JOURNAL OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

VOLUME 52 NUMBER 4 / ISSN 1077-3002 WINTER 2018

YOUNG PROFESSIONALS

NEWEA
WORKING FOR WATER QUALITY

JOURNAL OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

VOLUME 52 NUMBER 4 | ISSN 1077-3002 WINTER 2018

Contents

On the cover: Turners Falls, Massachusetts—inversion and steam curing of CIPP liner via siphon outlet chamber

Page 67: Measurement unit conversions and abbreviations

NEWEA Journal ISSN #1077-3002
Published four times annually by
New England Water Environment Association, Inc.
This is Volume 52 Number 4
Periodical postage paid at Woburn, MA 01801, and at additional mailing offices

New England Water Environment Association, Inc.
10 Tower Office Park, Suite 601
Woburn, MA 01801-2155
Telephone: 781-939-0908
Fax: 781-939-0907
Email: mail@newea.org
Website: newea.org

Postmaster:
Send address changes to:
NEWEA Journal
10 Tower Office Park, Suite 601
Woburn, MA 01801-2155

Journal Committee Chair & Editor
Joseph Boccadoro
Joe.Boccadoro@aecom.com

Journal Committee
Alan Slater, Alexandra Bowen
Charles Tyler, Susan Landon
Dan Coughlin, Don St. Marie
Eric Staunton, Geraldine Ciardelli
Helen Gordon, James Barsanti
Mac Richardson, Matthew Hross
Meredith Zona, Michael Sullivan
William Murphy, Marie Rivers
Robert Mack

Guest Editors
Amanda Sparks
asparks@woodardcurran.com
Matthew Hross
MHross@hazenandsawyer.com

Technical Editor
Charles Tyler
charleswtyler@msn.com

Copy Editor
Thomas Heinlein

Design/Production Manager
Robert Randazzo

Photo credits
Off-season cranberry field on Cape Cod
(page 14) m01229,
Wikimedia Commons

White Rock Dam
(page 16)
Lia McLaughlin/USFWS,
Wikimedia Commons

NEWEA
WORKING FOR WATER QUALITY

OUR ASSOCIATION WAS ORGANIZED EIGHTY-NINE YEARS AGO in Hartford, Connecticut, on April 23, 1929, with the objectives of advancing the knowledge of design, construction, operation and management of waste treatment works and other water pollution control activities, and encouraging a friendly exchange of information and experience. From 40 charter members, the membership has steadily grown to more than 2,000 today. Membership is divided into the following classes:

Professional Member—shall be any individual involved or interested in water quality including any manager or other officer of a private waste treatment works; any person engaged in the design, construction, financing, operation or supervision of pollution control facilities, or in the sale or manufacture of waste treatment equipment.

Executive Member—shall be an upper level manager interested in water quality and who is interested in receiving an expanded suite of WEF products and services.

Corporate Member—shall be a sewerage board, department or commission; sanitary district; or other body, corporation or organization engaged in the design, consultation, operation or management of water quality systems.

Regulatory Member—this membership category is a NEWEA only membership reserved for New England Environmental Regulatory Agencies, including: USEPA Region 1, Connecticut Department of Energy and Environmental Protection, Maine Department of Environmental Protection, Massachusetts Department of Environmental Protection, New Hampshire Department of Environmental Services, Vermont Department of Environmental Conservation, and Rhode Island Department of Environmental Management.

Academic Member—shall be an instructor or professor interested in subjects related to water quality.

Young Professional Member—shall be any individual with five or fewer years of experience in the water quality industry and who is less than 35 years of age.

Professional Wastewater Operations Member (PWO)—shall be any individual who is actively involved on a day-to-day basis with the operation of a wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of <1 million gallons per day. Membership is limited to those actually employed in treatment and collection facilities.

Student Member—shall be a student enrolled for a minimum of six credit hours in an accredited college or university.

WEF Utility Partnership Program (UPP)—NEWEA participates in the WEF Utility Partnership Program (UPP) that supports utilities to join WEF and NEWEA while creating a comprehensive membership package for designated employees. As a UPP a utility can consolidate all members within its organization onto one account and have the flexibility to tailor the appropriate value packages based on the designated employees' needs. Contact WEF for questions & enrollment (703-684-2400 x7213).

BECOME A NEWEA MEMBER

- Complete and mail the membership application form on pages 75 – 76
- Download a membership application from **newea.org** by clicking—*How Do I Join?*
- Join online at **wef.org** by clicking—*Become a Member*

2018 RATES ($)

Professional 185
Executive 353
Corporate 411
Regulatory 50
Academic 181
Young Professional 69
PWO 109
Dual 40
Student 10

Water Environment Federation
the water quality people®

New England Water Environment Association | Statement of Ownership, Management and Circulation

Publication Title .... The NEWEA Journal
Publication .... #24559
Issue Frequency .... Quarterly (four per year)
Annual Subscription Price .... $20 (included with membership dues)
Complete Mailing Address, Known Office of Publication, General Business Office, Editors and Owner (non profit organization) .... NEWEA, 10 Tower Office Park, Suite 601, Woburn, MA 01801
Contact Person/Managing Editor .... Mary Barry, NEWEA Executive Director
Tax Status .... No change during the preceding 12 months

Issue date for circulation data below: 09/10/2018

Publication title: The NEWEA Journal	Extent and nature of circulation: Technical/ Educational/ Environmental	Average no. copies each issue during preceding 12 months	No. copies of single issue published nearest to filing date
Total number of copies		2,500	2,500
Legitimate paid and/or requested distribution	Outside country paid/requested mail subscriptions	0	0
	In-country paid/ requested mail subscriptions	2,200	2,200
	Sales through dealers & carriers	8	8
	Requested copies distributed by other mail classes	0	0
Total paid and/or requested circulation		2,208	2,208
Total nonrequested distribution		0	0
Total distribution		2,208	2,008
Copies not distributed		292	492
Total		2,500	2,500
Percent paid and/or requested circulation		100	100

President's Message

Janine Burke-Wells
Executive Director of the
Warwick Sewer Authority
City of Warwick, Rhode Island
Janine.Burke-Wells@warwickri.com

This is my final President's Message—it is hard to believe my term is almost over! I will always cherish my year as your president, but NEWEA moves steadily on.

My mother was fond of the saying, "This too shall pass." Usually she uttered these words to comfort me after some major personal disappointment. It was not until years later, as an adult, that I learned (while watching Jeopardy!) that the phrase was coined at the behest of King Solomon who challenged his wise men to come up with a phrase that would be true in all situations. "This too shall pass" speaks to impermanence, and supposedly the phrase caused even King Solomon to realize that his wealth and good fortune were fleeting.

We have all learned that things change whether we want them to or not, so we need to hang on to those moments, both good and bad; learn from them and keep on moving. At our cellular level, dear readers, we are in constant flux. There is no such thing as equilibrium at the cellular level. The term equilibrium can be found in chemistry and physics, and it describes situations in which forward and reverse (re)actions occur at equal rates. Thus, equilibrium to me signifies no change and no progress.

NEWEA has not been sitting still, that is for sure. We have made great progress due to so many (staff and volunteers) who make things tick. While not yet confirmed by end-of-year tallies, the number of members and committee volunteers is clearly higher in 2018. This means more hands to share the load as we keep moving forward; together we have accomplished much.

