Fall 2021, Vol. 51, No. 3

New York Water Environment Association, Inc.

ClearWaters

The Chesapeake Bay Partnerships and Strategies to Protect a Valuable Resource

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Clear Waters

New York Water Environment Association, Inc.

Cover: Blue crab in Annapolis, Anne Arundel County, Maryland. A blue crab briefly emerges from the water of Spa Creek during a mahogany tide on May 28, 2020. Excess nutrients from stormwater runoff can lead to blooms of algae such as *Prorocentrum minimum*, which turns the water a rust color. As the algae dies and decomposes, the process sucks oxygen from the water and can lead to fish kills.
Will Parson/Chesapeake Bay Program

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Get Ready for the Annual Meeting!

It is hard to believe it is that time already! The Program Committee, Future Conference Task Force and Conference Management Committee have been hard at work planning an amazing (and long overdue!) in-person annual meeting, our 94th! We can't wait to see our NYWEA friends and family in New York City Feb. 7-9, 2022, at the Marriott Marquis in Times Square. The opening session will highlight the year's "Reflect. Protect. Connect." theme through the lens of several of our esteemed colleagues, including Zarine Ali from the U.S. Environmental Protection Agency; Steven Sanders from Environmental Training Center, Morrisville; Walt Walker from Greeley-Hansen, and Jeanette Brown from Manhattan College, a past president of the Water Environment Federation!

Over the past several years, the NYWEA board and various committees have discussed and brainstormed ways to have a more diverse mix of our members at the annual meeting. While we strive to offer sessions that cover a wide range of topics to attract a wide variety of people from the sector, there are some factors that we just can't overcome, such as operators needing to cover shifts at their plant or young professionals not having the budget to travel to and stay in New York City.

Enter the pandemic, and the almost universal acceptance of virtual meetings. We now have a workable option to bring parts of the annual meeting to our members. To that end, in addition to our typical in-person session offerings, we will be broadcasting several sessions live for our conference participants to attend virtually from the comfort of their own home or office, including:

- Opening Session
- Operators Forum
- CSO/SSO Wet Weather Planning
- Design-Build
- Awards Ceremony

While we can't bring the amazing and energizing networking component to their door, we feel bringing them industry and NYWEA information, in addition to great technical content with the possibility of RTCs and professional development hours, is a great foray into what our in-person meeting has to offer!

Chesapeake Bay

Switching gears, in this issue of *Clear Waters*, we are once again delving into the details surrounding improving water quality in the Chesapeake Bay. Someone outside of the water sector may question why we are even thinking about it, let alone devoting an entire issue of our New York Water Environment Association magazine to it. However, we in the water sector know how water connects us (and flows downhill), even a couple of states away. It also goes to show that it takes a team to accomplish the goal of protecting public health and environment and we truly are all in this together. One water!

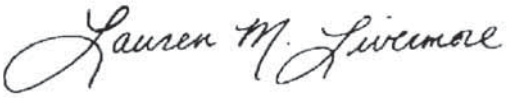
Overcoming Staffing Challenges

On the seventh annual "Imagine a Day Without Water," recognized Oct. 21, NYWEA and a few of our esteemed colleagues – Mayor Brian Schenk from the Village of Naples, Water Ambassador Joseph Fiegl from the Erie County Department of Sewerage Management, Central Chapter Board Representative Richard Kenealy from the Village of Webster and President-elect Khristopher Dodson – presented on "A Day in the Life." The discussion highlighted forming collaborative relationships with our regulatory partners as well as the challenges utilities large and small are facing on a daily basis.

It seems everyone is doing more with less across all sectors in the United States, but in the world of water resource recovery, the lack of staff does not preclude you from doing things right. You can't just take on fewer projects or postpone deliverable deadlines – the flow keeps coming in whether you are fully staffed or not. Unfortunately, it is hard to fill open positions today in many utilities; not only is it hard to get interested applicants, it is also hard to hire them!

Cutting the red tape out of the hiring process for our essential water workers could not be more important to human health and the environment, especially as we continue to navigate the COVID-19 pandemic. To assist with hiring in the public sector, the NYWEA board created a Civil Service Task Force with plans to reduce the duplicative testing requirements and streamline employee titles, among other critical tasks. As we enter the wave of the silver tsunami, we know it will be more important than ever to attract and hire people in the water sector and train them expeditiously to make sure they are prepared to be the next generation of environmental professionals.

So, what is our next task as members of the water sector? To encourage the next generation to get into water sector careers. As an operator. As an engineer. As a scientist. As a maintenance worker. As an electrician. As a regulator. Come one, come all – we have a job to fit everyone's passion and skills.



Lauren M. Livermore, P.E., BCEE
NYWEA President

The Chesapeake Bay is bordered to the east by the Delmarva Peninsula and to the west by the lowlands of the Appalachian Mountains.

iStockphoto.com, FrankRamspott

Executive Director's Message | Fall 2021

We are pleased to bring to you this issue of *Clear Waters* that focuses on the Chesapeake Bay. Many thanks to the authors who have taken the time to share their stories!

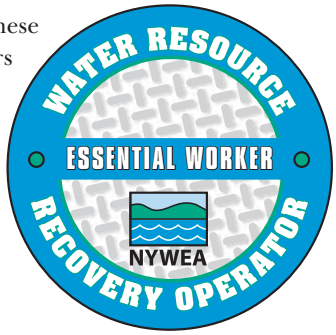
As President Livermore announced, we will be in-person in New York City in February for NYWEA's 94th Annual Meeting. Be sure to register early and save money on not only the registration rate, but the hotel room rate as well!

Recognizing Our Essential Workers!

The last two years have been a challenge on so many fronts. When the pandemic first hit, there were so many unknowns; in fact, there still are! One thing is certain, and that is the work carried out by water resource recovery operators is essential!

During the pandemic, we developed an essential worker sticker. At the suggestion of Crate Voerg, former chair of the Utility Executives committee, the stickers are reflective to fulfill a Department of Transportation requirement, while at the same time carrying an important message highlighting the essential work that is carried out.

NYWEA has issued batches of these stickers to the Utility Members and had a supply of them printed. They are sized appropriately to fit front and center on hard hats. Please contact Carolyn Steinhauer if you would like to purchase these stickers at *carolyn@nywea.org*.



Congratulations Competitors!

During WEFTEC in Chicago, four NYWEA teams competed in the Operations Challenge: the Genesee Valley Water Recyclers, the Long Island Brown Tide, the Rockaway Sludge Hustlers and the Watertown Water Bears. Congratulations to everyone for making it to a national competition! We extend our heartfelt appreciation to every team member for the time and effort they put into preparing for the competition! Hats off to the Division 2 winners: the Brown Tide in third place overall; and the Rockaway Sludge Hustlers for placing 12th overall. An admirable win for the Watertown Water Bears that placed second overall in Division 3!

50th Anniversary – Clean Water Act

In 2022 we will celebrate the 50th anniversary of the Clean Water Act! This law forever changed the way water pollution was handled, and is something many NYWEA members implement on a daily basis. The objective of the Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. NYWEA will be celebrating the anniversary throughout the year.

Honoring Grit

It is NYWEA's scholarship season, and we have some really wonderful things happening that I am delighted to share! The NYWEA board of directors approved the Avril Woodhead "Grit" Scholarship in September. The concept of this scholarship was developed by NYWEA's own Claire Baldwin, whose mother, Dr. Avril D. Woodhead, was an entrepreneur, scientist, single parent and had "amazing grit."

This scholarship was created in Dr. Woodhead's name, as she exemplified the characteristics of grit in both her personal and professional life. Born in 1930 and growing up during WWII, she caught rheumatic fever twice leaving her unable to walk. But, with the love of her mother and countless hours of gritty effort she regained her mobility. She went on to have a highly successful life beginning with her early work collaborating with Dr. Alex Comfort on cell aging, to later publishing in the journal *Nature* and being featured in *The New York Times* science section (Dec. 20, 1989) for her breakthrough work on malignant melanoma. Dr. Woodhead retired shortly after her 85th birthday and lived until she was 90! This nontraditional scholarship will be awarded for the first time during NYWEA's 94th Annual Meeting.

Dr. Avril D. Woodhead

Low Income Household Water Assistance Program

Thanks to the NYWEA members led by the efforts of Water Ambassador Joe Fiegl and Oluwole McFoy, the Low Income Household Water Assistance Program (LIHWAP) is now funded and up and running. This program helps low income households pay the cost of drinking water and wastewater services. The program assists households who have past due bills (arrears) for drinking water and/or wastewater services. Benefits are paid directly to the household's drinking water and/or wastewater vendor(s).

Eligibility and benefits are based on income, household size and the amount owed to wastewater and or drinking water provider(s).

Work-in-Water Grant Program Success Stories

In this issue of *Clear Waters,* you'll see an article covering NYWEA's Work-in-Water Grant program, where two out of eight grants were issued to the City of Watertown and the City of North Tonawanda. These summer internships are a fantastic way to introduce high school students to water careers. Please do not hesitate to reach out to me to find out more at *pcr@nywea.org.*

Be well and take care everyone!

Patricia Cerro-Reehil, pcr@nywea.org

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New York's Chesapeake Bay Watershed Program Has Local Benefits

New York is a "headwater" state in the Chesapeake Bay watershed with obligations under a complex, multistate Total Maximum Daily Load (TMDL) pollution budget. While the TMDL focuses on reducing the nutrients and sediment flowing into the Chesapeake Bay (via the Susquehanna River in the case of New York), the focus of DEC's implementation program to meet TMDL requirements has been on actions that will have local benefits.

Achieving the goals of the Chesapeake Bay program within New York has been a true partnership. Working with DEC are the Department of Agriculture and Markets, the State Soil and Water Conservation Committee, Cornell University, two regional planning boards, and the Upper Susquehanna Coalition (USC), among others. This partnership has been creatively installing nutrient-reducing management practices that provide multiple benefits here in New York. In addition to reducing nutrients, projects often have the co-benefit of abating flooding, restoring streams, improving agricultural sustainability and soil health, fostering climate resiliency, and enhancing the economic vitality of the Southern Tier (think water-based tourism).

The USC, a coalition that includes 18 soil and water conservation districts within New York, helps achieve TMDL milestones while focusing carefully on improving local conditions. Experts from USC design and implement sustainable agriculture projects, restore stream corridors and enhance wetland function. To date these efforts have involved hundreds of projects in the Susquehanna River watershed, including the construction and restoration of well over a square mile of wetlands.

An excellent example of USC's work using federal, state and local resources is the on-going program to make Binghamton and the surrounding Broome County more flood resilient. Broome County, one of the most flood-prone areas in the state, has suffered millions of dollars in flood damage from multiple events, including considerable damage to the Binghamton-Johnson City Wastewater Treatment Plant (WTP).

Broome County and Binghamton are now implementing flood resiliency projects to augment existing levee and flood wall protections, elevate buildings and wastewater treatment infrastructure, create wetlands to detain floodwater, and add rain gardens and bioswales to collect and clean stormwater. Although these projects are constructed with flood resiliency in mind, they also reduce the amount of nutrients and sediments entering the Susquehanna from stormwater runoff. Interestingly, the Chesapeake TMDL is the only program I know of that has been expressly upgraded to consider the worsening impacts of climate change on water quality.

The Binghamton-Johnson City WTP has been restored, improved and made more flood resilient by building a floodwall to safeguard against the 500-year storm and adding rainwater pumps as a backup to the storm drain system. Plant improvements are also reducing phosphorus and nitrogen entering the Susquehanna River, helping New York meet its Chesapeake Bay TMDL milestones.

New York's Chesapeake Bay program is successful because our partners are working toward common goals that meet the TMDL requirements while improving life here in New York.

– James Tierney,
Deputy Commissioner
for Water Resources,
NYS Department
of Environmental
Conservation

MacArthur Elementary School in Binghamton, Broome County, New York, Oct. 8, 2020. After remnants of Tropical Storm Lee inundated the MacArthur Elementary School with over three feet of water from the nearby Susquehanna River, the school was rebuilt with numerous measures to improve its resilience to flooding. The lower level of the school, sitting in the river's flood plain, was converted to a playground that can flood without lasting damage, while rain gardens and other structures to soak up and filter stormwater are scattered throughout the campus.

Will Parson/Chesapeake Bay Program

Preventing High-Pressure Injection Injury: A Hazard of Hydraulics and Pneumatics

A high-pressure injection injury involves air, fluid, or solids forced into the skin by high pressure. These injuries can occur when working with compressed air lines such as pneumatic tools; hydraulic-powered machinery and equipment; pressure washers; diesel engine fuel injectors; or other pneumatics/hydraulics at greater than 103 pounds per square inch gauge (PSIG). Typically, these occur when feeling for leaks with the fingers, so injuries in the hands and fingers are the most common. They could occur when checking for an air leak with the tongue (ouch!) or listening for leaks producing an injury into the side of the face or being struck by a detached hydraulic hose whipping around in the air.

It could feel like a pinprick and not hurt much **at first**, deceiving the victim into delaying medical aid. As the injected material puts pressure on the blood vessels blocking circulation, the skin beyond the point of injection becomes pale and can appear white or mottled blue. **As the swelling and inflammation develop, the pain becomes unbearable**. Tissues are starved of oxygen and nutrients, infection can develop, and injected materials can migrate from the site of injury (such as from the hand up into the arm). Medical treatment consists of a surgeon opening the injection site, decompressing the tissues, cleaning out the injected material, and providing antibiotics to prevent infection. Delaying treatment has led to gangrene, amputation of a fingertip, or permanent nerve damage. **Always seek emergency medical treatment immediately**.

Gloves and clothing are not usually protective – **so we need to move higher up on the hierarchy of controls**. Training on the hazard of high-pressure injection injury is a must. Maintenance on high-pressure lines or equipment should be in the workplace's lockout/tagout program to make sure that all pressure is bled/released before repairs are done; never loosen or tighten a hydraulic connection when the system is under pressure – it could fail catastrophically. During maintenance, you will want to inspect all gauges for zero pressure and review the hydraulic/pneumatic schematic for pressure traps, such as accumulators and check valves. Other control strategies may include:

- reducing the operating pressure below 103 PSIG – a possible option for pneumatics or for pressure washers
- using a low-pressure sensor or alarm so that a leak is known
- having a **preventive maintenance program** that includes inspecting hoses at regular intervals and replacing worn ones before leakage
- using braided hoses that blister before leaking – warning of impending failure
- forbidding the use of the fingers (or any other part of the body) for leak detection. Instead, consider submerging a line under water; applying a soap solution to show bubbles; adding dye to a fluid
- hydraulic lines and components that are exposed and routed near the equipment operator should be shielded to protect the operator.

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

Be aware of high pressure hydraulic systems in your facilities. *iStockphoto.com, Thossaphol*

New York's Efforts to Protect the Chesapeake Bay

by Cassandra Davis

History of Chesapeake Bay Water Quality

What do brook trout in New York's Southern Tier streams and blue crabs off piers in Maryland have in common? They are both residents of the Chesapeake Bay Watershed ***(Figure 1)***. The Chesapeake Bay is the largest estuary in the United States. It is home to more than 2,700 species of plants and animals and produces about 500 million pounds of seafood per year.

Water quality has been impaired in the bay for decades due to excessive nutrients (nitrogen and phosphorus) and sediment. The main sources contributing to excessive nutrients are sewage, agricultural manure, inorganic fertilizer and atmospheric nitrogen deposition. Most of the sediment comes from agriculture, stream bank erosion and construction sites. Progress is underway to reduce the amount of nutrients and sediment entering the bay's watershed.

During the 1980s, a multistate program was formed to address "dead zones" caused by excessive nutrients. Dead zones are areas with low oxygen conditions that are inhabitable for marine life and are caused by eutrophication. In 2010, the U.S. Environmental Protection Agency (USEPA) established the total maximum daily load (TMDL) or "pollution diet" for the Chesapeake Bay. A TMDL defines the maximum amount of a pollutant allowed to enter a waterbody and still meet water quality standards. Because nutrients and sediment in the bay come from all over the watershed, all seven jurisdictions (New York, Pennsylvania, Maryland, Delaware, Washington, D.C., Virginia and West Virginia) are required to meet the goals outlined in the Bay TMDL. All the landside best management practices (BMPs) and reductions from wastewater needed to achieve the Bay TMDL targets must be in place by 2025.

New York and the Chesapeake Bay

New York's portion of the Chesapeake Bay watershed is made up of the Susquehanna River and Chemung River watersheds.

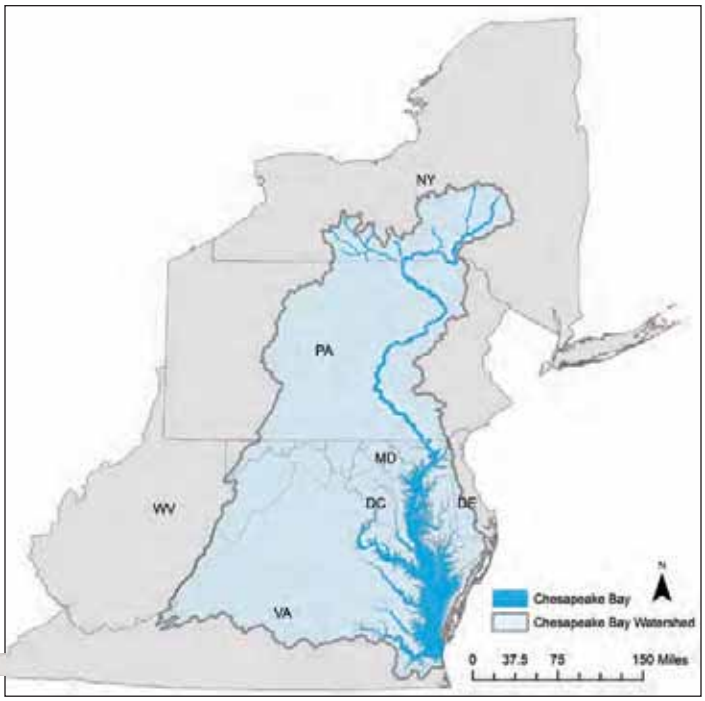

Figure 1. The Chesapeake Bay watershed spans the borders of New York, Pennsylvania, Maryland, Delaware, Washington, D.C., Virginia and West Virginia. *NYSDEC*

Together, these two watersheds form the northern headwaters of the Chesapeake Bay and cover much of New York's Southern Tier. In total, some or all of 19 New York counties are in the Chesapeake Bay watershed:

- Allegany County
- Broome County
- Chemung County
- Chenango County
- Cortland County
- Delaware County
- Herkimer County
- Livingston County
- Madison County
- Oneida County
- Onondaga County
- Ontario County
- Otsego County
- Schoharie County
- Schuyler County
- Steuben County
- Tioga County
- Tompkins County and
- Yates County.

About 10% of the bay's total watershed area lies within New York's boundaries, and 640,000 New Yorkers live within the watershed.

The Susquehanna River begins at Otsego Lake in Cooperstown, New York, and flows 444 miles south to the northern end of the Chesapeake Bay in Maryland. The Chemung River flows across the western portion of the Southern Tier and joins the Susquehanna River in northern Pennsylvania. The Susquehanna River is the Bay's largest tributary and the longest river on the East Coast of the United States. It contributes nearly 50% of the fresh water that enters the Bay – an average of 19 million gallons of water per minute.

As of 2020, about 70% of the New York portion of the watershed land use is categorized as "natural," which includes forest, water, wetlands and natural succession. Agricultural areas including crops, hay, and pasture make up about 21% of the watershed. The remaining 9% of land use is split between impervious roads, buildings and pervious turfgrass, all categorized as developed land.

