NYC Environmental Protection

NYWEA

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2024 Watershed Science & Technical Conference

PROGRAM | COMPENDIUM OF ABSTRACTS

Bear Mountain Inn, Tomkins Cove, NY | September 10, 2024

Program-at-a-Glance

Opening Session—Perkins Room

8:45 am	**Khristopher Dodson,** NYWEA Executive Director
8:50 am	**Lisa Derrigan,** NYWEA President
8:55 am	**Lisa Melville,** NYC Watershed Progams Coordinator, NYSDOS
9:00 am	**Paul Rush,** Deputy Commissioner, NYCDEP
9:05 am	**Jane Gajwani,** Director, Office of Energy and Resource Recovery, NYCDEP *DEP Reponse to Climate Leadership Community Protection Act*
9:25 am	**Jonathan Binder,** Deputy Commissioner, Climate, Air & Energy, NYSDEC *Clean Energy & Becoming Carbon Neutral*

9:45 am Break

Morning Session 1—Perkins Room

Moderator: Gregg Shaw, Stantec
Contact Hours: + Engineer 2.0 ◆ Water 1.5

10:00 am
+ ◆ Latest Climate Projections for NYC Water Supply System
Kinsey Hoffman, Hazen and Sawyer; Rajith Mukundan, NYCDEP

10:30 am
+ ◆ An Evaluation of Forest Ecosystem Response to Climate Change and Associated Water Quality Impacts in the NYC Watersheds
Dr. Phoebe Aron, Hazen and Sawyer, Laurie Machung, NYCDEP

11:00 am
+ Improving SWAT-C Model Carbon Flux Simulation of Forest Ecosystem: Modification of Forest Growth and Initial Evaluation
Sijal Dangol, Hunter College, CUNY

11:30 am
+ ◆ Considerations of a Surface Water Treatment Facility Proactively Preparing Against Harmful Algal Blooms
Dr. Daniel Whalen, Hazen and Sawyer

Morning Session 2—Appalachian Room

Moderator: Scott Davis, Carollo Engineers
Contact Hours: * Wastewater 1.5 + Engineer 2.0 ◆ Water 1.0

10:00 am
*** + Green Roofs on NYC Schools: Inter-Agency Collaboration and Challenges**
Flavio Reyes, NYCDEP

10:30 am
+ ◆ Copper Sulfate Treatments in 2023 on the Croton System of the New York City Water Supply to Suppress Taste and Odor Compounds by Preventing Harmful Algal Blooms
Richard Kowalczyk, NYCDEP

11:00 am
*** + ◆ Addressing Disinfection Byproduct Formation One Bottle at a Time: A Bench-Scale Chlorine Dioxide Evaluation**
Liliana Calix, Arcadis; Maithili Sajip, Arcadis

11:30 am
*** + Delivering Projects Using Community Based Partnership to Meet Chesapeake Bay TMDL Requirements in Prince George's County, MD and Key Lessons Learned**
Srikanth Gorugantula, HDR; Roland Jones, Corvias

12:00 pm Lunch—Perkins Room

Afternoon Session 3—Perkins Room

Moderator: Kinsey Hoffman, NYCDEP
Contact Hours: * Wastewater .5 + Engineer 2.0 ◆ Water 1.5

1:00 pm
*** + ◆ Can Bypassing Boyd Corners Outflow Improve Water Quality in West Branch Reservoir?**
Dr. Rakesh Gelda, NYCDEP

1:30 pm
+ ◆ A Paired Subwatershed Study to Investigate Land-Use Effects on Water Quality in NYC Water Supply Streams
Dr. Rajith Mukundan, NYCDEP

2:00 pm
+ Assessing New York City Water Supply Using Year-1450-to-Present Inflow Estimates Derived From Tree Ring Sample Data
Dr. John Clayton, Hazen and Sawyer;
Naresh Devineni, Jerry Mead, CCNY

2:30 pm
+ ◆ LCRI Requirements: Optimizing Corrosion Control in the NYC Distribution System
Julie Herzner, NYCDEP

Afternoon Session 4—Appalachian Room

Moderator: Linda Allen, NYSDEC
Contact Hours: + Engineer 2.0 ◆ Water 1.0

1:00 pm
+ Presentation on the Agricultural Program Metrics Evaluation; a Joint Effort by DEP and WAC, Part Two
Sara Storrer, Connor Young, Michael Vander Werff, NYCDEP

1:30 pm
+ Exploring In-situ Absorption Spectra to Assess Dissolved Organic Matter Quality in Neversink Reservoir: A Preliminary Analysis
David Van Valkenburg, NYCDEP

2:00 pm
+ ◆ Harmful Algal Blooms: Methods for Water Quality Management Programs
John Kaurich, NYCDEP

2:30 pm
+ ◆ Quantitative and Seasonal Assessment of Protozoa Pre- and Post-Ultraviolet Disinfection (2018-2023)
Kerri Alderisio, NYCDEP

3:00 pm Break

Afternoon Session 5—Perkins Room

Moderator: Robert White, AKRF
Contact Hours: * Wastewater .5 + Engineer 1.0 ◆ Water 1.0

3:15 pm
+ ◆ Innovative Approaches and Use of Knowledge Metrics in Simulation Exercises
Shawn Corrigan, Carollo

3:45 pm
*** + ◆ Cybersecurity: Tabletop 101**
Michelle Rissolo, NYCDEP

Afternoon Session 6—Appalachian Room

Moderator: Lina Posso, Carollo Engineers
Contact Hours: + Engineer 1.0 ◆ Water .5

3:15 pm
An Experiment to Assess the Fate of Land-Applied Class "B" Biosolids
Jay Slate, City of Watertown PCP

3:45 pm
+ Implementing Precast Porous Concrete Panels in the Gravesend Bay Neighborhood of Brooklyn, NY
Graciela Miguel, NYCDEP

4:15 pm
+ ◆ Evaluating Stream Turbidity Production Conditions and Reduction Management Strategies in the Esopus Creek Watershed: A Status Report
Wae 'Dany' Davis, NYCDEP

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Latest Climate Projections for NYC Water Supply System

Kinsey Hoffman, Hazen and Sawyer Email: khoffman@hazenandsawyer.com
Rajith Mukundan, NYCDEP (Co-Speaker)

