Fall 2022, Vol. 52, No. 3

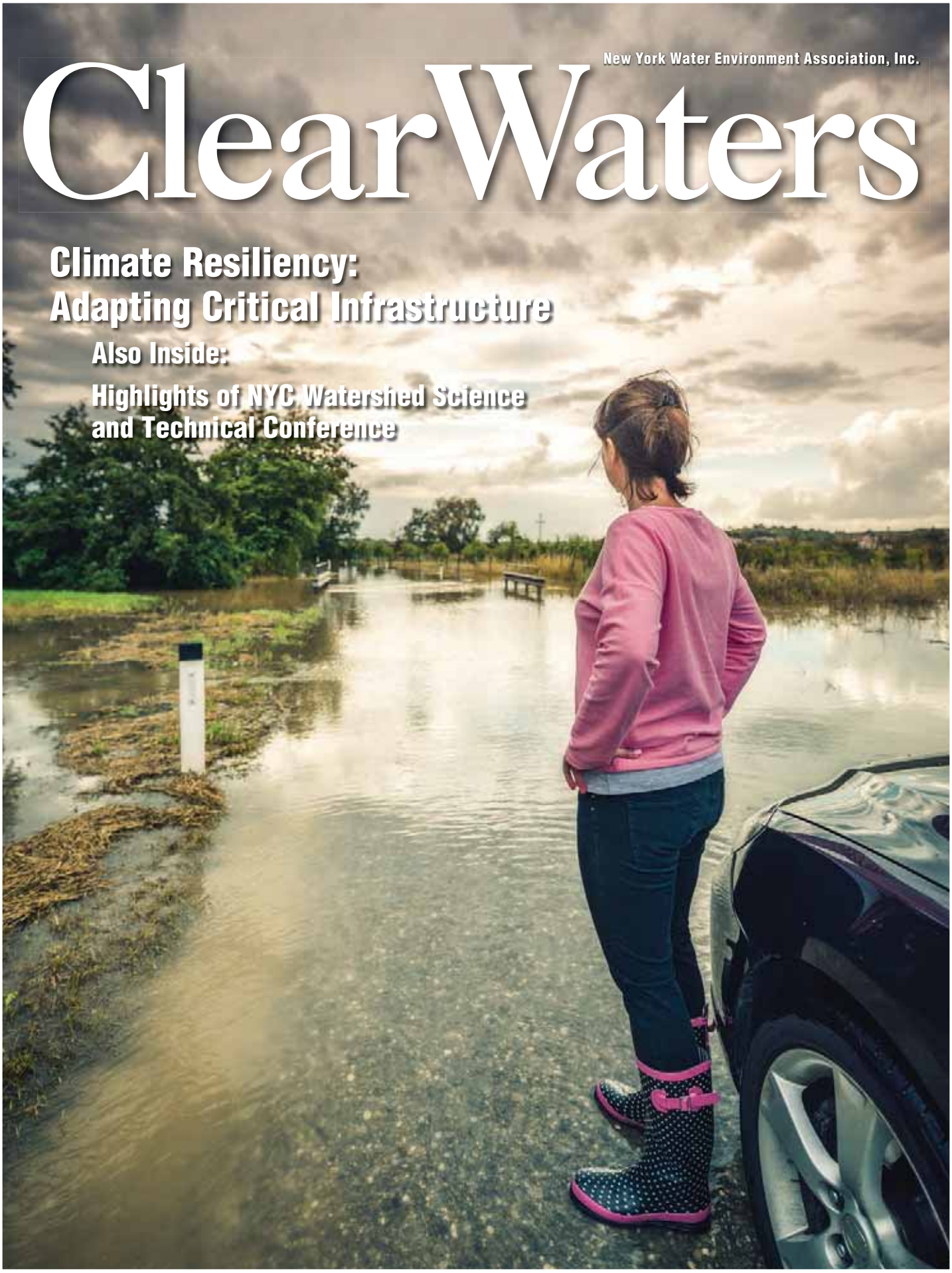
New York Water Environment Association, Inc.

ClearWaters

Climate Resiliency: Adapting Critical Infrastructure

Also Inside:

Highlights of NYC Watershed Science and Technical Conference



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Fall 2022, Vol. 52, No. 3

Clear Waters

New York Water Environment Association, Inc.

Cover: As global atmospheric temperatures rise, the air can hold more moisture, leading to more frequent intense storms. Communities already at risk are even more vulnerable to flooding resulting from these storms. According to a recent climate change overview report issued by NYSDEC, most regions of the state have experienced an increase in average annual precipitation over the past century, as well as increasingly frequent extreme precipitation events. *istockphoto.com, egon69*

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President's Message | Fall 2022

Fall Highlights

Happy Fall, NYWEA! This is probably my favorite season: the colors, the crisp air, and good sweater and sleeping weather. I hope you all enjoy it, too, and will also enjoy this issue of *Clear Waters*.

Focused on resilience and climate change, the articles in this issue provide readers with various perspectives on the different aspects of this topic. Whether we see direct or acute impacts at the local level, globally we are seeing the impacts affect others, as it has impacted so many New York state communities in the past with storms like Sandy, Lee and Irene, among others. We've also experienced unexpected drought, warming waters that create harmful algal blooms that affect our ability to enjoy our lakes and ponds, and prolonged heat in regions of our state where such sustained high temperatures have not been consistently experienced in the past. Air conditioning, which was once a luxury or only needed a few times during the summer, now seems like a necessity.

The topics of resilience and climate change have also been making their way into NYWEA's conferences for quite some time now, speaking to the impacts on our industry and the ways that some of our communities are trying to adapt. In this issue of *Clear Waters,* we see examples as well.

For instance, Michelle McEntire's article, "Irondequoit Bay Marine Park Project: Adapting to a New Normal," discusses the 71% increase in precipitation in the Northeast over the last 70 years, as well as the elevated water levels in Lake Ontario and its impact on shoreline communities. She details the ways that Monroe County used the state's Resilience and Economic Development Initiative (REDI) funds to make the marine park more resilient to flooding and ensuring that it can remain a recreational and economic asset into the future.

Another example that hits closer to home to those of us in the wastewater industry is the article written by George Bevington and Amy Weils titled "Tapping into Energy and Climate Protection from Water Resource Recovery Anaerobic Digestion." Written in the context of the state's Climate Leadership and Community Protection Act (CLCPA) and the ongoing transformation of wastewater treatment plants to water resource recovery facilities (WRRFs), the article outlines the priorities ahead of us, particularly when it comes to anaerobic digestion. The CLCPA waste panel, on which George sat, made recommendations focused on anaerobic digestion that included:

- Support beneficial reuse of biosolids
- Support beneficial reuse of biogas
- Increase anaerobic digestion programs with excess digester capacity
- Reduce fugitive emissions from WRRFs, septic systems and sewers

The authors provide greater detail of each of these in the article. They also include case studies on the work and transformations taking place in some of our facilities including those in Gloversville-Johnstown, Ithaca, Rome, Oneida County and Niskayuna.

An article by Bill Brower, "The Potential for Carbon Credits from Biosolids Land Application," does a deeper dive into the climate benefits of biosolids land application and what the future could look like if credits were offered for this use.

This issue of *Clear Waters* also draws attention to the ongoing work the NYSDEC Finger Lakes Hub is conducting to monitor for harmful algal blooms in an article written by Aimee Clinkhammer.

Richard Loeffler's "Digital Twins: It's What You Do with the Data That Matters" is a fascinating look into optimizing utilities by assimilating the data you have on your system into day-to-day operations. From there utility managers can go to the next level, hydroinformatics. Using data can help with operations, capital expenditures, workforce and, of course, decreasing impacts of climate-related events.

Of course, there are other great articles in the issue that I hope you take the time to read, but I thought I'd give you a preview of a few to whet your appetite!

Khristopher Dodson
NYWEA President

A Fun NOLA Story! As you may have read in the Summer issue of *Clear Waters*, NYWEA's long-time member and former NYCDEP Commissioner, Bob Adamski, acquired quite an alligator collection. The collection was donated to the Great American Alligator Museum in NOLA and NYWEA's Meet & Greet was held at the collection's opening during WEFTEC. Here's to you Gator Bob! (Dressed as "Ed Norton" here with his partner Rhona and myself.) **More photos on page 56.**

Executive Director's Message | Fall 2022

Synergy from Maine to New York

Sometimes synergy happens when you least expect it. While on vacation in Maine this summer I was impressed by how much attention the 50th anniversary of the Clean Water Act was getting. With references appearing in print in several places, from the *Portland Press Herald* to *Seacoast Current* newspapers, finally our clean water industry is getting the recognition it deserves!

I learned from my reading that it wasn't just the famed Cuyahoga River in Ohio that ignited over 50 years ago; the Androscoggin River in Maine had a similar claim to catching fire. In all that I read in these papers and magazines, the accolades for the brilliance and crafting of the Clean Water Act were bestowed on Edmund Muskie, U.S. senator from Maine. (This happened just one decade after another Mainer, Rachel Carson, published *Silent Spring*). Leon G. Billings, a former aide to the senator, illustrated how Senator Muskie recognized the synergy and interconnectedness between clean air and water and human health. On this page, I have included a bit of what Mr. Billings wrote about Senator Muskie's legacy.

In 1981, NYWEA leaders voted to award Senator Muskie with the Nelson A. Rockefeller Award.

What goes hand in hand with policy is the funding to meet the intended goals. This will hopefully happen in New York with the recently approved $4.2 billion Environmental Bond Act, which earmarks $3.5 billion for climate change and resiliency projects.

NYWEA Members Make Everyone Proud during WEFTEC!

There were many proud moments at WEFTEC starting with NYWEA's Meet & Greet that was attended by many New York members who came out to celebrate the debut of Robert Adamski's alligator collection. *(See page 56 for photos.)*

From the students at SUNY-ESF to the Operations Challenge teams to our members who volunteered for the WEF Service Project, as well as the members who made presentations and moderated at WEFTEC, New York was well represented in New Orleans. Hat's off to the two teams from SUNY-ESF who competed in the Water Environment and Wastewater categories, and the Water Environment Team who earned second place in the Student Design Competition.

New York also sent five teams to compete in the Operations Challenge. Congratulations to the Long Island Brown Tide for their third place win in the Division 1 Laboratory event; the Watertown Water Bears for their second place win in the Division 2 Process Control event; and the Onondaga County Mixed Liquors for their first place wins in the Division 3 Safety and Pump Maintenance events, second place in the Laboratory event and first place overall in Division 3! Thank you all for making us proud!

Upcoming 2023 Conferences and Training

Be sure to attend NYWEA's Annual Meeting February 6-8, at the New York City Marriott Marquis, and help us celebrate the organization's 95th anniversary! Select from 30 technical presentations, and visit the over 125 exhibitors on the fifth floor!

The synergy continues in 2023 with our Northeast sister association, the New England Water Environment Association, as we plan our Joint Spring Technical Conference & Exhibition that will take place in a new format, Wednesday through Friday, June 7-9 at the Hilton Hotel and City Center in historic Saratoga Springs, New York. Volunteers and staff from both organizations are busy planning what will be a tremendous conference.

I also direct your attention to the Thomas J. Lauro Member Education training program for 2023, where you will find unique training both via zoom and in-person, see *nywea.org* for more details.

Finally, relating to the theme of this issue of *Clear Waters,* NYWEA will hold a Climate Change Specialty Conference in Utica, New York, on March 23. See page 30 for the program. We hope to see you there!

Wishing you and yours a wonderful holiday season!

Patricia Cerro-Reehil, pcr@nywea.org

Maine Senator Edmund S. Muskie*

"Before Ed Muskie, there was no national environmental policy. There was no national environmental movement. There was no national environmental consciousness."

By Leon G. Billings

Edmund S. Muskie leaves an indelible legacy as one of the pivotal figures of post-war America. Before Ed Muskie, we protected places and things. Stewardship was seen only in conservationist terms. Modern environmentalism, which protects human health and welfare, was mostly an academic subject. Through a unique blend of leadership, courage, and foresight, Ed Muskie made it national policy to protect human health by protecting the air, the water, the land. And that policy, that philosophy, has spread across the geopolitical surface of the planet.

Under his direction, the nation's environmental laws became a fabric. There was legal continuity, definition, and purpose. There was a policy basis which the public could grasp – health in Clean Air, biological integrity and drinkable, fishable and swimmable in Clean Water. There were tools to achieve objectives and timeframes for action. There were performance mandates and defined roles for program administrators, the courts, and the public. No earlier federal laws contained all of these. Most contained none.

Source: https://www.muskiefoundation.org/founder.html

**Image received in NYWPCA office in 1981 from Senator Muskie's office.*

NYC Watershed Science and Technical Conference

"Clean Water Through Protection and Partnership"

Nearly 200 people attended the conference held Sept. 21 at the Bear Mountain Inn, Tomkins, New York. Meeting attendees selected from five sessions covering a wide variety of topics from NYS Wastewater Surveillance to Zebra Mussels to the Climate Leadership & Community Protection Act. Many thanks to Lisa Melville and the members of the Watershed Committee, speakers, moderators, sponsors and exhibitors. Special thanks to the members of the NYCDEP Bowery Bay Coyotes Operations Challenge Team for performing a demonstration during lunch.

NYWEA President Khris Dodson welcomes attendees to the conference.

Lisa Melville, NYSDOS, NYC Watershed Committee Chair.

Commissioner Rohit T. "Rit" Aggarwala, NYCDEP, addresses the meeting during Opening Session.

NYCDEP

Four panelists discuss "The Rehabilitation of the Catskill Aqueduct after Its 100-Year Birthday". Top left, Dan Michaud, NYCDEP; top right, Dan Peterson, Schiavone Construction Co.; bottom left, Eric Kight, NYCDEP; bottom right, Gregory J. Shaw Jr., Parsons.

L-r: Eric Kight, NYCDEP; Gregory Shaw Jr., Parsons; Dan Michaud, NYCDEP; Paul Rush, Deputy Commissioner for Water Supply, NYCDEP; and Dan Peterson, Schiavone Construction Co.

The Opening Session was well attended.

Kerri Alderisio speaks on high-volume field filtration.

Dr. David Larsen of Syracuse University gave a presentation on the Wastewater Surveillance Network.

Kinsey Hoffman serves as moderator for Session 2.

Sara Urbanczyk, of GA Fleet, introduces the next speaker.

NYCDEP Mike Spada, Session 1. *NYCDEP*

Rich Van Dreason, Session 5, discusses salt trends in the Croton System of NYC water supply.

NYWEA's Maggie Hoose, left, and NYSDOS' Lisa Melville sign in attendees on arrival to the conference.

See more photos on page 54-55.

Photos:
NYCDEP, Patricia Cerro-Reehil and Madison Quinn

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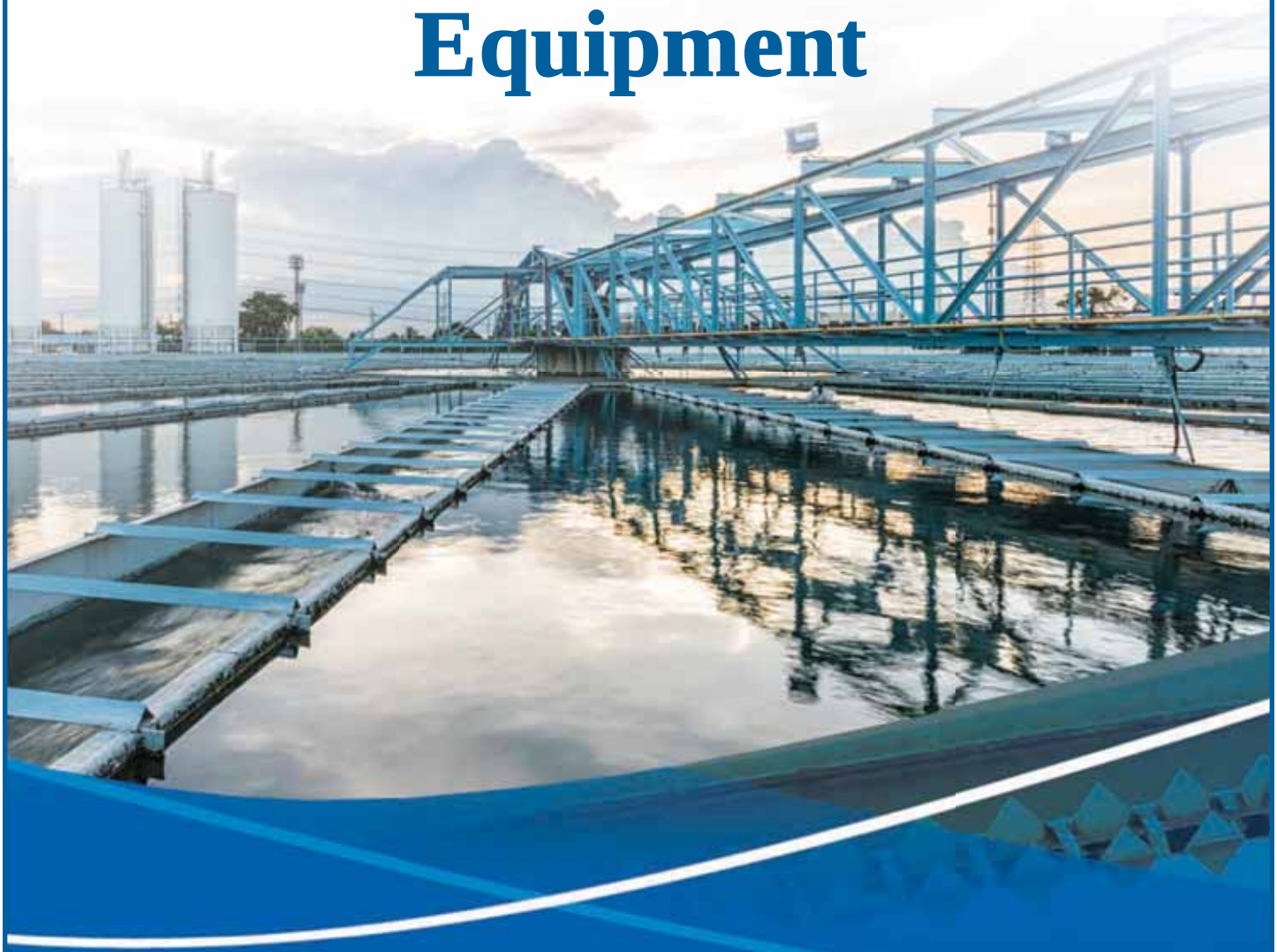

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Water Views | Fall 2022

Climate Resiliency

New York is a national leader in efforts to reduce greenhouse gas emissions and adapt to the unavoidable impacts of climate change. The 2019 Climate Leadership and Community Protection Act (CLCPA) builds on prior efforts to reduce greenhouse gases and increase flood resiliency. The goal of the CLCPA is to reduce economy-wide greenhouse gas emissions by 40% by 2030, and 85% by 2050 (from 1990 levels). Due to the worsening effects of carbon emissions, we need to enhance critical infrastructure resilience against intensifying storms.

The Climate Action Council, created by the CLCPA, was tasked with developing a draft "Scoping Plan" to serve as an initial framework for how the state will reduce greenhouse gas emissions, increase renewable energy usage, and ensure climate justice. The six-month public comment period for the draft Scoping Plan has closed. Also, this past summer, the Climate Action Council asked for public comment on proposed criteria to identify disadvantaged communities – as part of a larger program to better ensure that underserved communities benefit from the state's transition to clean energy.

Some key strategies identified in the draft Scoping Plan: implementation of energy efficiency measures; transitions from fossil gas; electrification of buildings; maximization of carbon sequestration in lands and forests; mitigation of fugitive methane emissions across the waste, agriculture and energy sectors; and strategic use of low-carbon fuels and carbon capture technologies for certain industrial applications. Municipalities, public utilities, businesses and individuals are all essential to the success of implementing the CLCPA.