In August, I was honored to offer opening remarks at the Water Reuse Conference at the University of Connecticut in Storrs. I used my latest favorite quote: "Water should not be judged by its history, but by its quality," from water reuse pioneer Dr. Lucas Van Vuuren. Nick Ellis and his Water Reuse Committee did an outstanding job; the session was full, and everyone who had signed up showed up, a first according to program coordinator Janice Moran. I also attended NEWEA's teacher training event, hosted by the Public Education Committee at the Massachusetts Water Resources Authority's Deer Island treatment facility. Also well attended, the event was held in a historic steam pump station building at the site that furnished a perfect atmosphere for teaching teachers about what we do.

Believe it or not, I attended my first WEFTEC this year, flying into New Orleans at the end of September. "It's a marathon, not a sprint" was the advice that we first-timers were given, and it was good advice. There was so much to do, with meetings, sessions, and the vast trade show floor, with plenty of super-sized booths and displays. The Operations Challenge event is huge and chaotic. When the dust settled, though, the Rhode Island team took home two trophies and the Connecticut team one other in a proud showing for New England.

I joined in the fun of playing in the NEWEA golf tournament on October 22. Despite the chilly day, it was another successful event, and all with whom I spoke enjoyed themselves. Thanks to Lisa Feitelberg, Past President Ray Willis, and the rest of the volunteers who made the day a worthy event. Also in October, I trekked to EPA Region I's Regional Industrial Pretreatment Program annual conference hosted by long-time NEWEA supporter Jay Pimpare of EPA. While there, I tasted what it is like to be a vendor, tending the NEWEA booth with Vice President Jenn Lachmayr. My month concluded with a trip to the Connecticut Association of Water Pollution Control Authorities fall workshop—a perennial favorite of mine—where I witnessed the advantages of having regulators at the table, making presentations and mingling with the regulated, and how these activities elevate our conversations and interactions.

As my deadline for this article loomed, I finally achieved my goal of attending an association banner event in each of the six New England states. Driving up to Burlington, Vermont, for the Green Mountain Water Environment Association (GMWEA) fall trade show on November 8, I recalled that I had been there some 15 years ago as the exchange operator from Rhode Island—a still-vital NEWEA program that I highly recommend to operators. Vermont is where I saw my first sequencing batch reactor (SBR) in operation, and observed co-generation and composting facilities and other early resource recovery efforts. GMWEA's leadership in the One Water concept and the experience of Burlington in the autumn are two of the many reasons that this annual Vermont event is a worthy destination.

I want to use my bully pulpit here to say a heartfelt thank you and goodbye to long-time office administrator Linda Austin, who will retire after the spring conference this coming June. Ms. Austin is a thoroughly good person, like many in our business, and she keeps that NEWEA office humming. She helped me every day (except Fridays), with a solid response every time I asked for assistance. Thank you, Linda, for bringing those big piles of NEWEA collection system certifications and lately a lot of laboratory analyst certifications for me to sign. We are all going to miss her—a lot. Time will tell how quickly we will need to find a new "keeper of the sludge bed," but, in the NEWEA way, someone will step up if necessary and things will move on.

Things will change; that is a given. And because NEWEA approaches change positively, we will endure and flourish. A treasured staffer shared with me the following quote about evolution:

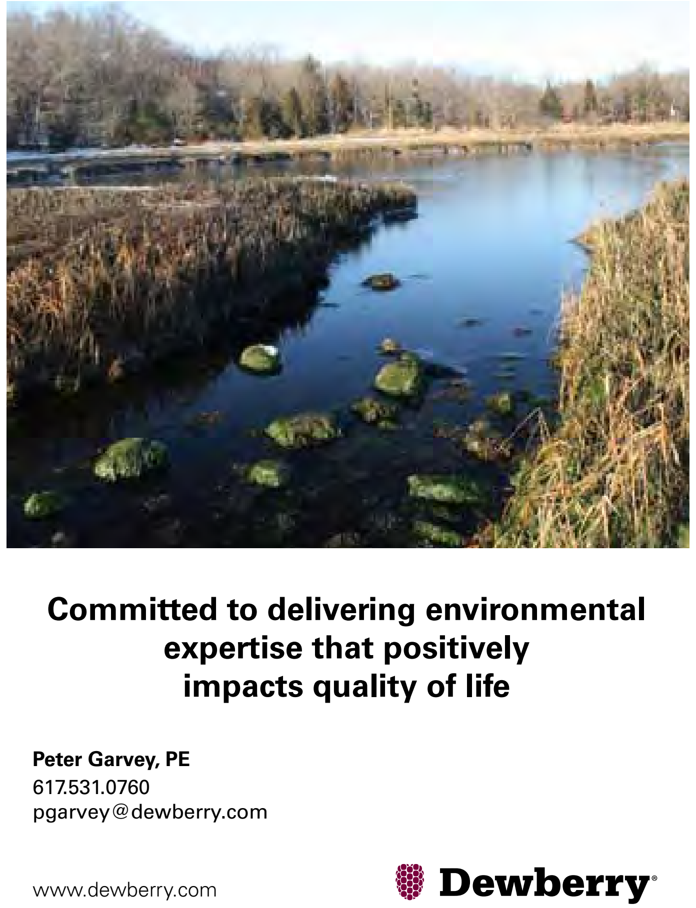
"Yes, change is the basic law of nature. But the changes wrought by the passage of time affect individuals and institutions in different ways. According to Darwin's *On the Origin of Species,* it is not the most intellectual of the species that survives; it is not the strongest that survives; but the species that survives is the one that is able best to adapt and adjust to the changing environment in which it finds itself. Applying this theoretical concept to us as individuals, we can state that the civilization that is able to survive is the one that is able to adapt to the changing physical, social, political, moral, and spiritual environment in which it finds itself." *

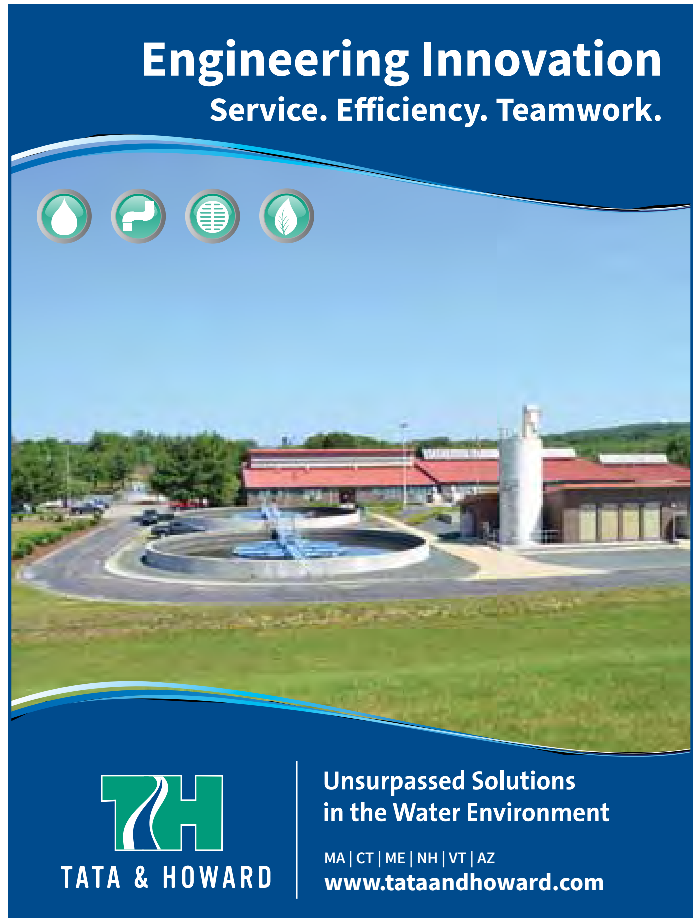
Those are words to ponder; I could not have said them any better. When I think about NEWEA, I see an organization poised to survive and thrive. I am excited about the future, with Ray Vermette from New Hampshire ready to take the gavel from me in January; he will focus on innovation—the word itself connotes positive advancement, and so the collaboration with the New England Water Innovation Network (NEWIN) will continue. Jennifer Lachmayr has imaginative plans for 2020, and incoming senior management team members Virgil Lloyd and Mac Richardson will step up to put their unique stamps on things.