NYCDEP is currently undertaking a climate change impact assessment on the drinking water supply system. The Operations Support Tool (OST) is DEP's tool for conducting modeling and simulations to assist with operational and planning decisions for the City's water supply system. The sixth assessment cycle of the Coupled Model Intercomparison Project (CMIP6) and the Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC AR6) provide the most recent and comprehensive climate change projections, reflecting a collaborative effort to standardize simulations across models, and offer policymakers robust assessments of potential future scenarios. CMIP6 projections are being used to generate inputs for the OST to represent future conditions. Model outputs from CMIP6 are typically downscaled to spatial areas of interest and bias-corrected to better align with in-situ observations. Two downscaled datasets were selected for this assessment:

1) the Localized Constructed Analog (LOCA) dataset produced by University of California San Diego Scripps Institution of Oceanography researchers and

2) the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6) dataset that uses a Bias-Correction Spatial Disaggregation (BCSD) approach produced by NASA researchers. Gridded output was translated to reservoir point locations and watershed boundaries of interest using area-weighted averaging. Time series for each location were then bias corrected using quantile-to-quantile mapping. Watershed rainfall-runoff models (GWLF) were then used to simulate projected streamflows using projected temperature and precipitation as drivers. This presentation will summarize results of temperature, precipitation, and streamflow projections in the NYC watershed.

ADDITIONAL AUTHORS: Rakesh Gelda, NYCDEP; Adao Matonse, NYCDEP and Jerry Mead, NYCDEP.

An Evaluation of Forest Ecosystem Response to Climate Change and Associated Water Quality Impacts in the NYC Watersheds

Dr. Phoebe Aron, Hazen and Sawyer Email: paron@hazenandsawyer.com
Laurie Machung, NYCDEP (Co-Speaker)

Forests cover up to 90% of the NYC water supply watersheds and play a critical role in maintaining high water quality in the NYC water system. Climate change has already caused changes in temperature and precipitation in the NYC watershed region and in the coming decades will likely lead to more intense and frequent extreme precipitation events and a shift in seasonality toward warmer, wetter winters and hotter, drier summers. In the NYC watershed forests, climate change will likely increase the frequency and/or severity of drought, extreme runoff events, fire activity, infestations of invasive vegetation, and disease. Despite well established climate change projections and clear relationships between forests and water quality, links between water quality and forest ecosystem responses to climate change are not well known and may have significant impacts on NYC watershed management and water quality. To fill this gap, this presentation will describe an ongoing study that evaluates potential water quality changes under several possible climate-driven forest change scenarios in the NYC watersheds. Water quality impacts will focus primarily on turbidity and dissolved organic carbon because these are important water quality constituents of concern for NYC, but will also include an overview of potential changes to nutrients (nitrogen and phosphorus) and water temperature as these parameters can also cause regulatory, management, and treatment challenges. The forest change scenarios reflect anticipated, climate-driven changes in the NYC watersheds, including a reduction in forest compositional diversity through the introduction and/or expansion of generalist species or acceleration of impacts from disease and pests, intensification of summer drought, and structural disturbances in riparian zones, among others.

This presentation will include an overview of the modeling tools and empirical relationships that are available to estimate potential water quality changes and will provide estimates of potential changes in stream turbidity, dissolved organic carbon, nutrient loadings, and temperature in each forest change scenario. Importantly, the presentation will also include a discussion of critical uncertainties and next steps to better understand links between forests, climate change, and water quality in the NYC watersheds.

Improving SWAT-C Model Carbon Flux Simulation of Forest Ecosystem: Modification of Forest Growth and Initial Evaluation

Sijal Dangol, Hunter College, CUNY Email: sdangol@dep.nyc.gov

Forest ecosystems play a crucial role in sequestering atmospheric carbon in the form of vegetation and soil organic carbon, while also providing high quality water supply through water and nutrient cycling. The Soil and Water Assessment Tool (SWAT), a watershed model used by the New York City Department of Environment Protection (NYCDEP), utilizes a single plant growth algorithm to simulate cropland, grassland, and forest ecosystems, and has not been thoroughly tested for simulating plant growth and carbon cycling in forest ecosystems. To address this gap, detailed representation of forest growth dynamics, such as biomass production, allocation, death, and decomposition of leaf litter, root, and woody components is needed to assess the impacts of forest management on soil organic carbon, hydrologic processes, and water quality. In this study, we integrated the DAYCENT model-based tree growth algorithms into SWAT-Carbon (SWATC-Forest) to enhance the model's capability for simulating forest growth, and carbon and water cycling. We optimized parameters related to tree growth and soil properties and evaluated SWATC-Forest simulations of carbon fluxes using flux tower observations at seven AmeriFlux sites, as well as evapotranspiration (ET) with MODIS-derived ET. Preliminary results indicate that SWATC-Forest generally performs well in simulating net ecosystem exchange (NEE), ecosystem respiration (Reco), and ET. Sensitivity analysis suggests that simulated carbon fluxes are most sensitive to temperature and soil moisture control parameters. SWATC-Forest will serve as a useful tool for improved integrated assessment of carbon, nutrient, and water cycling in forest ecosystems under a changing climate.

Considerations of a Surface Water Treatment Facility Proactively Preparing Against Harmful Algal Blooms

Dr. Daniel Whalen, Hazen and Sawyer Email: dwhalen@hazenandsawyer.com

This presentation provides an overview of surface water treatment considerations for dealing with a Harmful Algal Bloom (HAB) from two perspectives—the impact on finished water quality in terms of cyanotoxins as well as the impact on filtered water production capacity. Information included in this presentation will cover a brief overview of HABs, associated regulations, and general best operational management practices when dealing with an HAB event. This presentation will also cover results from a desktop HAB study performed by Hazen and Sawyer on New Jersey American Water's Canal Road Water Treatment Plant. Review of this presentation will be beneficial to engineering and operations professions related to water quality, water resources management, engineering process design, process monitoring, and process and operational optimization. Additionally, the case study presented can be used to aid in the development or refinement of NJDEP-required cyanotoxin management plans. New Jersey American Water (NJAW) operates the Canal Road Water Treatment Plant (WTP), treating surface water from the Raritan River and Millstone River up to a firm capacity of 80 million gallons per day (MGD) and a peak capacity of 100 MGD. Beginning in mid-July 2022, and lasting through November 2022, the Millstone River experienced a serious HAB event. NJAW successfully prevented the HAB event from impacting the WTP's intake and treatment process. In a proactive response following the HAB event, NJAW hired Hazen and Sawyer to perform a desktop assessment of the WTP's treatment and capacity capabilities in handling HAB conditions. The treatment portion of the assessment involved outlining the WTP's physical and chemical processes capable of treating HAB constituents, reviewing and characterizing historical water quality, and modeling the WTP's chemical processes for cyanotoxin (microcystin) treatment using the AWWA Hazen/Adams CyanoTOX model. The capacity portion of the assessment involved reviewing the WTP's historical process flows, evaluating filtration capacity performance under different water quality conditions, and outlining considerations for solids handling procedures under HAB conditions.