While we transition to clean energy, we need to continue to reduce the flood risks to critical water infrastructure. The Binghamton-Johnson City Wastewater Treatment Plant, located in one of the most flood-prone areas in the state, was made more flood resilient by building a flood works to safeguard against the 500-year storm. The $300 million "Resiliency and Economic Development Initiative" is funding infrastructure resiliency projects in flood prone regions along Lake Ontario and the St. Lawrence River that were battered by record floods in 2017 and 2019. On Long Island, work is progressing on the Bay Park Conveyance Project to improve storm resiliency and water quality in Long Island's Western Bays. The Bay Park water reclamation facility is now resilient against the 500-year storm.

Identifying the vulnerabilities in a wastewater treatment facility is the first step toward protecting it. DEC has made available the *Asset Management Guide for Publicly Owned Treatment Works (https://www.dec.ny.gov/chemical/101412.html)*. It's a tool that, among other things, can help POTWs make decisions regarding investments to reduce climate vulnerabilities and increase storm resiliency.

Our climate is changing, and New Yorkers are stepping up to protect our natural resources and critical infrastructure.

– James Tierney, Deputy Commissioner for Water Resources
New York State Department of Environmental Conservation

Focus on Safety | Fall 2022

Endocrine-Disrupting Chemicals

Every day there is more news on PFAS, bisphenol-A, phthalates, and other chemicals in our environment, personal care products, food and drinking water – chemicals formerly considered safe. So, what are these endocrine disruptors?

Endocrine glands include pituitary, thyroid, pancreas, adrenal cortex, testes, ovaries, and the small fat cells that regulate blood glucose and blood insulin levels. These glands and tissues secrete hormones controlling growth, development, reproduction and metabolism – from conception through adulthood into old age.

An endocrine-disrupting chemical taken into the body will interfere with or even mimic hormones produced by endocrine glands. The chemical bonds to a target cell, forcing it to carry out the chemical's instructions. Those instructions could be dramatic and devastating to the body, depending upon the chemical and the type of cell. Some examples are:

- Altering the cell's proteins
- Altering the timing of body processes, even causing premature aging of cells
- Turning on/off genes, resulting in poorer defense against pathogens or an inability to recognize and destroy abnormal cells that could become cancer
- Causing stem cells to turn into fat cells
- Causing multigenerational effects on offspring

Health problems you experience now could be from your exposure as an adult, or the result of an exposure of your parents (pre-conception to eggs or sperm) or during your fetal development or puberty.

Some chemicals, thought to be safe, have turned out to be hazardous – even chemicals considered miraculous problem-solvers, such as DDT, PCBs, Teflon and flame retardants. Many endocrine disruptors are in products used on our bodies, to package food, manufacture clothing, or in electronics and plastics at home or at work. Some endocrine disruptors go down the drain and, if not removed by wastewater treatment, continue into receiving waters that, in turn, become drinking water sources. Regulation, and even banning, of some endocrine disruptors has begun, as has research into upgrading water and wastewater treatment processes to remove or destroy them. Some can be difficult to avoid, but we can reduce exposure:

- Eat more whole foods and fewer packaged or processed foods
- Use metal or glass containers to store food
- Avoid washing plastics in the dishwasher
- Discard old or scratched plastic
- Do not microwave food in plastic or touching plastic wrappings or package coatings; use microwave-safe glass or ceramic
- Avoid vinyl shower curtains and PVC flooring
- Use fragrance- or phthalate-free personal care products. (Products labeled as "unscented" may still contain fragrance and are not necessarily free of phthalates)
- Use detergents derived from plant-based oils rather than petroleum
- Buy flame-retardant-free carpets and furniture

– Nellie J. Brown, MS, CIH, ILR School, Cornell University

Climate Leadership and Community Protection Act

by Brendan Hannon

In 2019, New York state passed the Climate Leadership and Community Protection Act (CLCPA), launching itself down a path toward a decarbonized economy. The law sets ambitious goals for the state to reduce its greenhouse gas emissions and deploy renewable resources. While it is clear on issues such as how gasses will be accounted or what renewable production targets are, the law was not written with an instruction manual for how the state will reach these goals. This article explains what changes are required by the CLCPA and how those changes will impact the water and wastewater sector in New York state.

What's in the CLCPA, Anyway?

The CLCPA is filled with enough climate-related goals to keep New York state busy for the next 30 years. Following the recommendations of the U.S. Global Change Research Program (USGCRP) and the Intergovernmental Panel on Climate Change (IPCC), the CLCPA sets the target for New York state to

> **"reduce greenhouse gas emissions from all anthropogenic sources 100% over 1990 levels by the year 2050, with an incremental target of at least a 40% reduction in climate pollution by the year 2030."**

This goal is supported by additional milestone markers that include a requirement to install 6 gigawatts of solar capacity by 2025, 9 gigawatts of offshore wind capacity by 2035, 3 gigawatts of storage by 2030, and a staggering 185 trillion British thermal units (BTUs) of reductions in on-site energy savings from energy efficiency. All of this is to be supported by the grid transitioning to 70% carbon-free electricity by 2030 and 100% zero-carbon electricity by 2040.

The CLCPA applies to the entire economy, unlike a Renewable Portfolio Standard, which would only apply to electric utilities. There are three features of the CLCPA that separate it from previously passed renewable energy legislation. The first is an overarching focus on environmental justice; the law mandates that 35% of the benefits of spending from the CLCPA must be directed toward disadvantaged communities that will bear the brunt of the impacts of climate change. Secondly, the law requires that the greenhouse gas (GHG) accounting use the Global Warming Potential (GWP) on a 20-year timeframe, instead of a 100-year timeframe, to evaluate methane's impact on the environment. This leads to a greater emphasis on achieving methane emission reductions as compared to the accounting using the 100-year value for GWP. Lastly, the law does not differentiate between emissions from biogenic fuels (such as digester gas) and fossil fuels (such as natural gas); both of these must be counted in the state's gross GHG accounting inventory.

Greenhouse gas accounting is at the heart of the CLCPA – it is the measure by which the state ultimately has to judge its progress on the law. This essential component is assigned to the New York State Department of Environmental Conservation (NYSDEC), which must produce a greenhouse gas inventory of the state and then update the inventory moving forward. Technically, the 100% emission reduction is defined as "net-zero" emissions, meaning that the state must reduce its emissions to 15% to 85%. The CLCPA orders the state to create a program to identify eligible offset projects that would balance out the remaining 15% to achieve "net zero" emissions, provided that the offsets are "real, additional, verifiable, enforceable and permanent."

As far as water and wastewater utilities are concerned, there is little mention of the industry except for discussion of anerobic digesters. These show up twice – first as greenhouse gas emission sources to be included in the inventory, then later as an eligible offset project where energy produced is put to local use.

The Climate Action Council and the Scoping Plan

While the CLCPA is very clear about what New York state needs to achieve, it does not prescribe the steps that bring New York into a carbon-free future; instead, the law creates a Climate Action Council (CAC) tasked with charting the course for the energy transition. The CAC, chaired by Basil Seggos of NYSDEC and Doreen Harris of NYSERDA, is a 22-member body consisting of gubernatorial appointees, commissioners of state agencies and other political appointees. They are responsible for writing a scoping plan within two years of the passage of the CLCPA that will contain recommendations for the state to attain the greenhouse gas emission limits established in the law.

Given the breadth of the planning challenges facing the CAC, the CLCPA provides for the CAC to convene advisory panels with subject matter experts to inform the scoping plan. Six working groups are set out in the law:

- Transportation
- Energy-intensive and Trade-exposed Industries
- Land Use and Local Government
- Energy Efficiency and Housing
- Power Generation
- Agriculture and Forestry

In addition to these advisory panels, the CLCPA mandates the creation of a Climate Justice working group to comment on other advisory panels' recommendations. The law lacks a requirement for a Waste advisory panel, but the CAC quickly realized the necessity for such a panel and voted unanimously to form one during one of their meetings (this panel included representation from NYWEA and member organizations). All these advisory panels worked from 2020 through early 2021 to brainstorm the recommendations that would become the scoping plan.

The CAC and state staffers synthesized recommendations that came out of the advisory panels into a draft scoping plan (those who have the time should read the 861-page document!), which has been voted on, approved by the CAC, and put out to the public for comments. Since it was released, the draft scoping plan has received tens of thousands of individual comments from engaged New Yorkers. After incorporating the feedback from the state's citizens, the CAC will release a finalized scoping plan by Jan. 1, 2023.

Wastewater in the Scoping Plan

The draft scoping plan released for public comment is broken up into chapters that correspond to the sectors and the associated advisory panel. Some recommendations in other chapters might apply to water and wastewater utilities. For example, converting fleets to electric would be covered by the Transportation panel, while best management practices for watersheds might fall in the purview of

the Land Use and Local Government panel. But the recommendations most relevant to wastewater utilities are in the Waste Sector.

Each Waste Sector strategy is broken down into multiple components. Three key strategies for wastewater utilities are:

- W.4 – WRRF Conversion
- W.7 – Reduce Fugitive Emissions from WRRFs
- W.9 – Biogas Use

WRRF Conversion

The first recommendation – WRRF Conversion – is to

"transform treatment plants from a waste disposal priority to Wastewater Resource Recovery Facilities that emphasize the capture of beneficial products."

This strategy includes the following components:

- beneficial use of biogas and biosolids
- optimization of anaerobic digestion
- co-digestion where capacity allows
- continued research of co-pollutants such as emerging contaminants

This strategy mirrors a transition that has been underway in the wastewater industry for years and now has increased support from the state. From a greenhouse gas perspective, putting biosolids to beneficial uses and keeping them out of landfills will be one of the most impactful changes utilities can make. In light of the higher GWP of methane in the state's accounting, avoiding methane emissions from landfills is a high priority for the state. Similarly, optimizing digestion to increase capacity creates an opportunity to divert even more organic waste from landfills, furthering the state's emission reduction goals.

Reduce Fugitive Emissions

Reducing fugitive emissions from WRRFs is another goal that emerges from using a higher GWP coefficient (i.e., 20-year timeframe) for methane. Given the focus on anaerobic digestion as an emissions source, it is essential that utilities that use anaerobic digestion monitor their facilities for methane leaks to ensure as few fugitive emissions as possible. This monitoring will be a new responsibility for many utilities. The scoping plan says that NYSDEC would run the methane monitoring program for WRRFs. Ideally, utilities will capture and beneficially reuse biogas; at worst, they will be flaring any excess. Methane leak detection technology has been applied primarily to oilfields and pipelines; in the future, wastewater utilities will conduct similar surveys to identify leaks in their plants.

Biogas Use

The requirement to minimize fugitive emissions from WRRFs is linked to a recommendation for biogas utilization. While biogas is excluded from the CLCPA's definition of renewable energy systems, it is eligible to be counted as an offset project. The details of a mechanism or market for locally produced biogas have not been hammered out, but it will be critical for the state to identify a means to deliver renewable biogas to energy users who cannot replace fuel for heating.

The fact that the CAC has established a goal to evaluate the strategic use of biogas leaves room for a future in New York state that includes biogas. A market willing to pay utilities for renewable biogas would help to incentivize elimination of fugitive methane emissions. Should the state establish a "stick" in the form of penalties for vented methane, a market can act as the "carrot," encouraging utilities to capture the biogas for local energy generation. It would be better for utilities to be rewarded for capturing and selling methane, enabling further reinvestments in a biogas system, than to be penalized for fugitive emissions, reducing the amount of available funds for state-of-good-repair work.

When Does the Change Begin?

Like a boulder dropped into a lake, the impacts of the CLCPA have already begun rippling through New York state's economy and government apparatuses. Enforcement power for the CLCPA is distributed among state agencies such as NYSDEC and the Public Service Commission. As an example, in October 2021, the NYSDEC denied a Title V air permit for a natural gas turbine generator that would be sited in Astoria. More recently, the NYSDEC denied a new request for a Title V permit to the Danskammer Generating Station in Newburgh, which proposed new equipment that would operate on natural gas; while the new equipment would be more efficient than the existing system, it would also be online more frequently, resulting in increased emissions on-site. The NYSDEC denied the permit on the grounds that the proposal conflicted with the goals of the CLCPA, and the decision was upheld in court.

In the near term, the majority of the movements originating from the CLCPA will be from state-led actions such as permit renewals (or denials) and regulatory revisions. The first appearances of the CLCPA will be a collection of permitting and regulatory decisions, gently steering New York state away from fossil fuel consumption. These bureaucratic steps will gradually unfold into the larger programs spelled out in the draft scoping plan. Before that can happen, the state Legislature must pass another bill that will identify funding mechanisms for the programs required to meet the CLCPA's goals. One potential legislative channel to procure that funding is the Climate and Community Investment Act (CCIA), currently sitting in the state Senate's Environmental Conservation Committee.

All of this is to say that it is an exciting time to work in New York state's sustainability sector. Water and wastewater utilities exist at a critical point; our infrastructure receives one of society's most consistent waste streams. The decisions made on utility boards influence the flow of materials and energy through our landscape and economy. NYWEA and its member organizations are well positioned to hasten New York's transition to a decarbonized economy. You can find the most recent developments (rulemaking, updates to the scoping plan, meetings) regarding the CLCPA at *https://climate.ny.gov.*

Brendan Hannon is an energy program analyst in the Office of Energy and Resource Recovery Programs with the New York City Department of Environmental Protection and may be reached at bhannon@dep.nyc.gov.

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Tapping into Energy and Climate Protection from Water Resource Recovery Anaerobic Digestion

by George E. Bevington and Amy H. Weils

New York state passed the Climate Leadership and Community Protection Act (CLCPA) in 2019 with the goal to reach net-zero emissions in the state and mitigate climate change. This act set emissions goals throughout the state through the next several years and established specific emission targets from multiple sectors.

The extent of the CLCPA is vast and provided recommendations for each sector as developed by a panel of experts. For the wastewater sector, recommendations focused on transforming wastewater treatment plants (WWTPs) to water resource recovery facilities (WRRFs). Renaming these facilities is emblematic of the shift in priorities. The CLCPA waste panel's specific recommendations included:

- Support beneficial reuse of biosolids
- Support beneficial reuse of biogas
- Increase anaerobic digestion programs with excess digester capacity
- Reduce fugitive emissions from WRRFs, septic systems and sewers

This article focuses on anaerobic digestion at WRRFs, addressing several of the CLCPA's recommendations as well as providing additional benefits to the community.

Anaerobic Digestion's Role in Energy and Climate Protection

Anaerobic digestion at WRRFs serves multiple purposes relating to the goal of net-zero emissions. These include:

- Sludge stabilization and volume reduction
- High-strength organic waste acceptance
- Renewable energy generation
- Climate mitigation

Sludge Stabilization and Volume Reduction

Given sufficient time, organics will break down waste products naturally, but anaerobic digestion equipment and operator adjustments optimize the decomposition process so that it occurs faster. Anaerobic digestion occurs in the absence of oxygen, at a mesophilic temperature (95 to 98 degrees Fahrenheit), where the microorganisms decompose organic waste material. The process occurs in two main steps, typically in the same tank: acid formation, followed by methane formation. At WRRFs, anaerobic digestion treats the solids produced, achieving stabilization and volume reduction to meet New York state requirements. When used for wastewater solids treatment, anaerobic digestion has been shown to consistently reduce solids by about 30%. The volume reduction decreases the amount of biosolids to be landfilled or managed by other methods.

High-Strength Organic Waste Acceptance

Anaerobic digestion allows for the acceptance of high-strength organic waste (HSOW) at WRRFs. HSOW is typical of the dairy industry, food and beverage industry, and source-separated organic waste from commercial facilities or institutions. Local WRRFs can provide a safe and sustainable disposal method for regional generators, stimulating economic activity. For municipal systems, the tipping fees generated by accepting outside waste can be significant and often help to balance the budget and reduce strain on rate payers in the community. Existing anaerobic capacity or constriction on new capacity at WRRFs can be utilized to co-digest HSOW along with waste activated sludge (WAS) and primary sludge generated at the facility.

Renewable Energy Generation

The anaerobic digestion process produces biogas, which is typically about 60% to 70% methane and 30% to 40% carbon dioxide with some other trace gases. Biogas can be beneficially used in place of liquid fossil fuels such as natural gas. Typical biogas uses include building heating, digester heating, power generation, firing equipment such as sludge dryers or blowers, and renewable natural gas production. Depending upon the equipment, some level of biogas cleaning is required to remove impurities before use.

Climate Mitigation

Anaerobic decomposition occurs in other, less controlled environments, such as landfills and septic tanks. Septic tanks have no gas collection, allowing for fugitive methane gas emissions. Depending on the presence of a gas collection and utilization system, landfills also account for fugitive methane emissions across the state. By implementing anaerobic digesters at WRRFs, additional methane can be captured and used as a renewable energy source. The collection of nearly all methane produced at WRRFs is possible since the anaerobic digestion process is accomplished in covered tanks with dedicated biogas piping for beneficial use of the gaseous byproduct.

Case Studies

Several flagship projects in New York state have demonstrated the benefits of implementing anaerobic digestion, as summarized in the following case studies. As climate measures progress, similar projects are being pursued and additional anaerobic digestion products are anticipated in the future.

Case Study #1: GJJWTF

The Gloversville-Johnstown Joint Wastewater Treatment Facility (GJJWTF) helped to bring co-digestion and renewable power generation to New York's wastewater treatment facilities. A digester project implemented in 2005 repaired the existing digester cover, installed a new gas flare, and constructed a new biogas holder. These improvements helped to capture and store biogas. Additionally, digester upgrades allowed for controlled feed of HSOW from a local cheese manufacturing plant for co-digestion. In 2008, a new HSOW customer built a $150 million facility neighboring the GJJWTF and dramatically increased the digester loading via a dedicated HSOW force main, resulting in substantially more biogas generated. The biogas is fired in reciprocating engines for electricity production and helped the GJJWTF become the first net-zero electricity user in the state. By 2010 the plant was also bringing in about $800,000 in trucked waste revenue annually.

For 30 years, GJJWTF has operated anaerobic digestion and produced electricity and heat via a combined heat and power

Yogurt company expansion resulted in significant quantities of HSOW for anaerobic digestion. *George Bevington, Barton and Loguidice*

system. For the last 20 years, GJJWTF has used excess anaerobic digestion capacity to successfully co-digest organic matter – as was recommended by the CLCPA panel. For the last 10 years, GJJWTF has been net zero in terms of electricity use and often a power exporter, generating millions of electrons from renewable biogas produced on-site. In addition, waste heat from the generators has been recovered to dramatically reduce the purchase of natural gas for digester and building heat.

Case Study #2: Rome WRRF

The Rome, New York, WRRF has been operating anaerobic digesters for over 50 years, reaping the benefits of sludge stabilization and volume reduction.

In 2017, the facility started a pilot program to accept a limited amount of HSOW from a local industry. Operators immediately saw additional biogas production and were able to generate some tipping fee revenue. City Hall became interested as they witnessed the benefits co-digestion could bring to the community and pursued a digester upgrade project. Existing digester tanks were rehabilitated, and new equipment installed for digester mixing and heating. A new biogas holder was installed to provide gas storage for beneficial reuse in digester boilers and the new 400-kilowatt microturbine combined heat and power (CHP) system. The upgrade was recently completed, and the Rome WRRF has begun to accept additional HSOW, generate more biogas, and produce electricity for the plant.

Rome's 400-kilowatt biogas-fired microturbine combined CHP system. *George Bevington, Barton and Loguidice*

While the system is new, it has already resulted in acceptance of HSOW from multiple customers and has been successful in anaerobically digesting the waste, resulting in increased biogas generation. At times, the facility has been a net-zero emissions producer and minor amounts of excess electricity has been exported to the grid. Digester heating is now accomplished exclusively from heat reclaimed by the turbines or from biogas dramatically reducing natural gas use at the facility.

Case Study #3: Ithaca Area Wastewater Treatment Facility

The Ithaca Area Wastewater Treatment Facility (IAWWTF) has been recovering energy from waste for many years. Typically, 40% to 60% of electricity demand is generated on-site with microturbines. The facility is driven to reach a goal of net zero electricity by attracting additional HSOW for increased biogas production. In 2013, the facility underwent an Energy Improvements Project adding a high-strength waste receiving area and providing linear motion mixers to the anaerobic digesters – the first facility to do so in New York state. Trucked waste revenue is important to this facility and contributes about $500,000 per year to the budget. The IAWWTF anaerobically digests multiple HSOW to produce renewable biogas.