Before descending from this pulpit, I need to thank Jim "Coach" Barsanti, who paved the way for me to smoothly enjoy my year as president. I also want to thank Priscilla Bloomfield, the ultimate team player, who always looks to help with her positive, "can do" attitude. It is impossible to thank Mary Barry and Janice Moran enough for all of their help and support. And a special thanks to Charlie Tyler for often helping find the right word in a pinch.

It has been a blast being your president. And, yes, this too shall pass. But I am proud to be a part of this passing to the next NEWEA milestone. We are having a positive impact on discussions about the water environment in New England and beyond. As we move along to our next challenges, let us all keep up the good work. Keep going all in. Water's worth it!

* 1963 June, Southwestern Social Science Quarterly, Vol. 44, #1, Lessons from Europe for American Business by Leon C. Megginson, (Presidential address delivered at the Southwestern Social Science Association convention, April 12, 1963)


Committed to delivering environmental expertise that positively impacts quality of life
Peter Garvey, PE
617.531.0760
pgarvey@dewberry.com
www.dewberry.com
Dewberry


Engineering Innovation
Service. Efficiency. Teamwork.
TATA & HOWARD
Unsurpassed Solutions in the Water Environment
MA | CT | ME | NH | VT | AZ
www.tataandhoward.com


Your city is now safe from SEWER OVERFLOWS . . .
ECHO
Advanced Sewer Level Monitoring
• System-wide performance at a glance
• Detect overflow conditions early
• Optimize sewer cleaning
• CSO overflow notification
For more information, contact Matthew Brown
mbrown3@idexcorp.com or 603.625.1212
ADS
www.adsenv.com/echo


Ti SALES
800-225-4616
www.tisales.com
Smith-Blair
NEPTUNE
AVK
AMERICAN AVK COMPANY
FORD
LMI
SCALETRON
ZURN
WILKINS
Cretex
PRO-RING
SCHONSTEDT INSTRUMENT COMPANY
RED-B-GONE
Rust Remover
FERNCO
REED
Serving You with Fast & Dependable Service since 1963


Are you forced to do more with less?
So, when do you find time for pump servicing?
PVP Pumps save Time and Money. Here's how.
PVP Double Disc Pumps™ operate up to 10 times longer and cost up to 70% less to maintain. When you factor in the total life cycle expense (labor costs, maintenance and repair), you will find PVP's Double Disc Pumps are a better value. Our pumps offer...
PVP pumps operate at lower speeds with no sacrifice in performance: Lower wear rate = Longer life.
Our Maintain-in-Place design reduces downtime and lowers maintenance costs.
Seal-less, gland-less, oil-less design lowers operating costs.
PVP pumps can run dry indefinitely without damage.
Fewer moving parts means less need for repairs or maintenance.
PVP Penn Valley Pump
DOUBLE DISC PUMP
Toll Free: 800-311-3311 • PennValleyPump.com
The PVP Life Cycle Cost Advantage
Are you operating rotary lobe or progressive cavity pumps? Then you are familiar with their repair and maintenance costs.
Learn the facts. Contact us today and discover how PVP's positive displacement pumps are your most cost-effective, long-term value.
Represented by:
New England Environmental Equipment, Inc.
Phone: (781) 275-1001
Web: www.ne3inc.com

From the Editor

In the preceding section, in her final President's Message, Janine Burke-Wells eloquently states how quickly time passes and how NEWEA will move on to the next talented leader. I echo her sentiments because like her, I am also preparing my last entry as editor.

The last three years were really a blur, but very satisfying and rewarding. Not often can you say you helped to prepare 12 magazine issues and publish more than 30 feature articles, and in the process, worked with as talented a group of individuals as you can imagine.

Speaking of talented, Allie Bowen will become the new editor and chair of the *Journal* Committee. Ms. Bowen has served the committee in various roles and has always done an incredible job. She brings tremendous energy, enthusiasm, and new ideas to the position, and I have no doubt she will succeed as editor. Please join me in congratulating her.

Joe Boccadoro, P.E.
Associate Vice President–Water
AECOM
Joe.Boccadoro@aecom.com

Below I recognize the *Journal* team member by member. The *Journal* is an impressive publication because of this team's efforts, and I appreciate its hard work to make it so. Here is your *Journal* team, in alphabetical order:

- James Barsanti, past president and active member (among many other committees and initiatives; How does he find the time?!)
- Allie Bowen, vice chair and incoming chair; guest editor numerous times
- Dan Coughlin, originator of the Spotlight section; responsible for most of its content
- Alexandra Doody, past member who moved from New England; vice chair and guest editor
- Helen Gordon, past chair; member emeritus; content generator; invaluable insight
- Tom Heinlein, copy editor extraordinaire; adept at smoothing out the rough edges
- Matthew Hross, frequent guest editor, including this issue
- Susan Landon, retired; past editor
- Gail Lollis, past member who moved from New England; vice chair and guest editor (multiple times!)
- Robert Mack, recent member; vendor perspective
- William Murphy, recent member; eager to contribute
- NEWEA office, Mary Barry, Linda Austin, and Janice Moran, always quick to respond to committee requests and provide content for the Events and Inside NEWEA sections of the *Journal*
- Bob Randazzo, expert graphic design and production, keeping the *Journal* humming along
- Mac Richardson, enthusiastic volunteer; always willing to contribute (member Spotlight, guest editor, interesting ideas, meeting minutes)
- Marie Rivers, new member hitting her stride; guest editor for the Spring 2019 issue
- Alan Slater, retired but still active; regulatory perspective; guest editor
- Eric Staunton, guest editor; thought-provoking ideas and perspectives
- Don St. Marie, regulatory perspective; guest editor and content generator
- Michael Sullivan, frequent guest editor; mentor to new members
- Charles Tyler, photography editor; Industry News coordinator; reviewer; editor; mentor; and more!
- Meredith Zona, Industry News coordinator; frequent guest editor; content generator

Thank you, *Journal* team, for making my time as editor such a pleasurable and rewarding experience. I now pass the baton to Ms. Bowen, who, with the help of the committee members above, will put her stamp on the *Journal*. And, thanks to all our readers and contributors. We appreciate your support.

Journal themes & submission deadlines
Spring 2019—**Stormwater** (December 28, 2018)
Summer 2019—**Wastewater Treatment** (March 29, 2019)
Fall 2019—**Collection Systems** (June 28, 2019)
Winter 2019—**Safety** (September 27, 2019)

JOURNAL OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

Contribute to the *Journal*

NEWEA encourages all to submit a paper for publication in the *Journal*.