Green Roofs on NYC Schools: Inter-Agency Collaboration and Challenges

Flavio Reyes, NYCDEP Email: freyes@dep.nyc.gov

This presentation will highlight the importance of stakeholder coordination between the NYC Department of Environmental Protection (DEP), NYC's Department of Education (DOE), and NYC's School Construction Authority (SCA) in implementing green roofs at schools in New York City. It will also highlight how the coordination effort among these agencies depend on the feasibility of green roofs. The successful implementation of green roofs at schools depends heavily on the collaborative effort between the agencies; consideration of agency priorities and procedures; project goal alignment; addressing challenges such as potential disruptions to school operations and ensuring building code compliance. As each agency operates with their own procedures to meet their own priorities, promoting cooperation amongst them can sometimes be challenging, especially when aligning project priorities. One of the SCA's missions is to rehabilitate and modernize school buildings and infrastructure; one component that commonly requires rehabilitation is a school's roof. DEP has been collaborating with the SCA to take advantage of the type and timing of these projects to lead the design and implementation of green roofs for the management of stormwater on-site. As these two agencies work on common goals, collaboration with DOE, whose priority is to manage the New York City School System, is important to avoid disruptions to school operations due to the work this coordination entails. The feasibility of green roofs relative to the condition of an existing roof, or the planned rehabilitation of a roof, are key considerations in their implementation. To assess this, DEP's design engineers conduct comprehensive feasibility studies. These studies include: coordination with the SCA to determine if the schools are due for roof replacements; whether the existing roofing materials are adequate for stormwater management applications; estimating the total stormwater management capacity of roofs; performing structural analyses to assess the roof's capacity for handling additional loads as green roofs include vegetation, soil, and water, etc. Based on these findings, they recommend the type of green roof the roof structure can support, thereby ensuring the feasibility and sustainability of the roof project.

Copper Sulfate Treatments in 2023 on the Croton System of the New York City Water Supply to Suppress Taste and Odor Compounds by Preventing Harmful Algal Blooms

Richard Kowalczyk, NYCDEP Email: KowalczykR@dep.nyc.gov

In 2023, as a proactive measure for the Rondout/West Branch dewatering exercise, four key New York City reservoirs, Croton Falls, Cross River, Muscoot, and New Croton, were treated using copper sulfate from May through August 2023. Known taste and odor compounds, 2-Methylisoborneal and geosmin, along with the phytoplankton assemblages and water quality parameters from the treated reservoirs were assessed. The presentation will explore the immediate effects copper sulfate had on the reduction of phytoplankton blooms in the reservoirs and taste and odor. Further discussion will highlight the cascading effect treatment had on up-reservoir locations starting at Croton Falls and Cross River reservoirs and the subsequent positive affect on down-stream locations at Muscoot and New Croton reservoirs. We will highlight the in-house enhanced monitoring efforts of New York City's field and laboratories in evaluating the copper sulfate treatments from 2023 and beyond.

Addressing Disinfection Byproduct Formation One Bottle at a Time: A Bench-Scale Chlorine Dioxide Evaluation

Liliana Calix, Arcadis Email: liliana.calix@arcadis.com
Maithili Sajip, Arcadis (Co-Speaker)

Disinfection is a critical step in the drinking water treatment process that safeguards public health from microbial pathogens. There is a challenge associated with the use of disinfectants such as chlorine, which is the formation of disinfection by-products (DBPs), created due to the reaction of chlorine with the background organic matter in the source water. These DBPs, namely trihalomethanes (THM) and regulated haloacetic acids (HAA5), are carcinogenic in nature and harmful to human health especially from repeated exposure. Use of alternative disinfectants are being explored that can minimize the formation of the DBPs. Chlorine dioxide (ClO_2) is one such disinfectant that has been found to lower the DBP formation potential by transforming some of the background organic matter into less reactive compounds. As an alternative to chlorine, the potential use of ClO_2 as a disinfectant and pre-oxidant at Shaft 18 of New York City's Delaware Aqueduct, on the Catskill Delaware (Cat-Del) system, was evaluated through a bench-scale bottle study. Much of the drinking water for New York City (NYC) originates from the Catskill and Delaware (Cat-Del) watersheds. The Cat-Del System is instrumental in reliably

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delivering more than 1 billion gallons of safe drinking water daily to nine million people. Water flows from the Cat-Del watersheds to the Kensico Reservoir, after which it travels to the Hillview Reservoir and then on into the city. At present, free chlorine is added at the outlet of the Kensico Reservoir for primary disinfection and to oxidize iron and manganese. Chlorine is again added at Hillview Reservoir, to allow for adequate chlorine residuals at the entry points. The NYC Department of Environmental Protection (NYCDEP) is considering a conversion from free chlorine to chlorine dioxide (ClO2) at the Kensico outlet. The main reason for this is that feeding ClO2 ahead of the first point of chlorination could lower total trihalomethane (TTHM) and regulated haloacetic acid (HAA5) levels in the distribution system.

This presentation will provide an overview of the laboratory study conducted to quantify reductions in DBP formation relative to chlorine and to determine if the reductions would be substantial enough to warrant full-scale implementation. The study was conducted over a period of 2 years and performed in two steps. Step 1 was a proof-of-concept study to determine whether ClO2 addition would reduce the DBP formation potential of the water after the outlet of the Kensico Reservoir (Shaft 18). The results of Step 1 indicated satisfactory DBP formation reduction potential to proceed with Step 2, a bench-scale study. The bench-scale study was designed to simulate the full-scale Cat-Del system, including the UV treatment step, and additional chemical treatment. As part of the bench-scale study, a bottle representing each step of the Cat-Del system was designed starting from Kensico Reservoir and ending in Hillview Reservoir. Each bottle received the exact treatment and travel time required to represent that step in the distribution system. This included the exact chemical and ultraviolet (UV) dosages that would be dosed at full-scale. Significant time was spent in designing the bottle treatment as accurately as possible to simulate the full-scale system. As part of this study, Arcadis and NYCDEP collaborated with the University of Colorado to develop a procedure for simulating full-scale UV treatment in a bottle to assist in designing an accurate bottle study. As shown in the proof-of-concept study, the bench-scale study indicated that ClO2 additional could substantially reduce DBP formation, as compared to historical levels. In addition to DBP formation potential, several other analytes were monitored to observe impacts on the background water quality. It was found that ClO2 additional did not greatly affect pH and that it noticeably reduced chlorine demand. In all, the study showed that ClO2 is a favorable alternative to chlorine at the Kensico Reservoir outlet and could substantially reduce DBP formation potential within the distribution system, providing New York City with a feasible option to consider.