Watershed Implementation Plan

New York and the other jurisdictions were each required to create a Watershed Implementation Plan (WIP) for the Bay TMDL. This plan documents the actions that will be taken to reduce nutrients and sediment and meet reduction goals by 2025. Each jurisdiction will also develop two-year goals, called milestones, which outline short-term steps that will be taken toward the long-term objectives described in the WIPs.

New York's Phase III WIP was developed in partnership with federal, state and local agencies. Organizations and agencies that participated in the WIP development process included:

- The New York State Department of Agriculture and Markets
- New York State Soil and Water Conservation Committee
- Upper Susquehanna Coalition
- County Soil and Water Conservation districts

- New York Farm Bureau
- The U.S. Department of Agriculture Natural Resource Conservation Service
- Southern Tier 8 Regional Planning Board
- Southern Tier Central Regional Planning Board
- Chemung County Stormwater Coalition
- Otsego County Conservation Association
- Syracuse University Environmental Finance Center, and
- Binghamton University.

The New York State Department of Environmental Conservation (NYSDEC) held public meetings focused on the agricultural sector and individual meetings with wastewater treatment facility operators, engineers and municipal officials.

The Phase III WIP is split into five sectors: agriculture, wastewater, developed, natural and septic. Load reduction targets were developed for each sector, based on balancing the amount of opportunity available to reduce loads from each sector, cost to implement practices in each sector, and achieving equity between sectors. The largest load sources for nitrogen and phosphorus are from agriculture and natural land. In New York's WIP, 32 large wastewater treatment facilities were given waste load allocations for nutrients. Several of these facilities have been upgraded or are in the process of upgrading to include nutrient treatment.

New York's plan to reach the 2025 nutrient and sediment targets includes utilizing state and federal grant programs; increasing reporting of voluntary best management practice (BMP) implementation; wastewater treatment upgrades; providing technical assistance, optimization services and training to wastewater operators; improving communication among local stakeholders; and creation of new targeted programs.

New York's Progress

Jurisdictions are required to track and report progress annually to USEPA. Wastewater nutrient effluent is reported using discharge monthly reporting (DMR) data; for smaller facilities that do not monitor for nutrients, default estimates are used. NYSDEC reports implementation occurring through construction stormwater projects and other nonagricultural nonpoint source BMP implementation programs. The data are incorporated into the USEPA Chesapeake Bay Watershed Model to determine the reduction in nutrients delivered to the bay.

NYSDEC has partnered with the Upper Susquehanna Coalition (USC) to track and report BMP implementation occurring on agricultural lands. The USC, established in 1992, consists of soil, water and conservation districts within the watershed dedicated to working on local water quality issues in the Upper Susquehanna River watershed. The USC's buffer, agriculture, stream, and

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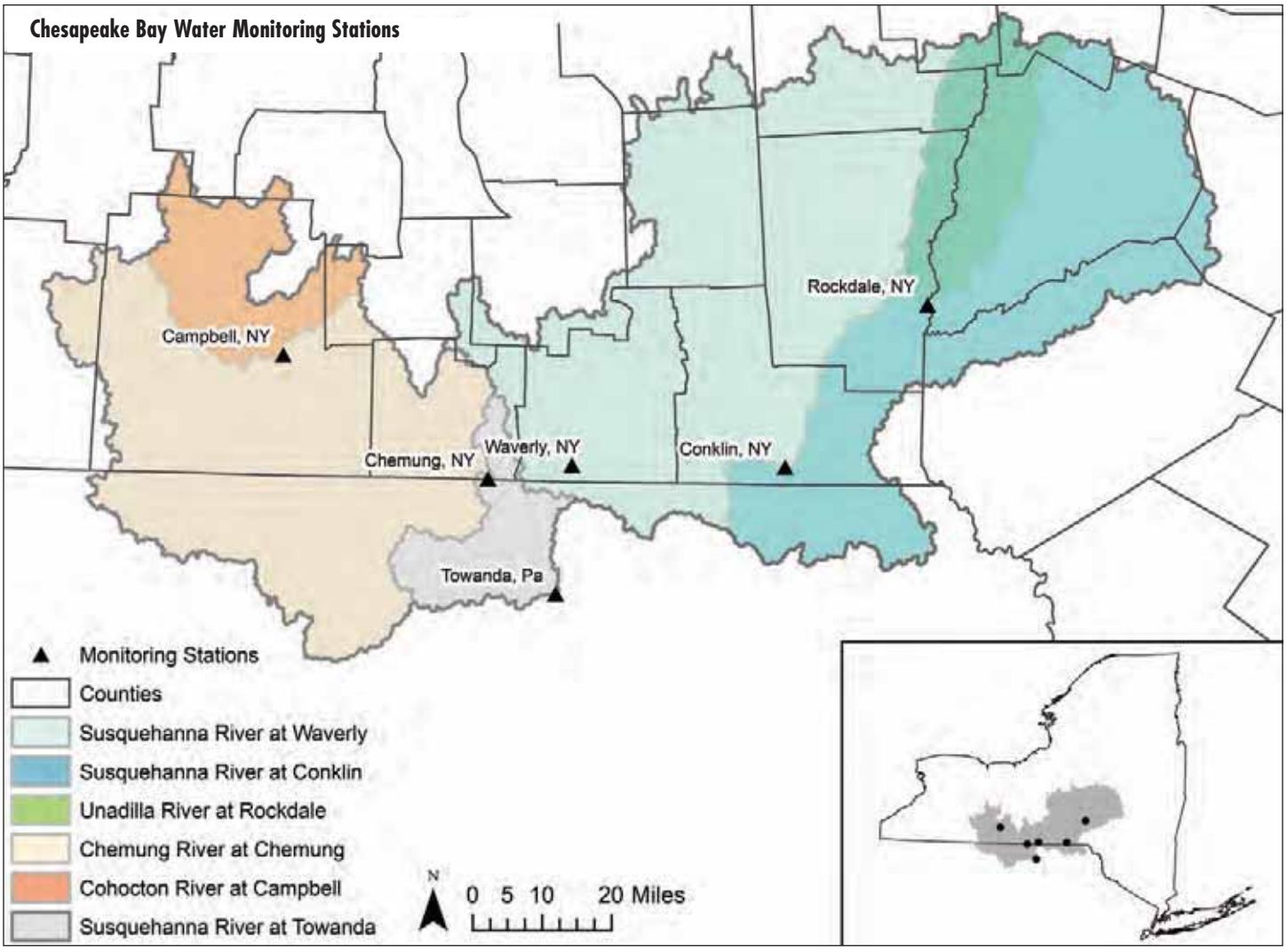

Figure 2. USGS water monitoring stations in the Chesapeake Bay watershed are used to assess ambient water quality in the northern headwaters of the bay. *NYSDEC*

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continued from page 11

wetland teams provide resources for education and for planning, implementing, funding and coordinating projects in the watershed.

In addition to the Watershed Model, ambient water quality monitoring data collected from a network of U.S. Geological Survey (USGS) stream stations are used to evaluate water quality trends and to measure the success of implementation efforts ***(Figure 2)***. Five USGS stream stations located in New York are used to measure water quality trends in the Chemung and Susquehanna basins, and one station located in Towanda, Pennsylvania, is used to measure trends of the whole New York portion of the watershed.

For nitrogen ***(Figure 3)***, short-term trends show improving water quality at the Susquehanna River station in Conklin, and no trend at the Unadilla River station in Rockdale. The remaining three short-term trends show degrading nitrogen trends. Phosphorus short-term trends ***(Figure 4)*** show improvement at all but one station, with the Susquehanna River station at Conklin showing no short-term trend. Long-term trends at the Susquehanna River station in Towanda, Pennsylvania, show improving trends (loading reduction) for nitrogen and degrading trends (loading increase) for phosphorus. Water quality trends may not reflect improvement resulting from implementation due to the lag time between installation of projects and the environmental response.

Since 1985, New York has reduced 5.4 million pounds of nitrogen and 0.61 million pounds of phosphorus. ***Table 1*** shows the amount of nutrients reduced for each sector since 1985.

Table 1. New York's Net Change in Nutrients Delivered to the Chesapeake Bay since 1985.

	Modeled Load Change (million lbs.)	
Sector	**Nitrogen**	**Phosphorus**
Agriculture	-4.2	-0.24
Developed	0.56	0.011
Wastewater	-1.6	-0.26
Natural	-0.20	-0.12
Septic	0.03	no data
Total	-5.4	-0.61

Positive values represent a net increase in loading, while negative values represent a net reduction in loading.

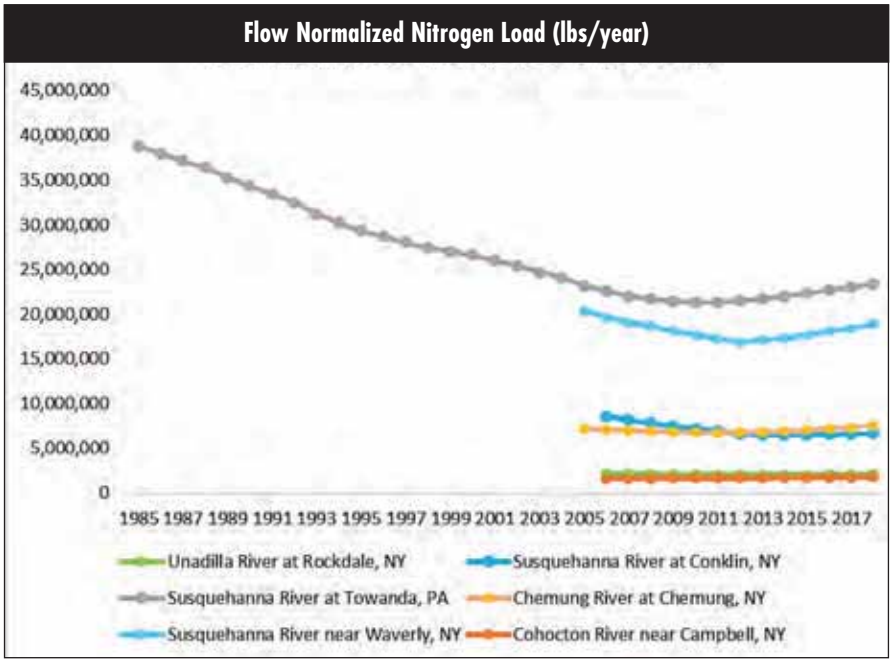

Figure 3. Flow-normalized nitrogen loading over time at six USGS water quality monitoring stations. *NYSDEC*

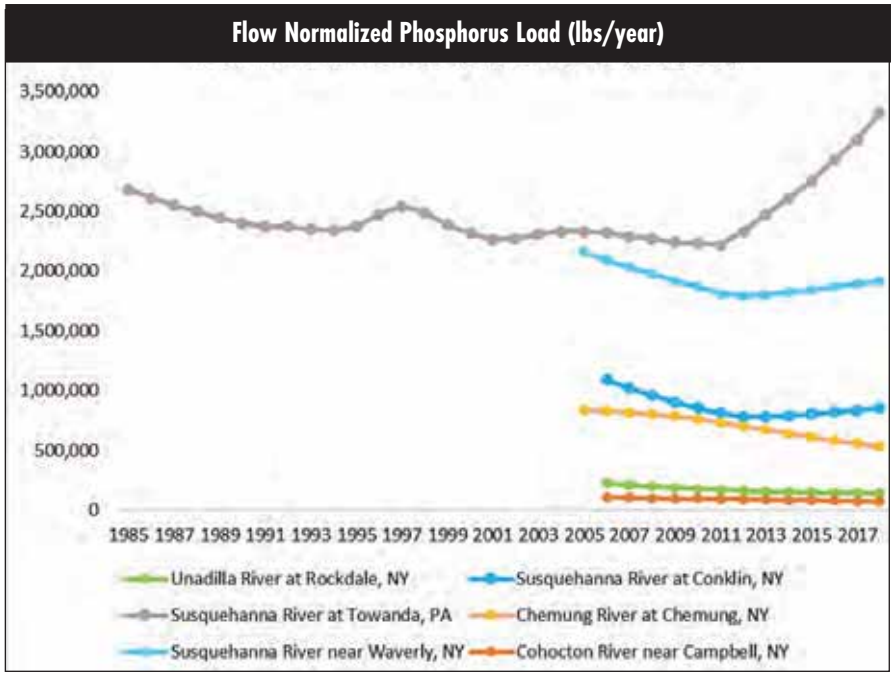

Figure 4. Flow-normalized phosphorus loading over time at six USGS water quality monitoring stations. *NYSDEC*

Addressing Climate Change

Climate change affects dissolved oxygen in the bay through increasing sea level rise, temperature, watershed flows and loads. New York is expected to be affected by climate change through increased temperature and precipitation volume and intensity. Climate change may negatively affect public health, agricultural production, water resources and stressed infrastructure. In 2020, USEPA and the jurisdictions decided to offset the modeled nutrient impacts from climate change from 1995-2025 based on a Chesapeake Bay Water Quality Climate Risk Assessment. New York is faced with an additional modeled load of 400,000 thousand pounds of nitrogen and 44,000 pounds of phosphorus due to impacts from climate change. New York plans to address these new loads by capitalizing on co-benefits, aligning with existing state adaptation and mitigation strategies, engaging local agencies, and implementing existing regulations and programs focused on climate change.

Cassandra Davis is an environmental program specialist with the New York State Department of Environmental Conservation and may be reached at Cassandra.davis@dec.ny.gov.

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The Power of Partnership: Chesapeake Bay Program

by Michelle Price-Fay

View of Flag Ponds Nature Park along the Chesapeake Bay from the Southern Maryland shoreline. *istockphoto.com, ymn*

So, what is the Chesapeake Bay Program?

The Chesapeake Bay Program is a unique, regional partnership consisting of representatives from federal and state agencies, local governments, academic institutions, nongovernmental organizations, businesses and individuals.

The program sets the policy and oversees the ultimate restoration and protection of the Chesapeake Bay, the nation's largest estuary. Funding comes primarily from the U.S. Environmental Protection Agency (USEPA) and over two-thirds of the program's annual budget goes directly back to states and localities to fund on-the-ground work that helps restore and protect the Bay and its watershed.

Fueled by science and driven by partnership, the program provides solutions to sustain a thriving Chesapeake Bay watershed. The Bay is a crucial natural resource for everyone who lives, works and plays within its watershed, not just those who reside along its shores. It is an economic powerhouse and increases the health and well-being of those in the region.

The program's work relies on rigorous science, quality assurance and control, policy, and management. This approach, combined with access to world-class experts, allows us to be responsive to the changing needs of the Bay watershed, including those of its people. This process is referred to as adaptive management, and it is the backbone of everything the Chesapeake Bay Program does.

Program Partners

But our work could not be accomplished without our many partners across the watershed. We see ourselves as a convener – bringing everyone involved in the Bay restoration process to the same table. All our partners are critical to the overall health of the Chesapeake Bay and its surrounding rivers, streams and lands.

Our partnership is led by the Chesapeake Executive Council, which consists of the governors of the six Chesapeake Bay watershed states – Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia – the mayor of the District of Columbia, the chair of the Chesapeake Bay Commission and the administrator of the USEPA, who represents the entire federal government.

The Executive Council recently approved a *Collective Action for Climate Change Directive,* committing the Chesapeake Bay Program to addressing the increasing threats of climate change in all aspects of the partnership's work. Program partners will use their tools and resources to prioritize the communities, working lands and habitats that are most vulnerable to the risks that a changing climate is bringing to the region.

The program is also continuing to incorporate environmental justice into the full range of its actions, most recently guided by a *Diversity, Equity, Inclusion and Justice Action Statement* approved in August 2020, which recognizes that healthy local waters and a restored Chesapeake Bay are best achieved through the equitable involvement of all people residing in the watershed.

Representatives of nongovernmental organizations, academic institutions, businesses and local governments participate in one or more of our many workgroups. The USEPA maintains an office in Annapolis, Maryland, where their staff, grantees, contractors and some select academic, federal or state agency partners work. These are the people responsible for ensuring the day-to-day operations of the Chesapeake Bay Program.

Watershed Agreement

Members of our Chesapeake Executive Council are referred to as signatories of the *Chesapeake Bay Watershed Agreement*. The *Watershed Agreement* governs the work of our partnership. There have been several watershed agreements to this point, but our most current was signed in 2014.

The *Watershed Agreement* contains five themes:

- Abundant Life
- Clean Water
- Climate Change
- Conserved Lands
- Engaged Communities

Under these five themes, there are 10 goals and 31 outcomes. Each of these outcomes has a related workgroup that is dedicated to meeting its restoration target. For example, our Oyster Outcome seeks to restore native oyster habitat and populations in 10 tributaries by 2025. Members of the workgroup that strive to meet this target come together from a variety of different organizations. Using the Oyster Outcome as an example, some of the organizations represented on their workgroup include the Virginia Institute of Marine Science, the City of Norfolk, Virginia, the Elizabeth River Project, the Maryland Department of Natural Resources and Pleasure House Oysters, among many others.

Total Maximum Daily Load

The Clean Water theme of the *Watershed Agreement* incorporates one of the signature efforts to restore the Bay: the Chesapeake Bay Total Maximum Daily Load (Bay TMDL), more commonly referred to by USEPA as a "pollution diet."

The Bay TMDL sets limits on the amount of nitrogen, phosphorus and sediment pollution that the six watershed states, and the District of Columbia (D.C.), can release into the Chesapeake Bay, and still have it meet standards for healthy water quality. The Bay TMDL was put into place in December 2010 with the goal of having each of the six watershed states and D.C. having all necessary practices in place to meet their pollution reduction targets by 2025. The targets vary for each of the states and D.C. and were calculated through state-of-the-art modeling tools, extensive monitoring data, peer-reviewed science and interactions with each state and D.C.

In crafting the *Watershed Agreement,* partners wanted to include

elements of the Bay TMDL to recognize its connection to the Chesapeake Bay Program. Two of the outcomes – 2025 Watershed Implementation Plans and Water Quality Standards Attainment and Monitoring – are the ways in which the *Watershed Agreement* integrates with the Bay TMDL. The 2025 Watershed Implementation Plans, or WIPs, consider modeling data in tracking progress, while the Water Quality Standards Attainment and Monitoring outcome is tracked using monitoring data.

Where to Find Program Information

We track progress toward the outcomes of the W*atershed Agreement* through the *Chesapeake Progress* website. This is a one-stop shop for much of our data and information. It includes the most current data for all the outcomes, which is collected from experts across the watershed, ensuring accurate reporting of our progress.

Every year, the Chesapeake Bay Program releases an annual report called the *Bay Barometer,* which is a roundup of the most current data and information that is published on *Chesapeake Progress* throughout the year.

Our Chesapeake Monitoring Cooperative works with groups and individuals throughout the watershed to standardize data collected through community science efforts and make it publicly available.

Our Chesapeake Bay Watershed Data Dashboard is an online tool that provides accessibility and visualization of data and technical information that helps guide water quality and planning efforts. Our flagship website, *chesapeakebay.net,* lists out all the other types of datasets that are available.

Among the resources on our website, we have *Discover the Chesapeake*. This is where you can get a baseline understanding of the Chesapeake Bay watershed. We have a history page about people and events that happened in the region, a field guide section where we identify over 250 wildlife species, a page about the Bay's ecosystem and a few other educational sections.

We have a *Learn the Issues* page. Here you can learn about how things like agriculture, invasive species and climate change impact the watershed specifically. We detail these issues and then at the end of the page we have examples of what individuals can do to help. Also, to the side of the page we have a frequently asked questions (FAQ) section related to each issue. The FAQ page is another part of our website where visitors can submit questions and get responses from our team.