2019 *Journal* themes and submission deadlines:

Summer—**Wastewater Treatment** (March 29)

Fall—**Collection Systems** (June 28)

Winter—**Safety** (September 27)

For more information visit the NEWEA website, or contact Allie Bowen at BowenAB@cdmsmith.com

The Falmouth Rod & Gun Club received a watershed grant for an innovative project to restore a former cranberry bog back to a natural wetland and native fish run habitat with public access

EPA and Partners Announce $4.5 Million in Grants for Coastal Southeast New England

EPA, in partnership with Restore America's Estuaries (RAE), has announced $4.5 million in new funding for organizations working to restore clean water and healthy coastal ecosystems to southeastern New England.

The funding is provided under the 2018 Southeast New England Program (SNEP) watershed grants, a collaboration between EPA New England (Region 1) and RAE. The grant program aims to build and support partnerships to tackle the region's most pressing environmental issues, such as nutrient pollution and coastal habitat loss.

"Protecting iconic waters like bays and estuaries in southern New England is a priority for EPA, and these projects will help further that goal," said EPA New England Regional Administrator Alexandra Dunn. "This funding will help protect clean water and establish innovative, watershed-based models that are vital to the ecological resiliency and economic vitality of our coastal communities."

RAE selected 14 grant recipients through a rigorous competitive process. The awardees include municipalities, non-profit organizations, state agencies, universities, and regional planning organizations, each of which is leading an innovative, high-impact project of regional importance. The $4.5 million in federal funds will be matched by an additional $1.8 million in state and local dollars, providing altogether more than $6.3 million in funds to protect and restore southeast New England's environment.

In Rhode Island, 2018 SNEP watershed grants are funding the following:

- Town of Bristol to restore Silver Creek on Bristol Harbor ($300,000)
- RIDEM to work with the state of Connecticut on restoring the Pawcatuck River Estuary and Little Narragansett Bay ($450,000)
- City of Pawtucket to build a "green and complete street"—integrating clean water and transportation improvements—adjacent to the new rail station ($376,000)
- RIDEM to upgrade environmental monitoring equipment in Narragansett Bay ($300,000)
- Save The Bay to restore clean water in Hundred Acre Cove in Upper Narragansett Bay ($132,000)
- University of Rhode Island for a scientific study of groundwater pollution to Narragansett Bay and the South Shore salt ponds ($475,000)

In Massachusetts, 2018 SNEP watershed grants are funding the following:

- Association to Preserve Cape Cod to restore water quality in the Three Bays area of Barnstable ($300,000)
- Buzzards Bay Coalition for a multi-community collaboration to reduce nitrogen pollution to upper Buzzards Bay ($419,000)
- Cape Cod Commission to collect and manage water resources information regionally, to improve clean water management Cape-wide ($400,000)
- Falmouth Rod & Gun Club for an innovative project to restore a former cranberry bog back to a natural wetland and native fish run habitat with public access ($450,000)
- Martha's Vineyard Commission to build and test an innovative system to reduce nitrogen pollution in groundwater flowing into Lagoon Pond on Martha's Vineyard ($250,000)
- Pleasant Bay Alliance to restore water quality in Cape Cod's largest estuary ($250,000)

2018 SNEP watershed grants are also funding two interstate projects:

- New England Interstate Water Pollution Control Commission to develop a new method of assessing coastal water quality, providing an important new tool for state and local clean water restoration ($250,000)
- Southeast Regional Planning & Economic Development District to assist municipalities and others in improving water quality protection and restoration in the Taunton River watershed ($100,000)

Clean water and healthy coastal ecosystems are essential to southeastern New England's environment, economy, and quality of life. By funding locally based partnerships that reduce pollution and restore coastal habitats, the SNEP watershed grants program is helping to ensure a sustainable and prosperous future for southeastern New England communities.

More information about SNEP and this program can be found at the following two websites: epa.gov/snecwrp and snepgrants.org.

EPA Awards $72 Million in Grants to Three New England States to Support Clean Water Projects

EPA recently awarded Clean Water and Drinking Water State Revolving Loan Fund (SRF) grants of approximately $19 million, $31 million, and $22 million, respectively, to Vermont, Connecticut, and Rhode Island. These grants will finance community-based short- and long-term water infrastructure projects, such as upgrades to municipal sewage plants and public drinking water systems, that address high-priority water quality and health-based concerns.

"Communities across Vermont, Connecticut, and Rhode Island will enjoy cleaner water and make important infrastructure upgrades thanks to this funding," said EPA's Ms. Dunn. "These low-cost loans further EPA's commitment to ensuring American communities have access to clean water, safe drinking water, and the infrastructure necessary to support local needs."

Vermont—"As we work together to ensure clean water across Vermont, I appreciate that all Vermont's 251 towns and cities will be eligible to apply for these Drinking Water and Clean Water SRF funds," said Governor Phil Scott. "These loans are especially important to our smallest communities, helping pay for crucial infrastructure upgrades, and can be used to enhance drinking and wastewater treatment facilities, keep pollution in check, and support green infrastructure projects."

Funding for Vermont came through separate grants to the Vermont Department of Environmental Conservation (DEC) of nearly $7.9 million for its Clean Water SRF program and of $11.1 million for its Drinking Water SRF program. With the funds awarded to the state, DEC will fund a series of long- and short-term community-based projects that address high-priority water quality and health-based concerns. In partnership with the Vermont Municipal Bond Bank, DEC administers the SRF programs at the state level. It will oversee engineering and construction of the Clean Water and Drinking Water SRF programs, as well as the individual projects funded by it, while the bond bank will execute the loan agreements for both programs.

Connecticut—"Connecticut is dedicated to continuing to improve the quality of our waterways by upgrading our wastewater treatment plants and ensuring they meet the highest standards through improved management of stormwater runoff," said Connecticut Department of Energy and Environmental Protection (DEEP) Commissioner Rob Klee. "Protecting our waters requires a major financial investment, and we are thankful for the support of our federal partners in helping our state achieve its water quality goals."

"The provision of potable drinking water is recognized as one of the great public health achievements in history," said Connecticut Department of Public Health Commissioner Dr. Raul Pino. "This funding demonstrates that our federal partners and the state of Connecticut are committed to ensuring that public drinking water infrastructure is sustainable for future generations."

Funding came through separate grants to the Connecticut Department of Energy and Environmental Protection (DEEP) of nearly $19.7 million for its Clean Water SRF program and the Connecticut Department of Public Health (DPH) for $11.1 million for its Drinking Water SRF program. In partnership with the Office of the Treasurer, DEEP and DPH administer the SRF programs at the state level. DEEP and DPH will oversee engineering and construction of the Clean Water and Drinking Water SRF programs, respectively, as well as individual projects funded by it, while the treasurer's office will manage the finances of both funds.

Rhode Island—"The imperative for clean water is never more obvious than in the summertime, when Rhode Islanders flock to Narragansett Bay, beaches, and waterways to cool off, fish, boat, and just relax," said Janet Coit, director of the Rhode Island Department of Environmental Management (RIDEM). "Rhode Island can leverage this much-needed EPA grant money to fund a wide array of projects to improve the vitality of our state's waters. RIDEM is grateful to Senator Jack Reed and our entire congressional delegation for fighting to maintain robust funding of these critical SRF grants."

Funding came through separate grants to the Rhode Island Infrastructure Bank (RIIB) nearly $10.8 million for its Clean Water SRF program and $11.1 million for its Drinking Water SRF program. DEM and DOH will oversee engineering and construction of the Clean Water and Drinking Water SRF programs, respectively, as well as the individual projects funded by it, while the RIIB will manage the finances for both funds.

For more information about the Clean Water and Drinking Water SRFs, visit epa.gov/cwsrf and epa.gov/drinkingwatersrf, respectively.