Energy efficient digester mixer at the IAWWTF. *Jacob Yousey, Barton and Loguidice*

Case Study #4: Oneida County WPCP

The Oneida County Water Pollution Control Plant (WPCP) recently constructed new egg-shaped digesters to process sludges generated by their WPCP treatment process. A solid-waste transfer station, operated by the Oneida-Herkimer Solid Waste Authority and located adjacent to the plant, began a source-separated organics acceptance program, providing a new feedstock and new opportunity for the county WPCP. Food waste is intercepted, debris removed, and the slurry is pumped to the digestion complex. Biogas from the digesters is converted to electricity by microturbines. The project was driven by new and proposed

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Source-separated food waste ready for processing before anaerobic digestion at the Oneida County WPCP. *Jesse Semanchik, Barton and Loguidice*

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regulations scheduling the diversion of food waste from landfills and provided an opportunity for the WPCP to implement climate mitigation measures.

Case Study #5: Niskayuna WWTP

Niskayuna, New York, upgraded their WWTP in 2018 to improve existing anaerobic digestion systems. New mixing systems, covers, and a new biogas holder were constructed. The facility was designed to accept about 30,000 gallons per day of HSOW from local food and beverage industries. A reciprocating engine is installed with the potential to generate a significant percent of plant power.

Gas holder, Niskayuna WWTP. *George Bevington, Barton and Loguidice*

Regulatory Landscape

New regulations will change how New York state wastewater plants operate. The shifting regulatory and environmental landscape has the potential to reshape the state's economy. Sewage treatment facilities have been rebranding to water resource recovery facilities – implementing the principles of the circular economy and becoming champions of the state's climate mitigation goals.

Special thanks to the operators of the WRRFs who provided updates about how their climate mitigation facilities are operating.

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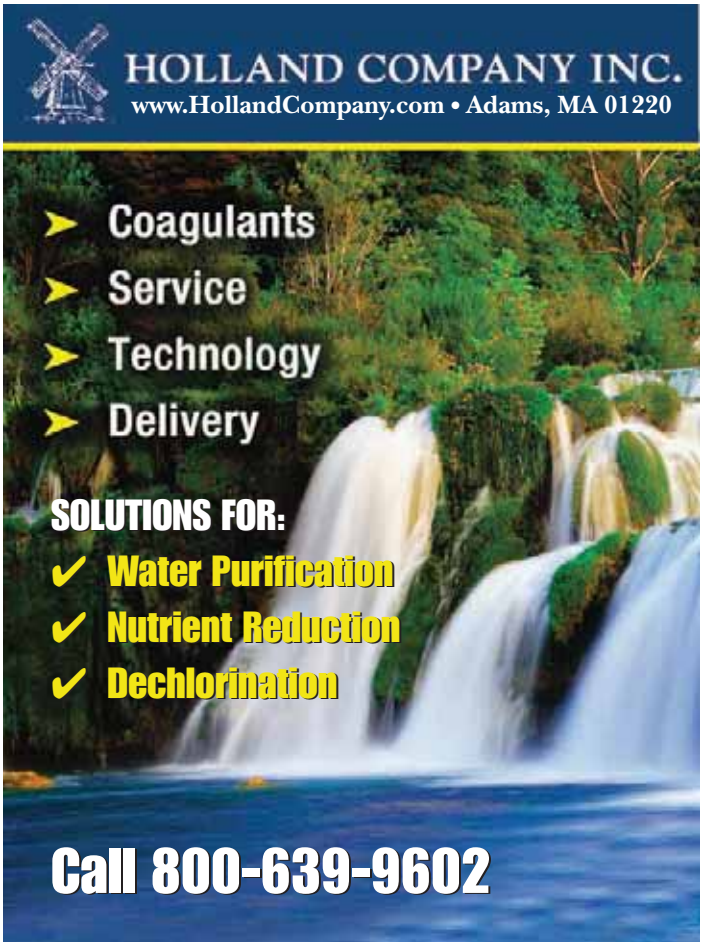

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The Potential for Carbon Credits from Biosolids Land Application

by Bill Brower

Land application of biosolids has several climate benefits and there is increasing interest in monetizing these benefits through carbon credits. Carbon markets are designed to incentivize activities that lead to lower greenhouse gas emissions or remove carbon from the atmosphere; however, I am not aware of anyone receiving carbon credits for biosolids beneficial reuse in the U.S. (and possibly the world). This article will examine the climate benefits of biosolids land application, how carbon markets work and what a biosolids carbon project could (and should not) look like.

Climate Benefits of Biosolids Land Application

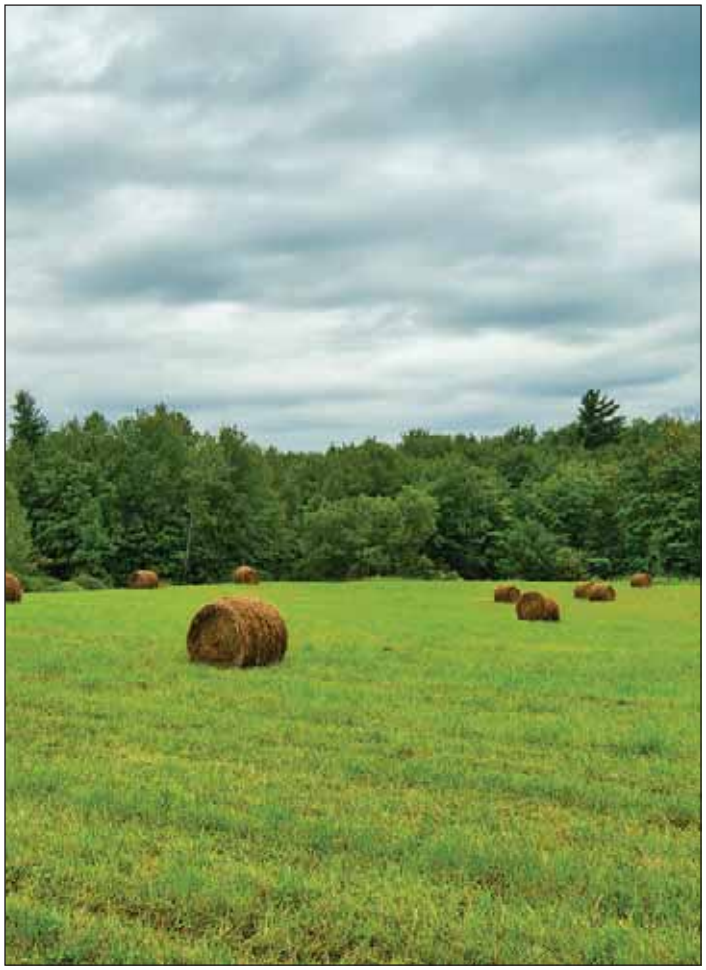
At a time of growing concern about the group of chemicals known as PFAS, it is helpful to remember the significant climate benefits of biosolids beneficial reuse. Perhaps the most obvious benefit is the recycling of carbon in biosolids back to the soil from whence it came, thereby closing the loop of the carbon cycle. Some of that carbon will be sequestered – that is, it will remain in the soil for a long period of the time. How much is sequestered and for how long is a question of considerable debate *(Popkin, 2021),* but the results from long-term biosolids land application *(Wijesekara et al, 2021)* and land reclamation *(Torri et al, 2014)* studies show that the amount of carbon in the soil increases with the amount of biosolids applied. A forthcoming systematic review by researchers from Virginia Tech promises to provide the most comprehensive look at the available literature and hopefully provide carbon sequestration values for biosolids land application based on different biosolids treatment, soil properties and application methods *(Badzmierowski et al, 2021)*. In addition to increasing the amount of carbon in soils, using biosolids also helps remove carbon from the atmosphere by improving above- and belowground biomass growth, particularly in land reclamation projects *(Torri et al, 2014)*.

The other climate benefits of biosolids land application concern avoided emissions associated with alternative management practices. If biosolids from a water resource recovery facility are currently being landfilled, moving to land application avoids the significant fugitive methane emissions associated with landfilling organic matter *(Brown and Leonard, 2004)*. Even in modern landfills with methane collection, a significant amount of the methane generated from anaerobic decomposition of organic matter will be emitted to the atmosphere. Since methane is a potent greenhouse gas (28 times the global warming potential of carbon dioxide), even small amounts have a large impact on the climate.

When biosolids are used in place of inorganic fertilizers, the emissions associated with the production and delivery of inorganic fertilizers are reduced or eliminated *(Brower et al, 2021)*. Many inorganic fertilizers are derived from or require significant amounts of fossil fuel for production *(Woods et al, 2010)*.

Carbon Markets

Historically, the primary carbon markets in the U.S. were "regulated" markets, which are established by governments to legally require an entire economy or specific sectors to lower their emissions. Regulated organizations within these markets are required to reduce their emissions over time. Most reductions must come from changes made to internal operations, but with the understanding that it can be more cost effective to encourage emissions reductions elsewhere in the economy: typically a certain percentage of obligations can be obtained by purchasing carbon offsets. These offsets are verified reductions that another organization has made and is essentially selling the right to claim. The only active regulated market covering New York state is the Regional Greenhouse Gas Initiative (RGGI), covering the power sector in 11 eastern states.



Developing a project for one or even a few average-sized farms in New York state (around 200 acres) would likely not be feasible at current carbon prices. *Joan D Squared*

In the last several years much of the activity has shifted to "voluntary" markets. Corporations and individuals are the typical purchasers of voluntary credits, using the credits in a similar manner as regulated organizations to meet emissions reduction targets. Rather than regulation, participants in voluntary markets are driven by nonbinding internal goals and stakeholder pressure, often as a result of considerations for environmental, social and governance (ESG) impacts. Demand for high quality, verifiable credits from major corporations and others has led to market growth and maturity. Since these markets are not regulated, the quality of credits varies widely.

Carbon credits for a distinct project are issued by a "registry," which is the organization responsible for verifying project claims and often for determining how credits are measured and verified. The main registries are the American Carbon Registry, Climate

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Action Reserve (CAR), Gold Standard and Verra. A "protocol," often developed by a registry, is a collection of written rules for how credits will be calculated. There are existing protocols available that are relevant to biosolids land application, including the CAR Soil Enrichment Protocol (which explicitly includes biosolids). Verra is also developing an afforestation/reforestation protocol. New protocols can be developed but at a significant cost, so the use of an existing protocol is the most cost-effective approach.

Protocols typically dictate that some project emissions are directly measured (e.g., soil carbon changes over time), while others are calculated (e.g., methane emissions from field storage of material, nitrous oxide emissions). Calculated emissions are dependent on the assumptions and emissions factors in the protocol, which are not always specific to biosolids. For instance, according to an analysis by the California Association of Sanitation Agencies (CASA) the Soil Enrichment Protocol uses an emission factor from cow manure to determine the methane emissions from storing biosolids. Emissions from well-digested biosolids should be considerably lower than raw manure so this assumption adversely impacts the overall greenhouse gas accounting in this protocol. Our industry will need to work with protocol developers to improve and customize their assumptions to ensure climate benefits are accurately determined.

What Would a Biosolids Carbon Project Look Like?

Carbon credits are issued for distinct projects. The project "owner" – the entity obtaining the rights for the carbon credits – typically would be the landowner or a project developer, but in this case could be the wastewater utility or a biosolids management company. Baseline emissions are determined for the status quo operation via the rules in the selected protocol. Project emissions are then calculated and/or measured in the years following the change in management practice (e.g., biosolids land application). The difference between baseline emissions and project emissions is the reduction eligible for a carbon offset credit.

Larger scale projects, such as reforestation or land reclamation, could provide the needed economies of scale to be cost-effective. *Kent Raney*

CAR estimated the cost to initiate a new forestry project as more than $40,000 and the annual cost for maintenance and verification to be more than $15,000, so these projects must be of sufficient size to be cost effective *(The Carbon Offset Toolkit, 2019)*. A project developer can provide upfront costs for a share of future revenue. Developing a project for one or even a few average-sized farms in New York state (around 200 acres) would likely not be feasible at current carbon prices. Larger scale projects, such as reforestation or land reclamation, could provide the needed economies of scale.

The value of carbon credits differs by market and fluctuates over time. One carbon credit is issued for each verified metric ton of carbon dioxide equivalent ($MTCO_2e$) reduced or removed. The most recent RGGI auction price from September 2022 was $13.45 *(RGGI, Inc., 2022)*. Terrapass "Business Carbon Offsets" are currently selling for $16.99 *(Terrapass, 2022)*. The August 2022 California Cap-and-Trade program auction price was $27.00 *(California Air Resources Board, 2022)*.

Carbon Credits Must Be Real

Organizations and individuals buy carbon credits to offset real emissions associated with their activities; therefore, if the credits do not represent actual reductions in the amount of greenhouse gas in the atmosphere, then they are exacerbating climate change. Since the amount of credit obtained is often based on assumptions, our industry has a responsibility to work with protocol developers

Regional Greenhouse Gas Initiative Auctions

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative, market-based effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and Virginia to cap and reduce CO_2 emissions from the power sector. It represents the first cap-and-invest regional initiative implemented in the United States.

Within the RGGI states, regulated power plants must acquire one RGGI CO_2 allowance for every short ton of CO_2 they emit. The RGGI states distribute allowances at quarterly auctions, where they can be purchased by power plants and other entities. Some states hold a limited number of allowances in set-aside accounts to sell at a fixed price or otherwise distribute outside of the auction process.

These auctions are sealed-bid, uniform price auctions that are open to all qualified participants. They result in a single quarterly clearing price.

The RGGI states utilize an online auction platform to offer and sell CO_2 allowances. The CO_2 allowance auctions are conducted in accordance with the statutory and/or regulatory authority of each state offering CO_2 allowances for sale in that auction.

Proceeds from the auctions are returned to the RGGI states and have been primarily invested in consumer benefit programs: energy efficiency, renewable energy, direct energy bill assistance, and other greenhouse gas reduction programs.

More information about this program is available online at *http://www.rggi.org/*.

Source: The Regional Greenhouse Gas Initiative website

to ensure the emissions factors relevant to projects are based on the most up-to-date research.

More importantly, we need to make sure that credits are only obtained for projects that cause actual reductions. One of the key concepts for carbon credits is additionality, the idea that the changes in greenhouse gas emissions or sequestration associated with a project would not have happened without the project. For instance, a practice cannot be both required by regulation and obtain a credit. For example, biosolids diverted from landfill that are required to comply with an organics landfill diversion law would not be eligible for carbon credits. Most protocols consider additionality from the viewpoint of the land where the management change will occur – for example, has this land been applied with biosolids in the last three years? But if the biosolids were coming from a utility that had been land applying all their biosolids before the project then from the viewpoint of the climate there is no new reduction in greenhouse gas emissions associated with the project *(Powlson et al, 2011)*.

There are three scenarios where I believe biosolids land application is truly additional. When the value of the carbon credit:

- makes land application viable for a utility that is currently landfilling their biosolids.
- pushes biosolids currently being beneficially reused into a use with a greater climate impact (e.g., moving from agricultural land application to reforestation of former mine sites).
- keeps land application viable for those currently land applying in light of new costs (e.g., an increased biosolids fee to the state).

Hopefully, one day there will be real financial incentives associated with the climate benefits of land-applying biosolids. Our industry will need to ensure these funds are obtained solely for projects that truly have an additional impact on the climate.

Conclusion

With millions of tons of biosolids generated each year, there is a real opportunity to generate revenue and address climate change by incentivizing climate-friendly biosolids reuse through carbon credits. While all the pieces to do so currently exist, there is work to be done before this can become widely practiced. As those with the specialized knowledge, we must work with protocol developers to ensure the most accurate, biosolids-specific assumptions are used in their calculations. We need to work with project developers to focus on projects of sufficient size and marketability to make the upfront and ongoing costs worthwhile. We need to be a part of the push to bring those costs down so a broader range of projects can move forward. When we get all of that figured out, we need to ensure that the projects we pursue are producing real, additional climate impact.

The Water Environment Federation Greenhouse Gas Subcommittee and the North East Biosolids & Residuals Association Carbon Trading Committee are groups of passionate individuals pushing to make these projects a reality. If you are interested in getting involved, please contact Mahia Qureshi *(mqureshi@wef.org)* or Janine Burke-Wells *(janine@nebiosolids.org),* respectively. Together we can do our part to address climate change.

Bill Brower, P.E., is a senior biosolids engineer with Brown and Caldwell, and inaugural chair of the Carbon Trading Committee of the North East Biosolids & Residuals Association. He may be reached at bbrower@brwncald.com.

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Hydrologic and Hydraulic Modeling Supports the NYC Stormwater Flood Map

by Melissa Enoch, Alan Cohn, Erika Jozwiak, Greg Mayes, Joel Kaatz and Jerry Kleyman

A Changing Climate and Urban Flash Flood Risk

Extreme rainfall events are becoming more frequent and disruptive in New York City (NYC) and beyond. According to the Fourth National Climate Assessment, significant increases in precipitation are already occurring in the Northeast – noting that heavy precipitation events have increased more than average precipitation – and this trend is expected to continue over the coming century. Further, thunderstorm-related hazards have increased more significantly since 1980 relative to other types of extreme weather *(USGCRP, 2018)*.

The NYC Panel on Climate Change (NPCC) anticipates that by the 2080s, NYC will experience increases in annual rainfall and extreme rainfall events, defined as days with at least 1, 2, or 4 inches of rainfall *(Horton and Bader et al, 2015)*. These events, compounded with increased urban development and undersized sewer systems – designed for a climate with less intense and fewer storms – are causing urban flash flooding in many communities. Further, this flooding is not limited to traditional coastal and riverine floodplains and can result in public infrastructure service disruptions, public and private property damage, and even loss of life. As a result, communities need to develop new action plans to increase their understanding of urban flooding vulnerability and improve community awareness to become more resilient.

NYC Stormwater Resiliency Plan

NYC achieved greater understanding of its vulnerability to more intense rainfall events and communicated this risk to New Yorkers with the release of the NYC Stormwater Resiliency Plan (the "Plan") in May 2021 *(NYC, 2021a)*. The Plan was NYC's first-ever citywide analysis of rainfall-based flooding, and outlines NYC's approach to managing this risk. A critical component of the Plan was the development and publication of an online interactive Stormwater Flood Map *(NYC, 2020)*. The Stormwater Flood Map serves as a hands-on tool for the broader public to identify areas of NYC at risk of rainfall-driven stormwater flooding. Together, the Plan and Stormwater Flood Map provide a foundation for further study and the development of focused interventions, charting NYC's path toward greater resilience.

Before this study, flood risk planning in NYC was largely focused on coastal storm surge and inundation following the catastrophic impact of Hurricane Sandy in 2012. While this coastal risk had been assessed in detail, including Federal Emergency Management Agency (FEMA) floodplain mapping, limited studies focused on purely rainfall-related flood risk absent of storm surge. NYC needed to better understand this risk and developed the appropriate tools to do so, taking a major step toward a more resilient city.

Mapping Flood Risk with Hydrologic and Hydraulic Models

Multiple tools and approaches are available to help communities understand and map urban flash flood risk. These options include:

- consolidating existing flood complaint data
- developing topography-based risk maps that utilize detailed elevation data but exclude local drainage sewer infrastructure
- using hydrologic and hydraulic (H&H) models to more quantitatively estimate both underground sewer system dynamics and aboveground surface flows

The options range across various data and resource requirements, as well as applicability of the results and tools developed.