The website also includes a section on the *State of the Chesapeake*. This is essentially information about our progress toward resolving those various issues.

We have a *How-To's & Tips* page that lists ways that the public can help restore the Bay and keep it healthy. *Find a Group* is a map you can use to find watershed groups in your area, attend an event calendar with educational webinars and volunteer events. *Visit the Chesapeake* is another map of different parks, boat launches and other public access locations. And there is a section with three different Chesapeake Bay newsletters you can access.

We also have an *In the News* section, which includes the *Press Center* and the *Recent News* pages. *Press Center* is where we post press releases from the Bay Program, and *Recent News* is our blog section. We write about 10 news blogs a month, covering stories about wildlife, restoration projects, outdoor recreation, Bay history and various unique places in the watershed.

You can check out the *Who We Are* section, where we provide information about our staff, our partners, how we're organization, our history, budget and financing, job openings and contact information. And lastly, we have a *What We Do* section, which has various pages about our work including our Programs & Projects, our Grants & RFPs (Requests for Proposals), a meetings calendar, and a publications, data and maps page that has a wide variety of available resources.

Photography and Videography

We present a range of documentary visual storytelling featuring the people and places that make up the Chesapeake Bay watershed. Our photography and video storytelling first appear as part of many of the articles described earlier. Like our other content, we freely share our archive of original photography and video footage for noncommercial or media use; most things educational or editorial would qualify.

To date we have over 14,000 photographs available through our archive, which is searchable on Flickr. We offer a range of subjects; we visit a lot of parks, so wildlife photography is well-represented in our archive. We cover the range of restoration efforts, from forest buffers and cover crops to green infrastructure. We also have a representative amount of aerial photography, produced in partnership with the nonprofit SouthWings.

Our videos include our "Bay 101" series, which is our flagship series of videos that serve as introductions to environmental issues and topics, like oysters or population growth. We also produce feature stories that show a more personal perspective.

Ongoing Progress

Through the Chesapeake Bay Program, we offer world-class scientific data and information, access to subject matter experts across a variety of environmental fields, shareable web content, articles, blogs, photos and videos. Thanks to our experts and scientists, our partnership has pioneered cutting edge science and research. For example, in the early 1990s, our researchers found that airborne nitrogen was a significant contributor to bay nutrient loading. Our computer models are among the most sophisticated and studied throughout the entire world.

As we approach important milestones in our efforts, we appreciate the power of partnership in working toward a clean Bay and watershed. We still have much to do to reach our goals, but we have made significant progress under the collective banner of the Chesapeake Bay Program.

Michelle Price-Fay is the acting director of the Chesapeake Bay Program Office for the USEPA and may be reached at Price-Fay.Michelle @epa.gov.

Links

Chesapeake Executive Council
https://www.chesapeakebay.net/who/group/chesapeake_executive_council

Collective Action for Climate Change Directive
https://www.chesapeakebay.net/documents/43419/climatedirective_final_2.pdf)

Diversity, Equity, Inclusion and Justice Action Statement
https://www.chesapeakebay.net/documents/PSC_DEIJ_Action_Statement_FINAL_With_Signatures.pdf

Chesapeake Bay Watershed Agreement
https://www.chesapeakebay.net/what/what_guides_us/watershed_agreement

Chesapeake Progress website
https://www.chesapeakeprogress.com/

Strategies for Effectively Funding Chesapeake Bay Restoration in NY

by Khristopher Dodson

New York has effective statewide funding programs in place for environmental conservation activities, including water quality restoration. However, projects that advance Chesapeake Bay Watershed Implementation Plan (WIP) execution must compete against many other statewide needs. New York's Chesapeake Bay watershed comprises 12% of the state's total land area and is home to just 3% of the total population. Yet given the federal mandate to reduce nutrient and sediment loads entering waterways in this region, New York's Southern Tier may require a disproportionately larger share of statewide investments, especially as the state works to meet the 2025 total maximum daily load (TMDL) deadline.

To maintain and accelerate progress toward TMDL goals, it will be necessary to increase funding for water quality initiatives in New York's Chesapeake Bay watershed so that this funding is both sufficient and stable over time. One approach to do so involves targeting existing statewide funding programs for water quality improvement projects in New York's Southern Tier region until TMDL goals have been met. This avenue does not involve creating new funding mechanisms or new funding programs, which could be slow to implement, would entail additional administrative burdens, and may not be easy to communicate to the public or legislators. The second approach is to generate additional revenue through taxes, fees and debt financing. Because it is never politically or administratively easy to launch a new revenue mechanism, such an initiative would ideally be coupled with efforts to reduce compliance costs and leverage outside funds.

Augment Existing Funding Programs

Dedicate a portion of the Environmental Protection Fund to the Chesapeake Bay watershed, and ensure the Fund's long-term stability.

The Environmental Protection Fund (EPF) is the most significant source of state funding for environmental conservation in New York, yet it does not provide dedicated funding for water quality restoration. Statewide, demand for EPF grant money exceeds available funding, and projects within the state's Chesapeake Bay watershed are not always the most competitive projects. The Chesapeake Bay is one of the few watersheds in New York that does not receive a direct line item from the EPF (1). While it could require legislative change, creating a direct line of funding for the bay watershed would signal the state's commitment to achieving water quality goals in the Southern Tier and would be an effective way to ensure dedicated, reliable funding for WIP implementation.

Use Clean Water State Revolving Funds to support nontraditional water quality protection efforts in the Southern Tier, including nonpoint source and green infrastructure projects.

The Clean Water State Revolving Fund (CWSRF) can be a significant source of funding for water quality and watershed protection efforts. While the fund has traditionally been targeted toward wastewater infrastructure needs, Title VI of the Clean Water Act authorizes the use of this program for other types of projects as well. Such projects focus on agricultural nonpoint sources, urban green infrastructure, or improving water or energy efficiency; eligible recipients include both public and private entities.

Given the significant reductions still needed from non-wastewater sources in order to meet 2025 nutrient and sediment targets, New York's CWSRF program is a viable funding option for projects targeting pollution from agricultural nonpoint source, decentralized wastewater treatment systems (including septic, or on-site, systems) and municipal stormwater runoff.

Evaluate the Need for New Revenue Sources

New York may also consider implementing new dedicated revenue streams for Chesapeake Bay WIP implementation in the form of taxes or fees. While not likely to be a politically popular choice, this is one of the main tools a state has at its disposal to generate sufficient and stable funding. Revenue from any new tax or fee could be used to buttress existing funding programs or it could be used to capitalize a new fund, perhaps in combination with a new direct line of funding from the EPF.

One alternative in this category is a fee on nutrient and sediment discharges. Pollution taxes have the benefit of directly disincentivizing the undesired activity (in this case, water pollution), and when set at the appropriate rate, they can achieve reductions in the most economically efficient way and catalyze the development of innovative pollution reduction technologies. They are also more easily administered than many regulatory programs, and they provide a flexible revenue stream because the rate can be adjusted as needed (2).

Another fee-based option is the stormwater utility fee. While a local rather than state funding source, stormwater fees are increasingly being used around the country to provide a sufficient, equitable, and dedicated source of funding for stormwater management. By shifting the responsibility for managing – and financing – stormwater to the local level, significant efficiencies can be achieved. New York's Chesapeake Bay watershed has 26 regulated municipal separate storm sewer system (MS4) communities.

More than half of all states have enacted enabling legislation that provides local governments and municipalities the authority to establish stormwater utilities and associated fees to support their stormwater management programs (3). In New York, however, no such law has been passed.

Beyond taxes and fees, a third option for generating capital is bond financing. This mechanism can infuse funds into immediate needs. However, it has the disadvantage of imposing a long-term liability on the state and costing more over the long term. New York state can issue general obligation bonds, which are supported by the state's taxing power and typically must be voter-approved, as well as revenue bonds, which are repaid by specified tax or other revenue generated by the project (common examples include toll roads, bridges and hospitals) (4). Other potential options include green bonds, the proceeds of which are dedicated to implementing environmental needs such as water quality practices, as well as public building authority bonds, which can often be used for wastewater treatment plants, combined sewer separation projects, and stormwater projects.

Leverage Private Sector Capital and Capacity to Support Bay Restoration

With Chesapeake Bay TMDL deadlines approaching and state and federal resources increasingly limited, there is compelling reason to leverage private sector investment in restoration activity.

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In addition to directly partnering with private sector firms to implement practices, the state could implement approaches to make public investments function in a market-like manner, which could further incentivize private sector involvement.

Four ideas could help set the stage for New York to engage the private sector in water restoration priorities:

- Enable and pursue strategic public-private partnerships
- Adopt a comprehensive, performance-oriented financing approach in state funding programs
- Direct economic development investments to industries that support water quality restoration
- Authorize an independent financing entity to deploy bay restoration funds

Enable and pursue strategic public-private partnership.

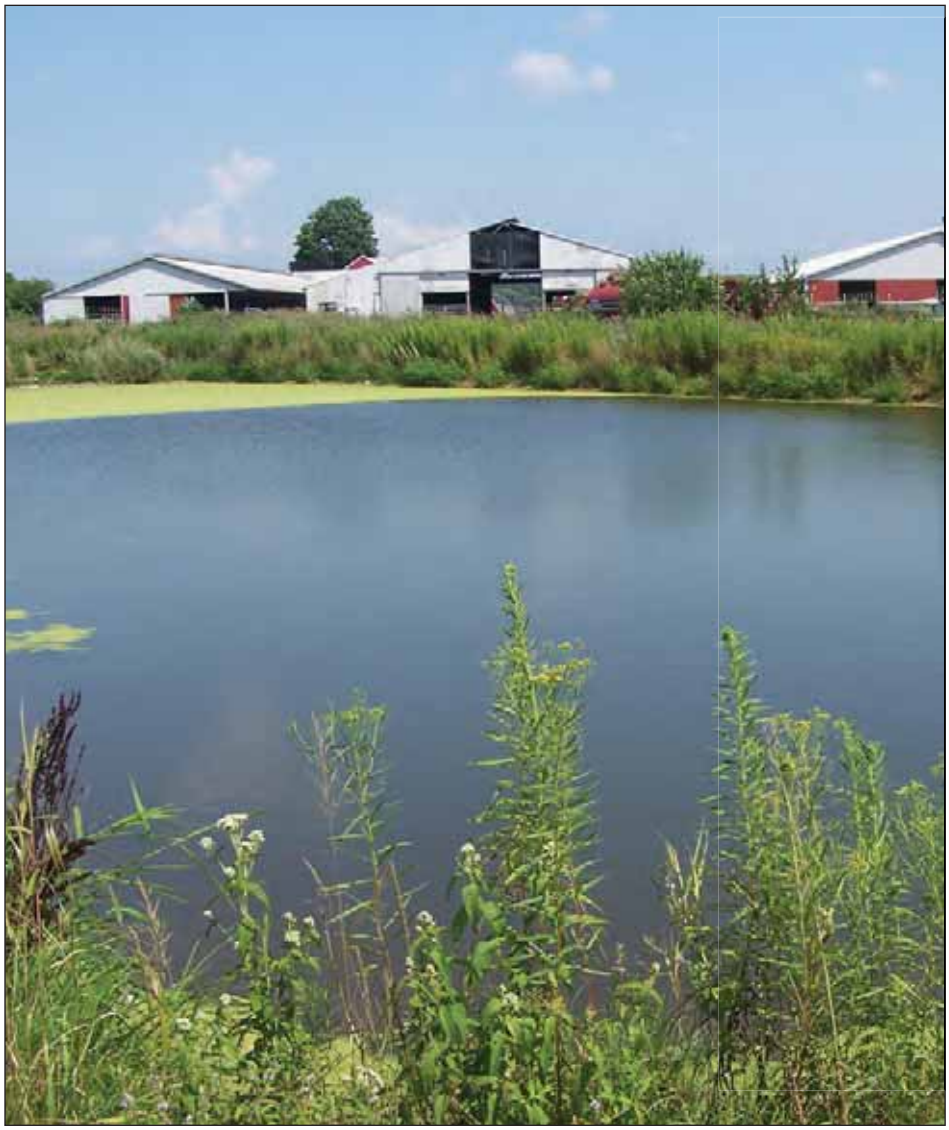
The potential use of public-private partnerships (P3s) for stormwater management in particular has attracted a great deal of attention throughout the bay region. A P3 is a contractual arrangement between a public agency and a private sector entity, through which the parties collaboratively deliver a good or service and share in bearing the potential risks and rewards (5). P3s can be used for an entire project or for selected aspects, such as financing, design, construction, operations and maintenance, and monitoring and evaluation.

Adopt a comprehensive performance-oriented financing approach in state funding programs.

Performance-oriented financing can be a powerful tool for reducing implementation costs and engaging the private sector. This approach focuses on the desired outcome (pounds of nutrients or sediments reduced) rather than the means to get there (particular BMPs or projects). Paying for results instead of projects provides the incentive to find the most cost-effective and highest-performing practices, thereby maximizing the impact of public dollars spent. It also provides clear expectations and rules, key enabling conditions for securing the participation of private sector partners.

A challenge with this approach is the cost of monitoring, measuring and verifying outcomes. However, building these costs into contracts not only accounts for them up front; it creates an incentive to improve the efficiency of monitoring procedures.

A specific performance-based financing mechanism that New York might consider is the pay for success contract. In this model, state or local government agencies contract with private sector investors who provide up-front funding to a service provider, which in the case of water restoration may be a private landowner, nutrient credit aggregator, watershed organization or other similar party. The service provider conducts whatever activities are necessary to produce the desired outcome – e.g., pounds of pollution abated. If this can be achieved at a cost below what the government agency has agreed to pay, the remainder is profit to the investor. The government agency then repays the investors if the program meets its goals. If the program fails, taxpayers pay nothing. The pay for success model offers significant benefits to the public sector, including improved performance (as better performance equals a greater return on investment), increased innovation and reduced costs. The model also transfers risk from the public to the private sector, which is usually better equipped to efficiently mitigate that risk (6).



Concentrated animal feeding operation (CAFO) in Chenango County. *SU-EFC*

Direct economic development investments to industries that support water quality restoration.

While not a direct water quality financing mechanism, an opportunity to reduce pollutant loads while advancing other local and regional priorities (e.g., economic growth and job creation) is to integrate restoration into broader economic development initiatives. Specifically, this approach would involve prioritizing public investments toward markets and industries that are supportive of water quality protection and restoration.

One opportunity is to direct public economic development subsidies to clean water industries. Investment in these sectors could not only attract new businesses and create jobs but also would be supportive of efforts to maintain water quality.

A related opportunity is to offer incentives to launch and/or expand innovative initiatives that both generate revenue and function

as restoration practices in and of themselves. Some examples might include freshwater aquaculture, cultivating fruit and nut trees within forest buffers, and installing waste-to-energy systems. All of these have capacity not only to create jobs but also to improve water quality.

Authorize an independent financing entity to deploy bay restoration funds.

Implementation of several of the previously discussed strategies could be facilitated by employing this next concept, which is to authorize a financing authority to hold and disperse restoration funds with autonomy and flexibility. This entity could be newly established, or it could be an existing institution whose capacity and mandate is expanded. In either case, essential characteristics include the capability to:

1) Pool capital from various sources including state and federal agencies, private investors and even philanthropic donors, so that public funding can effectively be used with other sources of capital.
2) Deploy funds to high-yield projects, investing when effective projects are ready to be funded, not necessarily when public budgeting cycles dictate.
3) Establish performance criteria and award funding based on these criteria (and adapt criteria as new information becomes available over time).
4) Facilitate water quality trades within a state or regional credit financing system, should a water quality trading program be established in New York.

New York has a number of financial tools at its disposal to meet its Chesapeake Bay TMDL 2025 targets. The above listed represent overviews of major types of funding mechanisms the state could use as it advances water quality improvements in New York's Chesapeake Bay watershed.

Khristopher Dodson is the associate director at the Syracuse University Environmental Finance Center (SU-EFC) and may be reached at kadodson @syr.edu.

End Notes

1) Lauren Townley, New York Department of Environmental Conservation. 6/12/18. Communication with EFC.
2) Experimental Economics Center. "Advantages of Green Taxes." Accessed 9/29/16: *http://www.econport.org/content/handbook/Environmental/pollution-control-revised/Advantages.html*
3) National Association of Clean Water Agencies. 2016. "Navigating Litigation Floodwaters: Legal Considerations for Enacting, Implementing & Funding Stormwater Programs." Available: *http://www.nacwa.org/docs/default-source/news-publications/White-Papers/2016-11-04stormwaterwhitepaper.pdf?sfvrsn=2.*
4) New York State Division of Budget. "New York Bonds" website. Accessed 6/12/18: *https://bonds.ny.gov/bonds/BYNB-bondsTypes.html*
5) The National Council for Public-Private Partnerships. "7 Keys to Success." Accessed 2/14/19: *https://www.wateronline.com/doc/the-keys-to-successful-public-private-partnerships-0001*
6) The *Pay for Success Learning Hub,* maintained by the Nonprofit Finance Fund, is a repository for information on this model and includes an assessment tool for governments to evaluate readiness to implement such a program.

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Cooperstown's WTP Renewed after 40 Years

by Jarrett Hotaling

The Susquehanna River is the greatest source of freshwater to the Chesapeake Bay, making wastewater treatment along the river vital to the health of the Chesapeake Bay Watershed as a whole. The Village of Cooperstown's Wastewater Treatment Plant (WTP) is situated just over one mile south of Otsego Lake, which is the headwaters of the East Branch of the Susquehanna River. The village also gets its drinking water from Otsego Lake.

With Glimmerglass State Park at the north end of Otsego Lake and the Village of Cooperstown at the south end, conservation and monitoring efforts are closely watched. The State University of New York at Oneonta's Biological Field Station, Otsego County Conservation Association and the Otsego Lake Association work together to ensure water quality and management practices are held to a high standard.

Cooperstown's WTP uses two outfalls. One leads directly into the Susquehanna River following treatment while the other outfall empties into a treatment wetland by way of roughly 1,500 feet of force main. To accommodate the Chesapeake Bay Watershed Total Maximum Daily Load (TMDL) regulations, Cooperstown began a considerable plant overhaul in the fall of 2019 that either rehabbed or replaced almost all existing treatment components.

With funding from the New York State Environmental Facility Corporation and coordination by Delaware Engineering, the Village of Cooperstown is closing in on completion of a $9.1 million plant upgrade. Once a plant with a lone primary clarifier, Cooperstown's WTP now has two primary clarifiers:

- The existing primary clarifier, as well as the two existing secondary clarifiers, were outfitted with all new interior components and valving.
- A hydraulically driven trickling filter with rock media was replaced with a motor-driven distribution assembly and synthetic media.
- Three rotating biological contactors (RBCs) were stripped down completely and reconstructed with new drive ends, load cells, galvanized framing and new media packs.
- The drying beds have been replaced with a belt press, which sits in a brand-new, two-bay storage facility.

With cooperation from on-site contractors and thorough planning, Cooperstown remained in regulatory compliance throughout the project. Nitrogen and phosphorus limits set for the Chesapeake Bay region are being met well within reason, in part because of the improvements made. Only a few minor punch-list items are still to be done, but the Village of Cooperstown's WTP upgrade is primarily complete and the newest it has been in over 40 years.

Jarrett Hotaling is a wastewater operator for the Village of Cooperstown and may be reached at jarhot94@yahoo.com.