New England Citizens and Organizations Recognized by EPA for Environmental Achievements

Several individuals and organizations across New England were recognized on September 12 at the 2018 Environmental Merit Awards ceremony of EPA's New England regional office for their water environment work. These environmental leaders were among 28 recipients.

"New England is rich with individuals, businesses, and organizations that exhibit their strong commitment to local communities and to a clean and healthful environment. EPA is very proud to recognize these meaningful accomplishments," said EPA's Ms. Dunn.

EPA New England each year recognizes individuals and groups in the six New England states who are distinguished by their work to protect or improve the region's environment. The merit awards, given since 1970, honor individuals and groups who have shown ingenuity and commitment through their work or actions from the prior year. Award categories are as follows: individual; business (including professional organizations); local, state, or federal government; and environmental, community, academia, or non-profit organizations. Also, EPA presents lifetime achievement awards each year.

The 2018 Merit Award Winners related to water environment efforts are summarized below.

James Houle, University of New Hampshire Stormwater Center, Durham—The work and accomplishments of James Houle, program manager of the University of New Hampshire

White Rock Dam, North Kingstown, Rhode Island (now removed)—five dam removals, and river restoration projects have upgraded water quality, reduced flood risks, and opened the river to spawning of migratory fish

Stormwater Center, help provide clean and safe water to the region and nation. Mr. Houle works on the cutting edge of stormwater management and watershed restoration. His innovative work has led to green infrastructure technologies and policies to reduce stormwater pollution at local, state, and national levels. Most recently, Mr. Houle deserves recognition for his work in furthering municipal approaches to stormwater management. He is adept at bridging the gap between day-to-day Department of Public Works (DPW) functions and the academic world of stormwater. He ably takes "the message to the streets" so towns understand that efficient green infrastructure does not have to be complicated or expensive. A highlight of his accomplishments is the hands-on technical assistance he provides to states, federal agencies, and municipalities to address stormwater impacts and restore watershed functions. His pragmatic approach is unique for a researcher. His ability to listen and provide thoughtful responses to DPW concerns has earned him deep respect from municipal stormwater managers. For example, during the Berry Brook Restoration Project in Dover, New Hampshire, Mr. Houle worked with DPW staff on 22 site-specific stormwater solutions that met budget and staffing demands as well as pollutant load reduction and restoration goals. Always willing to collaborate on stormwater projects, he is the first to recognize others' efforts.

New Hampshire Department of Environmental Services, PFAS Coordination Team, Concord—LeaAnne Atwell, Karlee Kenison, Amy Doherty, Jennifer Marts, Brandon Kernen, Sarah Pillsbury, Tracy Wood, Catherine Beahm, Ed Peduto, Andrew Fulton, James Martin, KateEmma Schlosser, Clark Freise, Derek Bennett, Rick Skarinka, Gary Milbury, Keith Dubois, Ray Gordon, Robert Scott, Michael Wimsatt, Fred McGarry

The perfluoroalkyl and polyfluoroalkyl substances (PFAS) coordination team at the New Hampshire Department of Environmental Services (NHDES) has overseen one of the largest environmental efforts in state history, involving a level of community outreach that exceeds any of its prior efforts. In 2016, NHDES was notified by Saint-Gobain Performance Plastics that drinking water in its Merrimack facility was contaminated with low levels of perfluorooctanoic acid (PFOA), a chemical used and emitted into the air by the facility since the 1980s. NHDES began sampling wells at homes and businesses in the area and found wells within a 2 mi (3 km) radius were possibly affected, including wells supplying the Merrimack Village District Water System. Bottled water was distributed and the state ordered that Saint-Gobain arrange for continuing a water supply. A smaller area was found then to be affected by a former facility in Amherst, New Hampshire, operated by Textiles Coated International. An NHDES group (PFAS coordination team) has met at least weekly to direct the agency response. Work has focused on making sure no one in New Hampshire is drinking water contaminated by PFAS. Its efforts, focused on the six towns affected by the two plants, has extended to involve other facilities statewide. The team has worked to control air emissions from facilities, supplied safe drinking water to more than 500 homes, and led the cleanup of several sites.

University of New Hampshire Center for Freshwater Biology, Durham—Jim Haney, Alan Baker, Jeffrey Schloss, Robert Craycraft, Shane Bradt, Amanda Murby McQuaid, Anne Ewert, Katharine Langely, Nancy Leland, Jonathon Dufresne, Sabina Perkins, Sonya Carlson

The University of New Hampshire (UNH) Center for Freshwater Biology has worked with EPA New England and other entities across the region to address cyanobacteria issues. The UNH center has been instrumental in ongoing research as well as development of tools to understand global proliferation of harmful cyanobacteria blooms and educate the public on its impacts. It worked with state and local entities to develop a scientific approach to monitoring and tracking cyanobacteria blooms. Its research, as well as education and monitoring, resulted in participation from 28 of the 50 state environmental agencies and often across state and national boundaries. The program has educated hundreds of people and local associations nationwide, building public participation in monitoring. All six New England environmental agencies have participated, and municipal water suppliers have incorporated the program's techniques into standard practices. The UNH center's work has included pioneering innovative approaches to monitoring cyanobacteria and engaging the public, and the center has been at the forefront of research on cyanotoxins. In addition, its many tools are now used by EPA and states for tracking bloom formation and cyanobacteria development in freshwater. Not only has the team helped advance the science behind cyanobacteria blooms and toxin occurrence, it has dedicated time and energy to collaboratively improving water quality.

Pawcatuck River Restoration Project, Hope Valley, Wood-Pawcatuck Watershed Association, The Nature Conservancy – Rhode Island Chapter—Wood-Pawcatuck Watershed Association and The Nature Conservancy's Rhode Island Chapter restored a passage for fish, improved the flow of water, upgraded the water quality, and reduced flood risks. Five dam removals and river restoration projects in the last decade have left the headwaters of the Pawcatuck River open to spawning of migratory fish for the first time since colonial development of mills and dams there. This was made possible by more than $10 million of government funding, the leadership of the Wood-Pawcatuck Watershed Association and The Nature Conservancy, and the efforts of landowners and citizens. Among the projects, the Lower Shannock Falls Dam was removed, and a natural river channel and a riverside park were created. Another project removed the Kenyon Mill Dam and constructed a pool and rock ramp next to a textile mill. In addition to the new spawning grounds and improved passage provided to migratory fish, these projects have reduced flood risks. They also have provided safe boating passage and improved the river for fishing. These restoration projects reflect the desire of the Rhode Island and Connecticut association and watershed communities that the Wood-Pawcatuck river system be designated a National Wild and Scenic River under the U.S. Department of Interior National Park Service, a designation the river system is near achieving.

Lifetime Achievement Award: Dr. William Howland, Isle la Motte, Vermont—Dr. Howland's lifetime spent working on environmental issues has led to lasting results in the Lake Champlain basin, as well as across New England and our polar regions. In his positions as program director of the Lake Champlain Basin Program, professor at the University of Vermont and Middlebury College, and director of Audubon Vermont, Dr. Howland initiated programs and promoted environmental awareness. He effectively communicated with representatives from different jurisdictions and agencies on the importance of water quality, invasive species management, cultural heritage, and environmental conservation.

Throughout his nearly 20-year career with the Lake Champlain program, from which he recently retired, Dr. Howland furthered the vision of a clean lake and advanced legislation supporting the lake. Before joining this program, as executive director of Audubon Vermont, he supported wildlife protection and land conservation initiatives. As director of the Northern Studies Program at Middlebury College, he promoted a better understanding of fragile arctic and subarctic regions. As part of the faculty of both Middlebury and the University of Vermont, he educated the next generation of environmentalists.