NYC's goals for the Stormwater Resiliency Plan were multifaceted. Through the Plan and the Stormwater Flood Map, NYC set out to identify and map flood vulnerability from extreme rain, update operational response, advance policies to help reduce urban flooding, and develop short- and long-term stormwater flood alleviation measures. For this reason, NYC chose to use H&H models. The use of H&H models allowed NYC to quantitatively evaluate a range of rainfall return periods and account for changing climate conditions by modeling the impact of sea-level rise on NYC's drainage infrastructure. Multiple scenarios could be considered by inputting various combinations of precipitation and sea-level rise into the model simulations. This degree of quantitative analysis, which could not be achieved by relying solely on existing flood

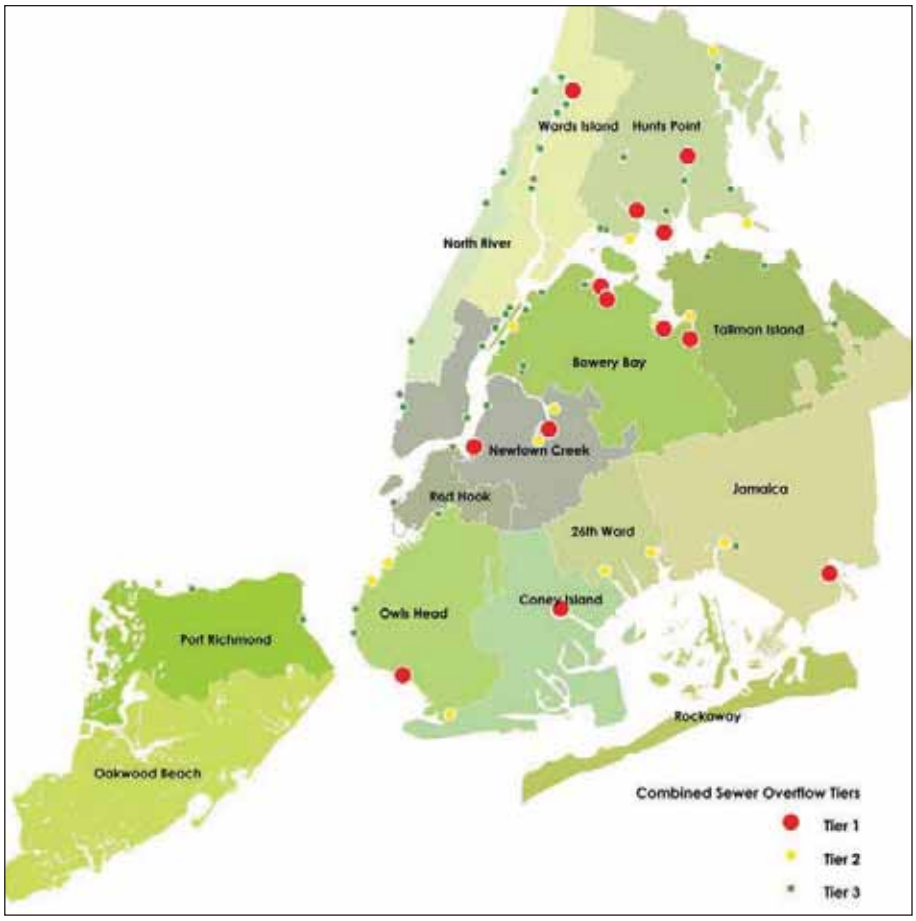

Figure 1. NYC WRRF drainage areas and CSO locations. *NYCDEP*

complaint data or topography-only based evaluations, required use of H&H models.

Developing NYC 1D-2D H&H Models

Over the past few decades NYC Department of Environmental Protection (NYCDEP) has invested significant resources in developing H&H models for NYC. The H&H models were developed primarily for Combined Sewer Overflow (CSO) Long-Term Control Plan (LTCP) regulatory analyses. The NYC sewer system is modeled across 13 different H&H models that generally align with the hydraulic boundaries of NYC's 14 water resource recovery facilities (WRRFs), shown in ***Figure 1*** along with CSO locations.

Like efforts carried out by many communities, these models only included the largest sewers in the sewer system, were one-dimensional (1D), and were constructed and calibrated with a focus on CSO volume quantification during the typical year precipitation. In this state, the models did not lend themselves for direct use in extreme rainfall flood risk mapping because:

1. The models had a relatively low-resolution representation of the sewer drainage network and did not contain sewers in many low-lying areas where flooding can occur, making it difficult to assess flood risk in these areas.
2. The 1D models were not capable of routing flood water over the surface and mapping flood extents and depths in two dimensions (2D).
3. Like many LTCP models, the calibration period did not include extreme precipitation events.

To overcome the challenge of leveraging the existing models for this study without an entire model rebuild and recalibration, the team developed an innovative modeling approach, combining a 1D-2D model with a rain-on-mesh model for use under extreme precipitation events.

Model Construction

Construction of the 1D-2D model began with expanding the existing 1D models, focusing on maintaining the LTCP calibration while increasing resolution to facilitate street-level flooding analysis. A 1D model represents water depths, velocities, and flow rates within the underground sewer system. In the existing LTCP 1D models, the volume of water that floods from each sewer manhole is documented but cannot be visualized spatially. As part of the model buildout, a 2D mesh that represents surface elevations was incorporated to visualize this flooded water. With the incorporation of the 2D mesh, the models become 1D-2D models, meaning that the hydrology of rainfall translated to runoff is 1D and the hydraulics of runoff entering and flowing through the sewer system is 1D, but the hydraulics and visualization of flooded water out of the sewer system is in 2D to facilitate mapping efforts.

Model Validation

After completing buildout of the models and incorporating the 2D mesh, the models were validated to ensure that they maintained the LTCP model calibration. Validation leveraged the sewer flow-monitoring data previously collected under the LTCP program, as well as associated rainfall and tidal conditions. The models were simulated during these historic calibration periods (2014-2017) and the model results were compared to both the monitor data and the output from the original LTCP models to ensure consistency or improvement relative to prior results.

Applicability of Models for a Range of Storm Events

After constructing the models, two initial combinations of rainfall and sea level conditions were chosen to depict estimated flood risk. The sea-level condition was simulated as a constant Mean Higher-High Water (MHHW) elevation with various levels of projected sea-level rise (SLR), based on the NPCC's 90th percentile projection for the 2050s and 2080s *(Horton and Little et al, 2015)*. These models include the impacts of potential blocked storm drains and outfalls from SLR. In 2022, an additional scenario without SLR was added to show current flood risk. The scenarios are shown below in ***Table 1***.

Table 1. Rainfall and Sea Level Combinations Used for Flood Risk Mapping

Rainfall Return Period	Sea Level Condition
10-year	Current MHHW
10-year	Current MHHW + 2.5 feet SLR (2050 projection)
100-year	Current MHHW + 4.8 feet SLR (2080 projection)

When the 100-year event was simulated using the 1D-2D model, the results did not show significantly more flooding than the 10-year events, which would have been expected given the relative increase in rainfall return period and intensity. When assessing these results and the 1D-2D model applicability for this larger rainfall return period, the calibration of the original LTCP models was considered. The intensity of the calibration events used for the LTCP models were typically less than a five-year storm, which was applicable for LTCP typical rainfall event analyses. However, the team found that the model was not constructed and calibrated to conservatively estimate the response to such large events as a 100-year storm. To assess the 100-year storm, a more conservative approach was developed. The modeling approaches for the

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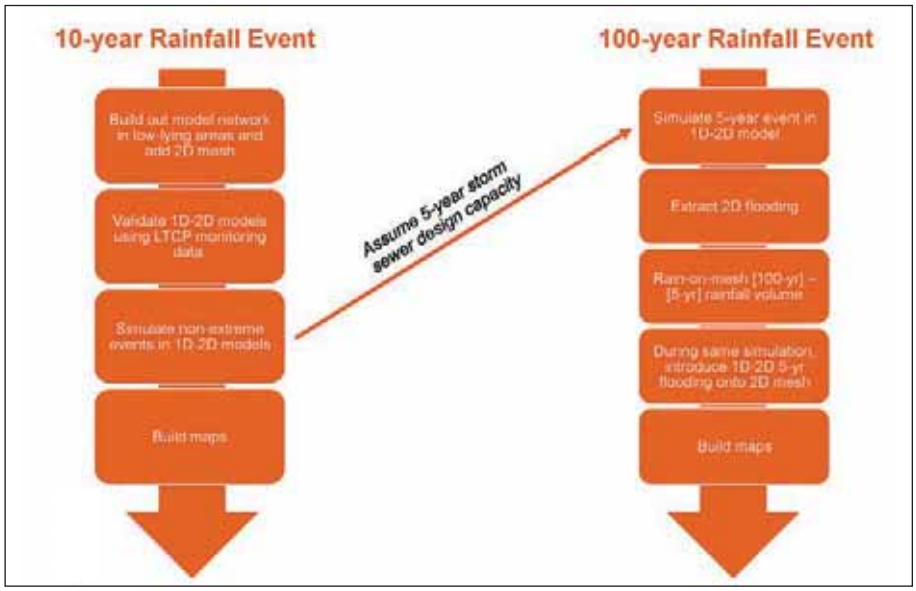

Figure 2. H&H modeling approach summary. *NYCDEP*

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10-year and 100-year events are shown in ***Figure 2***.

The approach first simulates the 1D-2D models under a five-year rainfall event to understand the sewer network capacity and associated flooding under the typical design standard (NYC sewers were historically designed for a three- to five-year storm event). The flooding from the sewer network under this event was then used in the second-step simulation to capture areas where the sewer system did not manage the five-year event.

The second-step simulation assumes that the sewer pipe capacity is already utilized during the five-year storm and accounts for the remaining rainfall volume (100-year minus five-year) by introducing it directly onto the 2D mesh along with the five-year flooding results from the first-step simulation. This approach accounts for the difference between this rainfall event and the calibration events used in the LTCP model development by incorporating the typical sewer design for NYC.

The approach allowed NYC to estimate flood risk for large events without creating entirely new models. Local sewer capacity restraints could be identified by simulating smaller storm events in the 1D-2D portion of the model and areas with flood risk due to larger surface depressions could be identified by simulating larger events in the 2D rain-on-mesh portion of the model.

Mapping the Results

After developing and simulating the H&H models, the results were post-processed in ArcMap GIS for public viewing as part of the online Stormwater Flood Map ***(Figure 3)***. The process considered feedback from multiple city agencies and included testing of different visualization options. Flood risk results were mapped with two depth categories showing ponding between 4 inches and 1 foot, and a separate color for ponding greater than 1 foot. Model results were aggregated and smoothed-out to improve the visualization and interpretation of results. The final public maps were shared using ArcGIS Online Experience Builder to provide a user-friendly way for the public to experience the maps and understand flood risk.

Future Improvements to the H&H Models and Stormwater Flood Map

Future efforts to improve the H&H models and develop refined maps include:

1. Additional model buildout to contain a higher percentage of NYC's sewers in each model. A higher resolution model of the sewer network will allow for more detailed site analyses and facilitate assessment of future interventions. Model representation of the sewer network can also be improved through sewer manhole survey.
2. Validation data collected for larger storm events at more locations across the city. More data will provide the opportunity to better validate the model results. This can be facilitated through additional sewer flow monitoring programs, which place sensors inside sewer pipes to continuously record flow depths and velocities.
3. Quantitative surface-level validation data to provide insight to flooding extent and depth. To complement additional in-sewer data, sensors on the surface level can continuously record surface ponding to help validate flood mapping.
4. Mapping additional storm scenarios.

Leveraging the NYC Stormwater Resiliency Plan and Flood Map

To date, the H&H models, Stormwater Flood Map, and the Plan have been used to further assess extreme rainfall risk in NYC and chart next steps for NYC to evaluate, communicate and advance measures to alleviate this risk.

The extreme rainfall events that occurred in 2021 provided an opportunity to further validate the models and improve future maps. Data from Hurricane Ida in the fall of 2021 were compared to the mapped flood risk, showing good validation of modeled results at many locations. NYC also released a post-Ida report, titled *The New Normal (NYC, 2021b)*, reinforcing NYC's commitment to flash flood resilience and funding.

In July 2022, NYC released a short-term stormwater action plan titled *Rainfall Ready NYC Action Plan (NYC, 2022a)*. This plan focuses

Figure 3. Screen shot of online Stormwater Flood Map. *NYCDEP*

on the shared actions New Yorkers and city government can do to combat intense storms, together, today. As a part of this effort, an additional mapping scenario was added to help New Yorkers understand their current risk to stormwater flooding and agencies plan for extreme events.

Additionally, NYC is using the data from the Stormwater Flood Map and models to support Cloudburst Neighborhood Planning by identifying at-risk areas to focus investment *(NYC, 2022b)*. Once areas are identified, the models will be used to test cloudburst solutions, facilitate design and support funding applications.

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Road to Resilience:
A Recent Timeline of Wayne County's Climate Preparedness Journey

by Tess Clark

Wayne County, New York, boasts over 35 miles of coveted shoreline along Lake Ontario, the easternmost and lowest lake in the Great Lakes system and 13th largest lake in the world. Living on the shoreline of one the world's largest freshwater lakes has never been without risks, but for shoreline communities in Wayne County, climate-related flooding and fluctuating water-levels are becoming a part of daily decision-making.

The Great Lakes were formed anywhere from 7,000 to 32,000 years ago, experiencing centuries of changing geological and climatological regimes before federal agencies in the U.S. and Canada began recording water levels in 1918. Long before European settlers arrived, Native peoples, including the Seneca and Cayuga, cultivated the land surrounding the southeast coast of Lake Ontario and fished its waters. Since the early 1700s, communities like Sodus Point, Wolcott, and Huron have experienced a rich history of boating, fishing and tourism, all supported by Lake Ontario and the resources it provides.

Although shoreline flooding is nothing new, in recent years record-breaking, high-water levels have spurred a number of new and innovative community projects in Wayne County. The chronology below offers a snapshot of the positive steps the county, its communities, stakeholder groups and supporting institutions have taken to prepare for a changing climate.

Spring 2017

Extremely wet winter and spring conditions overwhelm the Great Lakes system and contribute to record-breaking high-water levels on Lake Ontario. Rising water levels and flooding lead to beach closures, business closures and widespread damage to businesses, infrastructure and property in Wayne County, causing summer tourism to grind to a halt.

Fall 2017

Community members rally around flood recovery efforts, establishing citizen groups like Save our Sodus (SOS) to push elected leaders to support new investments in resiliency. New York Sea Grant and Cornell University release the results of the 2017 *Lake Ontario High Water Level Impact Survey* documenting the parcel-level impacts of the event on waterfront properties, which is later presented at New York state Senate hearings in October and November.

Fall 2018

New York Sea Grant's coastal community development specialist Mary Austerman partners with Jayme Thomann, formerly of the Genesee-Finger Lakes Regional Planning Commission, to host a Post-Flood Recovery Workshop in Sodus Point. As a result of the workshop, several projects are identified as priorities for the county, including creating a circulation, accessibility and parking (CAP) study, developing a local emergency response plan for Sodus Point, and seeking funding for a Coastal Hazard Erosion Zone designation.

Spring 2019

Water levels once again rise, breaking the record set in 2017. Communities still recovering from the devasting impacts of 2017 are faced with conditions that are the same or worse than before, leading to more damage, more closures and more financial losses.

May 29, 2019

The Governor's Office announces the Resiliency & Economic Development Initiative (REDI) to increase the resilience of shoreline communities and bolster economic development in the region. To identify projects, a REDI commission, led by the New York

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Powerful wind gusts of up to 50 miles per hour observed at Sodus Point Beach Park and Lighthouse. *Mary Austerman, New York Sea Grant*

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Post-Flood Recovery Building Workshop for the Village of Sodus Point summary report.
New York Sea Grant and Genesee-Finger Lakes Regional Planning Council

Department of State along with regional representatives:

- organized 25 community meetings and workshops
- brought local leaders together for over 15 planning meetings
- received and evaluated more than 500 proposed projects

May 30, 2019

The state of New York declares an emergency for the eight counties, including Wayne County, situated along the Lake Ontario shoreline.

September 2019

The National Oceanic and Atmospheric Association (NOAA) awards a team, led by Syracuse University Environmental Finance Center, with funding to investigate economic impacts of inundation in Wayne County, New York. The team includes New York Sea Grant, Cornell University, Genesee-Finger Lakes Regional Planning Council, and Great Lakes Integrated Science and Assessments (GLISA). The project, *Identifying Economic Impacts of Inundation on New York's Lake Ontario Water Resources Through Research and Engagement* concluded in August 2022. The project identified economic vulnerabilities of flooding to individual community members and businesses, developed recommended actions and policies, and created strategies to communicate recommended actions, policies and tools effectively.

October 2019

New York state commits $300 million to new resiliency projects across the eight counties impacted by flooding, including several flagship projects in Wayne County such as:

- the Crescent Beach shoreline restoration
- nature-based solutions to stabilize bluffs in Blind Sodus Bay
- a regional dredging project to remove built-up sediment along Sandy Pond

February 2020

Building off the REDI process, the New York Department of State launches the Coastal Lakeshore Economy and Resiliency (CLEAR) Initiative to engage lakeshore stakeholders in a forward-thinking, long-term planning process to increase climate adaptation around Lake Ontario.

Sept. 18, 2020

Dredging commences at North Sandy Pond on Lake Ontario, to remove built-up sediment and restore safe conditions for recreational boating and tourism.

July 2021

The New York State Department of Environmental Conservation (NYSDEC) and the Town of Ontario announce the start of construction of a floodwall system to protect the Ontario Main Wastewater Pumping Station (WWPS) from flooding.

October 2021

Final designs are completed for a living shoreline restoration of Wayne County's Crescent Beach, which will support increasing resiliency to erosion and future flood damage.

March 2022

The New York Department of State and regional partners, including Wayne County, complete the Wayne County CLEAR Initiative Plan. According to the New York Department of State, the plan implementation strategy and proposed projects are under active review.

June 2022

Construction is completed on a major repair of a critical sanitary sewer line in Sodus Point. The Lakestones Drive Flood Resiliency Project rebuilt a sanitary sewer main further back from the lakeshore and stabilized the eroding shoreline with rock.

Moving Ahead

As 2022 comes to a close, there is still a lot of work to do in Wayne County and across the state to achieve an equitable and climate-resilient future. Communities still need support in the form of education, engagement and awareness-building activities to ensure residents have the tools and information they need to make resilient decisions about their property. Continued investment and grant funding is needed to take recommendations from the CLEAR process to the next phase of development. Capacity and leadership are needed at the local level to manage and acquire funds. But many positive advancements in resiliency, such as those listed in the preceding chronology, have taken root with the help of many passionate community members and practitioners, and begin to chart a way forward for communities on the front lines of coastal flooding.

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10:00 am	Planning for Climate Vulnerability and the Future of Regional Resilience Jayme Breschard, Barton and Loguidice
10:30 am	Break
10:45 am	Extreme Heat Planning Leo Bachinger, NYSDEC
11:30 am	Flood Resilience in Broome County Beth Lucas, Director, Broome County Planning
12:00 pm-1:00 pm	**Networking Lunch**
1:00 pm	Lead with Listening: A Guidebook for Community Conversations on Climate Migration Patrick Marchman, CliMigration Network
1:30 pm	Great Lakes Action Agenda and Climate Change Emily Fell, NYSDEC
2:00 pm	Climate Change and Ethics Jodi Smits Anderson, EYP
2:30 pm	Harmful Algal Blooms, Aquatic Growth and Climate Change Tony Eallonardo, Technical Manager, Ramboll
3:00 pm	Adjourn

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NYSDEC's Ongoing Harmful Algal Bloom Work in the Finger Lakes

by Aimee Clinkhammer

Background

The Finger Lakes are a series of 11 freshwater lakes located in central and western New York. These beautiful and unique, glacially formed lakes include Conesus, Hemlock, Canadice, Honeoye, Canandaigua, Keuka, Seneca, Cayuga, Owasco, Skaneateles and Otisco lakes. They range in size from Canadice Lake at 642 acres to Seneca Lake at 43,342 acres. The lakes also vary greatly in maximum depth, from 30 feet in Honeoye Lake to 650 feet in Seneca Lake.

Like other New York lakes, the Finger Lakes face water quality challenges from climate change, nonpoint source pollution runoff, emerging contaminants, stormwater flows, aging infrastructure, septic impacts, and the effects of harmful algal blooms (HABs).

Waterbodies experience HABs due to many factors, including high nutrient levels and warming temperatures ***(Figure 1)***; the dynamics of these factors continue to be closely studied.