Delivering Projects Using Community Based Partnership to Meet Chesapeake Bay TMDL Requirements in Prince George's County, MD and Key Lessons Learned

Srikanth Gorugantula, HDR Email: Srikanth.Gorugantula@hdrinc.com
Roland Jones, Corvias(Co-Speaker)

Prince George's County, MD is located within the 80,000 square mile Chesapeake Bay watershed. EPA and the State of Maryland prepared the Chesapeake Bay Total Maximum Daily Load (Bay TMDL) for restoring the Chesapeake Bay's chemically, biologically and physically impaired waters. The Bay TMDL requires States, Counties and Cities within the watershed to limit the amount of Total Phosphorus, Total Nitrogen and Total Suspended Sediment that is discharged through point and non-point sources (urban stormwater runoff). Prince George's County combined meeting regulatory requirements with targeted local workforce and business development for this pioneering alternative delivery project. Prince George's County (County) and Corvias Infrastructure Solutions (CIS) developed the Clean Water Partnership (CWP) to design, build and maintain urban stormwater quality treatment best management practices (BMPs) to meet the County's Bay TMDL obligations. In addition to infrastructure improvements, the CWP balances risk, priorities, and social needs, through this Community Based Partnership (CBP). Bringing financing, engineering design firms, contractors, outreach and social/economic goals to this project, environmental compliance is being achieved with local economic growth and community involvement. This groundbreaking and innovative alternative delivery method is the first in the country and required a pioneering, dynamic and responsive team effort to meet the multiple program objectives. The two main CBP program elements include:

1) Environmental goals of design, permitting and construction of stormwater treatment devices, located throughout the 500-square mile County, to treat urban stormwater runoff.

2) Social and economic goals to meet aggressive target class utilization (40% for local, small and minority businesses) and local workforce (51% county resident utilization).

Between 2016 and 2021, CWP has successfully implemented over 150 projects, certified over 300 BMP devices to help meet the County's MS4 stormwater permit requirements. In this process, CWP spent over $140 million in design and construction and reduced approximately 53,700 lb. of Total Nitrogen (TN), 7,300 lb. of Total Phosphorus (TP) and 4,405,100 lb. of Total Suspended Solids (TSS). In addition, more than 15,000 acres of drainage area is also treated to reduce pollutants to Chesapeake Bay. A key to the success of the CWP Program has been clear programmatic metrics including indicators and beneficiaries from day one. Primary program metrics focused on schedule/speed, scale economies and performance, community outreach, local disadvantaged subcontractor utilization, local subcontractor development, workforce utilization, and workforce development. Additional metrics were related to alternative compliance and partner programs, and project budget books and schedules. Moving forward, the CWP Team is focused on executing efficiencies to design and construct additional large pond retrofit projects and stream restoration projects based on their monitoring and tracking of BMP cost-effectiveness throughout earlier phases. In addition to complete data inventories on the number of BMPs built and drainage area managed, the CWP Team analyzed pollution removal and cost data of BMPs to determine Total Nitrogen, Total Phosphorus and Total Suspended Solids reduction for 10+ different types of BMPs. This performance summary information directly influenced the planning and siting of each subsequent phase of BMP design and construction. At the same time the Program Management team will continue to rely on performance data and think creatively to achieve its program goals and metrics in future phases. The CWP team has been focusing on asset management as the Program matures to its subsequent phases.

This presentation will provide useful information for utility and public works department leaders, and stormwater management staff about creating or tailoring an existing program to meet large-scale targets for capital project delivery intended to meet water quality goals or other stormwater related objectives such as resiliency and flood risk reduction. Partnership goals, organizational structures and integrated delivery partners roles and responsibilities, and program metrics will be shared for discussion. Detailed information will also be presented related to specific program elements and BMP performance data that helped the CWP Team to achieve program milestones. As more communities face increasing regulation and climate-related threats to their stormwater infrastructure, bundling capital improvement projects for cost-effective and timely implementation may be necessary. The CWP Team will share lessons learned from their 6+ years of program execution, specific keys to success for other communities to consider and adaptive management strategies for future CWP success. ADDITIONAL AUTHORS: Roland Jones Market Director Corvias Infrastructure Solutions; James Lyons Sr. Program Administrator Prince George's County Department of Environment, MD.

Can Bypassing Boyd Corners Outflow Improve Water Quality in West Branch Reservoir?

Dr. Rakesh Gelda, NYCDEP Email: rgelda@dep.nyc.gov

West Branch Reservoir plays a crucial role as a terminal reservoir when the downstream Kensico Reservoir operates in float/bypass mode due to water quality concerns. Consequently, ensuring the water quality of West Branch Reservoir becomes essential. In addition to drainage from its watershed, West Branch Reservoir receives water from three other basins: Boyd Corners Reservoir, Lake Gleneida, and Rondout Reservoir (via Delaware Aqueduct at site Del9 when West Branch is operated in reservoir mode). The water quality parameter of interest for this study is UV254, a surrogate measure of dissolved organic matter. This organic matter includes substances that act as precursors to disinfection byproducts during chlorination. From 2013 to 2021, the average UV254 level in Boyd Corners outflow was 0.13 cm−1, which was ~ 3 times higher than that at Del9 (0.045 cm−1). Fluctuations in UV254 levels at Boyd Corners have been observed to directly impact UV254 levels in West Branch Reservoir, often within a few hours to a few days following the input from Boyd Corners Reservoir. These impacts are more noticeable when West Branch is in float/bypass mode, as there is no dilution from the Delaware System water. We hypothesized that if a portion of Boyd Corners outflow is bypassed prior to and during runoff events, then the impact of Boyd Corners UV254 levels on West Branch Reservoir could be reduced. To test this hypothesis, we considered a "what-if" scenario of reducing the outflow by 30 MGD and evaluated the impacts with a stand-alone W2 model (i.e., not operating within OST) for West Branch Reservoir. The results showed that simulated UV254 levels in West Branch Reservoir were reduced by 0.0004 – 0.0054 cm−1 (inter-quartile range). Greater reductions in West Branch Reservoir UV254 levels (~ 0.01 cm−1) was predicted when West Branch Reservoir was in float/bypass mode and Boyd Corners Reservoir was spilling. Future work may include exploring ways to manage Boyd Corners Reservoir storages to minimize spill of elevated UV254 water, increasing the frequency of monitoring Boyd Corners outflow, and investigating localized impacts of other tributaries into West Branch Reservoir on water quality within the reservoir.