Two new primary clarifiers have been added to the Cooperstown WTP. *Jarrett Hotaling*

The two existing secondary clarifiers have been outfitted with all new interior components and valving. *Jarrett Hotaling*

The hydraulically driven trickling filter with rock media has been replaced with a motor-driven distribution assembly and synthetic media. *Jarrett Hotaling*

Improving Water Quality through Energy Efficiency, Consolidation and Local Investment

by Taylor Bottar and Alex Hess

The Town of Chenango's Wastewater Treatment and Conveyance Improvements Project is among the many water resource recovery facility (WRRF) projects that are reducing nutrient discharges and contributing to the recovery of the Chesapeake Bay. Unique to this project is its consolidation of three WRRFs into one and a "batch" membrane bioreactor technology that will increase energy efficiency while also improving water effluent quality.

Background

The Town of Chenango is in Broome County, just north of the City of Binghamton in New York's Southern Tier region. The town's current population is just shy of 11,000. Much of the existing commercial and residential development present today originated in the 1980s and 1990s, occurring primarily along the Chenango River valley and tributary valleys such as Castle Creek. Sanitary sewer infrastructure followed this development with construction of a traditional gravity main/pump station collection system, the Northgate Wastewater Treatment Plant (WWTP), Pennview WWTP and Chenango Heights WWTP.

In the mid-2010s the New York State Department of Environmental Conservation (NYSDEC) classified the Northgate WWTP as "Bay-Significant," indicating it is a significant contributor to overall nutrient loading to the Chesapeake Bay watershed. Northgate's state pollutant discharge elimination system (SPDES) permit was modified in 2018 to reduce the total annual phosphorus loading from 1,910 pounds to 1,220 pounds by 2025. During that same period, the Town of Chenango assumed ownership of the Chenango Heights WWTP due to its deterioration and lack of maintenance.

With the need for a plan to meet Northgate's approaching phosphorus removal requirements and dire improvements necessary at Chenango Heights, the Town of Chenango retained Barton & Loguidice, D.P.C (B&L) to evaluate potential alternatives. B&L's holistic approach during the study phase led to the recommendation to decommission both the Chenango Heights WWTP and Pennview WWTP and convert them to pump stations, each with approximately 1.5-mile force mains that would discharge to the Northgate WWTP collection system. Process improvements along with the necessary capacity increase were proposed at the Northgate WWTP. This proposal provided a number of benefits to the town and Chesapeake Bay watershed including:

- Reducing wastewater operator and maintenance responsibilities and long-term asset management burdens at multiple WRRFs
- Increasing water quality, not just of existing Northgate effluent but also of Chenango Heights and Pennview discharges that did not have nitrogen or phosphorus loading limits

However, treatment options that met the future effluent requirements and increased capacity were limited at the Northgate WWTP given space constraints on the 1.2-acre parcel where two-thirds of the site are occupied by the existing composting facility.

The following three treatment technologies were identified as potential candidates:

Summary of the Existing Infrastructure

- ❑ Sanitary sewer collection system – gravity sewer mains with 19 pump stations
- ❑ Northgate WWTP – 0.8 MGD permitted 30-day average
  - Cyclic Activated Sludge System (CASS) treatment via three sequencing batch reactors
  - Disinfection via liquid sodium hypochlorite injection
  - Aerobic digestion, belt press dewatering, and static pile composting to achieve Class A biosolids
  - Effluent discharge to the Chenango River
- ❑ Pennview WWTP – 0.04 MGD permitted 30-day average
  - Steel-tank "package" treatment via aeration and solids separation
  - Disinfection via chlorine tablets
  - Solids disposal at the Northgate WWTP
  - Effluent discharge to Castle Creek
- ❑ Chenango Heights WWTP – 0.05 MGD permitted 30-day average
  - Concrete-tank "package" treatment via aeration and solids separation
  - Disinfection via chlorine tablets
  - Solids disposal at the Northgate WWTP
  - Privately owned until 2018
  - Effluent discharge to Chenango River

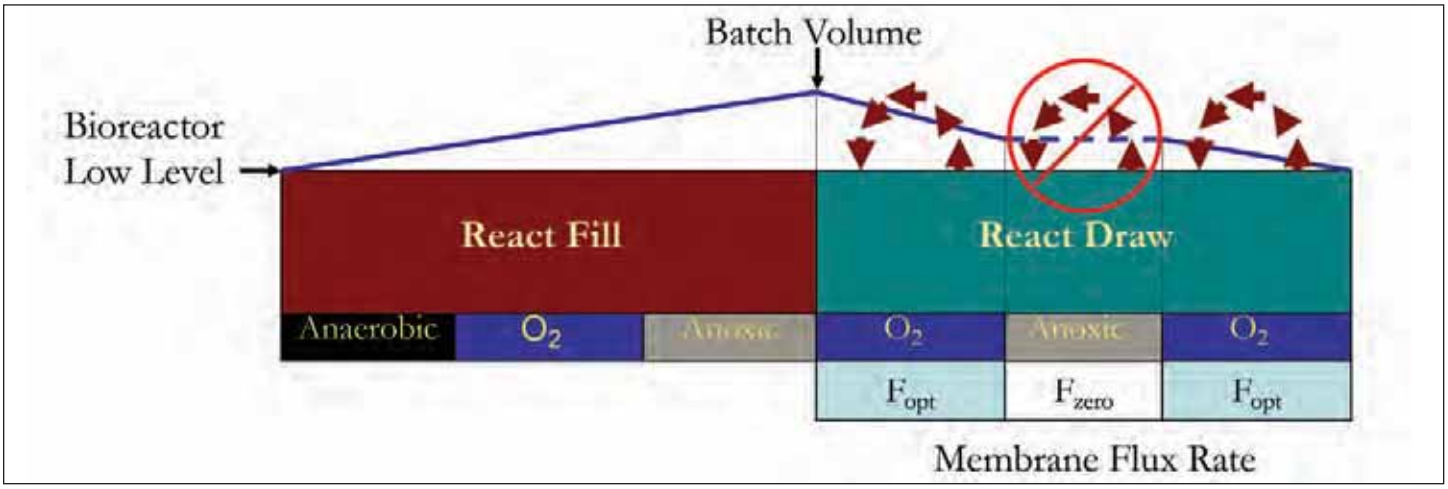

Figure 1. Batch MBR Treatment Cycle. *David Holland, 2015, p. 9*

1. "Batch" membrane bioreactor (MBR)
2. "Flow-through" MBR
3. Aerobic Granular Sludge (AGS)

Batch MBR

A batch MBR system would operate in similar fashion to Northgate's existing sequencing batch reactor (SBR) process where three separate treatment reactors operate simultaneously in various stages of fill, react and draw. By throttling blowers and mixers on and off throughout the react/fill and react/draw phases the batch MBR can achieve the anaerobic, anoxic, and aerobic stages required for biological phosphorous and nitrogen removal. ***Figure 1*** illustrates a typical batch treatment cycle.

Following a completed batch cycle, bioreactor effluent would discharge by gravity to the membrane tank where it would be filtered through hollow fiber bundle membranes via permeate pumps. Membrane filtrate would be pumped to a 3,000-gallon permeate tank for membrane cleaning backwash (as needed) prior to ultraviolet (UV) disinfection and outfall discharge. Solids retained in the membrane tank would be either recirculated to the bioreactors to maintain mixed liquor suspended solid concentrations or wasted to the plant's solids handling system.

Flow-through MBR

Unlike the batch MBR, a flow-through MBR system would create separate tanks/zones to establish the anaerobic, anoxic, and aerated conditions required for biological phosphorus and nitrogen removal. Influent wastewater, initially equalized in influent storage tanks, would continuously "flow through" the anaerobic stage first, followed by anoxic and pre-aeration prior to discharge to the membrane tank. Membrane filtrate would be pumped to the UV disinfection system and outfall discharge. Solids retained in the membrane tank would be either recirculated to maintain mixed liquor suspended solid concentrations or wasted to the plant's solids handling system.

Aerobic Granular Sludge

AquaNereda AGS is an emerging technology that has been developed in Europe and marketed in the U.S. by Aqua-Aerobic Systems, Inc., since 2016. AGS provides a unique solution to nutrient treatment that can eliminate the need for membrane filters while using a treatment process similar to that of Northgate's existing SBR. The main difference between SBRs and AquaNereda is that the AquaNereda system contains "conditioned" granular solids or AGS. The AGS is conditioned off-site by Aqua-Aerobic Systems and would be seeded into the Northgate WWTP.

As illustrated in ***Figure 2***, each granule contains an anaerobic, anoxic and aerobic zone. Further, due to the compact and heavy nature of the granules, the settling properties of AGS are significantly greater compared to conventional activated sludge, thus reducing tank volume requirements.

The AquaNereda system would operate similar to Northgate's existing SBR process and within the existing Cyclic Activated Sludge System (CASS) basins. Effluent filtration would be required in the form of cloth media filters, significantly less expensive than membrane filters, in order to meet phosphorus limits.

Unfortunately, site limitations would have prevented the AquaNereda system from treating peak hourly flows given existing tank volumes and thus would not have met regulatory requirements. AquaNereda AGS was therefore determined to be unfeasible for this application, but it is a promising technology for nutrient removal.

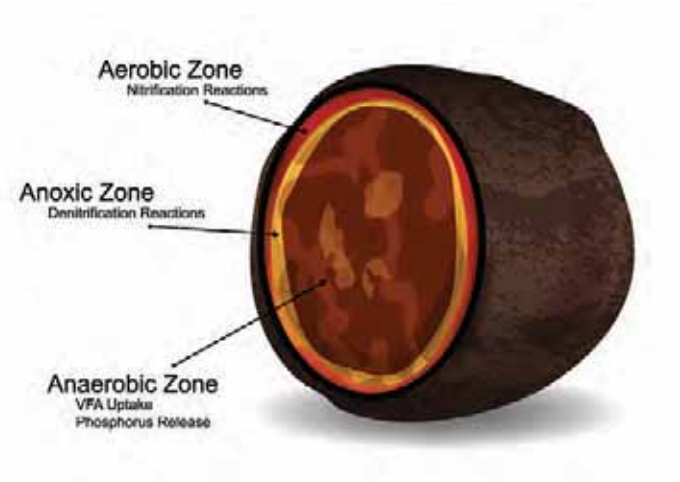

Figure 2. Aerobic granular sludge. *Aqua-Aerobic Systems, 2017*

Energy Consumption Comparison

MBR systems are traditionally known to be energy intensive. However, the batch MBR system allows substantial energy savings compared to flow-through MBRs given its ability to act in similar fashion to a traditional SBR – throttling blowers and mixers on and off throughout the treatment phases and sitting idle during low-flow periods. In fact, the proposed batch MBR system is anticipated to increase Northgate's existing energy consumption by only 16% while also increasing hydraulic capacity 25% and producing significantly higher quality effluent. A summary of estimated energy consumption is presented in ***Table 1***.

Table 1. Energy Consumption Comparison

Process Option	Treatment Capacity (Avg. flow)	Estimated Daily Electrical Consumption (kWh/day)[1]	Estimated Annual Electricity Cost[2]
Existing CASS	0.8 MGD	2,086	$60,000
Batch MBR	1.0 MGD	2,385	$70,000
Flow-through MBR	1.0 MGD	4,319	$126,000

Notes:
1. The Estimated Daily Electrical Consumption, in kilowatt-hours per day (kWh/day), was provided by the equipment vendor for each technology based on average day flow rate in million gallons per day (MGD).
2. The Estimated Annual Electricity Cost is based on $0.08 per kWh.

Selected Alternative and Effluent Quality

The batch MBR system was the selected alternative based on its energy consumption savings, the corresponding 20-year net present value analysis, and operations flexibility. ***Figure 3*** illustrates a

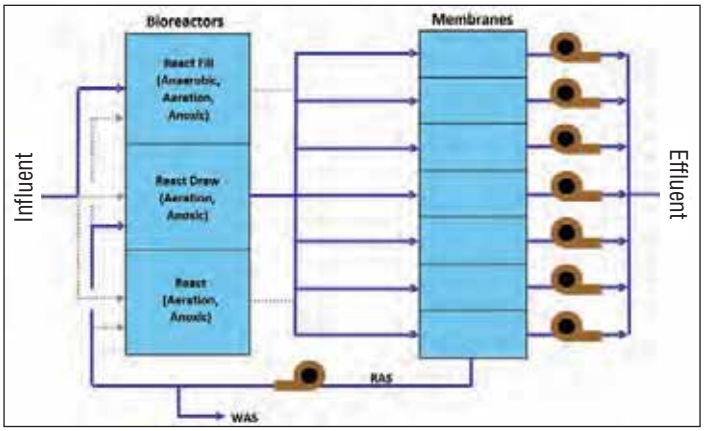

Figure 3. Batch MBR process flow diagram.

Courtesy of Aqua Aerobic Systems, Inc.

continued on page 26

continued from page 25

general process flow diagram of the batch MBR treatment process.

Anticipated effluent from the batch MBR system will enable Northgate to meet its future phosphorus loading limit and existing nitrogen loading limit while reducing five-day biochemical oxygen demand (BOD5) and total suspended solids (TSS) concentrations into the single digits, well below the current 30 milligrams per liter (mg/l) permitted limits.

Project Summary and Status

In addition to the proposed batch MBR system and pump station conversions, the project includes the following improvements:

- Northgate WWTP
  - o Batch MBR treatment system
  - o New headworks building with redundant, perforated plate influent screens (2-millimeter) and vortex grit removal system
  - o New influent and sidestream pump stations
  - o New aerobic digester tanks
  - o New UV disinfection system
  - o New supervisory control and data acquisition (SCADA) system
  - o Control building modifications and expansion
- Collection System
  - o Decommission of the Chenango Heights and Pennview WWTPs and conversion to pump stations
  - o Installation of approximately 3 miles of force main
  - o Rehabilitation of 19 existing pump stations, generally to include replacement of pumps, valves, controls and telemetry/SCADA

The project is currently in the final design phase with construction bidding anticipated winter 2021/2022. Construction is anticipated to be complete by 2024.

Investing in Our Local Infrastructure Has Far Reaching Impacts

This project is a shining example of the impacts local investment can have on the overall water quality in a region. Grants from the New York State Water Infrastructure Improvement Act and Water Quality Improvement Project programs and low-interest financing from the New York State Environmental Facilities Corporation enabled this project to come to fruition by making it affordable to the Chenango community. Through this investment in the Northgate WRRF and collection system infrastructure, the Town of Chenango can do its part in improving the water quality of the Chesapeake Bay and local communities connected throughout the watershed.

Taylor Bottar is a Managing Engineer with Barton & Loguidice, D.P.C. and may be reached at tbottar@bartonandloguidice.com. Alex Hess is an Engineer II with Barton & Loguidice, D.P.C. and may be reached at ahess@bartonandloguidice.com.

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Chemung County Sewer Districts' Consolidation on Track to Meet Chesapeake Bay Program Requirements

by Tom Rhoads, Ali Rennie and John R. Amend

In the Southern Tier of New York, the Chemung River winds through a beautiful valley. Flowing through steep slate cliffs gouged out more than 10,000 years ago during the last ice age, the Chemung River connects the region to its heritage and history going back to prehistoric times.

Chemung is an Iroquois word meaning "big horn" or " horn in the water," so named when Indigenous people found a mastodon tusk buried in river silt in the area. The river connects three counties, two states and four other rivers. From its beginning in Painted Post, where the Cohocton, Canisteo and Tioga rivers connect, the Chemung River flows through Steuben and Chemung counties and into Pennsylvania. The Chemung River ends where it merges with the east branch of the Susquehanna River in Athens, Pennsylvania. The river's waters continue onward through the Susquehanna River system to the Chesapeake Bay and Atlantic Ocean more than 350 miles away.

Today, communities and residents along the Chemung River remain connected to this important waterway through a shared respect and understanding of its geography, its ecology, past and future development and a common dependency on the river's waters. The river supplies public drinking water for nearly half of the people who live in the Chemung River Basin and the water from the Chemung serves many more people on its way to the Chesapeake Bay. The Environmental Protection Agency's Chesapeake Bay Program is central to maintaining, protecting and enhancing the entire river system and the Chemung County Regional Wastewater Treatment Plant consolidation program plays an important part in the long-term health of the river, the Chesapeake Bay, and all those people who depend on it.

Chemung County's Sewer Districts

Chemung County's county seat, the City of Elmira, is well known as the summer residence of Samuel Langhorne Clemens, better known as Mark Twain. At about the same time he was writing in Elmira, the city also began its "public" sewer system construction.

The Chemung County Sewer Districts (CCSD) serve the City of Elmira and seven local municipalities with wastewater collection and treatment via its two sewer districts. Like many urban systems built before 1900, the City of Elmira, served by the Elmira Sewer District, has a combined sewer system. CCSD's other district, Sewer District No. 1, is a long linear collection system following the river to communities in and along the valley plain, including Big Flats and Horseheads. The far reaches of this sewer district serve the Elmira Corning Regional Airport, and the Corning Hospital. The two sewer districts serve every major employer in Chemung County as well as all three hospitals in the area. Reliable and cost-effective wastewater collection and treatment service is fundamental to both the public and economic health of the community.

The Lake Street facility in the Village of Elmira Heights, which serves Sewer District No. 1, is over 50 years old. Having far outlived its useful life, the facility is operating on borrowed time, struggling to meet current effluent requirements during wet weather. The 35-year-old Milton Street facility, located just south of the City of Elmira, serves the Elmira Sewer District. While this facility is very well maintained, it is also nearing the end of its useful life and must be updated to continue its service to the community. The Chesapeake Bay Total Maximum Daily Load (TMDL) requires each of these legacy plants to improve treatment and remove additional nutrient loadings from the effluent. Disinfection of the effluent is also required by current regulations.

Geographically the two facilities are only 5 miles apart. Effluent from the Lake Street facility discharges through a long outfall to a bend in the river just a mile north of Milton Street. Because of this proximity, and the age and poorer condition of the Lake Street facility, it made sense to consider consolidating treatment at the larger Milton Street facility, turning it into a regional wastewater treatment plant.

The Consolidation Program

In 2018, a consolidation study was prepared that demonstrated savings of approximately 19% to consolidate treatment at the Milton Street site rather than upgrade both plants to meet the Chesapeake Bay TMDL. To accomplish consolidation, the Lake Street plant will be converted into a pretreatment and pumping facility. The Lake Street outfall provides a unique opportunity to reconstruct this effluent outfall into an influent interceptor sewer conveying water from Sewer District No. 1 to the new Chemung County Regional Wastewater Treatment Plant at the Milton Street site. The existing Lake Street outfall will be rehabilitated and extended, crossing the Chemung River and then consolidating all flows for final secondary treatment and resource recovery at the Milton Street location.

Although Sewer District No. 1 is a separate sanitary sewer system, it too is plagued with extraneous flows at times. By combining treatment at one facility, the new regional treatment plant will take advantage of the different timing of peak flows in the two districts. Thus, by consolidating flows, the new facility will abate sanitary sewer overflows (SSOs) from the existing Lake Street facility, while also providing additional treatment capacity for most wet weather events in the combined sewer system. While final long-term control plan effectiveness is still under study, this approach should enable economically attractive, low capital cost weir changes in the combined system to enable more storage and subsequent treatment of additional combined sewer flows.

Milton Street Plant Upgrades

The existing Milton Street plant site enjoys sizable acreage, enabling the rehabilitation of two existing primary and two existing secondary clarifiers, with the added capacity needed for consolidation provided by mirroring those existing process tanks with new tanks. The final design incorporates four primary clarifiers and four secondary clarifiers. Each of the legacy treatment plants uses trickling filters for biological oxygen demand (BOD) removal. For the consolidated facility, CCSD elected to continue to use trickling filters (two rehabilitated and two new) to remove BOD and for nitrification. The fixed-film technology approach was used rather than switching to an activated sludge process, to keep the aerobic process simple to operate and maintain, and because significant fixed-film infrastructure already existed.