Most HABs in freshwater lakes, rivers, and streams are made up of cyanobacteria. Under certain environmental conditions, dense concentrations (blooms) can form, which have the potential to cause aesthetic, ecological, and economic damage to afflicted waterbodies. Most importantly, HABs can cause physical harm to people, pets and livestock through the production of cyanotoxins.

Since 2012, most of the Finger Lakes have experienced periodic HABs, with all 11 Finger Lakes having confirmed blooms for the first time in 2017 ***(Table 1)***. The New York State Department of Environmental Conservation (NYSDEC) HABs Program established a public notification system in 2012 as part of an ongoing agency effort to improve public reporting and outreach regarding environmental hazards.

NYSDEC has sought to address HABs through prevention, mitigation, monitoring and modeling to help understand causes of HABs and ultimately to develop tools and strategies to combat and avoid HABs. Many of these strategies have been implemented in the Finger Lakes.

HAB Action Plans

In 2018, a multiagency HABs initiative was established, which included NYSDEC, the Department of Health (NYSDOH), and Department of Agriculture and Markets (NYSAGM). Spearheaded by New York state's Water Quality Rapid Response Team, national experts and local stakeholders collaboratively developed HAB Action Plans for 12 priority lakes that are vulnerable to HABs, are critical sources of drinking water, and are vital tourism drivers. These 12 lakes were chosen as part of New York state's HAB initiative because they represent a wide range of conditions and vulnerabilities, and the lessons learned can be applied to other impacted waterbodies. Five of the 11 Finger Lakes (Conesus, Honeoye, Cayuga, Owasco and Skaneateles lakes) were included as priority waterbodies. Each action plan identifies contributing factors fueling HABs and immediate actions that can be taken to reduce the sources of pollution that contribute to the formation of algal blooms. Many of these identified actions have either been completed or are underway.

HABs Advanced Monitoring Pilot

Furthermore, a HABs Advanced Monitoring Pilot was developed, in collaboration with the United States Geological Survey (USGS), in three Finger Lakes: Owasco, Seneca and Skaneateles lakes. The project had two main objectives:

1. Inform the development of monitoring strategies for HABs across New York.
2. Enhance understanding of the ecological factors associated with HAB development in New York lakes.

The HABs Advanced Monitoring Pilot was a two-year, multifacet-

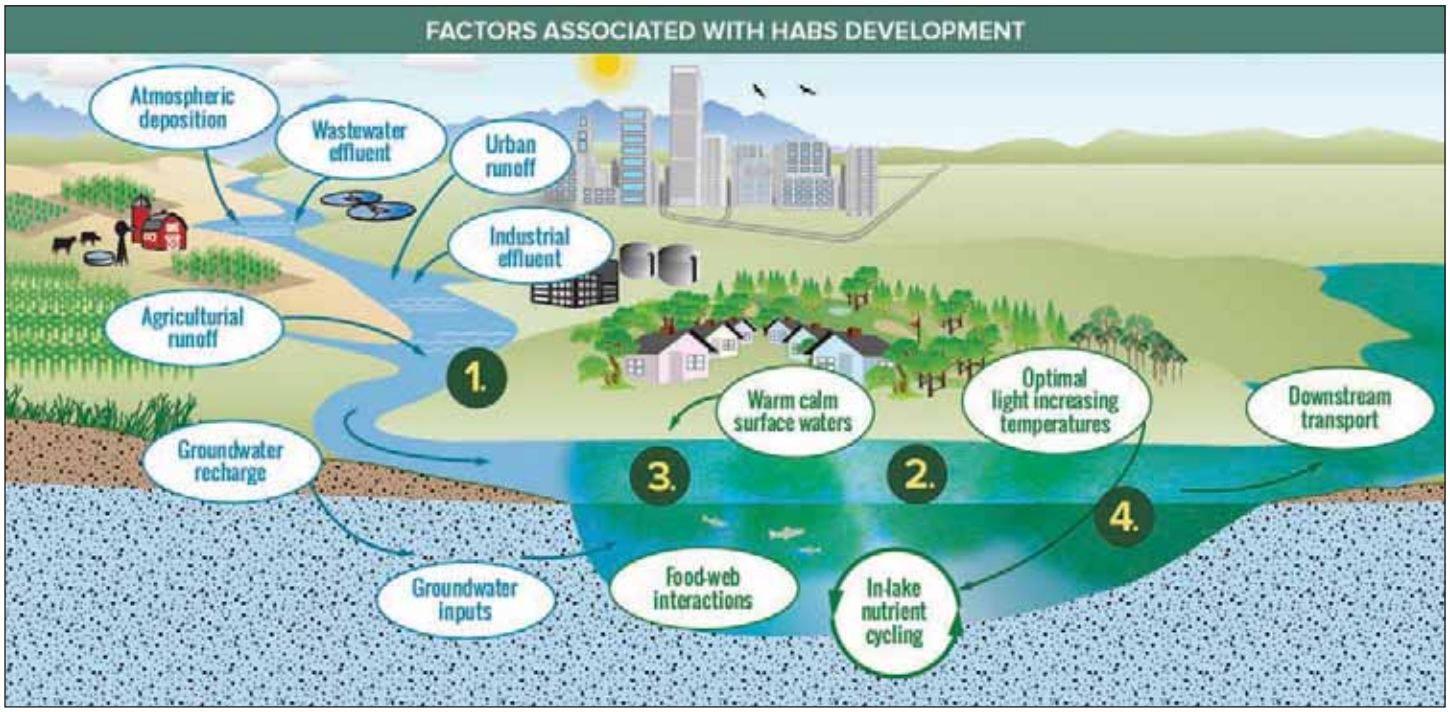

Figure 1. HABs Advanced Monitoring Program and factors associated with HABs development. Climate and waterbody morphological factors can also play a role in HAB development. *NYSDEC*

Table 1. Documented HABs in the Finger Lakes.

Lake	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Conesus	❍	❍	●	❍	●	●	●	●	●	●	●
Hemlock	❍	❍	❍	❍	❍	●	●	●	●	●	●
Canadice	❍	❍	❍	❍	❍	●	❍	●	❍	❍	❍
Honeoye	●	●	●	●	●	●	●	●	●	●	●
Canandaigua	❍	❍	❍	●	●	●	●	●	●	●	●
Keuka	❍	❍	❍	❍	❍	●	●	●	●	●	●
Seneca	❍	❍	❍	●	●	●	●	●	●	●	●
Cayuga	❍	❍	●	❍	●	●	●	●	●	●	●
Owasco	●	●	●	●	●	●	●	●	●	●	●
Skaneateles	❍	❍	❍	❍	❍	●	●	●	●	●	●
Otisco	❍	❍	❍	●	❍	●	●	●	●	●	●

❍ No HABs documented ● HABs documented *Source: NYSDEC*

ed approach to monitor the occurrence of, and contributing factors to, HABs in the study lakes. The collaborative project included four main strategies:

- tributary monitoring and assessment
- automated monitoring platforms
- nearshore mapping
- intensive lake characterization

Within the three lakes, high frequency monitoring occurred at multiple locations, at multiple depths and in key tributaries. Automated water quality monitoring platforms ***(Photo 1)*** transmitted data to a public website in near real-time. Data from the HABs Advanced Monitoring Pilot are publicly available and freely accessible. The data is currently being analyzed by NYSDEC and USGS and several reports are currently under development and scheduled to be published within the next year.

Finger Lakes Monitoring and Surveillance

NYSDEC, in coordination with lake associations across the Finger Lakes, has also trained several hundred volunteers to accurately identify and report HABs as part of the Finger Lakes HABs Enhanced Surveillance Program on Canandaigua, Keuka, Seneca, Cayuga, Owasco, Skaneateles and Otisco lakes. The blooms reports are submitted to an online, interactive map called NYHABS which shows the locations and reports of current HABs statewide.

The Citizens Statewide Lake Assessment Program (CSLAP) is a volunteer lake monitoring and education program that NYSDEC contracts with the New York State Federation of Lake Associations (NYSFOLA) to administer. NYSFOLA and its trained CSLAP volunteers collect water samples and lake information from more than 160 lakes annually, May through October, to help inform Division of Water's other regulatory programs. All the Finger Lakes joined the CSLAP program in 2017 and currently participate. Lakes are dynamic and active throughout the winter months as well. To get a complete picture of the water quality in the Finger Lakes, NYSDEC has piloted monitoring the Finger Lakes at least two times during the winter months to compliment the CSLAP dataset ***(Photo 2)***. The data collected under these programs are used in the development of clean water plans, assessing New York waterbodies, and by local stakeholders to help make lake and watershed management decisions.

Clean Water Plans

Clean water plans are a watershed-based approach to outline a strategy to improve or protect water quality in a waterbody. These plans document pollution sources, set pollutant reduction goals, and identify strategies that communities may use to improve and protect water quality. Total Maximum Daily Load (TMDL)

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Photo 1. Water quality monitoring platform on Owasco Lake. *NYSDEC*

Photo 2. Drone photo of NYSDEC staff sampling on a frozen Conesus Lake. *Karl Hanafin*


MTA-LIRR Third Track


Ronkonkoma Hub Pump Station


Clean & Green Biosolids Processing Facility


Bergen Point WWTP


Glen Cove WPCP


FDNY


Hofstra / Northwell School of Medicine


Village of Greenport BNR


Greater Atlantic Beach Water Reclamation District


Lawrence-Cedarhurst Consolidation


NCDPW Barnes Ave SSO Correction


Sacred Heart Academy


Museum of American Armor


Baxter Pond


Courthouse Commons Pump Station


Massapequa Creek Preserve


Garvies Point


Morrelly Homeland Security


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and Nine Element (9E) Plans are two types of clean water plans being developed in the Finger Lakes. NYSDEC finalized TMDLs for Honeoye and Conesus and a draft TMDL has been completed for Cayuga Lake. Local communities are spearheading efforts to develop 9E Plans for Canandaigua, Seneca/Keuka, Owasco and Skaneateles lakes.

New York is expected to be affected by climate change through increased temperature and precipitation volume and intensity, which may lead to increases in nonpoint source pollution run off and increases in lake temperatures. These factors are associated with increasing the chances for HABs in waterbodies. Modeling efforts for clean water plans can also incorporate climate change scenarios to predict impacts on water quality and to understand how best management practices can be implemented to safeguard the watershed against future impacts from climate change.

Photo 3. SUNY ESF (top) and Clarkson University (bottom) piloting HAB treatment technologies on Lake Neatahwanta in Fulton, New York. *Lewis McCaffrey, NYSDEC*

HAB Mitigation

Although watershed management strategies are the best solution to reducing nutrient sources causing HABs, it is a long-term strategy. In-lake management strategies can potentially control bloom formation and size offering a short-term, temporary approach to mitigating HABs.

NYSDEC began mitigation pilot projects on waterbodies representative of a range of water quality conditions commonly associated with HABs in 2018. Several treatment strategies were selected based on available research demonstrating effectiveness at mitigating HABs, and/or potential for cost-effective deployment on a larger scale. These mitigation strategies included hydrogen peroxide, aerators, ultrasonic devices, alum treatment, and an innovative HAB removal technology called the Harmful Algal Bloom Interception, Treatment and Transformation System (HABITATS) developed by U.S. Army Corps of Engineers.

In 2019, SUNY ESF and Clarkson University each developed novel HAB mitigation technologies: hydrodynamic cavitation with hydrogen peroxide, and electrochemical oxidation filtration, respectively ***(Photo 3)***. In July 2020, NYSDEC funded a collaborative project to study Clarkson and SUNY ESF's HAB mitigation technologies on Lake Neatahwanta in Fulton, a small lake with a history of lakewide HABs.

NYSDEC continues to identify potential HAB mitigation technologies for research projects across the Finger Lakes and New York state. Results from these pilot studies are currently being analyzed and will be shared as they become available. NYSDEC also released a HABs Research Guide that highlights topics to advance the study, management, and mitigation of HABs in New York. Four research focus areas (Prevention and Mitigation, Causes of HABs, Monitoring and Modeling, and Engagement) are intended to prioritize NYSDEC research efforts and lay the foundation for HABs research coordination.

Resources

NYSDEC continues to be at the forefront of HABs research, monitoring, prevention/mitigation, and outreach. To stay up to date on the latest information about HABs and activities from the Finger Lakes Watershed Hub, please visit the following resources:

- Clean Water Plans: *www.dec.ny.gov/chemical/23835.html*
- Finger Lakes Watershed Hub: *https://www.dec.ny.gov/lands/122661.html*
- Harmful Algal Blooms: *www.dec.ny.gov/chemical/77118.html*
- NYHABS: *on.ny.gov/nyhabs*
- Water Quality Data Portal: *https://www.dec.ny.gov/chemical/23848.html*
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Aimee Clinkhammer is the watershed coordinator for the Finger Lakes Watershed Program of the New York State Department of Environmental Conservation. She may be reached at aimee.clinkhammer@dec.ny.gov.

Using Digital Field Microscopes and Artificial Intelligence to Rapidly Identify Harmful Algal Blooms

by Abby M. Webster, Danara Dormaeva, Igor Mrdjen, Christopher Nack, Gregory L. Boyer, Roxanne Razavi and Stephen Shaw

Waterbodies around the globe continue to experience increases in harmful algal blooms (HABs). These increases are due in part to greater nutrient loading to waterbodies but also to a changing climate. In New York state (NYS), observed HABs in inland waterbodies have increased in the last decade to now number over several hundred per year *(NYSDEC, n.d.)*.

Of particular concern are HABs consisting of cyanobacteria that can produce toxins. While any bloom is a nuisance and can impact aesthetics and recreation, HABs are of particular concern because of their potential to lead to serious health impacts in humans, animals and lake ecosystems. However, HABs remain difficult to discern from benign blooms of common green algae or diatoms. Besides testing directly for algal toxins, the only other way to diagnose if a bloom is a potential HAB is to examine water samples under a microscope, in a laboratory. Due to the time lag in getting results from laboratory analysis, HABs may go unidentified for several weeks or, conversely, a recreational waterbody may be closed out of caution while waiting for further lab validation. To adapt to the likely increased frequency of algal blooms in a changing climate, new tools are needed to more rapidly identify HABs.

Artificial Intelligence Image Processing

One such tool now in development is the combination of digital field microscopes with artificial intelligence (AI) image processing. The digital field microscopes connect to a smartphone and image water samples for rapid, automated cyanobacteria classification via the AI software. This patent-pending technology is being developed by BloomOptix, LLC (a Ramboll Innovation program) with the assistance of the SUNY College of Environmental Science and Forestry (SUNY ESF) as a partnership supported by the NYS Center of Excellence in Healthy Water Solutions.

As more lakes experience HABs in NYS, there is growing interest by lake associations to increase their monitoring efforts. Participation by lake residents and citizen scientists is extremely valuable in these efforts as they often have long-term knowledge about their lake water quality and how it may be changing over time. Engaging and easy-to-use tools are needed to provide the public with accessible and accurate monitoring technology. Lake monitoring typically consists of measuring clarity with a Secchi disk, recording basic physio-chemical properties such as temperature or conductivity, taking water quality samples, and making visual observations of surface algal blooms. However, digital field microscopes offer an innovative approach to volunteer lake monitoring.

Approach

To bring this patent-pending technology to NYS, we have deployed portable, digital microscopes manufactured by ioLight (Cambridge, United Kingdom). The handheld microscopes ***(Figure 1)*** provide 150 to 200 times magnification – enough to discern the type of cyanobacteria and colony size. The microscopes connect to a smartphone, tablet, or computer via a wireless connection, thus allowing images to be transmitted to web-based AI software, where they are analyzed for presence of HAB-forming cyanobacteria. Having tested their use in the hands of trained scientists and citizens alike, we have demonstrated that anyone can use ioLights to collect high-quality microscope images of HABs with minimal training. The goal of developing this tool is to make the identification of a HAB as accessible, affordable, simple, and instant as taking and uploading a photo on a smartphone.

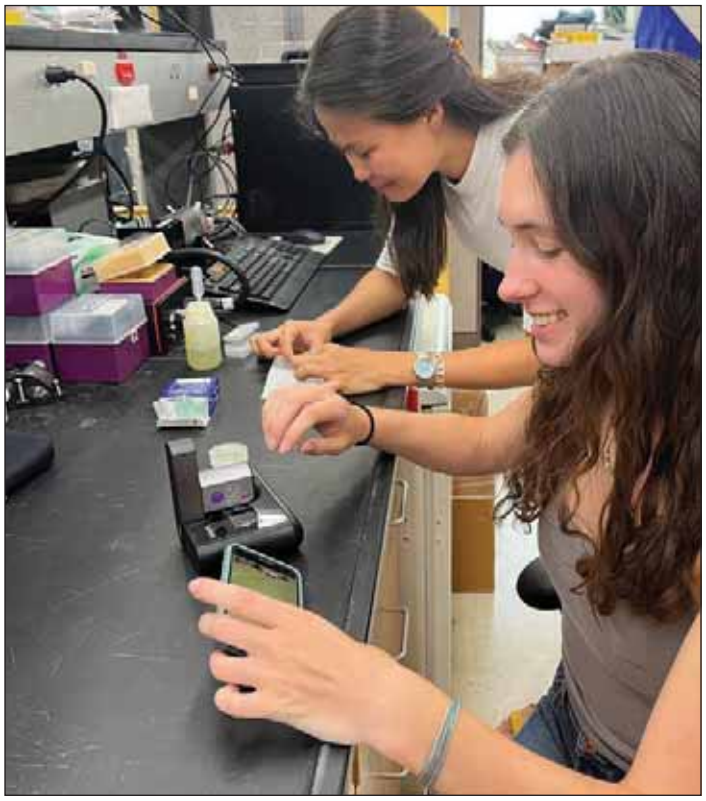

Figure 1. Abby M. Webster (front) using the ioLight connected to her smartphone while Danara Dormaeva (back) prepares a microscope slide. *Sydney Hall (SUNY ESF)*

With help from volunteers across the eastern United States, we are collecting HAB and non-HAB images to help validate the accuracy of the AI in identifying and enumerating HAB-causing cyanobacteria. Currently, the AI is trained to look for several of the most common freshwater planktonic cyanobacteria ***(Figure 2)***. using thousands of images that our team has manually classified. The image on the left side of ***Figure 2*** shows a magnified water sample from Lake Mendota, Wisconsin. The image on the right shows the colonies as labeled by the AI. The program did not label other objects (i.e., bubbles), vague colonies or separate cells. Images uploaded to the BloomOptix AI are processed in approximately 15 seconds and common cyanobacterial genera are identified with high accuracy.

Internal testing comparing human and AI analyses of *Microcystis,* the most common genus of bloom-forming cyanobacteria in the Northeast U.S., showed the AI was greater than 95% accurate in recognizing colonies. Similarly, identification accuracies were high – and are improving rapidly – for other common cyanobacteria genera ***(Table 1)***.