A Paired Subwatershed Study to Investigate Land-Use Effects on Water Quality in NYC Water Supply Streams

Dr. Rajith Mukundan, NYCDEP Email: rmukundan@dep.nyc.gov

The paired watershed monitoring approach is widely used to investigate hydrologic processes and water quality, providing streamflow and water quality records for long-term trend analysis, as well as data for developing and testing hydrologic models. Here, we present a study where we utilize 20 years of streamflow and water quality data, along with a watershed model, to examine sources of stream nutrients and their changes over time in a pair of streams within the NYC water supply system.

We compare sources and trends in stream nitrate and dissolved phosphorus in the urbanized Amawalk watershed with those of the predominantly forested Boyd Corners watershed in the Croton system. Stream monitoring data reveal a decreasing trend in nitrate in both watersheds, whereas dissolved phosphorus shows a decreasing trend only in the Amawalk watershed. Watershed model simulations indicate that urban land use and wastewater sources dominate nutrient loads in the Amawalk watershed, contributing 55-80% and 9-27% of the annual loads, respectively, while forested areas contribute as much as 80% of nutrients in the Boyd Corners watershed. Furthermore, we find that more than 80% of the input nitrogen from atmospheric deposition and fertilizer sources is retained in these watersheds.

Assessing New York City Water Supply Using Year-1450-to-Present Inflow Estimates Derived from Tree Ring Sample Data

Dr. John Clayton, Hazen and Sawyer Email: clayton@hazenandsawyer.com

Naresh Devineni, Jerry Mead, CCNY (Co-Speakers)

Historical stream flow records at many gages within the New York City water supply watersheds extend back almost 100 years. Examinations of these records suggest that three phases of consistent multi-year hydrologic patterns have occurred over that time:

- Relatively moderate flows prior to about 1960.
- Relatively and persistently low flows through most of the 1960's.
- Relatively and persistently high flows from 1970 to the present.

Notwithstanding annual variations within each of these phases, it is commonly understood that the post-1970 period represents a pluvial, or extended period of wetter-than-normal hydrologic conditions. Furthermore, paleoclimate studies based on annular tree ring records spanning the 500 or so years indicate that the duration of the current pluvial is already the longest such period seen in that time. This suggests two different potential ways that the historical record might misrepresent future system conditions:

- If the current pluvial is indeed an outlier in terms of length and intensity, the fact that it occupies half of the gage flow historical record would suggest that future flows might be drier and more variable than seen over 1970-present. Future water supply reliability from sources in these watersheds might therefore be more sensitive than the historical flow record suggests.
- If the pluvial is instead a "new normal", perhaps due to persistent changes in climate, the pre-pluvial hydrology might overstate the intensity, durations, and frequencies of future droughts, causing supply reliability to be more secure than the entirety of the historical flow record suggests. However, the "new normal" might also suggest greater water quality challenges since the pluvial contains more frequent high-flow events than the pre-pluvial.

This presentation will describe a study undertaken by New York City Department of Environmental Protection (NYCDEP) to assess how reliability in water quantity and quality for their supply system would be impacted based on the two interpretations of the post-1970 pluvial described above. The primary focus of this presentation will be a method of synthesizing water supply reservoir inflows over extended historical periods using paleoclimatic tree ring records. The resulting hydrologic dataset extends back to the year 1450 AD, the beginning of the longest tree ring record, and places the modern pluvial within the context of likely flows over that period. As such, the dataset not only treats the pluvial as an outlier but indicates the extent to which it varies from historically evident hydrology.

Hierarchical Bayesian Regression models were built that related tree ring widths for core samples within the Upper Delaware, Lower Delaware, Catskill, and Croton watersheds to annual streamflows at gages within those watersheds. These models also produced annual gage flow estimates for years prior to the flow record based on tree ring widths in those years. The extended stream flow records were

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then translated temporally from annual to monthly and then daily time steps and from geographically from USGS gage locations to reservoir inflow locations using modified Kirsch-Nowak stochastic streamflow generation procedures.

The presentation will explain these methods in greater detail and show how reservoir inflow scenarios vary between use of the standard historical and extended paleoclimate inflow datasets.

LCRI Requirements: Optimizing Corrosion Control in the NYC Distribution System

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In preparation for EPA's proposed Lead and Copper Rule Revisions (LCRR), DEP undertook a multi-year study to further investigate optimization of corrosion control, and better understand lead exposure. Recent regulatory updates under the Lead and Copper Rule Improvements (LCRI), has made this rule more challenging to meet. Balancing these challenges with the urgent need to reduce lead exposure remains a critical task for DEP. DEP currently adds orthophosphate (oPO4) at an operational maintenance dose of 2 parts per million (ppm) and adjusts pH to control the solubility of lead from plumbing into drinking water. The addition of orthophosphate can reduce the release of lead from lead service lines (LSLs) and household plumbing containing lead components or solder joints. DEP commenced corrosion control pilot study in 2018 to assess the effects on lead levels at the consumer's tap by increasing oPO4 dose from 2 ppm up to 4 ppm. The study included operating two pipe loops, and a partial system evaluated through sequential "profile" sampling in homes with a lead source, and scale testing of lead service line pipes removed from the NYC distribution system. The study evaluated the impact of lead release using oPO4 under various conditions including different water sources, water temperatures (warm vs cold), and doses (2 ppm vs 3 ppm vs 4 ppm). The results showed that particulate and dissolved lead levels decreased in homes sampled as orthophosphate levels increased, and how source water supply and temperature affect lead concentration. The primary objective of the study is to determine 5th liter impacts on the 90th percentile lead concentration that will be used to determine compliance, and if further optimization is possible.

Exploring In-situ Absorption Spectra to Assess Dissolved Organic Matter Quality in Neversink Reservoir: A Preliminary Analysis

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Monitoring of dissolved organic matter (DOM) within the watersheds that supply New York City with high-quality drinking water is important to guide reservoir operations and minimize the formation of disinfection byproducts (DBPs). DBPs are formed during disinfection when a chlorine compound reacts with the naturally occurring DOM. The extent of DBP formation depends largely upon the concentration and quality of the DOM within the reservoirs. DEP initiated a pilot project where SCAN UV-Vis Spectrolyser units were deployed for inline monitoring of absorption spectra ($a\lambda$; λ = 200 – 700 nm), a proxy measure of DOM, at the aqueduct location downstream of Cannonsville, Pepacton, Neversink, and Rondout reservoirs.