The decision was also made to use a sidestream moving bed biologic reactor (MBBR), to provide the required denitrification. The

Photograph 1. The existing Milton Street Plant, with clarifiers in the foreground and the solids handling buildings behind. The steep hills that form the Chemung River valley are visible in the background. *Tom Rhoads, CCSD*

MBBR will contain plastic media (biocarriers) and will be operated anaerobically to denitrify and meet the new nutrient limits resulting from the Chesapeake Bay Program. These new nitrogen (N) nutrient effluent concentration limits are slightly less than 6.9 milligrams per liter (mg/l) at the proposed design rated capacity of 28.2 million gallons per day (MGD). The consolidated facility will have 46 MGD of secondary treatment capacity during wet weather events.

The existing facilities also enjoy very deep clarifiers with excellent historic solids removal. However, to meet the strict new phosphorous (P) limits of the Chesapeake Bay TMDL (P less than 0.429 mg/l at new design flows of 28.2 MGD) the final design team continues to evaluate various coagulants as well as the need for tertiary filtration, as proposed in the Preliminary Engineering Report. The sensitive receiving waters in the Chemung also necessitate the use of ultraviolet (UV) disinfection to meet very low total residual chlorine limits in the effluent. The consolidation program will also allow CCSD to meet the State Pollutant Discharge Elimination System (SPDES) permit deadlines to provide effluent disinfection for flow from Sewer District No. 1.

Lake Street Plant Outfall Modifications

While process treatment design is a significant element of the consolidation program, another critical project component is the conveyance system bringing the Sewer District No. 1 flows to the consolidated treatment facility, and the constructability and environmental considerations required to cross the Chemung River and its flood-protection levee system. This conveyance system will rehabilitate and reuse the existing Lake Street outfall, converted to

continued on page 30

Photograph 2. The Lake Street Plant's trickling filters will be decommissioned. *RC Holmes, CCSD*

continued from page 29

a new raw wastewater interceptor sewer, to convey flows to Milton Street for treatment. A three-barrel siphon is proposed to convey flows under the river and the associated levee, into a new 48-inch gravity sewer extending from historic Dunn Field to the consolidated plant.

Here again the Chemung River shapes the efforts, not just with the construction challenge of crossing of the flood levee, but also with the need to plan for and mitigate impacts to endangered freshwater mussel species that are likely present in this reach of the river. In addition to endangered species concerns, the Chemung River also was the transportation system long used by the Indigenous peoples of the region, and this project will include archeological surveys to ensure any relevant cultural and historic resources are also protected during the construction of the new conveyance system.

Schedule and Financing

With approval of the Preliminary Engineering Report by the New York State Department of Environmental Conservation (NYSDEC) in early 2021, CCSD and the design team (Arcadis and Larson Design Group) are now very engaged in final design. An aggressive schedule proposes final design being complete in early 2022, with all relevant river crossing permits and rights of way being secured in mid-2022 and the bidding phase proposed in late 2022. Construction of the project would then begin in 2023 in order to meet the Chesapeake Bay TMDL deadline of Jan. 1, 2025.

The NYSDEC and the Environmental Facilities Corporation (EFC) each continue to tremendously support the successful and timely completion of the project. **At a total estimated cost of $160 million, the project will be the largest public works project in the history of Chemung County.** Median household incomes (MHI) for most of the service area are below the hardship threshold of the EFC, including a City of Elmira MHI of approximately $39,000. As the Chesapeake Bay reaches the Atlantic Ocean 350 miles to the south, median household incomes are commonly 2.5 times larger than those in the Southern Tier of New York. Working with state and federal funding sources will be the final ingredient to enable the project to be a success for the river, the Chesapeake Bay and for the hard-working blue collar hardship community served by the Chemung County Sewer Districts.

Bringing this exciting and challenging project back to its river connections, the Chemung River Friends are the first to help CCSD tutor the many parties involved:

"The secret to success is simple: We are all on this paddle trip together. Let's keep our paddles in the water and paddle in the same direction."

Jim Pfiffer, co-founder, Chemung River Friends

Tom Rhoads, PE, is the interim executive director for CCSD and may be reached at trhoads@chemungcountyny.gov. Ali Rennie, EIT, is a senior wastewater engineer for CCSD and may be reached at abrennie@chemungcountyny.gov. John R. Amend, PE, is the Midwest market leader for Arcadis and may be reached at John.Amend@arcadis.com.

Protecting Freshwater Mussels

by Ethan Nedeau

A freshwater mussel survey was required as part of CCSD's Consolidation Program. CCSD hired an ecological consulting firm, Biodrawversity LLC, to develop a study plan for NYSDEC approval, to acquire the necessary permit, and to conduct the fieldwork.

The survey focused on state-listed mussel species that may occur in the Chemung River in areas that could be disturbed by the project ***(Figure 1)***. Target species included the green floater *(Lasmigona subviridis)* and brook floater *(Alasmidonta varicosa),* which are listed as Threatened in New York, and are known to occur in the upper Susquehanna River watershed.

The mussel survey area included the full channel (bank to bank) from 50 meters upstream to 100 meters downstream from the proposed sewer line; the entire area was divided into a grid of 10-by-10-meter cells. Biologists conducted mussel surveys in each cell by wading, snorkeling and SCUBA diving, depending on water depth. Biologists identified and counted mussel species, recorded locations and habitat for state-listed mussels, and recorded habitat conditions within each cell. Biologists also evaluated potential relocation sites a safe distance upstream from the project area.

Biodrawversity completed the fieldwork in September 2021 and a report is forthcoming. Green floater was detected at low densities both upstream and downstream from the proposed sewer line crossing, but brook floater was not found. Biologists also found five other native mussel species – a good sign for the health of the river! Biologists also found suitable places upstream where green floater and other species could be relocated prior to any instream disturbance. Biodrawversity and CCSD will now work with agency partners to develop and implement a freshwater mussel protection plan for the next phases of the Consolidation Program.

Ethan Nedeau is the owner and principal aquatic biologist of Biodrawversity LLC and may be reached at nedeau.ethan@gmail.com.

A field biologist wades in shallow water looking for freshwater mussels. *Ethan Nedeau/Biodrawversity LLC*

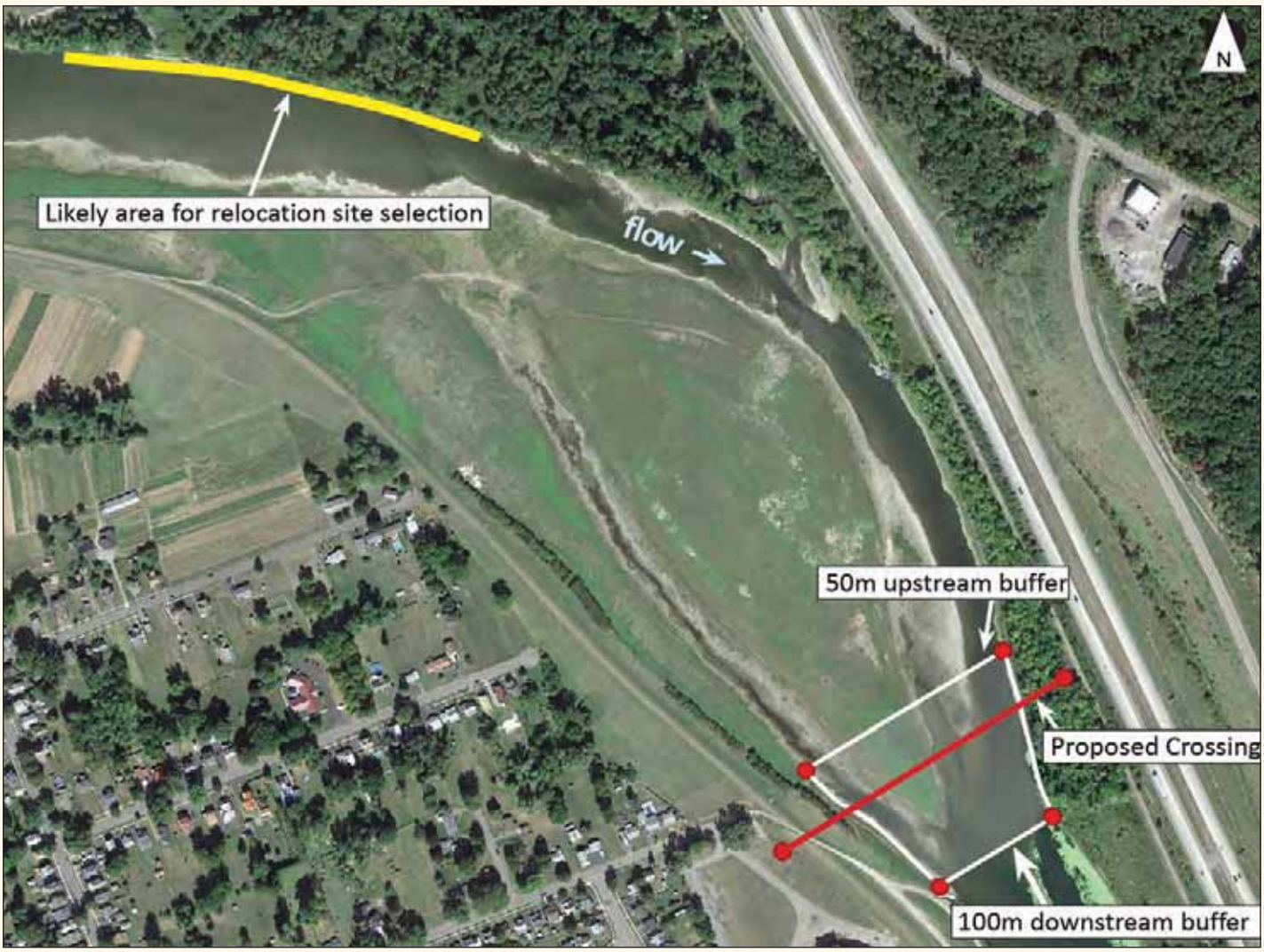

Figure 1. Proposed freshwater mussel survey areas in the Chemung River in relation to the proposed sewer line crossing (Elmira, New York).
Biodrawversity LLC

Field biologists with their gear in tow are ready to survey the river bottom for freshwater mussels. *Ethan Nedeau / Biodrawversity LLC*

Elktoe *(Alasmidonta marginata)*.
Ethan Nedeau/Biodrawversity LLC

Above: Green floater shell *(Lasmigona subviridis)*.
Ethan Nedeau/Biodrawversity LLC

Yellow Lampmussel *(Lampsilis cariosa)*.
Ethan Nedeau/Biodrawversity LLC

Watershed Coalition Leading the Way in Nonpoint Source Pollution Reductions

by Lydia Brinkley and Troy Bishopp

With lofty nutrient and sediment reduction goals outlined in New York's Watershed Implementation Plan (WIP), the state is called upon to accelerate and increase implementation rates in restoring water quality and habitat to rivers and streams that flow into the Chesapeake Bay. It has been a big challenge since the U.S. Environmental Protection Agency (USEPA) mandated Total Maximum Daily Load (TMDL) came out in 2000. For this historical scope, you need an effort worthy of the task. That is where the Upper Susquehanna Coalition (USC) helps "rise the tide that lifts all boats."

The USC *(www.uppersusquehanna.org)* is a coalition of 22 soil and water conservation districts (SWCDs) who are the local driving force in both New York and Pennsylvania for providing technical and financial assistance, focusing on the implementation of best management practices (BMPs) in the watershed.

The **USC Agricultural Team's** approach to implement on-the-ground projects is to support environmental and economically sustainable agriculture by prioritizing practices like grazing systems, riparian buffers and cover crops.

The **USC Stream Team** works to rehabilitate stream corridors using natural stream design techniques and reconnecting and reforesting floodplains while providing technical expertise and training to USC members and the watershed community for local projects.

The **USC Wetland Team** delivers wetland conservation on a watershed scale. The team works to increase wetland restoration efforts, promotes and assists existing wetland programs, and expands wetland education and understanding across the region.

The **USC Buffer Team** plants innovative riparian restoration projects and develops long-term functionality of riparian areas across the watershed through promotion, planning, implementation and monitoring.

In doing this important work over the last 30 years, the USC has grown as a collaborative partnership network that includes local, state, and federal partners spanning public and private sectors, including:

- New York State Department of Environmental Conservation (NYSDEC)
- Department of Agriculture and Markets
- Natural Resource Conservation Service
- Farm Service Agency
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- Friends of the Chemung River
- Finger Lakes Land Trust
- Otsego Land Trust
- One Tree Planted

While this evolution brings with it a lot of responsibility, it also brings recognition to the growth and maturation of the USC's regional approach and delivery mechanisms. With such a strong focus on water quality, the USC has been recognized with the NYSDEC Environmental Excellence Award in 2014, 2015 and 2021, as well as awards from USEPA Region 2, the New York Chapter of the Wildlife Society, and the Arbor Day Foundation for program development that leads to on-the-ground results.

The USC tirelessly applies for and receives financial support from private, state and federal sources to put into place the practices and initiatives needed to get the bay cleaned up. The SWCDs also compete statewide for agricultural practice implementation dollars through the Agricultural Nonpoint Source Abatement Program and the Climate Resilient Funding program. USC districts have an excellent record of competing for these dollars, as over the course of both programs they have secured 50-55% of the available state funds, totaling over $44 million.

The project examples from Tioga and Cortland counties included within this issue of *Clear Waters* (pages 34 and 36, respectively) demonstrate the type of on-the-ground projects we fund, plan and implement. Conservation practices implemented on private land are done so voluntarily and are prioritized by the USC for their nutrient and sediment reduction potential, but also for their contribution to wildlife habitat and diversity.

For more information, contact Wendy Walsh, Tioga County SWCD District Manager and USC Watershed Coordinator, at *walshw@tiogacountyny.gov* or by phone (607)687-3553.

USC supports economically sustainable agriculture, such as establishing buffers and pasture water systems to protect water quality.

Troy Bishopp

Lydia Brinkley is a riparian buffer coordinator with the Upper Susquehanna Coalition and may be reached at lbrinkley@u-s-c.org. Troy Bishopp is a grazing specialist with the USC and may be reached at troy-bishopp@verizon.net.

USC Cover Crop Program

by Troy Bishopp

"A farmer's productive capacity is directly related to the health of his or her soil," said Howard Buffet. Farmers in the Chesapeake Bay Watershed are planting acres of cover crops that in turn compliment their nutrient management and risk strategies. In doing so they also help their community with ecosystem benefits.

In New York, cover crops are used after row crops are harvested or in between harvest and re-planting to promote general soil health in agricultural lands. Soil health is important as it means less erosion, less compaction, greater nutrient cycling, increased microbial activity and improved water infiltration into the soil, improving overall water quality. Cover crops can also contribute to weed suppression and interruption of pest cycles while attracting beneficial insects. Another added benefit is that cover crops can reduce the use and cost of fertilizer by supplying sufficient nutrients back to the soil.

Because of the Chesapeake Bay TMDL pollution diet regulations, a significant amount of education, support and resources are being directed in the Upper Susquehanna River Watershed as a cover cropping model area. Addressing these issues with the aim of stimulating more cover crop implementation on corn silage acres in New York, the USC continues its Cover Crop Initiative with funding from the NYSDEC to reach their environmental goals.

In 2020, the USC partner counties have planted over 12,350 acres of "covers" to stem soil erosion, increase soil organic matter and improve the biological, chemical and physical soil properties that will create a more resilient 2021 cropping season. "The need still far outweighs the funding capacity as more farmers are adopting this water quality practice," said USC Ag Coordinator Emily Dekar.

To learn more about the USC Conservation Tillage Initiative and the New York State Agronomic Cover Cropping Workgroup, visit *www.u-s-c.org* or contact Emily Dekar, USC Ag Coordinator, at (607) 972-2346 for more details.

Cover crop signage identifies farms doing their part to help protect water quality. *Troy Bishopp*

Farm Water Quality Improvement Project in Tioga County

by Danielle Singer

Tioga County Soil and Water Conservation District (the District) recently completed a project that addressed all the identified resource concerns on a dairy farm in the Town of Owego. A covered barnyard with a manure stacking pad was built to house the heifers that traditionally remained in a pasture year-round ***(Photograph 1)***. Exclusion fencing and a 1-acre riparian forest buffer were installed along the stream that flows through this pasture ***(Photograph 2)***. A milkhouse waste collection system was constructed to capture that water and allow the farmer to pump it into his manure spreader to spread on fields. Additionally, improvements were made to the access roads and laneways on the farmstead. The project took three years to complete the design and implementation of all the practices. The District utilized the New York State Agricultural Nonpoint Source Grant Round 23 and Regional Conservation Partnership Program (16 U.S. Code Chapter 58 Subchapter VIII) Round 1 to fund the project with some landowner cost-share.

The District also tried a new floor grooving technique, called traction milling, on this covered barnyard ***(Photograph 3)***. It provides a rough texture to 95% of the floor surface and the increased traction eliminates cows slipping on the concrete. Other grooving styles are a "slip & catch" type of fall prevention. The traction milling is supposed to increase cow health and comfort by reducing delamination and hoof trauma to the cows since they never slip on it. The technique was used on two covered barnyards built in 2020 and another in 2021. So far, the District and farmers are happy with the results.

Danielle Singer is a Water Quality and Nutrient Management Specialist with the Tioga County Soil and Water Conservation District and may be reached at singerd@tiogacountyny.gov.

Photograph 1. The finished covered barnyard and manure stacking pad.
Tioga County SWCD

Photograph 3. Traction milling technique on the concrete floor.
Tioga County SWCD

Photograph 2. The 1-acre riparian buffer (before the exclusion fence was built). The planted buffer area is visible as the white vertical "sticks" representing the newly planted trees.
Tioga County SWCD

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Mosquito Creek Culvert Replacement & Rehabilitation Project

by Jared Popoli

Protecting water quality for a large waterbody like the Chesapeake Bay starts with smaller projects in the upper reaches of the watershed.

The Mosquito Creek Culvert Replacement & Rehabilitation project is located north of the Village of McGraw, in the Town of Cortlandville, Cortland County, New York. The Mosquito Creek culvert is located where it crosses Heath Road. Mosquito Creek is a Class C stream with a drainage area of 3.8 square miles. The creek is a tributary to Trout Brook, which is tributary to the Tioughnioga River that flows to the Chenango River, connects with the Susquehanna River and eventually empties into the Chesapeake Bay. Though Mosquito Creek is not classified as a trout stream, both brook trout and brown trout have been caught at the project location; in fact, a large 16-inch brown trout was relocated from the project area before the work began.

The purpose of this project was to enhance aquatic organism passage through a damaged culvert by installing a new and properly sized pipe arch culvert. Additionally, this project stabilized a portion of Mosquito Creek by installing a series of riprap grade-control and fish passage structures, riprap bank protection, stream barbs, a riparian forest buffer, and cattle exclusion fencing. These measures contribute to the overall goal of water quality protection for the Chesapeake Bay.

This project was designed by the Cortland County Soil and Water Conservation District (Cortland SWCD) and installed by the Town of Cortlandville Highway Department. The project was completed through Cortland SWCD's Chesapeake Bay Watershed Stream Corridor and Culvert Rehabilitation Program with funding from the Clean Water Infrastructure Act/Environmental Protection Funds Water Quality Improvement Project Grant administered by the New York State Department of Environmental Conservation (NYSDEC).

This project also served as field training for the local highway department on proper culvert replacement, as well as riprap and riffle/weir installation.