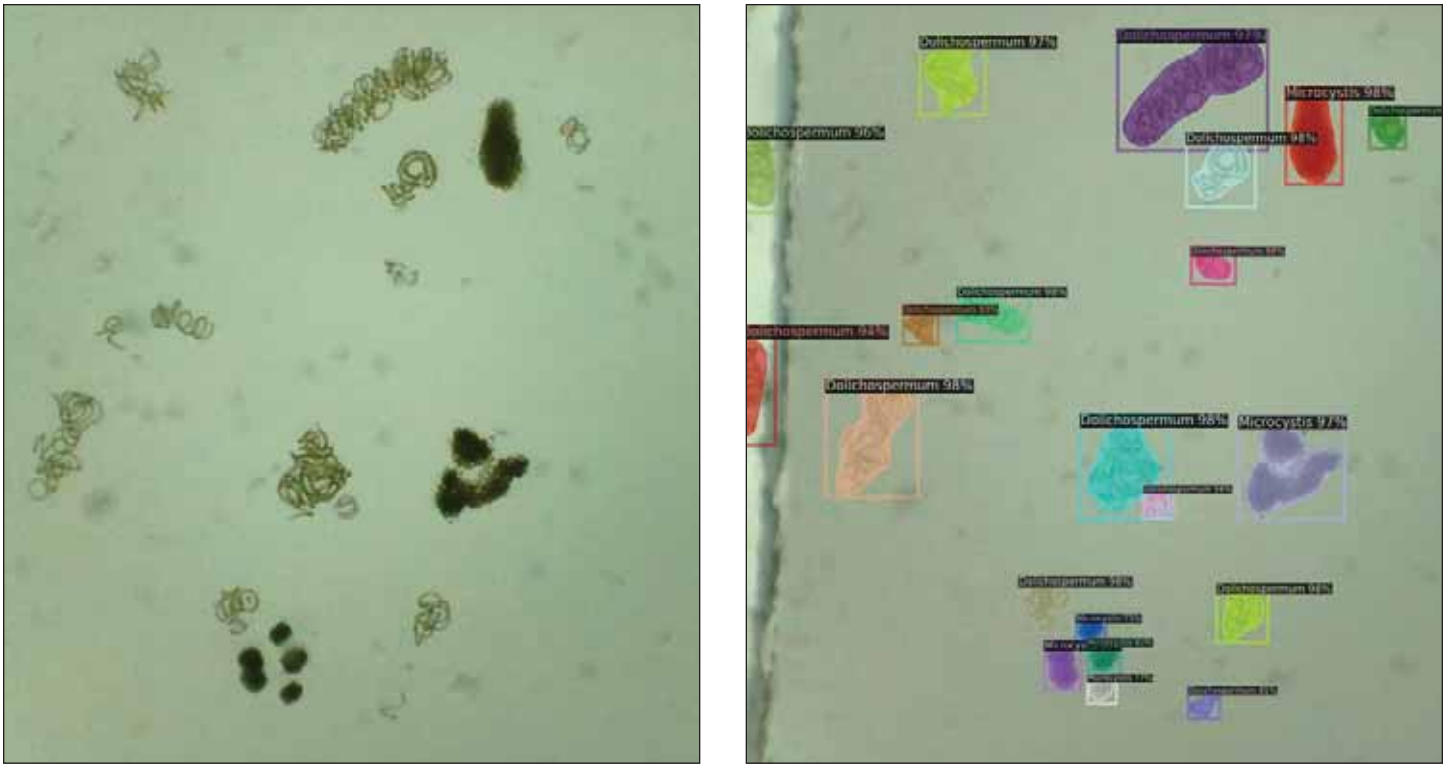

Figure 2. A raw digital image from the field microscope (left) with example of classification of cyanobacteria genus by the AI (right).

Igor Mrdjen, BloomOptix

Table 1. Identification Accuracies for Cyanobacteria Genera.

Cyanobacteria Genera	AI Identification Accuracy
Microcystis	greater than 95%
Dolichospermum (formerly Anabaena)	greater than 91%
Woronichinia	greater than 95%
Limnoraphis	greater than 95%

Upon the final validation of the approach, a smartphone application of the AI software will enable anyone to characterize cyanobacteria in their local waterbody without the need to wait for laboratory results. Additionally, each uploaded photo and test conducted can be geolocated and databased with other HAB-related measurements to easily increase monitoring reach, efficacy and data quality. While initial results are positive, this patent-pending technology continued to be tested in the summer of 2022. Over 20 volunteers from eight different states collected samples from their local lakes to further build a database of images for validation and training of the AI. This continued development will allow for the automated classification of a wider range of cyanobacteria types that occur in NYS waterbodies.

Application and Resiliency

The tools being developed here will help build climate resiliency in NYS by empowering citizen scientists to understand their local environment and enhancing the ability to collaboratively engage people in characterizing water quality across a multitude of waterbodies. These tools will provide a new ability to rapidly respond to HABs when they do occur. They may also help us understand why, when and where they may occur.

A similar patent-pending AI application called "opseyes" has been implemented to target filamentous bacteria in wastewater sludge *(opseyes, n.d.)*. Born out of Ramboll's Innovation Program, it was created to help a wide range of water resource recovery facilities. The AI reports the quality of bacteria and microflora in wastewater treatment tanks and helps diagnose problems upstream using these analyses. The goal of its performance is a similar concept to that presented here for HABs identification: simple solutions using digital microscopy for rapid results.

Abby M. Webster, corresponding author, is a Ph.D. student at SUNY ESF studying attached and benthic cyanobacteria in the Finger Lakes of New York. She works closely with lake residents to sample and monitor these cryptic algae and improve our understanding of their contribution to HABs. Abby may be reached at abwebste@syr.edu.

Danara Dormaeva, corresponding author, is a senior undergraduate student at SUNY ESF. While pursuing an environmental resources engineering degree, she has worked in various labs at SUNY ESF studying HABs the last two summers. Danara may be reached at ddormaev@syr.edu.

Igor Mrdjen is the project and science lead for BloomOptix. Christopher Nack is a Ph.D. student at SUNY ESF and a scientist for BloomOptix. Gregory L. Boyer (professor emeritus), Roxanne Razavi (assistant professor) and Stephen Shaw (associate professor) are with SUNY ESF.

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Wastewater Resiliency Measures Delivered Through a Task Order/ Job Order Contract Program

Achieving compressed project schedules and flexibility through use of an alternate delivery method.

by Colin A. Johnson, Andrew Dobner and Gabriel F. Giles

Hurricane Sandy made an unquestionable impact on New York City's infrastructure in 2012. This prompted a greater sense of urgency to planning and delivering work already underway by the New York City Department of Environmental Protection (NYCDEP) to make its water and wastewater infrastructure more resilient to flooding and extreme weather events. Recognizing the scale and multiple similar scopes of work required at many of its wastewater resource recovery facilities (WRRFs) and pumping stations, the NYCDEP decided to implement this work through a program using task order contracts (TOCs) and job order contracts (JOCs) instead of the typical design-bid-build project delivery method. This TOC/JOC approach allowed for greater management flexibility and a compressed overall implementation schedule.

NYC Wastewater Resiliency Program

NYCDEP had been evaluating the potential impacts of climate change on its infrastructure multiple years before Hurricane Sandy in 2012. In 2013, shortly after Hurricane Sandy, the NYCDEP published the *NYC Wastewater Resiliency Plan – Climate Risk Assessment Study and Adaptation Plan,* which laid the foundation for the work that would be implemented under the NYC Wastewater Resiliency Program (referred to hereafter as "the Program"). NYCDEP secured external funding through the New York state Storm Mitigation Loan Program (SMLP) as well as through the Federal Emergency Management Agency (FEMA) to partially fund the work being implemented under the Program. The Program commenced in 2016 with the initiation of a Program and Construction Management Contract, as well as TOCs for design services.

The Program includes work items at WRRFs, 56 pumping stations, one combined sewer overflow (CSO) facility and two leachate facilities. The overall total program value is approximately $420 million including program management, design, and construction costs and is funded by New York City, New York state and FEMA. The Program has approximately 1,500 individual scope items, consisting of many similar scope items across the facilities such as flood barriers, elevating equipment and making equipment flood-proof.

The TOC/JOC Delivery Approach

The schedule requirements and similar scope elements across multiple locations were the primary drivers for the NYCDEP to select a TOC/JOC approach for this work. In a collaborative TOC/JOC delivery effort, once a design is completed it can be immediately assigned to an applicable JOC for construction, greatly reducing the construction procurement duration typical in design-bid-build. Furthermore, since the Wastewater Resiliency scope elements were very similar across many of the locations, it was preferrable to implement a standardized approach to the work with common design requirements, as well as an established pool of TOC design firms and JOC contractors through design and construction.

While the TOC/JOC project delivery approach comes with a heavier management requirement and a learning curve for firms and individuals who are not familiar with TOCs/JOCs or have not used this approach previously, we have found this delivery approach provides flexibility and schedule savings.

For design services, the Program uses TOCs that have a "not-to-exceed" contract maximum capacity; TOCs are advertised and registered without defined projects or scopes of work. Each design assignment is then issued to a group of contracted task order design firms that competitively bid each project; the design assignment is

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Testing of one of many flood barriers implemented under the Program. *AECOM*

Typical flood wall to protect critical infrastructure. *AECOM*

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awarded based on a quality analysis of the submitted proposals. There were nine design task orders across WRRFs and pumping stations in the SMLP-funded portion of the Program.

JOCs are utilized for the construction portion of this Program. The JOCs utilize a Master Commitment contracting approach in which a maximum not-to-exceed cost is awarded based on the lowest competitively bid unit price adjustment factor, which is to be applied to a preestablished list of unit prices. The proposed adjustment factor is designed to cover all indirect work-related costs associated with construction activities, such as profit, insurances, and project and office management costs. In contrast to TOCs, JOCs (or assignments) are issued to a contractor as opposed to being bid on by all the JOC companies. Each issued construction assignment then goes through a proposal and reconciliation process, rather than a negotiation, during which preestablished unit prices appropriate to the defined scope of work are selected by the JOC, reconciled with the construction manager as to the quantity and the adjustment factor applied. There are 23 JOCs in this Program – 14 of which are currently active – and 280 construction job orders are expected by the end of the Program.

Typical Design-Bid-Build versus TOC/JOC Delivery

Figure 1 shows the typical design-bid-build sequence of a project at the top of the figure (in gray). Below this are shown scenarios for the design and construction activities for a project being implemented using a TOC/JOC approach. In this second scenario one project is being delivered using one TOC for design services containing two task orders, and two JOCs for construction containing three job orders. The TOCs and JOCs Master Commitments (contracts) were procured and issued an Order to Commence Work prior to issuance of any task orders or job orders. Typically, contract level documents such as management plans and environmental health and safety plans are completed by both the TOC and JOC prior to the issuance of any task or job orders. These documents are then amended via an addendum to reflect the scope that has been awarded to the firm based on new task order(s).

As illustrated in ***Figure 1***, the TOC/JOC approach compresses the project delivery timeline while also giving the owner flexibility to advance individual scopes of work to construction as soon as they are designed rather than waiting for the completion of a full site or project. While the management effort is heavier, we have found that this approach can provide greater flexibility and schedule savings.

In this TOC/JOC delivery approach, flexibility can be realized through:

- the deliberate packaging and sequencing of individual sites and specific work elements
- earlier design completion of stand-alone assignments, allowing for the procurement of longer construction lead items
- separation of simpler from more complex scope items into separate job orders to enable an earlier start/finish

Additionally, a wide range of contract financial sizes may attract a larger pool of contractors. And the ability to allocate work across multiple contractors at a single site may facilitate earlier contract completion, while efficiently using funding.

Schedule savings result from the ability to overlap the traditional phases of design, procurement and construction. This allows earlier release of design packages from more complex packages with longer design durations, the ability to process "change orders" in the form of supplemental assignments more quickly if a contract has funds available, and earlier contractual close out of awarded work.

Construction Management

The reconciliation phase of construction management can be more administratively intensive for both the JOC and the construction manager – depending on the number of assignments released at one time – but can be managed by assigning estimators well-versed in the unit prices and how they relate to the scope of work issued to the contractors. The Program found that meetings between NYCDEP, the construction manager, and the prime contractor on a regular basis during the kickoff phase improved the understanding and implementation of the defined contracting approach. Pre-bid meetings were held to understand the method of developing a bid proposal and the Program administrative requirements. As all parties become used to the process, the time to reconcile issued assignments reduces drastically and requires minimal reconciliation (negotiation) after the initial release.

The prime contractor and construction management team of resident engineers and inspectors are required to manage each assignment as if it were a standalone individual contract. This means that there are separate drawings, specifications and submittals to manage, which consequently means additional daily reports and administrative processes. But as the JOC is only paid based on the completion of an agreed to unit price item in whole – i.e., no payments based on percentage completion – the review of the quantities billed within a monthly invoice becomes streamlined as it is based upon work units completed.

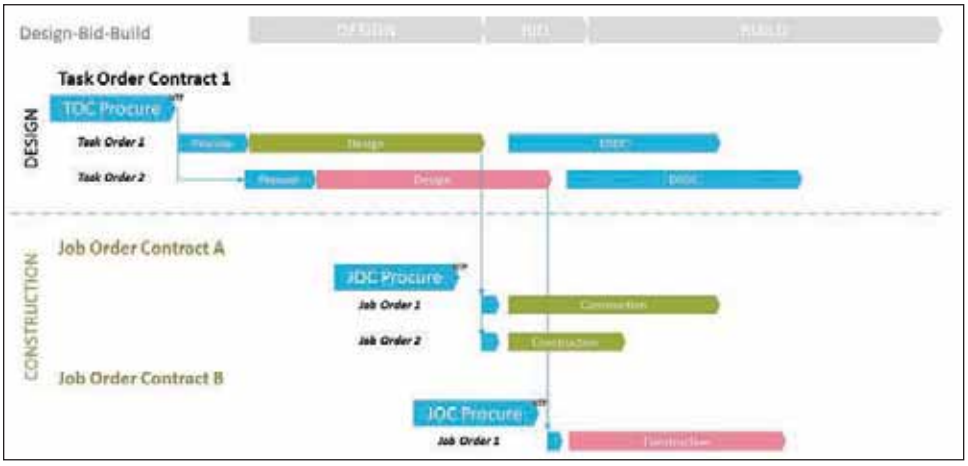

Figure 1: The TOC/JOC approach provides contracting flexibility as well as schedule time savings compared with design-bid-build project delivery. *AECOM*

Program Status

Currently, the Program is in the process of issuing substantial completion on multiple SMLP-funded assignments and approaching completion on several project sites, while other sites are approaching peak construction period. The Program's FEMA projects are currently starting the design phase with construction expected to begin in 2023.

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Digital Twins: It's What You Do with the Data That Matters

by Richard Loeffler

Across the country, utilities are embracing data analytics and digital technologies to deliver transformative outcomes for their communities. Digital solutions, particularly digital twins, are helping water operators and managers solve their most pressing challenges:

- minimizing water and revenue losses
- reducing capital spending to lower costs to communities
- decreasing the impact of climate events
- bringing down the costs of safely reclaiming wastewater
- reducing emissions

Now, the Bipartisan Infrastructure Law opens up a generational opportunity to scale our transition to smart, resilient infrastructure. But with each innovation comes a learning curve. The clay is still wet on many of the frameworks needed to integrate digital technologies across utility operations – and to maximize the potential of these solutions. The digital twin is a case in point.

Putting the Digital Twin to Work to Optimize Operations

A digital twin is the assimilation of data and an operational model that helps operators understand how a physical asset, process or system should be performing, and helps to provide insights and predict performance under changing conditions. Think of it as a virtual representation of a real-world object that can provide recommendations based on real-time data.

Traditional models for simulating infrastructure can be costly to build and do not readily assimilate live data. Today, sophisticated machine learning tools can better represent the infrastructure by automatically calibrating to match historical data.

Digital twin technology can deliver benefits at four levels:

Visibility. At its most basic level, a digital twin shows operators what is happening within an asset, process or system right now. This application relies on the operator to take action based on visibility of current operations.

Scenarios. At this level, the digital twin is capable of processing variables to predict an outcome, but it still requires the operator to manually optimize the asset, process or system.

Recommendations. In more sophisticated applications, the digital twin generates multiple scenarios and provides operational recommendations to achieve set key performance indicators (KPIs). The operator then chooses a course of action based on these recommendations. Think about GPS as a digital twin of a road network that recommends a route to your destination, while you – the operator – choose a course of action based on the GPS recommendation.

Control. When combined with decision support systems and water expertise, the digital twin has the potential to deliver autonomous, optimized control, freeing up operators to focus on other tasks. Think self-driving car!

Ultimately, the digital twin is an enabling technology – not a solution – and its potential is realized through how the data is applied.

Taking It to the Next Level with Hydroinformatics

In the more sophisticated applications described above, digital twin technology is coupled with advanced data science like hydroinformatics and water system expertise to create a powerful decision support system. This sets utilities up to meet their communities' needs reliably, affordably and sustainably.

Hydroinformatics engineers can help utilities sift through data by designing algorithms and interfaces that deliver the most useful data to the operator, in the right way and at the right time. These multidisciplinary experts combine hydraulic modeling skills, engineering and an in-depth understanding of the water cycle to tackle age-old water problems in new ways. These outputs can be real-time operational recommendations through a real-time decision

support system, as well as offline recommendations pertaining to assets and planning initiatives.

This holistic approach enables utilities to seamlessly integrate digital twins within their digital ecosystem for transformative results:

Lowering operational and capital expenditures (OPEX and CAPEX). By using past data and automatically 'calibrating' to better represent the infrastructure, the digital twin enables continuous, real-time optimization and highly accurate predictions to improve the efficiency and resilience of an asset, process or system.

Minimizing downtime. Operators are empowered with decision intelligence to quickly detect and diagnose operational anomalies and trigger proactive maintenance or asset replacement.

Addressing workforce challenges. Rather than starting from scratch, data from the digital twin helps new operators pick up where their predecessors left off, driving incremental improvements if turnover in workforce happens.

Supporting the integration of assets. For example, delivering insight on how an underperforming pump affects a collection network and what strategy is needed to compensate in the short term and enable optimal operational conditions.

Three Steps to Supercharge the Digital Twin

Whether at the asset, process or system level, utilities can unlock big results quickly by putting their digital twin data to work. Here are three suggested steps to maximize this technology:

Collaborate closely with your operations teams to identify areas where forecasted or more detailed data could inform more efficient operational or planning decisions. Establish a baseline by assessing what real-time data you have access to, and if and how you are using that data to make improvements.

Evaluate how a digital twin can add value in your utility's unique context. Explore the potential for a small initial project to dip your toes in the water. This can be a straightforward, low-cost route to determine challenges, opportunities and potential return on investment (ROI) of a digital twin investment.

Prioritize projects appropriate to your unique requirements. It might make sense to start by optimizing a single asset or area of the system, or there could be an opportunity to move faster.

As our sector's transformation continues, we're all on a learning curve. By sharing experiences and consulting with peers and technology partners, utilities position themselves to make the most of their investments and to speed the process to a more resilient and sustainable water future. Let's maximize how 21st century capabilities contribute to that common goal.

Richard Loeffler is a senior practice solution architect with Xylem and may be reached at Richard.Loeffler@xylem.com.

Digital Twins vs. Simulations

Although simulations and digital twins both utilize digital models to replicate a system's various processes, a digital twin is actually a virtual environment, which makes it considerably richer for study. The difference between digital twin and simulation is largely a matter of scale: while a simulation typically studies one particular process, a digital twin can itself run any number of useful simulations in order to study multiple processes.

The differences don't end there. For example, simulations usually don't benefit from having real-time data. But digital twins are designed around a two-way flow of information that first occurs when object sensors provide relevant data to the system processor and then happens again when insights created by the processor are shared back with the original source object.

Source: https://www.ibm.com/topics/what-is-a-digital-twin

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High-Tech Sector Water Reuse: A Compelling Alternative

by Darcy Sachs, Brandon Yallaly and Nathan Zaugg

Introduction

The U.S. is in the midst of its largest infrastructure investment since the national highway system. Our need for more data, at ever increasing speeds, is driving explosive growth in data centers and semiconductor chip manufacturing. These high-tech facilities use large volumes of water, and the wastewater generated can require expensive treatment to remove a variety of challenging constituents. The good news is that the environmental impacts associated with water use and wastewater generation by the high-tech sector can be mitigated through proper treatment and a focus on sustainability and reuse – a true One Water perspective.

Background

There are currently more than 2,700 data centers across the U.S. While many are a part of smaller facilities, dozens of new hyperscale data centers, typically consisting of more than 5,000 servers and over 10,000 square feet of area, are currently being constructed to meet the growing demands. Semiconductor chip manufacturing is also expanding at a high rate, due to supply-chain issues highlighted by the pandemic and the increasing automation associated with evolving technology. There are approximately 55 semiconductor fabrication plants in the U.S., with plans to add more than 45 facilities *(Wikipedia contributors. 2022)*. This expansion is likely to be supercharged thanks to the Aug. 9, 2022, passage of the federal CHIPS and Science Act, which will provide $52 billion in funding to support construction of new semiconductor fabrication plants in the U.S.