Lake Champlain would be different today if Dr. Howland had not been its advocate. His efforts to forge cooperative relationships aided the ongoing improvements in the health of the lake. Also, Dr. Howland supported critical research and monitoring essential to long-term management of the basin. His program supported more than 800 grants to municipalities and local watershed organizations, which continue to promote awareness of lake issues. His legacy can be seen in enduring programs that protect water quality, help control invasive species, and promote cultural heritage programming. His legacy at Audubon, meanwhile, was to create lasting protections for the fragile alpine ecosystems on top of the Green Mountains. Finally, many of the students Dr. Howland taught now are in the field or themselves teaching, promoting stewardship for ecosystems and natural resources.

Town of Hardwick, Vermont—Aging infrastructure contributes to instability and hurts the environment. When there is no investment in infrastructure, water quality suffers. Hardwick's innovative approach to improving water quality has protected its infrastructure. In 2011, the town had significant issues with water distribution. A fire led the state to work with Hardwick on a long-range improvement plan and to take inventory of its drinking water infrastructure. The town evaluated the condition of its system and ranked the risks to its infrastructure, helping it to set priorities for a capital improvement plan. These improvements have cut water loss in half without raising rates. The town also has set money aside for a rainy-day fund that can double as loan collateral, developed relationships with the state and other partners, leading to co-owned infrastructure for stormwater management, and collaborated with other towns and the state to deploy resources efficiently. Hardwick sets an example of a town that use resources wisely to secure its infrastructure and improve water quality. Continuing to innovate, it needs new industrial parks and so is planning to account for more stormwater and wastewater in its long-term plans to reduce pollution.

Margaret Shannon, Maine Lake Society, Belgrade Lakes—In 1999, Maggie Shannon moved to Maine to be near the lake where her family has vacationed for three generations. Thoughts of a relaxing retirement were dispelled as she took on roles as Belgrade Lake Association president, invasive plant patroller, and founder of a seven-lake Courtesy Boat Inspection Program. In 2003, Ms. Shannon became executive director of the Maine Congress of Lake Associations, now Maine Lake Society, representing more than 120 lake associations. She also is a board member of the Belgrade Regional Conservation Alliance and chairs its Lake Trust, while she continues as executive director, LakeSmart program director, and lake policy director of the Maine Lake Society. The state's LakeSmart Program had reached about 30 lakes when it was hit by budget constraints in 2011. Under Ms. Shannon's leadership, the Maine Lake Society took over the program in 2012, and since, it has spread to include more than 50 lakes. Ms. Shannon also has promoted legislation and policies to benefit Maine's lakes. Recently, she worked with environmental organizations to promote a bond referendum that would provide $5 million for tackling runoff pollution. What is more, she advocated recently for a measure to require septic system inspections in shoreland zones when real estate is transferred, for funding for local Youth Conservation Corps, and for measures to improve camp roads in lake watersheds. Ms. Shannon connects with residents and legislators, and effectively communicates the values of and threats to Maine's lakes.

Lifetime Achievement Award: Robert Zimmerman, Jr., Littleton, Massachusetts—Bob Zimmerman of Littleton retired this summer as executive director of the Charles River Watershed Association, having worked wonders for the Charles River. During a 27-year career, Mr. Zimmerman's ingenuity and vision took one of the state's dirtiest rivers and made it into one of the cleanest urban rivers in the United States. In this job, he raised awareness of issues on the Charles, growing the organization ten-fold. He sought non-traditional solutions to age-old environmental problems. He was a strong advocate for putting into place the Massachusetts Water Resources Authority's long-term plan for controlling combined sewer overflows (CSOs), the backbone of the Charles River and Boston Harbor cleanup that will

| INDUSTRY NEWS |

dramatically reduce the flow of sewage into the Charles. He established a monitoring and field science program that provided data to understand the dynamics of the river. Mr. Zimmerman also invented SmartStorm, a rainwater harvesting system, while creating a stronger regulatory climate for rainwater recycling.

The list of Mr. Zimmerman's successes continues, including starting a fish restocking program, supporting litigation to protect water resources and developing the underlying science for a phosphorus load limit, and developing software that reduces stormwater management costs. His advocacy led to the creation of new parklands. Mr. Zimmerman's work played a pivotal role in taking what was once an open sewer and turning it into the Central Park of Boston, an urban mecca that supports fishing, swimming, sailing, rowing, water-gazing, walking, running, bicycling, and other recreation by some 30,000 people each day in summer. The results can be measured in the 99.5 percent reduction in sewage discharged to the Charles from CSOs and that the river meets swimming standards about 70 percent of the time, compared to less than 20 percent early in Mr. Zimmerman's career. Boating is now safe nearly all the time. Mr. Zimmerman has been an inspirational leader in the watershed world.

Lifetime Achievement Award: William Napolitano, Taunton, Massachusetts—Over the past three decades, the ecology of southeastern Massachusetts and the Taunton River and its watershed has had no greater champion than William Napolitano. Mr. Napolitano's contributions to the ecological health of the region came through his role as senior environmental planner with the Southeastern Regional Planning and Economic Development District, the Taunton-based regional planning agency. In this capacity, Mr. Napolitano was one of the co-founders of the Taunton River Watershed Alliance in 1988, the first organization dedicated to serving the interests of the entire Taunton watershed. He served on its board of directors and continues to support the organization to this day. Mr. Napolitano was instrumental in the Taunton River getting federal designation as a National Wild and Scenic River, an accomplishment that took nine years of patient advocacy and quiet determination. The river's designation by Congress in 2009 was testimony to Mr. Napolitano's belief in the river's ecological significance, historical and cultural values, and dignity as a regional treasure that had historically been over-exploited and underappreciated. Mr. Napolitano championed the river fervently when few were willing to embrace that role, and made dozens of presentations to select boards, planning boards, and community groups. The value of this critical outreach was perhaps most clearly seen in votes supporting the designation in all 10 communities along the river.

Mr. Napolitano continues to work on behalf of the river as administrative support for the Taunton River Stewardship Council, which was established to implement the stewardship plan created when the river received its designation. He guides the council's meetings, prepares agendas, and provides critical support to council members, particularly citizen volunteers. Mr. Napolitano's wise counsel ensures that these citizen volunteers are energized to serve in their roles and have the resources necessary to fulfill their functions as council members.

Pleasant Bay Alliance, Harwich, Massachusetts—Nitrogen pollution in Cape Cod's water has led to algae, harmed estuaries, and damaged fish and shellfish. A plan approved by EPA in 2015 to tackle this pollution included new strategies for addressing this looming crisis and was the first such plan to include watershed-based permitting. This permitting empowered towns to work together and with the Massachusetts Department of Environmental Protection (MassDEP) as watersheds, rather than individual towns. It allowed towns to try innovative restoration approaches across boundaries. Before the (2015 EPA-approved) 208 Plan Update, these towns acted individually, which often meant progress was stalled or efforts were not as successful as hoped. The Pleasant Bay Alliance was formed by four towns—Orleans, Chatham, Harwich, and Brewster—to coordinate the resource management plan for Pleasant Bay and its watershed. All four towns signed on to the 20-year Pleasant Bay Targeted Watershed Management Plan to reduce nitrogen, find best practices for managing it, and install innovative treatments. This resulted in the first-of-its-kind watershed permit under MassDEP's pilot program. The four towns created a road map for other Cape communities as they work to reduce nitrogen pollution in shared watersheds. The success of restoring Cape Cod's waterways depends on trailblazers such as the Pleasant Bay Alliance and its towns.