Existing Conditions Assessment

The existing culvert, comprised of multiple pieces of pipe, was in disrepair and functioned as a severe barrier to aquatic organism passage; there was a 2.1-foot drop-off at the end of the culvert. Upstream of the site, excess gravel deposition and associated streambank erosion provided evidence that the culvert was undersized, a diagnosis supported by severe streambank erosion downstream of the culvert.

The project location was selected after the entire watershed was assessed utilizing the North Atlantic Aquatic Connectivity Collaborative protocol, which provided an aquatic organism passage score. Data collected was also used to estimate the maximum storm event the culvert was able to pass before overtopping the roadway. These two metrics coupled with an additional metric examining culvert condition provided a method to prioritize culverts to repair or replace. Other tools used to examine aquatic passage included HY8, a hydraulic computation model for roadway stream crossings; and the United States Forest Service's program, FishXing. The findings concluded that the culvert can barely pass a 25-year storm event before overtopping the roadway, and aquatic organism passage through the culvert was nonexistent.

New Culvert Design

The design of this project followed U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) standards for the design of rock weirs and streambed and shoreline stabilization with structures designed to the bank-full storm event

BEFORE: View from the culvert outlet, looking downstream. Cows were free to wade in the stream, contributing to erosion and nutrient release.

Cortland County SWCD

AFTER: View from the culvert outlet, looking downstream. Riprap has stabilized the shoreline, a riparian zone has been planted, and barriers are in place to prevent cows from entering the stream.

Cortland County SWCD

and design stability calculated to the 100-year storm event. The total project was approximately 290 feet long. To enhance fish and aquatic organism passage, and comply with permitting agencies, the new culvert was installed flatter than the earlier culvert and included a grade control and fish passage structure at the outlet to hold stream gravel inside of the new culvert, which is embedded 1.4 feet with stream gravel distributed throughout the culvert.

To aid in fish passage, protect against future head cuts and enhance instream structure, two rock riffle/weir structures were carefully installed downstream of the culvert. Many aquatic organisms and juvenile fish find it difficult to move upstream through traditional weirs, which often include a small waterfall. In Mosquito Creek, the weir structures were designed as "U-shaped weirs" that funnel flows toward the middle of the stream and dig a pool. Aquatic organisms can more easily pass through these structures compared to traditional weirs due to spaces between riprap, native stream gravel deposition and the lack of a waterfall compared to a traditional weir. The breaks between rocks give places for small aquatic organisms to rest as well as spaces for stream gravel to fill in.

The pools created by the structures will serve as important refuge areas for aquatic organisms during dry/hot periods of the year. Upstream, much of the stream dries up during summer months with this location being a year-round pool. Having riffles just upstream of the pools will assist the organisms to survive hot and dry weather as the water gets oxygenated as it flows over riffles. Willow cuttings installed along the toe of riprap will eventually grow to provide shade and habitat for the corridor. An approximately 0.7-acre riparian forest buffer was installed along the stream corridor as well as fencing and a stabilized access point to exclude cattle from the waterway.

Improved Performance

The installed culvert was assessed using the North Atlantic Aquatic Connectivity Collaborative protocol. FishXing was used to check for aquatic organism passage for a number of fish species including minnows, brook trout, brown trout and rainbow trout juveniles and adults. The new culvert is passable by the following fish species and flows:

- 1.0 to 10.4 cubic feet per second (cfs) for minnows
- 1.0 to 11.48 cfs for juvenile trout
- 1.0 to 14.23 cfs for adult trout

The installed culvert was also modeled using HY8, which found that the culvert will be able to pass a 24-hour, 100-year storm. This is an increase in capacity from the earlier, undersized culvert, which could not pass a 25-year storm without overtopping the road.

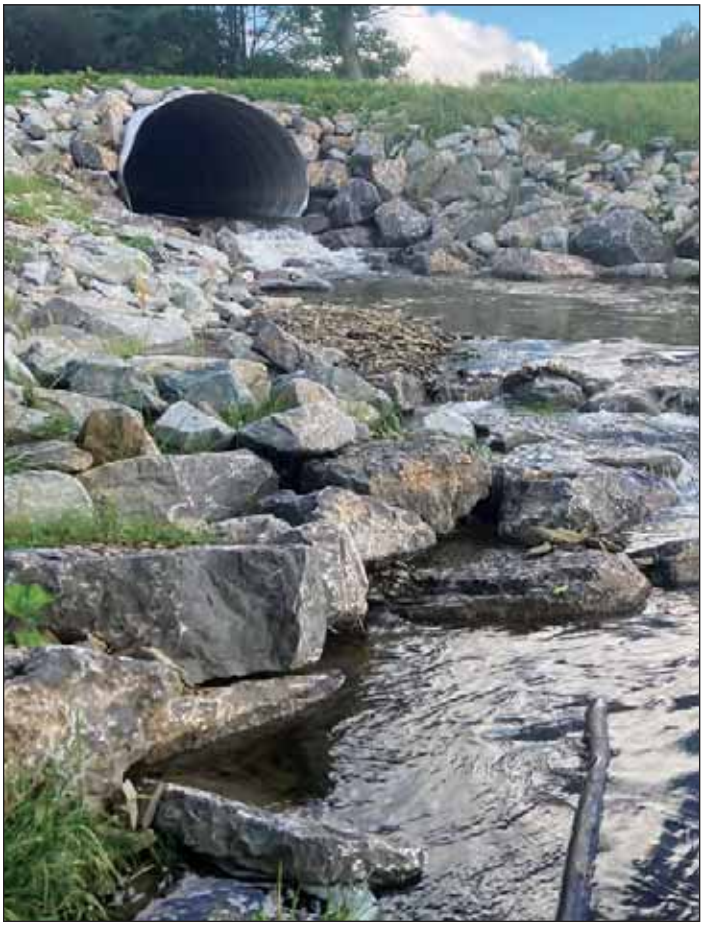
Conclusion

As a result of this project, aquatic organism passage was improved, and the culvert is now considered an insignificant barrier. Completion of this project will give access to approximately 1.7 miles of brook trout habitat and countless miles of habitat downstream to Trout Brook and its tributaries, restoring aquatic organism passage to a population that has been fragmented for many years. Stabilization of this part of Mosquito Creek will also help reduce erosion and protect the water quality of the Chesapeake Bay.

Jared Popoli is a Conservation Assistant with the Cortland County Soil and Water Conservation District and may be reached at jared.popoli@cortlandswcd.org.

BEFORE: View of the culvert outlet, looking upstream. A 2.1-foot drop-off at the end of culvert effectively prevented aquatic organisms from using habitats upstream.

Cortland County SWCD



AFTER: View of the culvert outlet, looking upstream. The new culvert includes a grade control and fish passage structure. Two rock riffle/weir structures downstream of the culvert outlet create pools that will serve as important refuge areas, while riffles just upstream of the pools will oxygenate the water. Eventually, the willow cuttings installed along the toe of riprap will grow to provide shade and habitat.

Cortland County SWCD

Oysters: Iconic Bivalve of the Chesapeake Bay

Oyster planting on the Tred Avon River in Talbot County, Maryland. Tom Dobson sprays oyster shells covered in spat off the side of the Robert Lee and into the Tred Avon Wednesday, June 30, 2021. "Hopefully, it's all worth the effort and makes some difference," Dobson said. "The Bay's got a lot against it."
Ethan Weston/Chesapeake Bay Program

Overview

The eastern oyster *(Crassostrea virginica)* is one of the most iconic species in the Chesapeake Bay. For more than a century, oysters have made up one of the region's most valuable commercial fisheries, and the filter-feeder continues to clean our waters and offer food and habitat to other animals. But overharvesting, disease and habitat loss have led to a severe drop in oyster populations. Scientists are working to manage harvests, establish sanctuaries, overcome the effects of disease and restore reefs with hatchery-raised seed in an effort to bring back the bivalve.

Why are Oysters Important to the Chesapeake Bay?

You don't have to like eating this peculiar-looking bivalve to appreciate its vital role in the Chesapeake Bay ecosystem and its importance to people in the region.

Cleaning the Water

Oysters are natural filter feeders. This means they feed by pumping water through their gills, trapping particles of food as well as nutrients, suspended sediments and chemical contaminants. In doing so, oysters help keep the water clean and clear for underwater grasses and other aquatic life. One oyster can filter more than 50 gallons of water in a single day.

Providing Food and Habitat

As oysters grow, larvae settle on top of adults, forming layers of oysters that spread upward and outward. With their countless nooks and crannies, these aquatic reefs provide habitat to hundreds of critters, from small fish and invertebrates seeking shelter to larger fish looking for food.

Oysters have a number of natural predators:

- Anemones, sea nettles and other filter feeders feed on oyster larvae.
- Flatworms and mud crabs feed on new spat.
- Blue crabs and some fish feed on older spat and first-year oysters.
- Shorebirds feed on adult oysters exposed on intertidal flats.

Historical and Economic Importance

Since the late 19th century, the oyster industry – including the catch, sale, shucking, packing and shipping of oysters – has contributed millions of dollars to the region's economy. Oysters have also added to the region's historical and cultural heritage, inspiring the unique design of the skipjack and fueling countless bull and oyster roasts.

What Caused the Chesapeake Bay Oyster Population to Decline?

The decline of the native oyster population can be attributed to several factors, including historic overharvesting, disease and habitat loss. The severity of this decline is often illustrated in terms of its impact on water quality: in the late 19th century, the Bay's oysters could filter a volume of water equal to that of the entire Bay in three or four days; today's population takes nearly a year to filter this same amount.

Historic Overharvesting

In the 17th century, huge numbers of oysters lived in the Bay. European settlers reported enormous oyster reefs that thrust up from the Bay's bottom, posing navigational hazards to their ships. Colonists first used hand tongs to harvest oysters, but by the 1800s, dredges were also in use. In the 1850s, more than 1.5 million bushels of oysters were harvested from the Bay each year; three decades later, this number jumped to 20 million. At the turn of the 20th century, the Bay's oyster fishery was one of the most important in the United States.

But overharvesting removed huge volumes of oysters from the Bay and led to the demise of the Bay's healthy reefs. Because these reefs have been scraped away by dredges, oyster beds are now often limited to flat, thin layers of dead shell and live oysters spread over the Bay's bottom. These damaged habitats offer less surface area for reef-dwelling critters to inhabit and can be easily buried by sediment.

Disease

In 1949, scientists discovered Dermo in the Bay. MSX was discovered in the region a decade later. Dermo, or *Perkinsus marinus,* is a parasite that most often infects oysters during their second year of life, causing slowed growth rates and death. MSX, or *Haplosporidium nelsoni,* also leads to oyster death, but can affect oysters of all ages. Both diseases are contracted between May and October, and their prevalence can be affected by water temperature and salinity.

Overcoming the effects of Dermo and MSX has posed a challenge to oyster restoration. It is estimated that by age three, 80% or more of a single oyster year class in a high disease area (like the Virginia portion of the Bay) will die due to disease.

Habitat Loss

Over the past century, the watershed has experienced a change in land use, as urban, suburban and agricultural areas have replaced forested lands. This has increased the amount of nutrients and sediment entering our rivers and streams and contributed to the poor water quality that affects aquatic life. Excess nutrients, for instance, fuel the growth of algae blooms that create low-oxygen "dead zones" that hinder the development of oyster larvae; sediment can suffocate oysters and other shellfish. Stress related to poor water quality can make oysters more susceptible to disease.

How are Oysters Being Restored?

Through the careful management of oyster harvests, the establishment of oyster sanctuaries and the restoration of oyster reefs, experts are working to support healthy, sustainable populations of the bivalve.

Managing Oyster Harvest

Managing oyster harvest can ensure the region's oyster industry remains sustainable. This requires estimating the amount of oysters that can be taken from the Bay without compromising restoration efforts or population size. In Maryland, harvest is managed by the Oyster Advisory Commission; in Virginia, it is managed by the Marine Resources Commission.

Establishing Oyster Sanctuaries

Oyster sanctuaries are underwater reefs from which shellfish harvesting is prohibited. When a reef is designated a sanctuary, it is often improved by scientists who clean off excess sediment or add shells or other materials for new spat to settle on. Restoring reefs and protecting them from harvest has the potential to increase populations of spawning adult oysters and, in turn, larval production in the Bay.

In the short term, the success of sanctuaries will be limited by disease and poor water quality. But sanctuaries will make important contributions to restoration if disease resistance evolves in wild oysters over time and is supported by management practices.

Overcoming Disease

Maryland and Virginia must confront different challenges when it comes to oyster disease. While the prevalence of disease in Maryland waters is dependent on weather conditions, oysters in the warmer, saltier waters of Virginia are faced with constant disease pressure. But research *(Carnegie and Burreson, 2009)* from the Virginia Institute of Marine Science (VIMS) has found that oysters subject to high disease pressure are developing disease resistance, and efforts are underway to breed greater disease resistance in native oyster strains.

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Carol McCollough, coordinator for Tilghman Island Grows Oysters (TIGO), visits volunteers tending cages of oysters on Tilghman Island Feb. 14, 2013. TIGO recruited over 80 volunteers to grow the oysters so that they can be transplanted on protected reefs a few miles away.

Steve Droter/Chesapeake Bay Program

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Current Restoration Goals

In 2010, Bay Program partners embarked on a tributary-based restoration strategy that will build, seed and monitor reefs in several Maryland and Virginia waterways. In the 2014 *Chesapeake Bay Watershed Agreement* (amended Jan. 24, 2020), we renewed our commitment to this restoration strategy. Ten tributaries have been selected for oyster restoration, five in Maryland and five in Virginia.

- Maryland: Harris Creek and the Little Choptank, Manokin, Tred Avon and upper St. Mary's rivers.
- Virginia: Great Wicomico, Lafayette, lower York, Lynnhaven and Piankatank rivers.

Each tributary is at a different level of progress in a process that involves developing a tributary restoration plan, constructing and seeding reefs, and monitoring and evaluating restored reefs.

Take Action

For Chesapeake Bay restoration to be a success, we all must do our part. Our everyday actions can have a big impact on the Bay. By making simple changes in our lives, each one of us can take part in restoring the Bay and its rivers for future generations to enjoy.

To restore oysters in the Bay watershed, consider recycling oyster shell so it can be used to build new reefs. Homeowners with access to a pier or dock can also raise oyster larvae at home, through oyster gardening programs like Maryland Grows Oysters or the Chesapeake Bay Foundation. As they grow, these oysters will filter local waters; once they are large enough, they will be used to restock reefs.

Since 1983, the Chesapeake Bay Program has led and directed the restoration of the Chesapeake Bay. Bay Program partners include federal and state agencies, local governments, nonprofit organizations and academic institutions. Staff members work at our offices in Annapolis, Maryland, and at partner organizations throughout the watershed. For more information about the Chesapeake Bay Program, visit the website at https://www.chesapeakebay.net. Reprinted with permission from the Chesapeake Bay Program.

Scott Budden of Orchard Point Oysters cleans a cage at his oyster lease on Kent Island in Stevensville, Maryland, on Aug. 17, 2020. "We've had to, because of the restaurant issues, pivot to doing a lot of retail," Budden said. "That started back in April, I believe. We still are selling to restaurants and wholesalers, it's just a lot less than before and we try to make up the difference with retail. Some weeks we do and some weeks we don't." *Will Parson/Chesapeake Bay Program*

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Carnegie, R.B. and E.M. Burreson. 2009. *Status of the Major Oyster Diseases in Virginia 2006-2008: A Summary of the Annual Oyster Disease Monitoring Program.* Virginia Institute of Marine Science, The College of William and Mary, Gloucester Point, Virginia. *https://www.vims.edu/research/departments/eaah/programs/molluscan_health/_documents/monitoring_rpt_2009.pdf.*

Chesapeake Bay Watershed Agreement. 2014. As amended Jan. 24, 2020. *https://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-HIres.pdf.*

Indian River in Chesapeake, Virginia. A shoreline restoration project is seen near homes on the Indian River Dec. 16, 2019. In 2018, resident Rogard Ross worked with the Elizabeth River Project and secured permission from his condo association to construct a 550-foot living shoreline in his neighborhood. In addition, 200 volunteers helped install 800 oyster castles and 5,000 native plants, including saltmarsh cordgrass and saltmeadow hay. The project helps protect the residents' shoreline from erosion. *Will Parson/Chesapeake Bay Program*

Photo Essay: Projects Around the Chesapeake Bay Watershed in NY

Photographs courtesy of the Chesapeake Bay Program

Cortland County

(Left) Dozens of acres of willow wattles, or shrubs, planted by children from local 4-H clubs line Factory Brook, which flows through McMahon's E-Z Acres Dairy Farm in Homer, New York, on Aug. 4, 2016. Factory Brook eventually connects with the Tioughnioga River and ultimately the Susquehanna River and the Chesapeake Bay.

Chesapeake Bay Program

Chenango County

(Right) Restored wetlands cover the 124-acre site of a former golf course on the Unadilla River in New Berlin, New York, on Aug. 3, 2016. The property was purchased by the nonprofit Wetland Trust and is being restored as part of an in-lieu fee program.

Will Parson/Chesapeake Bay Program

Tioga County

(Left) Logan Hill Nature Preserve is 348 acres of forest and meadows in Candor, New York, bordering Catatonk Creek, that is protected by a conservation easement through the Finger Lakes Land Trust.

Will Parson/Chesapeake Bay Program

Broome County

(Right) The Chenango River flows past downtown Binghamton, New York, on Oct. 8, 2020. Large storms in 2006 and 2011 led many property owners in the city to participate in a buyout program to improve the city's resilience to flooding.

Will Parson/Chesapeake Bay Program

Madison County

(Left) The Sangerfield River flows through Ninemile Swamp in Madison County, New York, on May 28, 2015. The slow-moving river is suitable for canoeing and kayaking and stretches 18 miles before joining the Chenango River. Ninemile Swamp is notorious as a historical hideout for the Loomis Gang.

Will Parson/Chesapeake Bay Program

Preparing SCADA/ICS to Survive Ransomware Attacks

by Bob George

Ransomware is now the leading cybersecurity concern for most organizations. The ransom demands to restore encrypted data typically run from tens to hundreds of thousands, if not millions of dollars. Extortion via ransomware has been a threat for over a decade, and yet today rarely a week goes by that we do not see headlines identifying yet another high-profile victim has been affected. While ransomware is not new, the increasing threat it poses cannot be overstated.

This article gives a brief overview of what ransomware is, how it affects organizations, why it is now being perceived as a growing threat to Supervisory Control & Data Acquisition (SCADA) and Industrial Control Systems (ICS), and basic measures you can implement to protect against, and recover from ransomware attacks.

Understanding Ransomware

To protect against ransomware, it is important to have a basic understanding of what it is and how it can swiftly and effectively affect entire organizations.

- In simplest terms, ransomware is a class of malware (viruses, trojans, worms and other cyber-attacks) that encrypts data, then demands payment for a decryption key.
- Ransomware may target all accessible files indiscriminately or target a specific type of application data file.
- Ransomware is a particularly effective event against isolated systems. Once the malware has been introduced, no external connection is required to operate or transfer data. Everything occurs inside the victim's computers and network. A single ransomware malware attack can simultaneously attack multiple victims without consuming attacker resources.
- Even isolated systems are frequented by multiuse or contractor laptops for support. If infected, such transient systems provide a path in for the attack.
- Pervasive network connectivity is now the norm in most organizations. Networks have expanded faster than our ability to effectively manage and secure them. Poorly secured networks allow access from multiple locations, assuming that anybody on the "inside" can be trusted. It is common to find that even a user with no login can connect to a network and access large numbers of files and systems.

Ransomware has always been moderately successful in that it can rapidly discover accessible networked files and begin encrypting them before detection. What has made it more effective is the incorporation of ransomware into increasingly sophisticated attacks.