This presentation will focus upon preliminary analysis of absorption spectra data collected at the aqueduct location downstream of Neversink Reservoir during 2017-2023. Five metrics of DOM quality were calculated from these spectra:

(i) ratio of a254 to dissolved organic carbon (SUVA254),

(ii) ratio of a250 to a365 (E2:E3),

(iii) ratio of a250 to a400 (E2:E4),

(iv) ratio of a440 to DOC, and

(v) ratio of spectral slopes (SR = S275-290/S350-400).

These metrics can provide indications of magnitude, aromaticity, molecular weight, and reactivity of DOM. Future research will explore seasonal variations in DOM quality concerning its potential to form disinfection byproducts. Additionally, absorption spectra data from different locations will be examined to investigate the role of watershed characteristics (e.g., land-use/land-cover, geomorphology, and soil characteristics) in producing the spatial variability in the water quality.

Harmful Algal Blooms: Methods for Water Quality Management Programs

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In 2015, with new health advisories for cyanobacterial toxins being implemented by the US Environmental Protection Agency, the NYC Department of Environmental Protection began a sampling program of routine reservoir sites to aid in the detection of harmful algal blooms. Along with phytoplankton samples that were collected on a routine basis according to the DEP's Watershed Water Quality Monitoring Plan, field teams collected water samples to be processed in the lab for microcystins, a cyanotoxin that can be found in lakes and reservoirs. Sampling sites for cyanotoxin analysis were chosen based on historical data that the DEP has collected, with phytoplankton and chlorophyll A data acting as baselines. DEP's Hawthorne laboratory processes cyanotoxin samples in-house to supplement phytoplankton and chlorophyll A sample data that has been collected concurrently, with the data available upon completion for review in our Laboratory Information Management System.

The purpose of this talk is to discuss in-depth the process through which the Abraxis cyanotoxin reader system detects the quantity of microcystins in a water sample and how the completed data can be compared to phytoplankton and chlorophyll A data, both current and historical. This talk will also discuss the comparison between the in-house Abraxis reader system and the contract lab LC/MS/MS system utilized for weighing data similarities between the two methods.

Quantitative and Seasonal Assessment of Protozoa Pre- and Post-Ultraviolet Disinfection (2018-2023)

Kerri Alderisio, NYCDEP Email: kalderisio@dep.nyc.gov

The Catskill/Delaware Ultraviolet Disinfection Facility (CDUV) began treating water in 2012 to fulfill the requirement for additional disinfection for unfiltered systems under the Long Term 2 Enhanced Surface Water Treatment Rule. In December of 2017, the NYC Department of Environmental Protection began to collect protozoan samples at the outflow of NYC's CDUV. The objectives were:

1) to see if UV treated (inactivated) cysts and oocysts were detectable at the UV plant outflow, and

2) if so, determine how those data might correlate with results upstream at Kensico Reservoir effluent (site DEL18DT), and downstream at Hillview Reservoir effluent (Site 3), the treated balancing reservoir for NYC's water supply.

In all, approximately 288 fifty-liter samples were collected from each of the three locations at a weekly frequency, for five and one-half years. Ultimately, only samples collected on the same day at all sites were used for analysis (total n=837). Early evaluation of the data in 2020 supported an expected trend of decreasing concentrations and detection as the water moved through the system, apart from a few seemingly random samples with greater detection downstream. This presentation will review the UV process and the results from over five years of monitoring at all three sampling locations, as well as discuss any statistical relationships, seasonal trends, and results of infectivity testing. ADDITIONAL AUTHORS: Douglass Walton, NYCDEP and Mark Bartlett, The Water Institute.

An Experiment to Assess the Fate of Land-Applied Class "B" Biosolids

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Findings have shown that synthetic fertilizers, especially for the cereal farmland industry, are becoming more expensive and are harder to create containing the necessary nutrients. Land-applied biosolids from sewage plants provide a much-needed nutrient rich fertilizer that is financially stable and pathogenically safe for humans. However, manufactured chemicals, such as PFAS, are making their way into our water pipelines adding potentially dangerous chemicals to these biosolids and water supply that are becoming ever increasingly difficult to remove. The City of Watertown Pollution Control Facility (PCF) is aware of the risks posed by PFAS and is committed to protecting and preserving our environment. Currently the Watertown PCF's goal is to maximize the beneficial reuse of wastewater. The plant converts solids waste removed from the wastewater into what is called "Class B Biosolids", leaving behind a clear, clean, recycled and almost fully decontaminated water to be returned to the river replenishing our water supply for beneficial reuse. The sludge taken out of the water is now land applied and no longer is sent and received by the landfill, thus reducing the carbon footprint of the Watertown PCF. An experiment was conducted to determine if land-applied biosolids are contaminating the farmland soils and groundwater with pollutants like PFAS leaching into the ground, and the effect on crop growth and future variability. This experiment is an attempt to raise public awareness of the potential environmental and domestic impacts from PFAS.

Innovative Approaches and Use of Knowledge Metrics in Simulation Exercises

Shawn Corrigan, Carollo Email: scorrigan@carollo.com

This presentation examines the role of response exercise planning, delivery, and evaluation in connection with performance indicators to create an action-oriented emergency response approach for the water industry. By walking through a real-world example, we will explore how preparedness, through the integration of systematic robust exercise planning and performance metrics, can lead to more effective and efficient response efforts and positive outcomes. As part of the exercise, we will show how the simulation of various emergency scenarios fosters readiness and improves response capabilities. We will highlight how the measurement of knowledge retention strategies, such as emergency management process awareness, utility crisis management capacities, and communications protocols, enables organizations to measure and evaluate the effectiveness of their emergency preparation efforts. The presentation will focus on how the case study utility has leveraged exercise planning and knowledge indicators to:

1. Enhance Preparedness: By carefully planning and executing an exercise that mimicked real emergency conditions, the utility was able to identify gaps in its response procedures, allowing for opportunity to improve plans, training, and resource preparation.

2. Improve Resource Allocation: Using performance indicators, the utility gathered information valuable to planning the allocation of resources during emergencies, allowing for opportunity to improve how assets can be deployed efficiently and effectively.

3. Streamline Communication: Examination of exercise performance highlighted areas where communication breakdowns were occurring. This data allows for adjustments and enhancements to communication protocols which can lead to more effective coordination among response teams.