Children's Health Award: Massachusetts Lead-in-Drinking-Water Team—To make sure children in Massachusetts schools have safe drinking water, Governor Charlie Baker in 2016 asked MassDEP to raise awareness about the importance of testing for lead and copper in drinking water in public schools. This led to the formation of the Massachusetts Lead-in-Drinking-Water Team, including representatives from MassDEP, the University of Massachusetts, the Massachusetts Water Resources Authority (MWRA), and other partners. The program included education to help schools establish sampling programs and address elevated lead and copper levels. MassDEP provided technical assistance and oversaw contracted laboratory analysis provided by MWRA to determine if water exceeded recommended lead or copper levels. Results were reported to the schools, along with resources provided to address problem fixtures. More than 150 communities received technical assistance and more than 800 school buildings had plans mapping out all fixtures to be tested. In addition, nearly 56,000 water samples were collected from about 32,000 faucets, fountains, and other fixtures in schools. The program was supported with $2.75 million from the Massachusetts Clean Water Trust. Sampling help will be offered to more schools in the coming year, and some 200 schools are expected to be tested. Besides spreading the word about lead and copper in school drinking water, this voluntary program taught school officials how to sample so the work can continue.

Call for presentations and papers

NEWEA invites the submission of abstracts for professional papers or presentations at its 2019 Spring Meeting and Exhibit. This annual meeting consistently attracts more than 300 engineers, consultants, scientists, operators, and students, and features a variety of technical sessions and exhibitor displays. It provides an opportunity for professional exchange of information and state-of-the-art concepts in wastewater treatment and water environment issues.

All abstracts must be submitted using the on-line form. Authors and presenters will be notified of the acceptance of their abstracts on or before April 5, 2019. Selected papers and presenters will be eligible for publication in the *JOURNAL* of the New England Water Environment Association. Session presentations may be limited to 20 minutes, with 10 minutes allowed for discussion.

For more information contact:
NEWEA Program Committee Chair,
Amy Anderson, Arcadis U.S., Inc.
CALL: 781-939-0908
EMAIL: mail@newea.org

Abstract submission deadline
February 15, 2019

Visit newea.org and click *Submit an Abstract* to complete the on-line abstract submittal form

NEWEA
WORKING FOR WATER QUALITY

Multi-faceted approach to remove copper at the Scituate wastewater treatment facility

AUSTIN WEIDNER, PE, Tighe & Bond, Worcester, Massachusetts
WILLIAM BRANTON, Town of Scituate Sewer Division, Scituate, Massachusetts
SARAH KEITHLEY, PhD, Tighe & Bond, Westwood, Massachusetts

ABSTRACT | Faced with a stringent effluent copper limit at its wastewater treatment facility, the town of Scituate, Massachusetts, undertook an extensive evaluation to identify sources of copper, understand the fate of copper through the treatment facility, and develop alternatives to achieve the permit limit. The most cost-effective solution was the addition of a specialty polymer designed for the removal of copper. Following successful jar test results, the town implemented a temporary chemical feed system to pilot test the polymer addition concept at full scale. Since implementation, Scituate has consistently met its effluent copper limit. Lessons learned from this case study provide a background to the challenges of metals reduction and help demonstrate several multi-faceted approaches.

KEYWORDS | Chemical feed, copper, metals removal, pilot test, source reduction

INTRODUCTION

The town of Scituate operates a 1.6 mgd (6.1 ML/d) wastewater treatment facility (WWTF), which discharges to a tidal creek that is a tributary to the Herring River and ultimately to the ocean via the North River. The WWTF consists of screenings and grit removal, an extended aeration activated sludge process for biochemical oxygen demand (BOD) removal and nitrification, denitrification filters for nitrogen removal, and UV disinfection. Waste sludge is mixed with septage and treated in aerobic digesters, prior to dewatering using belt filter presses. Currently, the Scituate WWTF treats a daily average of 1.3 mgd (4.9 ML/d) of primarily domestic wastewater.

In 2004, the town was issued a National Pollutant Discharge Elimination System (NPDES) permit that contained stringent new limits on effluent total copper, nickel, and zinc. The low metal limits stemmed from the almost non-existent dilution factor within the receiving water body. Owing to several years of non-compliance with the copper permit limit, EPA issued an Administrative Order of Consent (AOC) in 2007. The NPDES permit was subsequently reissued in December 2012 with an effluent total copper limit of 4.0 µg/L on a monthly average basis. Several months later EPA reissued an updated AOC, which established an interim effluent copper limit of 20 µg/L, annual reporting requirements, and a compliance schedule to achieve the permitted copper limit by November 1, 2017.

Between January 2015 and July 2016, the average influent copper concentration at the Scituate WWTF was 67 µg/L, fluctuating between 22 µg/L and 170 µg/L. The effluent copper concentration over this same period averaged 12 µg/L. Although the WWTF met the interim copper limit of 20 µg/L for every month except February 2016, the effluent copper concentration was never below the final NPDES permit limit of 4 µg/L.

EVALUATION OF ALTERNATIVES

Complying with a low-level metal limit, such as Scituate's copper limit, can pose a major challenge. These concentrations are close to the limits of detection, let alone the limits of the available removal technology. As a result, a simple and cost-effective solution to remove metals to these low concentrations has not yet been developed. Instead, successful case studies show that WWTFs can employ a multi-faceted approach of several alternatives tailored to their unique treatment goals and operating conditions. To comply with the low-level copper limit, Scituate evaluated many approaches, including source reduction, outfall relocation, and several treatment alternatives.

Source Reduction

One of the most effective ways to meet a low-level metal limit is to reduce sources of metals that contribute to the influent load of the WWTF. A smaller influent load reduces the treatment demand, making it easier for the WWTF to meet effluent limits. Potential opportunities for reducing sources of metals include identifying point sources (such as industrial users that directly discharge metals as part of a known process), reducing septage intake, and adjusting the drinking water chemistry to minimize corrosion within the domestic drinking water piping. The first part of the town's evaluation investigated these options to reduce the influent copper loading at the WWTF.

First, water consumption data between October 2015 and September 2016 were analyzed to identify major water users connected to the collection system. The analysis revealed that none of the town's major water users were industrial facilities. Instead, the major water users were municipal buildings, housing communities, and retail developments, all of which were believed to contribute copper in similar concentrations as typical domestic wastewater. In addition, town staff could not identify any lower-flow, high-concentration industrial discharges that might have been overlooked in the analysis.

Second, the evaluation investigated the town's Water Department operations to better understand the corrosion control practices intended to limit corrosion of copper from domestic water piping. Grab samples of the raw and finished water at each source were sampled and analyzed for total copper. The weighted average total copper concentration of the treated water was 16.5 µg/L. In comparison, the average influent wastewater concentration sampled over the same period was 40 µg/L, indicating an increase in copper across the collection system, most likely due to corrosion of copper piping.

The Water Department's current corrosion control strategy is to adjust the pH using potassium hydroxide (KOH) to a target pH of 7.5 ± 0.4 units in all its groundwater and surface water sources. The department does not add a sequestration agent, such as an orthophosphate-based chemical, to the drinking water to control corrosion. According to EPA guidance documents, the pH increase shifts the water chemistry to a range that is less corrosive to copper pipes. After reviewing these findings, the town decided that the potential for negatively affecting drinking water quality by further optimizing its corrosion control strategy would outweigh the limited benefits of reducing the influent copper concentration at the WWTF.