Advanced Persistent Threats (APTs) are sophisticated cyber-attacks that incorporate multiple techniques to compromise, discover, infect and ultimately attack victim systems. The first APT that gained widespread public attention was Stuxnet in 2010. While at the time Stuxnet was considered incredibly sophisticated, the techniques it used have become commonplace and are incorporated into toolkits readily available to any would-be attacker.

Many APT attacks can be launched when the victim simply opens a malicious webpage or opens a seemingly innocuous email attachment while using a vulnerable device. This initiates several attack phases, starting from initial compromise of a victim device to discovery, intrusion, exploitation, and compromise throughout the connected network within minutes.

If the victim's computer is moved between networks, APT components will begin searching for vulnerable systems in the new network. While most APT attacks attempt to establish a covert communications channel back to an internet-based command-and-control server, many are fully capable of reverting to a brute-force "dumb" attack mode.

Cryptocurrencies have reduced the risk to attackers by allowing fully anonymous transfer of funds (cryptocurrency) with no means of tracking transfers or either party in the transaction.

Social engineering has grown increasingly effective as more nontechnical users engage with networked applications and devices daily. Techniques using email (phishing), voicemail, texting, and other communications have become increasingly adept at impersonating official communications, convincing trusted system users to effectively open the door to attackers, bypassing sophisticated network protections.

Unlike "classic" malware, APT attacks are surreptitious. The days of an attack announcing itself are long gone. Attackers go to great lengths to avoid, and in many cases, deactivate detection.

Every modern networked system is potentially vulnerable to some degree to an attack that can spread instantly and effectively throughout any connected system. Traditional models based on "insider" and "outsider" control are ineffective when trusted insiders can become unwitting agents of outsiders. Isolated systems can be attacked through inadvertent introduction of malware via support or contractor laptops. Any internal system that connects externally via email or web browser must be assumed vulnerable.

Ransomware Threats to SCADA and Control Systems

As APTs have become increasingly sophisticated, they have also become more selective. In the past, SCADA/ICS tended not to be seriously impacted as only static program and image files were encrypted, and these were usually backed up. This is no longer true. Criminal enterprises launching APT and ransomware attacks

are fully aware of the importance of SCADA/ICS and the technical details of these systems. While stored data is typically only significant from a historical perspective, attackers understand that the inability to operate critical software and devices can have devastating consequences for a utility. New generations of APTs specifically target industrial networks and control system equipment. With the long lifecycles of SCADA/ICS and the difficulty of keeping these systems fully patched and protected, critical infrastructure has become a prime target for system-specific ransomware.

A ransomware attack can be more devastating than a large-scale natural disaster. While damage caused by storms, fires, flooding and other natural events is focused in geographic areas, ransomware attacks can engulf connected systems across a much larger area. With no advance warning or preparation time, an entire system can be disabled before any response is possible.

SCADA and Control System Considerations

Simply put, if your SCADA/ICS uses IP-based communications at any level, you need to assume it is vulnerable. If an APT does not target your system today, it is a safe assumption that threats will emerge in the near future. We need to adopt a multiprong approach to protecting our systems:

1. Identify the key assets – equipment, software, data and communications – in our systems and prioritize protection of the critical components.
2. Protect against and detect attacks. Traditional cyber protections such as isolation, access control, and traffic filtering and monitoring remain primary protections and can help delay and contain attacks. These measures should be bolstered with active detection and monitoring of network activity.
3. Plan for, respond to and recover from attacks. Resiliency is key. Assume your system will be hit by a devastating attack and plan accordingly. Assume your system will go "lights out" and be prepared to recognize and respond, and quickly restore everything needed to resume operations.

Without knowing what's critical, effective planning is impossible. Consider:

- Transient, time-sensitive traffic. Are any communications essential to system operation? Is central access critical to remote system operation?
- Stored data. Is any data stored on disk or in a database critical? How important is historical data? What data is required for compliance reporting?

- What programs are essential to system operation? What is required to install and operate these programs?
- What equipment is essential to system operation? What computers and network equipment must be operational?
- Are dongles, drives, removable media, or other items required for restoration at hand?
- Are you able to install licensing sufficient to operate your system on a 24/7 year-round basis?

4. Identify the time window in which each critical asset must be restored to avoid loss of critical data or operations and develop restoration plans to meet those targets.

Mitigation Strategies

The Department of Homeland Security (DHS) and Cybersecurity & Infrastructure Security Agency (CISA) have issued guidance for basic protection against ransomware attacks. This guidance can be readily adapted and applied to SCADA/ICS in the form of both short-term (immediate) and long-term protections.

Short-term Priority Mitigation

In order to prepare for a ransomware attack, every utility should verify and, where necessary, implement basic strategies for recovery.

Unsurprisingly, backups are the primary protection against long-term or unrecoverable system disruption. However, given the systemwide devastation associated with ransomware, backup strategies must encompass recovery on a scale more akin to recovery from a large-scale natural disaster than loss of a single computer or device. Time to restore is key. In most scenarios, every device must be removed from the network and only reconnected once fully wiped and reinstalled, if not replaced outright.

<u>You Get What You Pay For</u>

"Saving money" on automated backup and recovery capabilities can literally cost your organization many times any potential savings with the first ransomware event. Recognize that ransomware and APT attacks are a pervasive and ongoing threat.

<u>Strategize</u>

Develop strategies for static data (computers and programs) and dynamic data (historical and compliance data).

<u>Standardize</u>

Develop ***and document*** standardized templates for each computer and device type.

- Try to standardize on hardware for each type of device where possible.
- In many cases, a "gold image" for each type of computer can provide adequate backup provided it has been tested and is updated regularly.
- Where standardization is not possible, be prepared to develop separate images for each type of device.

<u>Update</u>

Regularly update and patch systems in accordance with your SCADA/ICS vendor's recommendations. Develop strategies for timely updates, testing, and deployment of updates and patches. Here again, standardization will greatly improve your odds of successful recovery.

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Backup

Backup ***and document*** programs and system configurations.

Consider adopting a "bare metal" backup and recovery strategy that allows restoration of everything on the computer, from OS to patches and applications, in one step. Traditional recovery by installing a new OS, then reinstalling applications and restoring data is inadequate when faced with the loss of every networked computer. Be sure that such backups can be restored onto whatever hardware platform you can acquire today. Look for solutions that can detect and restore to dissimilar hardware and can operate largely unattended when support staff is working on multiple computers simultaneously. Consider virtualization strategies to optimize disaster recovery.

Be sure backups and snapshot images are taken frequently enough that the system can rapidly be restored to full functionality within your target restoration time window. Automate snapshots and recovery whenever possible. The cost of backup media should not limit your ability to back up critical systems and data. Acquire sufficient drives and media or capacity to ensure every critical system can be backed up regularly and without intervention to the extent possible.

Adopt a backup retention policy that will allow restoration to a point in time weeks or months back. In many cases, APT software can operate for extended period without detection, and backups may be contaminated. Given the virulence of APT attacks, there is no acceptable level of contamination. You must be able to restore to a point ***before*** the initial compromise.

Equipment Redundancy

Consider adding equipment redundancy. While online redundant systems will typically be equally compromised during an attack, the ability to pull some equipment offline for restoration while the system operates in a compromised mode can significantly improve recovery times.

Overlay Security Technologies

Add "overlay" security technologies that can be installed and operated without significant disruption of critical production systems. Many cybersecurity solutions providers may not be in business over the lifetime of your system. Avoid vendor lock-in by insisting on interoperability with established standards so that equipment can be replaced as needed.

Secure Interconnect

Develop a "secure interconnect" to provide a secured means of transferring programs and data, and accessing SCADA/ICS from other networks when, and only if, necessary.

Require contractors and third-party support to comply with your in-house policies and procedures. Eliminate "back door" access even by authorized support. Require all external access (if any) use the secure interconnect. Do not allow laptops or other equipment inside the interconnect. Require and use dedicated support laptops.

Test Procedures

Verify the ability to restore each system to a fully operational state. Demonstrate the ability to bring back a system without accessing the original (presumably infected) equipment.

Cybersecurity Resources Available for Utilities

The *National Institute of Standards & Technology* (NIST) *Cybersecurity Framework* (CSF) is the leading cybersecurity guidance for assessment and development of a comprehensive cybersecurity program.

The AWWA's *Cybersecurity Guidance and Assessment Tool* are aligned with the NIST CSF and have been recognized for use by water and wastewater utilities in evaluating cybersecurity risks.

Other leading cybersecurity resources include:

- NIST SP 800-82 – *Guide to Industrial Control Systems Security.*
- WaterISAC – *15 Cybersecurity Fundamentals for Water and Wastewater Utilities.*
- DHS CISA.
  - o *Cybersecurity Evaluation Tool* (CSET) and other services.
  - o *Insights – Ransomware Outbreak,* Aug. 21, 2019 (last revised Nov. 1, 2021).

Incident Response Plans

Develop incident response plans that recognize ransomware as a systemwide threat. Incorporate system owners and operators in planning and prioritization of efforts.

Finally, Pay Attention

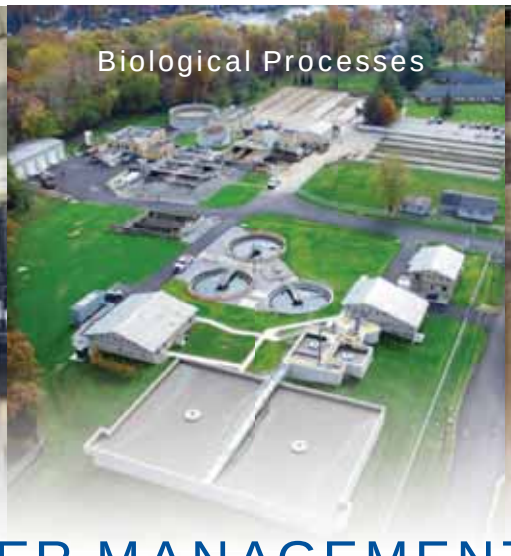
Ransomware spreads, and an attack in your utility or organization should trigger an automatic threat awareness. Engage with WaterISAC in your area and share information with other utilities in your region.

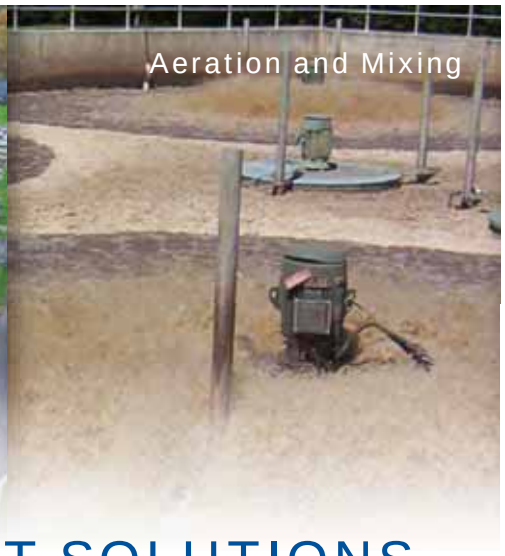
Long-term Mitigation

Long-term mitigation requires addressing cybersecurity as a core requirement for future system expansion and upgrade.

- Develop a secure network architecture for future system upgrades and replacements. Allow for incremental migration from existing networks to a secure architecture in a phased manner.
- Incorporate user and device access and identity control. Control the introduction of unknown users and equipment onto the SCADA/ICS network.
- Implement robust, secure remote access if needed.
- Develop cybersecurity policies, standards, and procedures that identify and describe authorized modes of system access and communications. Ensure access by other means is prevented.

Bob George is the director of Water/Wastewater Cybersecurity and Network Infrastructure Services for Tetra Tech and may be reached at bob.george@tetratech.com.





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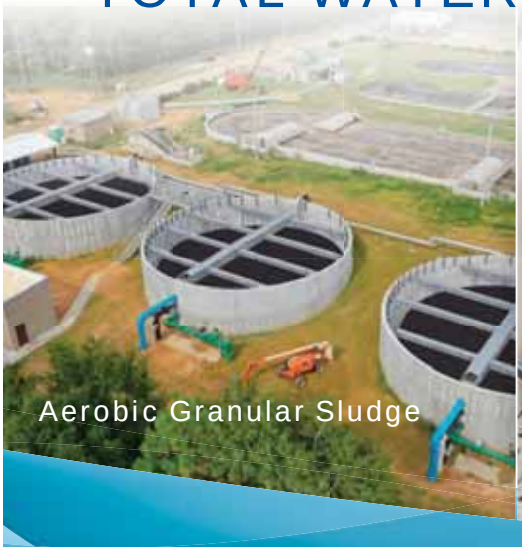

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From wef hq Leading-edge updates from the Water Environment Federation

Cybersecurity Fundamentals Guide for Water and Wastewater Utilities

by Michael Arceneaux and Jennifer Lyn Walker

Water and wastewater utilities provide critical lifeline services to their communities and their regions. Supporting these vitally important functions requires secure information technology (IT) and operational technology (OT), yet the sector's IT and OT networks continue to face an onslaught of threats from cyber criminals, nation states and others.

To support the sector in its cybersecurity goals, and in response to the continually evolving threats, WaterISAC, the Water Information Sharing and Analysis Center, published a newly updated resource: *15 Cybersecurity Fundamentals for Water and Wastewater Utilities.*

The updated guide contains dozens of best practices, grouped into 15 main categories, that water and wastewater systems can implement to reduce security risks to their IT and OT systems. Each recommendation is accompanied by links to corresponding technical resources. In sum, the guide connects users to the information and tools needed to take a dive deep into this important issue.

Here is a summary of the 15 fundamentals.

- **Perform asset inventories.** You can only protect what you know about. Knowing your environment is a basic requirement of a sound cybersecurity program.
- **Assess risks.** Once assets inventories are completed, OT and IT risk should be assessed, considering the likelihood a threat will occur and the degree of impact the threat will cause to the organization.
- **Minimize control system exposure.** Protect the control system environment from outside, untrusted networks. This involves network segmentation, traffic restrictions and encrypted communications.
- **Enforce user access controls.** Users on a network should have no more access than they need to do their jobs. Apply role-based access controls and the principle of least privilege, including limited use of administrator rights to prevent users from accessing systems and files they are not authorized to access.
- **Safeguard from unauthorized physical access.** If an adversary can gain physical access to your equipment, they can compromise it. Nontechnical, physical security controls can restrict physical access to IT and OT environments.
- **Install independent cyber and physical safety systems.** Cyber-attacks can result in physical effects. To protect critical assets from such "blended" threats, utilities should consider non-digital engineering solutions such as independent cyber and physical safety systems.
- **Embrace vulnerability management.** Largely informed by asset inventory and risk assessments, vulnerability management involves the need to identify and remediate cybersecurity gaps and vulnerabilities before the bad guys exploit them.
- **Create a cybersecurity culture.** Cybersecurity is everyone's responsibility, the break room to the boardroom. Effective cybersecurity starts at the top; to affect positive behavioral changes, involve every executive, board member, and employee in cybersecurity awareness and training.
- **Develop and enforce cybersecurity policies and procedures (Governance).** Create, disseminate, and operationalize clear and actionable organizational policies and procedures regarding cybersecurity expectations. The fundamentals in this guide can be used to begin developing policies that are most relevant to each organization.
- **Implement threat detection and monitoring.** You will not find it if you are not looking. The importance of configuring detailed logging and reviewing system logs to detect active threats in your environment cannot be overstated.
- **Plan for incidents, emergencies and disasters.** Plan ahead for maintaining business continuity and resilience. Emergency response plans (ERPs) are required by America's Water Infrastructure Act (AWIA) beginning in 2020.
- **Tackle insider threats.** The insider threat is a people problem, not a technology problem; however, not all insider threats are malicious. Mitigate this organizational-level threat by understanding behavioral indicators that predicate an insider threat and apply appropriate training and technology controls to deter an incident.
- **Secure the supply chain.** The supply chain/vendor relationship is a common threat vector for cyber-attacks and must be intentionally managed through security and vulnerability testing and risk assessments.
- **Address all smart devices.** When unsecured internet of things (IoT) and mobile devices are connected to networks, they create holes (often to the internet) that may not have previously existed. Cisco's 2018 Annual Cybersecurity Report states that few organizations view IoT as an imminent threat, yet adversaries are exploiting weaknesses in connected devices to gain access to industrial control systems that support critical infrastructure.
- **Participate in information sharing and collaboration communities.** Share information with others. Utilities can learn from each another by getting involved in WaterISAC, InfraGard and similar communities. Cyber-mature utilities can significantly help the community and sector by sharing their experiences.

About WaterISAC

WaterISAC is a nonprofit water and wastewater sector organization dedicated to protecting sector utilities from all hazards. WaterISAC disseminates threat advisories, reports, and mitigation resources to help utilities prevent cyber and physical security incidents and to recover from disasters.

WaterISAC draws information from federal and state law enforcement and many private sector sources to produce products that are relevant to the water and wastewater sector.

Membership, including a free 60-day trial, is open to utilities, consulting firms, sector associations and state agencies. More information is available at *www.waterisac.org.*

Michael Arceneaux is WaterISAC's managing director and Jennifer Lyn Walker is WaterISAC's cybersecurity risk analyst.

Summer Internships with NYWEA's Work-in-Water Program

Want to engage high school students in water careers? NYWEA's Work-in-Water program offers both students and utilities the tools, resources, and skills needed to build partnerships between schools and water utilities, develop fulfilling internships, and increase awareness of water careers. This unique, hands-on learning program allows students to see firsthand the skills, technology and people that are working to ensure the public has access to water quality resources.

Through a grant offered by the Water Environment Federation, NYWEA has established a Work-in-Water program (modeled after the Wichita State University Environmental Finance Center Program) that awards high school students with paid internships at water or wastewater utilities. The hope is the exposure to water careers will result in more people entering the field. There is also a mini-grant opportunity available through NYWEA's Work-in-Water program that can help both students and utilities. If you would like more information about this program, contact Patricia Cerro-Reehil at *pcr@nywea.org*.

Summer Internships with NYWEA's Work-in-Water Program

The following stories illustrate the experiences of two students who went through the program in 2021.

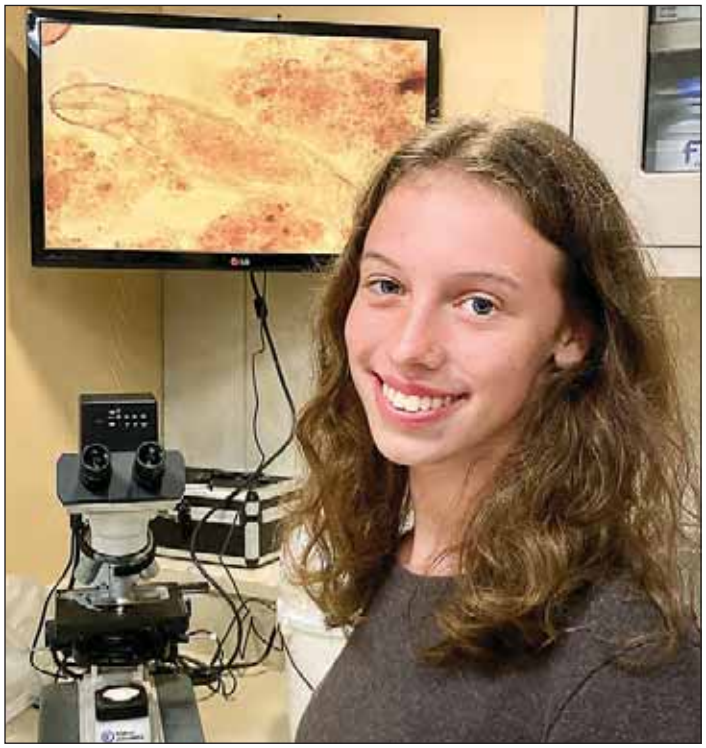
Trinity Schwedler, Indian River High School

Though I may not know what I want to do when I graduate, I think I would like it to be science or math related. Knowing this, I have challenged myself with taking college-level science classes and will continue to do so during my senior year.