For 20 years, New York state (NYS) has been positioning to attract these high-tech facilities. Over the past decade, NYS has invested $2.7 billion in infrastructure hubs to lure high-tech facilities and has provided over $4 billion in tax and other incentives to fuel economic growth *(Rock, 2021)*. On June 4, 2022, NYS continued that commitment with the passage of the Green CHIPS Bill, which provides qualifying companies with up to $10 billion in additional tax incentives. Those efforts and investments have paid off. NYS is currently third in the nation for high-tech employment.

These high-tech facilities are heavy water users and sufficient, resilient supplies are required to support their mission-critical operations. Specific to water supply, large volumes of water are required during summer months to support cooling demands associated with data centers and semiconductor facilities. In addition, large volumes of high-purity water are required as part of the chip manufacturing process, which frequently necessitates treatment processes like softening, ion exchange and/or reverse osmosis.

Wastewater generated by ultrapure water treatment and chip manufacturing can contain a variety of challenging constituents and typically requires extensive (and expensive) treatment. Noncontact cooling water from hyperscale data centers and semiconductor facilities often contains high levels of salts and contaminants, which have been cycled up to levels that cannot be discharged to the local wastewater treatment facility (WWTFs) and can contaminate our waterways, if not properly treated.

Many high-tech companies are increasingly focused on providing resilient and sustainable water solutions and have fostered ground-breaking work in water reuse that can serve as a guide for the industry. This willingness to explore creative solutions opens the door to better outcomes for our water environment.

NYS Waterways

NYS is water rich, with 690,000 acres of lakes, 87,500 linear miles of rivers and streams and 1,530 square miles of estuaries. Unfortunately, many of our water systems are not healthy. Based on the most recent assessed watershed data *(USEPA 2022)*:

- Roughly 25% to 55% of our coastal estuaries are impaired
- 20% to 30% of our streams/rivers have minor impacts/threats or are significantly impaired
- Approximately 40% of lakes and reservoirs have been assessed and 20% to 60% are impaired

These ranges reflect the different impairment categories, from water too contaminated with bacteria to be swimmable, to fish that can't be consumed. Complete summary data is not available as there is limited information to perform evaluations for most of our water systems.

In NYS, the top 10 reasons for water quality issues include:

1. Urban stormwater runoff
2. **Aging/inadequate wastewater treatment infrastructure**
3. Nutrient eutrophication
4. Atmospheric deposition and acid rain
5. Legacy pollutants in sediments and fish
6. Atmospheric deposition of mercury
7. Habitat/hydrologic modification
8. Nuisance aquatic weed growth and invasive species
9. Pathogen contamination of shellfish
10. Inadequate on-site wastewater treatment *(NYSDEC, 2018)*

It's not that NYS isn't making progress in improving our waterways – we are. We have the technical capabilities and have invested hundreds of millions of dollars toward improvements each year. For example, there is a Canadian/U.S. habitat restoration program that has completed 44 habitat protection and improvement projects along the Niagara River *(Niagara River Remedial Action Plan, 2022)*. In addition, the New York State Department of Environmental Conservation (NYSDEC) is working on improvements through the Water Quality Assessment process, via State Pollutant Discharge Elimination System (SPDES) permitting and establishment of Total Maximum Daily Loads (TMDLs). Older WWTFs are being updated and more stormwater and raw sewage (via combined sewer overflows) are being treated each year.

Water Treatment System and WWRF Infrastructure

The underlying challenge to addressing many of these issues is that upgrades and expansions are costly and construction costs are increasing exponentially due to a variety of issues. Adding new demands to water delivery and treatment systems and new flows and contaminants to existing WWTFs exacerbates the situation, particularly since the constituents discharged by these new industries are not typically within the capability of the existing processes to effectively treat. While NYS has established **$601 million** in Water Infrastructure Improvement grants and loans in 2022 (the largest allocation ever), this represents less than 1% of the estimated **$82.2 billion** needed to address existing aged and outdated water ($44.2 billion) and wastewater ($38 billion) infrastructure *(ASCE, 2022)*. This $82.2 billion does not include treating drinking water for emerging contaminants (e.g., PFAS compounds), drinking water

continued on page 46

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source protection, lead service line replacement, harmful algal bloom response and prevention, and climate resilient infrastructure. As NYS communities, our cost burden is ever increasing. It's time we think hard about reducing related public costs, which are currently over $11,000 per household *(see note on page 47)* if the current replacement costs were to be experienced in the next year.

High-Tech Industry Water and Wastewater

For purposes of this article, the high-tech industry includes semiconductor chip manufacturing facilities as well as hyperscale data centers. Semiconductor manufacturing was a $400 billion business in 2020 and is projected to reach $1.0 trillion by 2035. Hyperscale data centers are being planned and constructed throughout the U.S. Meta alone is planning 12 data center facilities over the next several years. For scale, in the U.S. the data center market is currently $8.4 billion and is expected to be $14 billion by year 2026. This is an 8.63% compounded annual growth rate. Globally the data center market is anticipated to be $517 billion by the year 2030.

Typical high-tech facilities can generate between 1 and 4 million gallons per day of organic and inorganic wastewater from each semiconductor fabrication plant or data center building. The quantity of wastewater generated is dependent on both facility size and operation. Both semiconductor plants and data centers generate wastewaters containing high levels of dissolved solids, biocides and corrosion inhibitors. Semiconductor fabrication plants also produce waste streams with peroxide and hydrofluoric acid wastes, as well as novel compounds that inhibit nitrification or are toxic to the bacterial populations used for treatment. These constituents have the potential to negatively affect biological activity, which is critical for efficient treatment of organic waste streams.

Without proper treatment, contaminants can impact the WWTF's ability to meet its SPDES permit requirements (e.g., effluent toxicity testing) or negatively impact receiving water quality. To minimize these impacts and support discharge under an Industrial Pretreatment Permit or directly under a SPDES permit, high-tech facilities often employ a variety of treatment technologies, from advanced oxidation processes to brine reduction with softening or reverse osmosis. This allows intensification of the process at the source and, when effectively executed, can mitigate many of the most severe impacts on municipal wastewater infrastructure. In the most progressive facilities, these impacts can be completely contained to the site itself through increased focus on reuse technologies.

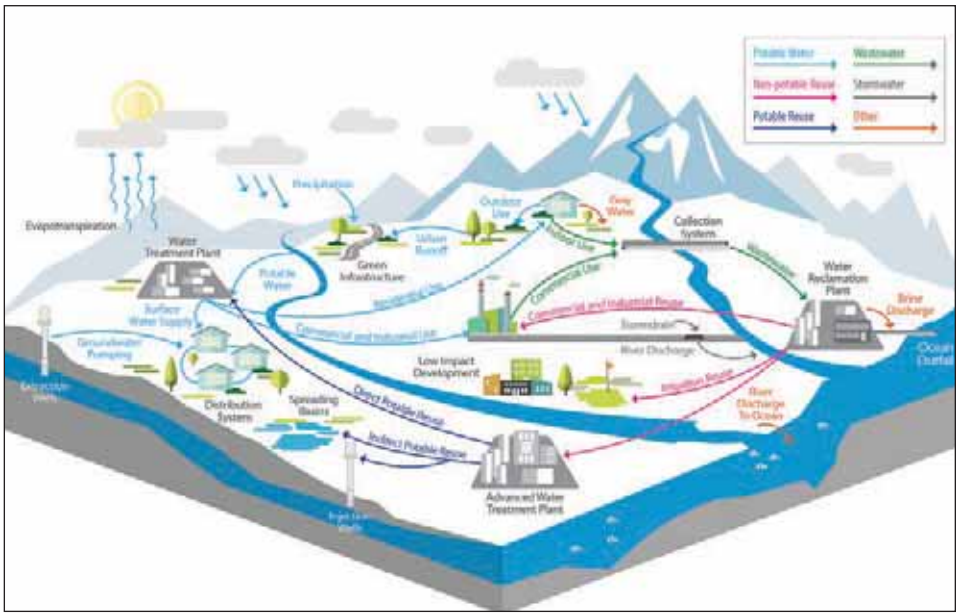

Figure 1. Reuse Schematic. *Carollo Engineers, Inc.*

Sustainability and Reuse

Due to the high level of treatment required and the subsequent high-quality effluent produced, reuse of high-tech wastewater can be a compelling alternative – particularly if dissolved solids (i.e., salts) are removed as part of the process. Reusing the water provides an "additional" and resilient source of high-quality water for use in the current facility and/or to support future facility expansion. Some high-tech companies are also implementing zero liquid discharge (ZLD) approaches, which further enhance available water resources for the industry. While most semiconductor companies will not reuse water directly in the chip manufacturing process, the water can be used in cooling, scrubbing or other applications. High quality water that cannot be reused by the industry can be returned to the utility partner to supplement their water resources.

Many high-tech companies have adopted sustainability goals that support efficient use of water resources and minimize their environmental impact. Some examples include:

Google's goal is to **replenish more water than consumed by 2030** and to support water security in communities where they operate. Google values "Stewardship" and they plan to improve the watershed health and ecosystems in water-stressed communities.

Microsoft plans to be net water positive by 2030, through expanding access to clean water and replenishment projects.

Intel's goal is to be net positive water by 2030, by conserving 60 billion gallons of water. In 2020, Intel was already returning and restoring 90% of its water usage to the supplier or watershed.

While return on investment (ROI) will always be a driving factor for industry, other factors are being given increasingly greater weight. Water reuse (with a ZLD component) can allow the facility to reuse the water many times as part of cooling operations – significantly decreasing raw water demands ***(Figure 1)***. In areas of significant water stress, this ability to reuse water may impact the ability to expand facilities, making reuse a lifeline to growth. In addition to supporting resilience and sustainability goals, this approach enhances the industry's ability to attract employees and investors who have a "green ethos."

Thinking Differently

Like most regions, NYS's high-tech hubs are in an expansion mode. A traditional mindset to support expansion relies on capacity upgrades like upsizing treated water supply lines, adding new sewers, and expanding the capacity of existing WWTFs. But is this "build more" mentality always the right solution? Approaching the situation from a more holistic perspective ***(Figure 2)*** could provide more resilient, sustainable and cost-effective solutions over the long term that minimize or postpone the need to expand existing utility infrastructure.

Irondequoit Bay Marine Park Project: Adapting to a New Normal

by Michelle McEntire

The devastating impacts of our weather and the ever-changing trends have become a familiar story in the news. From record heat in the West to devastating floods in the South, each region is being affected in some way. To those in the climate resiliency field, these trends come as no surprise. In 2014, the National Science and Technology Council and the U.S. Global Change Research Program released the report *Climate Change Impacts in the United States: Third National Climate Assessment (Melillo et al 2014)*. The report indicated that heavy precipitation events, defined as the heaviest 1% of all daily events, are increasing both in frequency and intensity across all regions of the contiguous United States. The report also states that changes in precipitation are projected to be amplified by season. In the winter and spring, wetter conditions are anticipated in the Northeast with drier conditions in the Southwest. Alternately, the report predicted that most areas of the contiguous United States would experience drier conditions during the summer months.

Communities located in the Northeast have been impacted the most by changes in heavy precipitation events. From 1958 to 2021, the Northeast has experienced a 71% increase in the amount of precipitation falling in very heavy events, which cannot be attributed to natural variation alone ***(Figure 1)***. Changes in heavy precipitation events can also be correlated to the magnitude of flooding in many parts of the United States. Like the precipitation trends, the magnitude of flooding in the winter and spring has decreased in the Southwest and increased in the Northeast ***(Figure 2)***. In New York state, the largest increase in the magnitude of flooding has been seen in the eastern and southeastern portions of the state along the Hudson River.

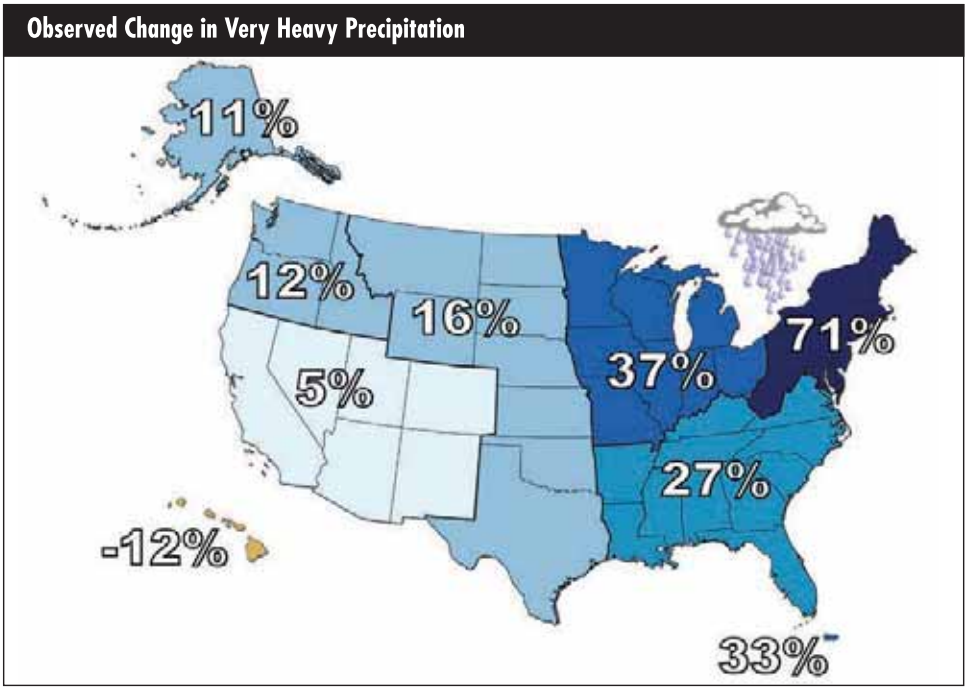

Figure 1. Observed percent increases in the amount of precipitation in very heavy events from 1958 to 2021. *Melillo et al., 2014*

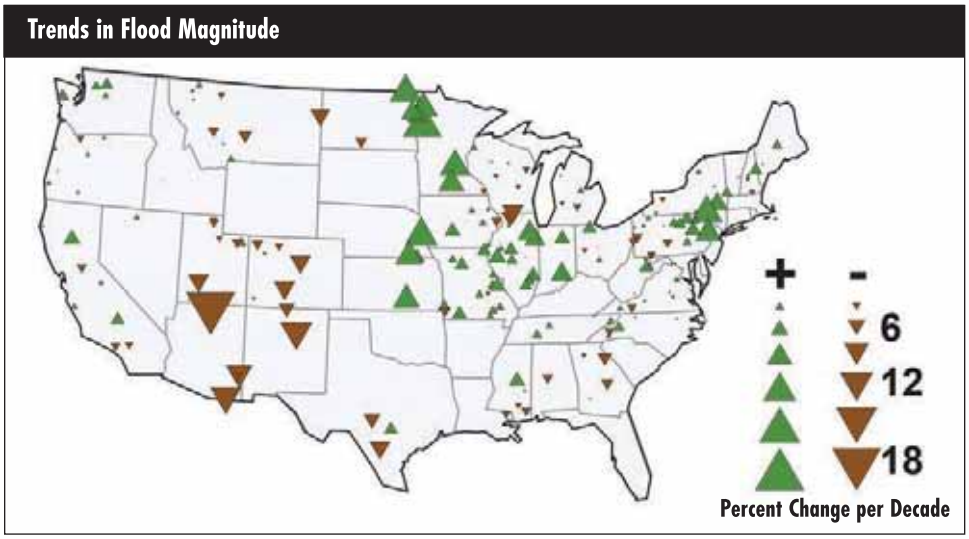

Figure 2. Trends in flood magnitude. *Melillo et al., 2014*

Historical Flooding in Monroe County

Like other communities in the Northeast, Monroe County has experienced multiple flooding events since 1953 due to record rainfall events, resulting in four federal disaster declarations *(NYSDOS 2021)*. Each time, these flooding events resulted in property damage, destruction of roads and bridges, impacts to public utilities and contamination of local water supplies. Besides the economic impacts, these flooding events have affected the community's use and enjoyment of recreational assets in the community and impacted wildlife habitats and natural ecosystems.

Within the last six years alone, the region has been hit by two major flooding events resulting from heavy precipitation and water level management. In the spring of 2017, Lake Ontario's water levels rose 30 inches *(NYSDOS 2021)*. The high lake level along with wind-driven waves caused infrastructure damage along the shores of Monroe County, including the City of Rochester and the towns of Greece, Irondequoit, and Webster. A Lake Ontario Response Team was developed by New York state to coordinate a response to the flooding in Monroe County and the City of Rochester *(NYSDOS 2021)*. Just two years later, Monroe County again experienced unprecedented water levels in Lake Ontario in 2019. Significant flooding created a heightened awareness of the communities' vulnerability to water-related damage.

In response to these elevated water levels, New York state developed the Resilience and Economic Development Initiative (REDI) to provide funding to affected communities along the Lake Ontario shoreline and pro-

Holistic Water Reuse

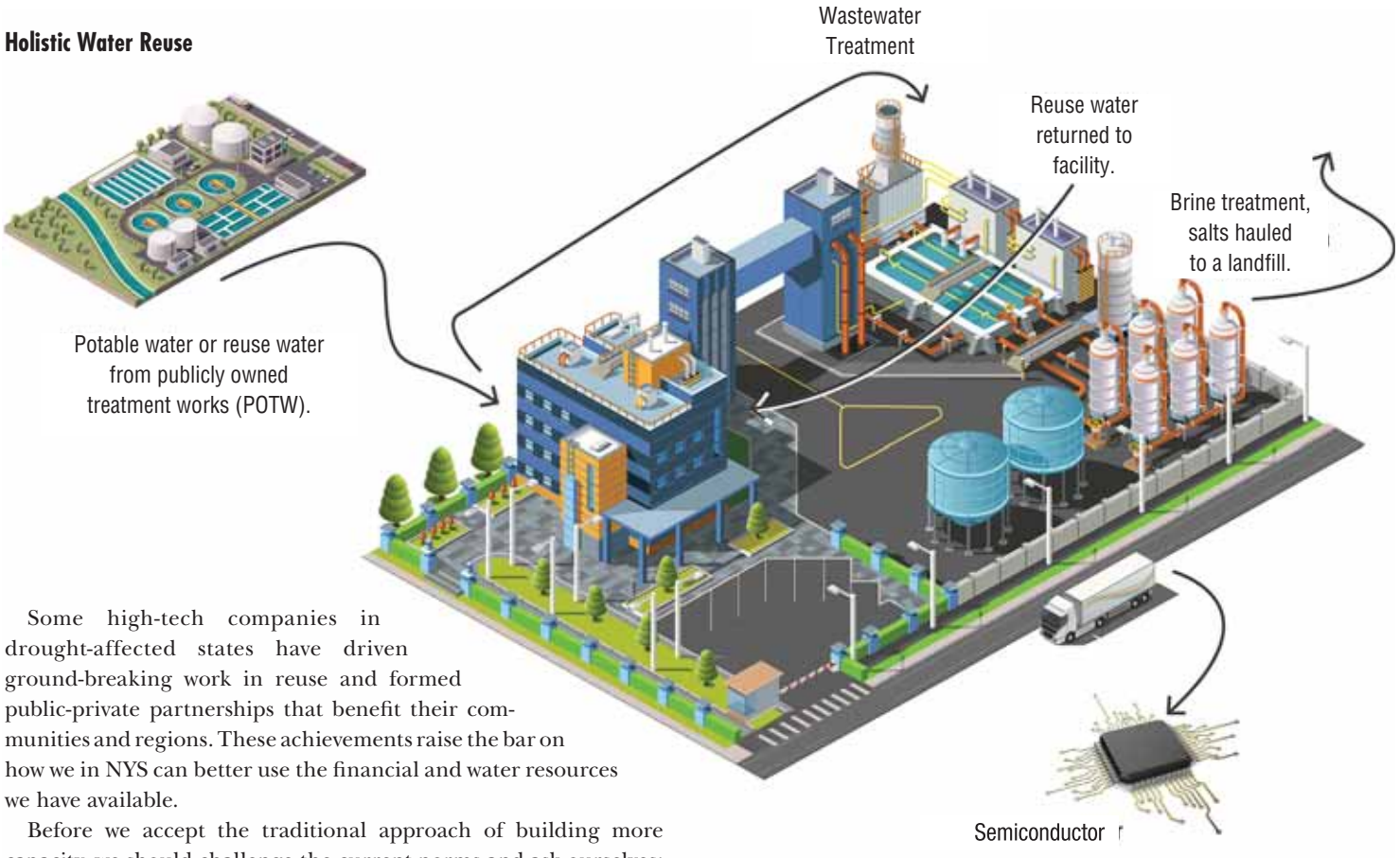

Figure 2. Holistic Water Reuse "One Water". *Carollo Engineers, Inc.*

Some high-tech companies in drought-affected states have driven ground-breaking work in reuse and formed public-private partnerships that benefit their communities and regions. These achievements raise the bar on how we in NYS can better use the financial and water resources we have available.