4. Enhance Trust: Exercise design and after-action analysis also reveal the positive impact of improved understanding of emergency response on (internal/external) stakeholder trust.

We will demonstrate that the benefits of a comprehensive approach to exercise planning, delivery, and evaluation linked with knowledge indicators is not only an investment in preparedness but also a means of elevating overall performance and resilience of water and wastewater utilities. By utilizing metrics in simulated experiences to continuously improve our response capabilities, we can better fulfill our role in protecting essential public services during times of crisis.

Implementing Precast Porous Concrete Panels in the Gravesend Bay Neighborhood of Brooklyn, NY

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New York City Department of Environmental Protection's (DEP) Green Infrastructure (GI) Program has implemented over 12,000 ROW green infrastructure assets citywide, preventing millions of gallons of stormwater from entering the sewer system and reducing combined sewer overflows (CSO). Assets include raingardens and infiltration basins, and the City had also piloted several porous pavement assets. This presentation provides an in-depth review of the processes followed to implement areawide installation of Precast Porous Concrete Panels (PPCP) from design through construction of contract GKOH15-02. This contract is the first of many areawide PPCP construction that NYC will be implementing as part of its CSO reduction GI program.

GKOH15-02 is an active contract that began construction in 2023 and will be completed in 2025. DEP is constructing over 7 miles of PPCP within the parking lane of roadways in the Gravesend Bay neighborhood of Brooklyn. Planning and design took 3 years, including feasibility studies, siting locations, geotechnical investigations, topographic survey, and development of detailed design drawings and specifications. The first step of designing PPCP installation is to perform a desktop analysis of the area to determine feasible locations. This analysis verifies the location of water and sewer mains, valves, manholes, vaults, tree roots, bike lanes, bus stops, driveways, catch basins, and fire hydrants. Each of these items have their own constraints in terms of how far the PPCP asset have to be from them. After this analysis, geotechnical investigations and survey are performed. Geotechnical investigations are required prior to design to determine soil characteristics,

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permeability rates, and depths to the groundwater table and bedrock. Survey is performed for the entire street where PPCP is proposed to be installed. To facilitate design, NYC DEP has Standard Green Infrastructure designs and specifications that are utilized for right-of-way contracts. The PPCP standard design includes precast panels that are 5′ long, 6″ deep, and either 4′ or 2′ wide. Under the panels, the design includes stone and drainage cells to store and promote the infiltration of stormwater. The overall depth of a typical PPCP asset is 2′.

After thorough coordination with all relevant city agencies and private utilities, final designs are advertised for bidding. The city selects the low bidder and construction begins. For GKOH15-02, the city received 14 qualified contractor bids. Construction of the PPCP requires multiple permits from other agencies and constant coordination with private utilities. This presentation will discuss the various permits necessary for this type of construction contract. During construction in GKOH15-02, multiple interferences with electric lines within the 2′ depth was observed. This presentation will also discuss how these conflicts were resolved during construction. Finally, the presentation will go over cleaning requirements of PPCP during the contractor guarantee period, as periodic cleaning is crucial for proper functionality.

Cybersecurity: Tabletop 101

Michelle Rissolo, NYCDEP Email: MRissolo@dep.nyc.gov
Ron Pena, Rob Knappenburger, NYCDEP (Co-Speakers)

No water utility is exempt from cyberattacks. There are examples every day of cyberattacks across all industries and around the world—some by nefarious players and some by curious happenstance amateurs. A water utility needs to be prepared and the best way to engage operators is with a mock exercise and give them an opportunity to critically think through the event from recognizing a cyber-attack to performing the correct response to mitigating the issue to maintaining compliant production of safe drinking water, and then ultimately returning to normal operation. This presentation will focus on the role of Cybersecurity and Infrastructure Security Agency (CISA), the preparedness checklist, the basics of a tabletop exercise, and a summary of tabletop exercises that have occurred in NYCDEP's Water Treatment Operations since 2021.

Evaluating Stream Turbidity Production Conditions and Reduction Management Strategies in the Esopus Creek Watershed: A Status Report

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Turbidity is a regulated water quality parameter that determines the status of New York City's (NYC) ability to maintain a filtration avoidance determination (FAD) of its water supply sourced in the Catskill Mountains. Turbidity cannot exceed 5 NTU at the Kensico Reservoir, which receives water from the Ashokan Reservoir in Ulster County, NY. The Ashokan Reservoir is prone to filling with highly turbid water following high magnitude, low frequency hydrologic events. Reservoir operational management or chemical treatment have been sufficient in the past to maintain FAD compliance. The recurring FAD requires NYC to invest in stream projects designed to reduce the delivery of turbid runoff to the Ashokan Reservoir by disconnecting the stream channel from turbidity source sediment. NYC Department of Environmental Protection (DEP) has partnered with the US Geological Survey (USGS) to design and implement a ten-year research project (USGS water years 2017 – 2026) to investigate turbidity production in the Esopus Creek watershed and to evaluate the efficacy of the FAD-mandated approach to achieving turbidity reduction in the Ashokan Reservoir watershed. In this presentation we report on:

1) the status of this research,

2) the conceptual model for stream reach to network scale turbidity production, and