I heard about the opportunity to be a summer intern, sponsored by the NYWEA Work-in-Water Program, at the Watertown Pollution Control Facility (PCF) through my friend's mom who works there. I like doing things involved with the environment, so learning about the internship really interested me. I started thinking of the benefits that could come from the experiences I would be gaining. Being the summer intern could help me out when choosing which path to take for my career while also pushing me out of my comfort zone. I adjusted to a new setting I was unfamiliar with and learned skills that will be helpful to me throughout life. A few of these skills include interacting with co-workers, promptness and self-confidence.

Before coming here, I had little to no knowledge of what goes on at a wastewater treatment facility or the process taking place there. Now knowing what I learned from the brief time I've been here, I have so much respect for people who are in this field of work. There are so many different skills that are needed to work at a treatment facility, from knowing where each pump is suctioning from and discharging to, where the substance is being transferred and though which pipes. Being able to do the many tests that happen in the lab, intaking haulers, understanding the treatment stages wastewater is going through as it moves throughout the plant and learning exactly what is going on at each of these stages is only a small sample of the knowledge required to work at a water resource recovery facility.

I learned an incredible amount in the few weeks I was here. I learned the process water goes through from start to finish. Influent from Watertown and Fort Drum combine in the primary



In addition to working around the plant, Trinity had the opportunity to inspect activated sludge under a microscope. She found a water bear in this sample, resulting in sheer joy throughout the lab. *Sam Hollister*

Trinity collected samples from the Aeration Tank. *Angel French*

tank. Water then flows to the splitter box where it splits to the trickling filters then to final tank A, while the rest goes to the aeration tank and then to final tank B. After a chlorination and de-chlorination process it goes out to the river as effluent.

The cycle wastewater goes through sort of replicates what happens in a river, just at an accelerated pace. Here at the plant, there are trickling filters where an arm is moving around in a circle with water flowing out of it and over rocks that have zoogleal film on

Yesterday was Trinity's last day interning with us. I have to say I have seen a complete change from day one until yesterday in her. It has been a wonderful experience for not only Trinity, but also for our facility to watch her grow over the few weeks she was here. I love watching people's opinions change from what they think we do as operators to learning what we actually do!

Angel French, 4A Wastewater Treatment Plant Operator

Both Sam Hollister (left) and Trinity Schwedler (right) interned at the Watertown PCF. Sam is a college student from the SUNY College of Environmental Science and Forestry interning with Angel French. Sam also served as an excellent mentor to Trinity, an Indian River High School student. *Angel French*

them. They help to clean the water as it passes through the rocks, much like what goes on in a river.

There are tests, like dissolved solids, suspended solids and total solids, settable solids, chlorine residual, etc., that are run in the lab to make sure the treatment process is working. Biochemical Oxygen Demand (BOD) is analyzed to make sure the amount of oxygen consumed from stabilizing the organic material is not too much for the river to withstand, and that the effluent stream will not harm the plants and fish. We make sure certain requirements, such as phosphorus levels, are met. All these limits are set forth by the New York State Department of Environment Conservation (NYSDEC) in a State Pollutant Discharge Elimination System (SPDES) permit.

It's not just water going through a process, things that settle and float do as well. Solids go to the thickeners, digesters, and plate and frame presses resulting in a Class B Biosolid ready to be taken to farms where it will be used as hay field fertilizer. These are a few of the many things I have learned in my time here.

I am so grateful for this experience and the life skills I carry now. I was very scared to put myself out there to work as the summer intern, but I'm glad I pushed myself to do it. These few weeks have taught me many things. I have learned how to be more open and effectively communicate. I gained so much confidence over the time I have been here, and it led me to find a new love for water bears, which I was lucky enough to find more than once under the microscope. I'm thankful for getting to learn everything I have while also meeting an amazing group of people who have made each day fun and exciting!

Elijah Kunze, North Tonawanda High School

My name is Elijah Kunze, I just finished my senior year at North Tonawanda High School. I have an interest in the environment and engineering and I had the opportunity to participate last summer in NYWEA's Work-in-Water program and interned at the City of North Tonawanda Water Treatment Plant. The experience was tremendous, and gave me an appreciation of what happens to water before it comes out of our taps! The internship opened doors for me and I was offered a seasonal position with the city! What follows next is what I learned during my internship.

North Tonawanda's Water Treatment Plant has many operations and processes that aid in the creation of potable water, the entirety of which contribute to protecting public's health, and safety. Different processes and chemicals are used in combination with readiness, and proactive testing in the plant and around the city, to provide safe and healthy water for everyone.

The first area for public health and safety is while the water is still flowing through the plant process. Aluminum sulfate is injected into the water, which coagulates turbidity together for the aiding of future removal, as well as keeping the water less basic, at a lower, more neutral pH. Hypochlorous acid and chlorine are also introduced, which disinfects the water protecting consumers from disease-causing microorganisms and pathogens. The water is then settled and filtered to remove all turbidity, keeping the water as clear as possible. Before leaving the plant, it is injected with a final dose of chlorine, ensuring consistent disinfection throughout the distribution system.

The second area for public health and safety are the numerous tests of water samples throughout the plant. A multitude of tests are done at different process stages. Chlorine, turbidity, and fluoride levels are determined and recorded hourly. Weather is monitored as different conditions can affect the plant in numerous ways. If a problem were to develop, this proactive nature ensures that the operators can react accordingly to minimize all possible problems and to make sure the water stays at a consistent, safe quality. Daily distribution samples are also taken around the city and sent to a nearby lab for analysis. If the test results exceed limits established by Department of Health regulations and the water is not safe to drink, a series of plans are enacted to correct the problem, inform the public affected and notify officials. Finally, the process areas of the water plant are thoroughly cleaned and checked, to maintain the highest water quality.

Public health and safety have always been seen as the No. 1 priority in the plant. Given the processes that are undergone with refining and creating our potable water supply and how carefully the operators monitor every step of the way, there truly is a noticeable care for the city and residents' health and safety.

North Tonawanda Treatment plant Water Operator David Conti, left, and intern Elijah Kunze are backwashing a filter. *David Conti*

Clarkson University as a Springboard to Water Environment Federation Leadership

by Laura Jo Oakes and Lauren Livermore

Laura Jo Oakes (Bertrand BS CE '03 MS CE '05) and Lauren Livermore (Crocker BS CE '04) both started off their WEF careers in the Clarkson University New York Water Environment Association (NYWEA) Student Chapter. They each served as the NYWEA student chapter president in their senior years. Fast forward 18 years and Laura and Lauren are serving on the executive board again, both now presidents of their respective Water Environment Federation (WEF) member associations: the Chesapeake Bay Water Environment Association (CWEA) and NYWEA. The presidents recently reconnected in Nashville, Tennessee, at a WEFMAX conference, along with fellow Clarkson Alum and Past President of CWEA, Ellen Frketic ('79).

Laura Jo Oakes is a professional engineer in the state of Maryland and a board-certified environmental engineer. She has served as an engineer and project manager at EA Engineering, Science and Technology, Inc., PBC, based in Hunt Valley, Maryland, since 2005. In college, she served as president for the university's NYWEA student chapter as well as several other roles. To bring it around full circle, while at Clarkson University, Laura was a recipient of a NYWEA Scholarship granted to students pursuing environmental degrees. Upon moving to Maryland in the summer of 2005, Laura became a member of the CWEA. In 2006, she expanded her involvement with CWEA by assisting in the review of abstracts for the WEF Nutrient Control Specialty conference and participated in a Young Professionals Community Service event at Roland Park Elementary School. In 2007, she became and has since stayed an active member of the Spring Meeting Committee and served on the board as the Maryland Trustee from 2015 to 2018. Laura is also a member of the CWEA's Select Society of Sanitary Sludge Shovelers (5S Society).

Lauren Livermore is a managing engineer in the asset management practice area for Barton & Loguidice in Syracuse, New York. She is a professional engineer in New York and a board-certified environmental engineer. Lauren holds a Bachelor of Science in civil engineering with a concentration in environmental engineering from Clarkson University. She has held numerous roles in both the Central Chapter and state NYWEA organization, including:

- Central Chapter Young Professionals representative
- Director on the Central Chapter board
- Member of the state Young Professionals Committee
- Young Professionals representative to the state board
- State Program Committee chair
- Association Activities Committees representative

Lauren was a recipient of one of the first two bronze shovels in the 5S Society, which are awarded to young professionals.

What Laura and Lauren share (besides their alma mater) is their passion for the environment and the need to convey the message to students, and young professionals alike, as well as the importance of getting involved in professional societies early in your career! For both, their connection to WEF built a strong foundation for their current positions of leadership in their respective member associations. The educational, networking and leadership opportunities that stem from professional societies are limitless!

(L-r) Laura Jo Oakes ('03, '05) and Lauren Livermore ('04) in Nashville, Tennessee, at a WEFMAX Conference in 2019.

If you would like to learn more about getting involved in professional societies, contact the authors Laura Jo Oakes at email loakes@eaest.com or Lauren Livermore at llivermore@bartonandloguidice.com.

Want to get more involved with NYWEA?

Visit nywea.org to find out more about leadership opportunities!

"Leave your comfort zone. Go stretch yourself for a good cause." –Kobi Yamada

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NYWEA Scholarship Program

Child of Member Scholarship

Did you know? The NYWEA Scholarship Programs include Child of Member Scholarships. If your child wants to follow in your footsteps and pursue a bachelor's degree in an environmental major, encourage them to apply for a scholarship! NYWEA awards more than $50,000 annually to high school seniors and college students.

Application deadline is Monday, February 28, 2022 at 5:00 pm.

The NYWEA Scholarship Programs are an investment toward the future of the water workforce! Visit **nywea.org/SitePages/Scholarships** to learn more and view eligibility criteria and application documents for scholarship for high school seniors, college student chapter members, graduate students, and certified operators/future operators looking to advance their careers in water.

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KUDOS!
KUDOS!
KUDOS!
KUDOS!
KUDOS!
KUDOS!

Congratulations to All 2021 NYWEA Scholarship Winners!

by Madison Quinn

Thanks to generous donations from our members, since 1998 NYWEA's scholarship programs have awarded $660,750 in scholarship funds to 259 individuals – including scholars pursuing environmental degrees and water resource recovery operators advancing in their careers.

2021 NYWEA Scholarship Program

A total of $54,000 in scholarship funds were awarded to 10 students this year – including the Environmental Career and the Nicholas J. Bartilucci scholarships, General High School scholarships, College Student Chapter scholarships, and the Child of Member scholarships! Congratulations to the 2021 scholarship winners:

- Ellie Vaserman, MIT –
  Environmental Career Scholarship $12,000, over four years
- Karson Smith, Dartmouth College –
  Nicholas J. Bartilucci Scholarship $8,000, over four years
- Abigail Herrington, RPI –
  General High School Scholarship $6,000
- Gabriella D'Angelo, Boston College –
  General High School Scholarship $4,000
- Jk Aroni Goongoon, City College of New York –
  General High School Scholarship $4,000
- Angela Mao, Stanford University –
  General High School Scholarship $4,000
- Molly Derriga, University of New Hampshire –
  Child of Member Scholarship $4,000
- Rianna Garlic, SUNY Binghamton –
  Child of Member Scholarship $4,000
- Samantha Hollister, SUNY-ESF –
  College Student Chapter Scholarship $4,000
- Robert Schneider, Clarkson University –
  College Student Chapter Scholarship $4,000

NG Kaul Memorial Scholarship Program

The NG Kaul Memorial Scholarship fund offers annual scholarships to students pursuing graduate or doctoral degrees in environmental/civil engineering or environmental science concentrating on water quality, who show a commitment to a career in government service. The scholarship honors the memory of NG Kaul, a highly respected engineer with a distinguished career in public service to New York City and then New York state, rising to the position of NYSDEC director of the Division of Water in 1992. That service was capped off, upon his retirement in 2002, by his appointment as director of the USEPA effort to implement the dredging of PCB-contaminated sediments in the Hudson River. Since 2006, through the NG Kaul Memorial Scholarship, the NYWEA has granted approximately $80,000 to 46 students.

This year, three scholarships were awarded, totaling $7,500 in scholarship awards:

- Cameron McKenzie, Yale University – $3,500
- Julie Yaish, City College of New York (CCNY) – $2,000
- Tyler Kleinsasser, South Dakota School of Mines and Technology – $2,000

Lucy Grassano Memorial Scholarship Program

This scholarship honors the memory of Lucy Grassano, who served as a principal administrative assistant at NYCDEP. She was a mentor, friend, teacher and "mother" to many operations staff throughout the years. Everyone needs a coach, and it is in this spirit that the scholarships are granted in her name.

The Grassano scholarship is offered each year to one certified operator from each of NYWEA's seven regional chapters to subsidize the cost of attending the NYWEA annual meeting in New York City. This serves to bring operators to the conference for the first time as a professional development opportunity and a chance to network with their fellow operators and other water professionals from throughout the state.

A total of $12,000 has been awarded to 20 operators from 2018-2020.

Brian Romeiser Pre-certification Workforce Scholarship

The purpose of this pre-certification scholarship is workforce development for individuals pursuing certification. Scholarship awards assist individuals pursuing their operator certification who have enrolled in pre-certification classes.

The pre-certification scholarship was renamed in 2020 to honor Brian Romeiser, a certified Grade 4A operator who was a selfless and dedicated individual. He spent his career helping to advance other operators and encouraging individuals to pursue water resource recovery careers.

A total of $11,000 has been awarded to 11 individuals since the scholarship began in 2019. Congratulations to the 2021 Brian Romeiser Scholarship winners:

- Jarrett Hotaling – $1,000
- Zachary Watts – $1,000
- Antwan Shaw – $1,000

Jim Anderson Memorial Scholarship Program

Jim Anderson was a senior vice president and the Director of Technology at Metcalf & Eddy, an AECOM company. Jim was a strong advocate for training and mentoring young environmental engineers, consistent with M&E's commitment to meaningfully contribute to the development of engineering professionals as envisioned by Leonard Metcalf and Harrison P. Eddy over 100 years ago. He conceived of Metcalf and Eddy's annual Student Design Competition, which challenges university students to tackle real-life design problems from the consulting world. Throughout his career he also developed close working relationships with universities and established successful research collaborations with many of the universities in the New York City metropolitan area.

The scholarship was founded to honor Jim's legacy of mentorship and forward-thinking engineering after he died of cancer in 2006. The Jim Anderson Memorial Scholarship offers one scholarship annually to students attending school in the New York City Metropolitan area. A total of $3,000 has been awarded since the program began.

Avril D. Woodhead Grit Scholarship

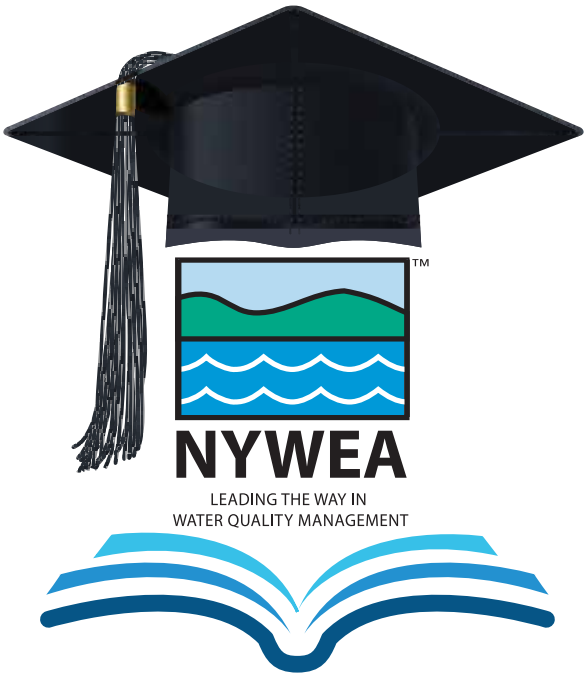
NYWEA's newest scholarship program, the Avril D. Woodhead Grit Scholarship, was recently announced at the Women of Water Summit on October 27, 2021. Grit is the ability of an individual to overcome challenges, maintain effort and engage interest despite failure. One annual $2,500 scholarship will be awarded to individuals who identify as female or non-binary and have demonstrated grit by maintaining effort and interest despite setbacks as they work toward their goals in a STEM field. Applicants must be 17 years or older.

How To Apply

Applications for all the above scholarships are available on the NYWEA website at *https://www.nywea.org/SitePages/Scholarships/*.

There are also many scholarship opportunities available from NYWEA's regional chapters. Visit the chapter pages at *nywea.org* for details on scholarships in your region.

Questions? Contact Scholarship Program Administrator, Madison M. Quinn, via email at *madison@nywea.org* or by phone at (315) 422-7811 x3.



Well done, All!

Operator Quiz Fall 2021 – Chlorination

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. Calculate the chlorine demand given the following information:
Feed rate = 150 lbs/day
Flow = 11.5 MGD
Measured chlorine residual = 0.5 mg/L
a. 6.01 mg/L
b. 1.66 mg/L
c. 1.06 mg/L
d. 0.66 mg/L

2. What chemical is commonly used for dichlorination?
a. Sodium hypochlorite
b. Sulfur dioxide
c. Ozone
d. Fluoride

3. Which of the following treatment processes is not an acceptable way to ensure all pathogenic microorganisms are destroyed?
a. Filtration
b. UV
c. Ozone
d. Chlorination

4. Chlorine gas is:
a. Lighter than air
b. Heavier than air
c. Has a rotten egg smell
d. Is odorless

5. Calculate the chlorine residual given the following information:
Dosing rate = 5.8 mg/l
Flow = 80 MGD
Chlorine demand = 4.5 mg/L
a. 1.30 mg/L
b. 1.03 mg/L
c. 0.93 mg/L
d. 0.30 mg/L

6. Pathogenic organisms can be removed from wastewater treatment process by which of the following?
a. Physical removal through sedimentation and filtration
b. Die-off through natural means and unfavorable environmental conditions
c. Deconstruction by chemicals added to the treatment process
d. Pathogenic organisms can be removed by all the above

7. Which of the following parameters should not be considered when operating a disinfection system using ultraviolet light?
a. Keeping the UV Channel water at a constant level
b. Preventing an excessive water level above the top lamp row
c. Keeping UV lamps always submerged
d. Maintaining the proper chlorine residual in the effluent

8. To prevent violent reactions from occurring:
a. Never pour acid into water
b. Never pour water into an acid
c. Never mix two substances
d. All are ok

9. One pound of sulfur dioxide will neutralize how many pounds of chlorine?
a. 1
b. 2
c. 5
d. 10

10. Chlorine is widely used as a disinfectant in wastewater treatment, but it can also be used to:
a. Control odor
b. Reduce BOD
c. Control foaming
d. All of the above

Answers below.

For those who have questions concerning operator certification requirements and scheduling, please contact Carolyn Steinhauer at 315-422-7811 ext. 3, carolyn@nywea.org, or visit www.nywea.org.

Answers: 1. (c) 1.06 mg/L **2.** (b) Sulfur dioxide **3.** (a) Filtration **4.** (b) Heavier than air **5.** (a) 1.30 mg/L **6.** (d) Pathogenic organisms can be removed by all the above **7.** (d) Maintaining the proper chlorine residual in the effluent **8.** (b) Pour water into an acid. **9.** (a) 1 **10.** (d) All of the above

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