWS is developing models to generate time series of climate data to be used in water quality simulations for watersheds and reservoirs that reflect current and future climate conditions. Using the predictions of global climate models, BWS is using statistical downscaling to generate future weather conditions for the New York City watersheds that include extreme events (i.e., floods and droughts) and consider various levels of greenhouse gas emission. This research is being conducted through collaboration between DEP modeling staff and post-doctoral researchers from the City University of New York.

Climate Change > Long-term Dissolved Oxygen Concentrations in Lakes and Reservoirs

BWS and academic partners in 2016 initiated a study on the effects of climate on dissolved oxygen (DO) concentrations in lakes and reservoirs around the globe. BWS contributed temperature, DO, nutrient, and chlorophyll data from Cannonsville and Neversink reservoirs, along with professional expertise. This work resulted in a 2019 paper to the journal Nature that focused on de-oxygenation of lakes due to the combined effects of eutrophication and climate change. The publication was provisionally accepted in December 2020.

Using a long-term, globally-distributed dataset compiled from 400 lakes and reservoirs and 22,983 DO and temperature profiles, this researched showed that decreases in DO are widespread in surface and deep waters of lakes. Data analysis revealed that deep water DO declines were associated with reduced water clarity and changes in thermal stratification, but not gas solubility. In 22% of the lakes, however, surface DO increased despite reduced solubility, likely as the result of increased algal biomass in highly productive warm lakes. Results demonstrate that lake ecosystems are being modified by complex and synergistic effects of temperature change and eutrophication.

Treatment > Nitrous Oxide Production and Mitigation Project

In 2020, BWT was awarded funding by The Water Research Foundation for a tailored collaboration to address GHG emissions from biological nutrient removal processes. New York City, among other major cities, leads in planning to achieve deep carbon reduction and energy neutrality by the first half of the 21st century. DEP faces an unprecedented challenge to reduce its emissions and energy consumption while meeting new, energy-intensive water quality mandates for nitrogen removal. Such mandates potentially lead to increased emissions of nitrous oxide, one of the most significant GHGs with a global warming potential about 300 times that of carbon dioxide. To achieve DEP's carbon neutrality goals, monitoring and mitigation of nitrous oxide emissions in biological nutrient removal processes is crucial. This project builds on research supported by DEP, The Water Research Foundation and National Science Foundation, and will inform process-specific monitoring and mitigation strategy planning for biological nutrient removal processes to control nitrous oxide production and emissions.

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DEP scientist talks to DEP staff about global climate models

List of Acronyms

AVID	Assessing Vegetation Impacts from Deer
BEC	Bureau of Environmental Compliance
BEPA	Bureau of Environmental Planning and Analysis
BOS	Bureau of Sustainability
BWSO	Bureau of Water and Sewer Operations
BWS	Bureau of Water Supply
BWT	Bureau of Wastewater Treatment
CCFRPMP	Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe
CFS	Carbon Fiber System
CHI	Cornell Hemlock Initiative
CSO	Combined Sewer Overflow
CUSP	New York University Center for Urban Science + Progress
DBP	Disinfection Byproduct
DDC	New York City Department of Design and Construction
DEP	New York City Department of Environmental Protection
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DOT	Department of Transportation
eDNA	Environmental DNA
EPA	Environmental Protection Agency
GI	Green Infrastructure
GAC	Granular Activated Carbon
HWA	Hemlock Woolly Adelgid
LSL	Lead Service Line
MS4	Municipal Separate Stormwater Sewer System
NAPL	Non-Aqueous Phase Liquids
NYCDOHMH	New York City Department of Health and Mental Hygiene
NYCHA	New York City Housing Authority
ORC	Organic Rankine Cycle
PO_4	Orthophosphate
PPCP	Pharmaceutical and Personal Care Protection
RHESSy	Regional Hydro Ecologic Simulation System
SWAT	Soil and Water Assessment Tool
TNC	The Nature Conservancy
USGS	United States Geological Survey
WM	Waste Management
WQI	Water Quality and Innovation
WRRF	Wastewater Resource Recovery Facility


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