Before we accept the traditional approach of building more capacity, we should challenge the current norms and ask ourselves:

1. Is there a more resilient and sustainable solution? Can existing systems be optimized? Can treatment and reuse be integrated into the plan?
2. Are there broader local or regional solutions available? Are other communities or industries facing similar water resource and treatment challenges that could be better addressed through a comprehensive solution?
3. Does the large, complex, and costly nature of these challenges provide an opportunity for public/private partnerships? Can local utilities or external partners provide integrated solutions including funding, operations, water management, etc.?
4. Who can benefit from closed loop industrial treatment systems that remove key contaminants and produce a high-quality reuse water? Who can utilize this reuse water to offset existing potable demands and support net positive water goals?
5. Can air-cooled systems provide a resilient alternative to water-based systems?
6. Should NYS be providing incentives for reuse (e.g., tax breaks, funding) that would facilitate these solutions?
7. Can some barriers to reuse, such as concentration-based local limits, be removed/modified to support more sustainable solutions?

Growth in the high-tech sector is on the verge of exploding. Without creative solutions to the water challenges that semiconductor and hyperscale data centers present, it will be difficult to support the needed expansion, without negatively impacting our communities and our environment.

The high-tech boom represents an opportunity to think about our water and wastewater solutions differently – to identify resilient and sustainable solutions that protect critical water resources and improve our environment, while supporting continued growth and economic development.

Corresponding author Darcy Sachs is a project manager and associate with Carollo Engineers, Inc., and may be reached at dsachs@carollo.com. Co-authors, also with Carollo Engineers, are Brandon Yallaly, vice president for engineering (Boise, Idaho) and Nathan Zaugg, vice president for engineering (Salt Lake City, Utah).

Note: The estimated cost of $11,000 per household was calculated by dividing the estimated $82.2 billion (ASCE 2022) by the U.S. 2020 census count of 7.4 million households in New York state.

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vide long-term protection given the variation in Lake Ontario water levels *(NYSOGS 2019)*. By developing this program, the state realized that communities, like Monroe County, must re-envision the relationship between the built and natural systems and adapt to a new normal driven by climate change and water level management.

Since the creation of the state's REDI program in the spring of 2019, 134 funded local and regional projects are underway, including 68 projects in the design phase, 25 projects in the construction phase, and 41 projects completed *(NYSDEC 2022)*. One REDI project that has received local, state and national recognition from the American Public Works Association (APWA) is the Irondequoit Bay Marine Park *(APWA Reporter 2022)*.

Irondequoit Bay Marine Park

The Irondequoit Bay Marine Park, located in the northeast corner of the Town of Irondequoit, was rendered unusable after the unprecedented high-water levels in Lake Ontario in 2019 ***(Photos 1A, 1B)***. The park provides water-based recreational opportunities to the public and includes the only public boat launch on the west side of Irondequoit Bay. Culver Road, which traverses the northern edge of the park, experienced significant flooding in both 2017 and 2019, cutting off residences and impacting a major evacuation route along the southern shores of Lake Ontario.

In March 2020, the town worked with Ramboll to initiate design on a project to rebuild the Irondequoit Bay Marine Park. Maintaining use of the boat launch through the active boating season was a project necessity, as well as completion of modifications to the boat launch area prior to Memorial Day weekend 2021. Allowing only six months to complete engineering, bidding and contractor procurement, it was necessary for construction to begin immediately after Labor Day 2020 to meet this aggressive schedule.

Photo 1A. 2019 flood event. *Ramboll 2019*

Photo 1B. 2019 flood event. *Town of Irondequoit 2019*

Photo 2. Stormwater pumping station to evacuate stormwater on Culver Road and adjacent parking areas. *Ramboll, 2020*

To ensure that Culver Road would be passable during flood conditions, the project included construction of a stormwater pumping station to control water that collects at the lowest road elevation while reducing stormwater build-up in local business parking lots ***(Photo 2)***.

Overall, this fast-track project provided a number of public amenities. For boaters, the boat launch lanes were extended, and new floating docks were installed to serve trailered boating access (two launch and one retrieve lanes). New floating docks with 24 slips were installed to serve transient boaters visiting the park and local businesses ***(Photo 3)***. A cartop boat launch was built along the west edge of the parking area for canoes and kayaks. To help control the dispersal of invasive species from boats entering or exiting the water, an invasive species disposal area was installed.

Accommodations for parking were also improved. Major revisions were made to parking areas to enhance trailer parking above the anticipated 100-year high-water elevation of 249.50 feet. More parking was added for improved access to the park and adjacent businesses. The improved parking provides better access to the new picnic pavilion and playground ***(Photo 4)***. This new playground, situated at the western edge of the park, fills a niche for the densely populated northeastern corner of the town, where there are few playgrounds available for families to enjoy. A new fishing pier provides recreational opportunities for anglers.

Shoreline protection was constructed along the perimeter of the park to reduce flooding ***(Photo 5)***. To enhance on-site stormwater control, the two western parking areas, originally constructed of permeable asphalt, were restored and expanded and the concrete sidewalk traveling the length of the southern edge of the site was replaced with permeable concrete. These features, along with strategically placed stormwater treatment systems consisting of swirl concentrators and rain gardens, provide stormwater treatment in

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Photo 3. Installation of transient dock systems for boater parking to support local businesses – capacity of 24 boats. *Ramboll, 2020*

Photo 4. New playground with a nautical theme. *Ramboll, 2020*

excess of regulatory requirements ***(Photo 6)***.

This $2.9 million construction project was started Sep. 3, 2020, and was completed on Sep. 9, 2021.

Perhaps the biggest success of this project was the collaboration between the contractors and the Town of Irondequoit to work closely together to achieve the team's overall goals. As part of the cost share arrangement for the grant funding, the town directly purchased the stormwater pumping system and playground equipment and performed a majority of the asphalt paving work, saving a significant amount of money.

The Irondequoit Bay Marine Park project was a tremendous success. During summer 2021, attendance at the park exceeded expectations and the facility was utilized to its full potential.

Michelle McEntire is a senior project manager with Ramboll and may be reached at michelle.mcentire@ramboll.com.

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Photo 5. Revetment installation to provide long-term flood protection. *Ramboll, 2020*

Photo 6. New stormwater outfall and pump station discharge *Ramboll, 2020*

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Career Advancement Through Networking and Education: Lucy Grassano Scholarship

by Carolyn Steinhauer

Attention certified wastewater and collections utility operators! Are you looking for an opportunity to network, earn renewal contact hours and learn cutting edge information about the future of the water resource recovery field? Then apply for a Lucy Grassano Operator Scholarship!

The Lucy Grassano Scholarship is named after Lucy Grassano, a former principal administrative assistant at the New York City Department of Environmental Protection. She was a mentor, friend, teacher and "mother" and helped many operations staff advance in their careers throughout the years.

After a brief respite during the virtual annual meetings of 2021 and 2022, we are looking forward to having career-minded operators reap the benefits of the scholarship in-person. Winners will receive full registration and a travel stipend to attend NYWEA's 95th Annual Meeting Feb. 6-8, 2023, at the New York City Marriott Marquis in Times Square. Winners also receive full registration and a travel stipend for the June 6-8, 2023, Joint NYWEA/NEWEA Spring Technical Conference and Exhibition in Saratoga Springs, New York. At both conferences, networking opportunities abound, and you'll be formally recognized as a scholarship winner.

Buffalo Sewer Authority's Daniel O'Sullivan kicked off his NYWEA involvement as a 2019 scholarship recipient. From his committee roles to his participation as a state-based member, Daniel's NYWEA experience has contributed to his professional growth as a water resource recovery operator.

"Being part of the NYWEA organization has provided me both opportunity and encouragement to grow professionally. Several years ago, I was awarded the Lucy Grassano Operator Scholarship, since that time my level of involvement has grown from committee membership, to committee leadership, to most recently becoming a member of the State Board. During my time as a member, I have also received several promotions with my employer and have been able to participate in member association programs on the national level.

Daniel O'Sullivan

The NYWEA organization does a tremendous job encouraging, supporting and recognizing the work of all operators which is very meaningful to me."

Do I Qualify?

To qualify for the scholarship, applicants:

1. Must be a certified wastewater or voluntary collections operator and work day-to-day in a wastewater treatment or collections facility.
2. Must never have attended a prior NYWEA annual meeting.
3. Must be a NYWEA member. A member application can accompany the scholarship application.

How Do I Apply?

To apply, complete an online application and submit a brief essay (500 words) describing how receiving this scholarship will further your career. Applications and essays are due Jan. 6, 2023. The application link and information about this and other operator scholarships are available on NYWEA's Operator Certification webpage *(https://www.nywea.org/SitePages/Operator-Certification/Information/default.aspx)*.

Lucy Grassano

If you have questions about the Lucy Grassano Scholarship or how to apply, contact NYWEA Operator Certification Administrator Carolyn Steinhauer at 315-422-7811 or *carolyn@nywea.org*.

Carolyn Steinhauer is the operator certification program administrator for the New York Water Environment Association.

Applications and essays are due Jan. 6, 2023.

2020 Lucy Grassano Scholarship winners (l-r): James Plochocki, Craig Hurteau, Tony Filer, Joseph Giarraffa and Michael Cush with then NYWEA President Bob Wither.

continued from page 7

More Watershed Science Conference photos.

Frank Parisio, NYCDEP, addresses attendees in Session 2. *NYCDEP*

Vijesh Karatt-Vellatt serves as a moderator for Session 1.

Jennifer Farmwald, NYCDEP, Session 5, talks about R&D in the 21st century. *NYCDEP*

Brendan Hannon, NYCDEP, speaks about the CLCPA in Session 1. ***(See corresponding article on page 10.)***

Rakesh Gelda, NYCDEP, Session 4. *NYCDEP*

Karen Moore, NYCDEP, Session 4. *NYCDEP*

Rajith Mukundan, NYCDEP, Session 4. *NYCDEP*

Photos: NYCDEP, Patricia Cerro-Reehil and Madison Quinn

The NYCDEP Bowery Bay Coyotes members: (l-r) Anthony Quadrino, Mike Prats, Pete Mander, Mike Leone and the team's coach, Joe Atkins. *NYCDEP*

Sara Igielski serves as a moderator for Session 5.

The Bowery Bay team sets up a demonstration of the Collection Systems Event during lunch. *NYCDEP*

The spectacular setting and grounds for the Watershed Conference at the Bear Mountain Inn.

A few attendees circle around for a photo outside the picturesque Inn.

NYWEA Meet & Greet at WEFTEC 2022, New Orleans, LA "The Great American Alligator Museum"

Madison Quinn and Carolyn Steinhauer greet attendees to museum event.

Bill Grandner and Sana Barakat.

Above: Members mingle on the street in front of museum.

Bob Wither, Nicole Brown and Sana Barakat.

(Right) Attendees mingle in the warm NOLA weather at the reception.

See y'all later, Alligators!

(L-r): Lucas Kasperowicz, Mike Burkett, Tony Filer, Dean Ellsworth with … a new friend …

Several of the Ops teams gather to enjoy the evening.

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Operator Quiz Fall 2022 – Mindful Maintenance

The following questions are designed for individuals/trainees pursuing certification as they prepare to take the ABC wastewater operator test. It is also designed for existing operators to test their knowledge. Each issue of *Clear Waters* will have more questions from a different process of wastewater treatment. Good luck!

1. The main function of a/an (_____) is to provide overcurrent protection of an electrical circuit.
a. Ammeter
b. Transformer
c. Fuse
d. Multimeter

2. What is NOT a function of a lantern ring?
a. Protection
b. Cooling
c. Lubrication
d. Tightening

3. (_____) is a condition that is the result of low pressures within a pump, which creates boiling water and vapor bubbles. Damage to the impeller can happen when these vapor bubbles burst.
a. Air lock
b. Plugging
c. Cavitation
d. Plugging

4. It is a valve that prevents the flow of fluid backward through a pump.
a. Gate valve
b. Check valve
c. Globe valve
d. Oil valve

5. Which valve should always be either fully open or fully closed?
a. Gate valve
b. Globe valve
c. Butterfly valve
d. Oil valve

6. A fluid's viscosity is the rate it will flow at a known:
a. Temperature
b. Pressure
c. Time
d. Rate

7. Before working on a piece of equipment it should be:
a. Inspected for warranty
b. Shut down, locked out and tagged
c. Broken
d. Leaking

8. The purpose of a turnbuckle on the stay rod of a trickling filter is to:
a. Control speed of drain
b. Support the distributor arm
c. Adjust and level the distributor arm
d. Adjust the return rate

9. In an electrical circuit a/an (_____) is used to measure current.
a. Ammeter
b. Transformer
c. Ohmmeter
d. Capacitor

10. Pump packing should:
a. Be changed every week
b. Be tightened to a drip
c. Be greased when worn
d. Not allow for any leaking

Answers below.

For those who have questions concerning operator certification requirements and scheduling, please contact Carolyn Steinhauer at 315-422-7811 ext. 4, carolyn@nywea.org, or visit www.nywea.org.

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Answers: 1. (c) Fuse. **2.** (d) Tightening. **3.** (c) Cavitation. **4.** (b) Check valve. **5.** (a) Gate valve. **6.** (a) Temperature. **7.** (b) Shut down, locked out and tagged. **8.** (c) Adjusting and level the distributor arm. **9.** (a) Ammeter **10.** (b) Tightened to a drip .

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Clear Waters

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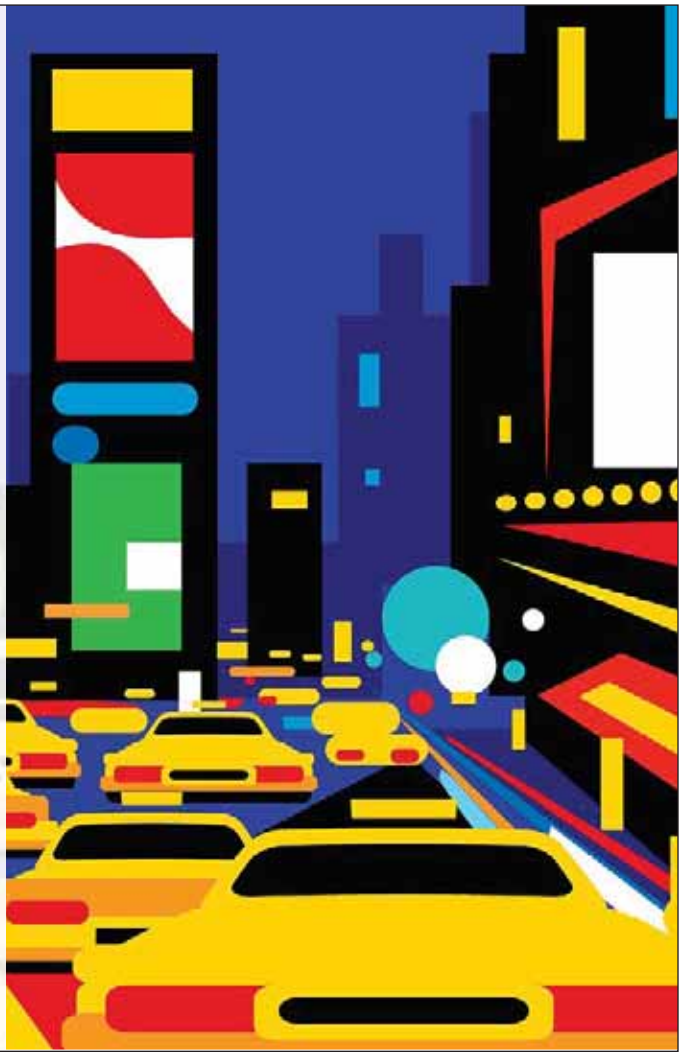

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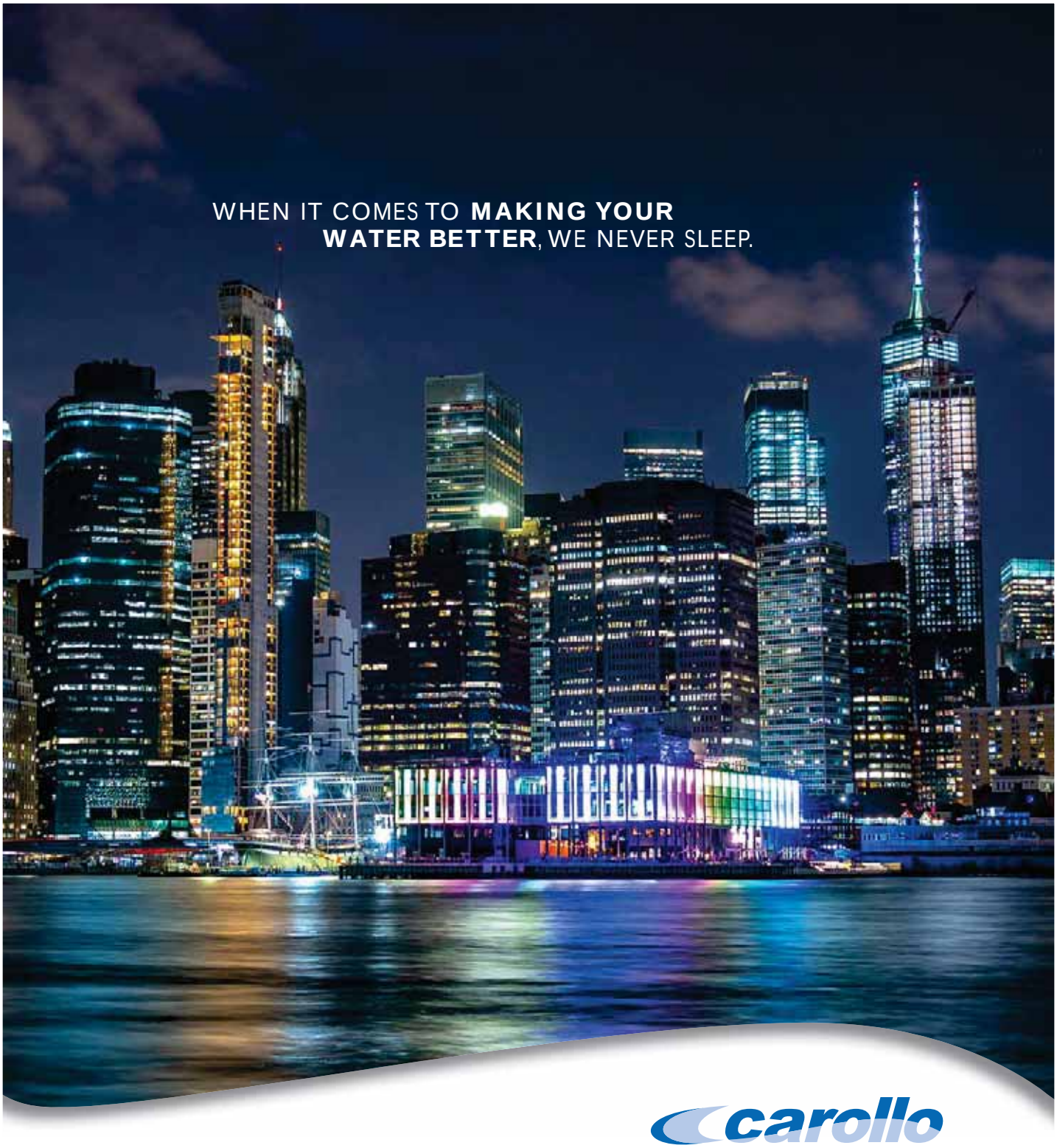

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