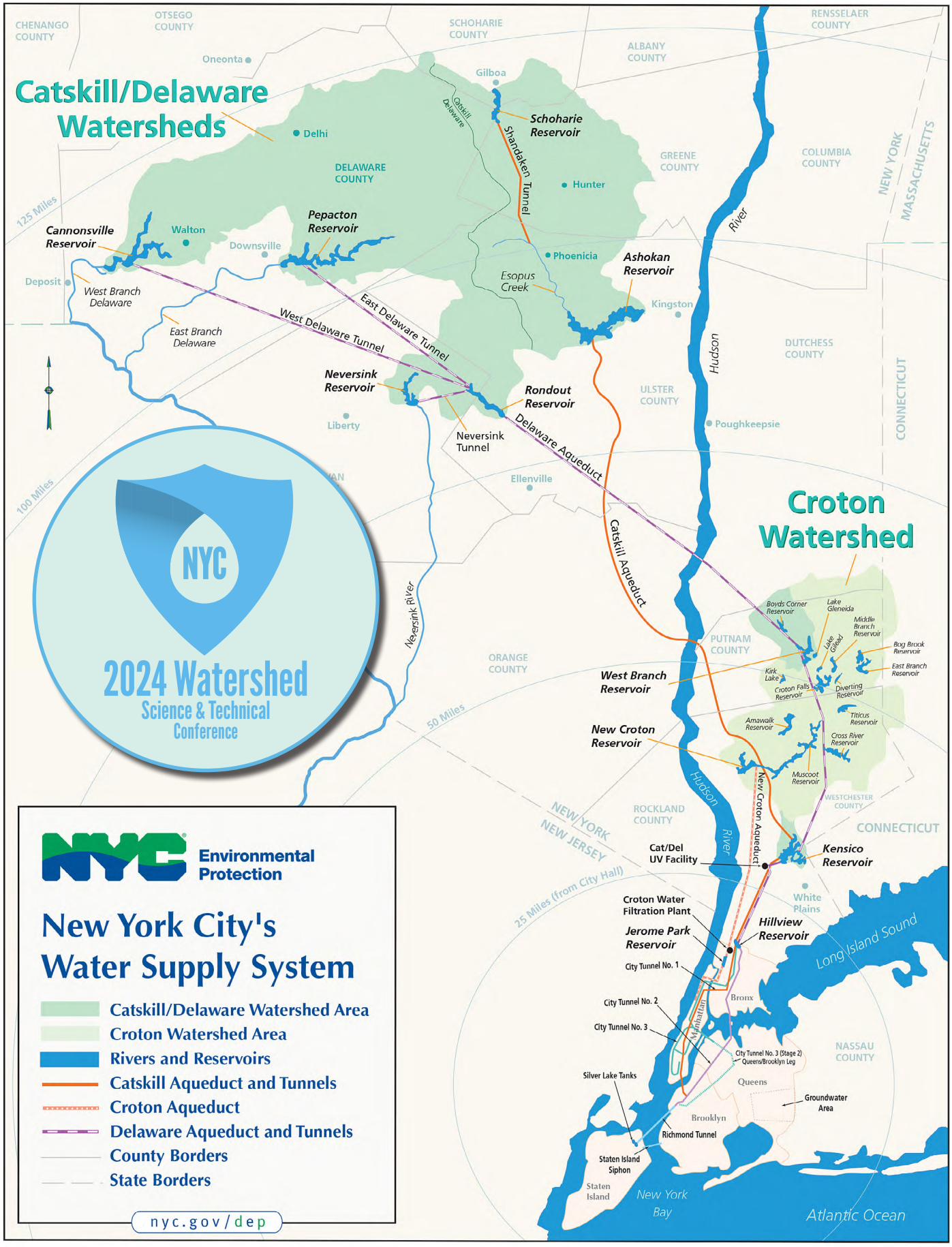
3) the critical driving and resisting forces as well as terrain composition that sets the limits for effective turbidity reduction management.

The results of the first seven water years (2017-2023) of stream monitoring, turbidity source characterization and stream turbidity reduction project evaluation provide information to guide ongoing turbidity reduction strategies as well as continue to inform the conceptual model assumptions about the drivers and controls of turbidity production.

Presentation on the Agricultural Program Metrics Evaluation; a Joint Effort by DEP and WAC, Part Two

Sara Storrer, NYCDEP Email: SStorrer@dep.nyc.gov
Connor Young, Michael Vander Werff, NYCDEP (Co-Speakers)

The New York City Department of Environmental Protection (DEP) and the Watershed Agricultural Council (WAC) has enjoyed a successful government-to-private-public partnership for more than three decades. This presentation will provide an overview of the Watershed Agricultural Program (WAP), current program metrics, a detailed analysis of the WAC agricultural program metrics, and ideas for a program review to strengthen WAC operations to ensure another 30 years of successful implementation. Working closely with WAC, DEP is required by the 2017 Revised Filtration Avoidance Determination (FAD) to assess the adequacy of current WAP metrics and submit a report by June 30, 2024, that recommends the continuation of current metrics and/or the consideration of potential new metrics. To support this effort, we will be providing details on the current program metrics used and presenting preliminary findings on current and potential new Best Management Practices (BMPs) milestones to be incorporated into the larger program review and FAD reporting. This portion of the presentation will touch on changes to agriculture in the watershed, implementation goals, and how WAC can continually adapt in response to these shifts. The review will also include an examination of the success and potential expansion of the Watershed Investigation and Repair Crew (WIRC). This in-house team of WAC experts has the potential to reduce the Repair and Replacement BMP backlog and provide increased responsiveness to the investigation and repair needs of program participants. This portion of the presentation will include success stories as well as preliminary proposals on the expansion of the crew. A brief discussion on how the AgMIP Climate change research project will help guide the future WAC long-term monitoring plan will also be discussed. We are proposing this presentation as Part Two of the presentation given last year. This presentation will provide a short overview of the WAC program, explain the analysis of a program review, and the recommendations for WAC program metrics changes.


Catskill/Delaware Watersheds
Croton Watershed
2024 Watershed
Science & Technical
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NYC
New York City's
Water Supply System
Environmental Protection
Catskill/Delaware Watershed Area
Croton Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Croton Aqueduct
Delaware Aqueduct and Tunnels
County Borders
State Borders
nyc.gov/dep
Schoharie Reservoir
Shandaken Tunnel
Pepacton Reservoir
Cannonsville Reservoir
Ashokan Reservoir
West Delaware Tunnel
East Delaware Tunnel
Neversink Reservoir
Rondout Reservoir
Neversink Tunnel
Delaware Aqueduct
Catskill Aqueduct
West Branch Reservoir
New Croton Reservoir
Kensico Reservoir
Hillview Reservoir
Jerome Park Reservoir
Croton Water Filtration Plant
Cat/Del UV Facility
City Tunnel No. 1
City Tunnel No. 2
City Tunnel No. 3
City Tunnel No. 3 (Stage 2) Queens/Brooklyn Leg
Silver Lake Tanks
Staten Island Siphon
Richmond Tunnel
Groundwater Area
Boyds Corner Reservoir
Lake Gleneida
Middle Branch Reservoir
Lake Gilead
Bog Brook Reservoir
East Branch Reservoir
Kirk Lake
Croton Falls Reservoir
Diverting Reservoir
Titicus Reservoir
Amawalk Reservoir
Cross River Reservoir
Muscoot Reservoir
New Croton Aqueduct
Deposit
Walton
Downsville
Delhi
Oneonta
Gilboa
Hunter
Phoenicia
Kingston
Poughkeepsie
Liberty
Ellenville
Esopus Creek
West Branch Delaware
East Branch Delaware
Catskill Delaware
Hudson River
Neversink River
Long Island Sound
New York Bay
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Manhattan
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