Figure 1. Conceptual alternatives for relocating the Scituate WWTF outfall

Outfall Relocation

The outfall for the Scituate WWTF discharges to a small tidal creek within a sensitive coastal wetland. During low tide, the flow in this creek is almost entirely WWTF effluent, so there is no available dilution or mixing. Since the WWTF is less than 1 mi (1.6 km) from the ocean, the town considered extending the outfall to either one of the larger tidal rivers (i.e., Herring River or North River) nearby or directly to the ocean. Discharging into larger water bodies would provide significantly more dilution, assuming the proper mixing was available. This in turn could theoretically make the copper limit less stringent and more attainable or remove it altogether.

Figure 1 shows three conceptual outfall alternatives that were evaluated. Both outfall alternatives 1A and 1B were ocean discharges that consisted of pipe laid on the ocean floor for approximately 0.75 mi (1.2 km) offshore where diffusers would achieve sufficient dilution. The main difference between the two alternatives was the overland route: 1A passed through a residential neighborhood while 1B passed through a coastal wetland. The third route, Alternative 2, discharged to the nearby Herring River. This alternative was sufficiently shorter, at only 2,700 LF (823 m), but would provide less available dilution compared to the ocean alternatives.

Conceptual designs for these three alternatives were developed to estimate the construction costs. All three routes would require a new effluent pump

Table 1. Percent removals of sampled parameters at Scituate WWTF

Percent Changes (avg. values)	Total Copper	Dissolved Copper	Total Nitrogen	Alkalinity
Overall plant removal	89%	-125%	91%	29%
Removal by secondary system	76%	-264%	32%	44%
Removal by tertiary system	13%	139%*	59%	-16%

* All percent removals were calculated as a percentage of the influent load. Negative percentages reflect a gain, while positive percentages reflect removal.

station to overcome the topography around the WWTF prior to a gravity discharge to the receiving waters. In addition, each of the outfall options would require many environmental permits, which would increase the cost and extend the schedule. Both ocean outfall options were estimated to cost approximately $15 million to construct. Since the discharge to the Herring River was much shorter, its estimated cost was only about $5 million. Although these outfall relocation alternatives would theoretically help the WWTF meet the copper permit limit, the large construction costs, numerous permitting requirements, and limited project schedule made them less than desirable to the town.

Treatment Alternatives

Owing to the town's concerns with the source reduction and outfall relocation alternatives, the evaluation focused primarily on improving and optimizing copper removal at the WWTF. The first step in evaluating treatment alternatives was to better understand the fate of copper through the existing treatment processes. This understanding was expected to help identify which unit processes were effective at removing metals and uncover locations where metal removal could be further optimized. To accomplish this, it was necessary to collect as much data as possible from the WWTF.

As part of this study, a comprehensive sampling plan was conducted at the Scituate WWTF across three 24-hour periods in November 2016. The goal of the sampling plan was to complete a copper mass balance of the WWTF. The sampling locations included influent, secondary effluent, final effluent, septage, cake solids, and various internal recycle streams within the facility such as filter backwash, digester decant, and belt filter press filtrate. At each location, the samples were analyzed for the following parameters: total copper, dissolved copper, nitrate (NO_3), nitrite (NO_2), Total Kjeldahl Nitrogen (TKN), alkalinity, and pH.

The data collected during sampling indicated the WWTF was removing total copper from the wastewater to just above the required permit limit. The influent and effluent total copper concentration averaged 40 µg/L and 4.6 µg/L, respectively, representing 89 percent removal. This result was promising because it suggested that minor process changes to optimize performance could achieve permit compliance, rather than having to invest in a major capital improvement.

The mass balance approach was helpful because the data collected helped to reveal locations within the treatment process where process optimization could improve copper removal. Table 1 summarizes the percent removal of all sampled parameters across the entire WWTF, as well as specific unit processes. These data show that the secondary system was the most effective at removing total copper (76 percent removal) compared to the denitrification filters (13 percent removal). However, the data also revealed an unexpected trend in the speciation between particulate and dissolved copper throughout the treatment processes. The negative dissolved copper percent removal represents an increase in the dissolved copper concentration across the WWTF and more specifically through the secondary system. This increase in dissolved copper directly affected the WWTF's ability to meet permit. Sampling data showed that 85 percent of the copper discharged from the WWTF was in the dissolved form, which is more difficult to remove because dissolved species pass through typical solids removal processes.

The sampling data provided clues to why dissolved copper was increasing through the secondary system. As seen in Table 1, alkalinity decreased by 44 percent across the secondary system, attributed to nitrification occurring within the tanks. As the biological process consumes alkalinity, the pH of the mixed liquor also drops. This change in water chemistry is believed to favor the dissolution of particulate metal species, including copper, and therefore increases the dissolved copper concentration within the tanks.

The mass balances also helped to determine the impact of the recycle streams on the copper through the WWTF. All the recycle streams are returned to the head of the plant, so we compared the copper load in the recycle streams to the influent load to determine the impact of each stream. Table 2 summarizes the percent contribution of each recycle stream to the influent load for several of the tested parameters—that is, the percent of the influent load attributed to each recycle stream. Both the filter backwash and belt filter press filtrate return less than 5 percent of the influent load for the measured parameters: total nitrogen, alkalinity, and both copper species. The digester decant recycle streams result in a 12 percent increase in total copper to the influent, whereas the increase in dissolved copper is 27 percent. These percentage increases are much greater than the other recycle streams; however, they are still small relative to the overall influent plant load.

One possible explanation for why the digesters recycle so much copper is that they receive a significant copper load from septage. During sampling, the average total and dissolved copper concentrations in the septage were 4,213 µg/L and 31 µg/L, respectively. Although the copper concentration of the septage entering the digester is high, the total copper in the decant is only 19 µg/L, suggesting that digesters capture this copper load effectively and remove it via the sludge pressing operation.

Sidestream treatment of recycle flows can be effective in reducing the overall load to a treatment facility and improving treatment performance. Although a sidestream treatment approach for the digester decant in Scituate appears to be a possibility, this recycle stream is infrequent (one or two days per week), so its impact on the WWTF's ability to meet the permit limit is minimal. That is, since the WWTF cannot historically meet the effluent limit (on days when inevitably there was no decant), a reduction in this recycle stream would not help consistently reduce copper in the WWTF effluent. Based on this analysis, targeting dissolved copper species in the secondary effluent was concluded to be the most effective in optimizing copper removal.

Removing dissolved copper effectively requires converting it into a particulate form and then removing the particle via conventional solids removal. Several chemical treatment solutions were investigated including a sulfide-based polymer designed specifically for low-level metals removal. The polymer contains sulfide functional groups that are incorporated into the polymer chain. These organic-sulfide sites have a high affinity for dissolved metals, causing the metals to bind to the surface of the polymer. Once bound the polymer forms small floc particles due to its high molecular weight and precipitates out of solution.

To test the polymer's effectiveness, jar tests were conducted on the secondary effluent at the Scituate WWTF. This dosing location was selected because it gave the polymer time to react and precipitate prior to passing through the denitrification filters, which would subsequently remove the precipitated solids. The sample was dosed at various concentrations and mixed for a reaction time of seven minutes. Each jar was then filtered to simulate the approximate pore size of the denitrification filters. The filtrate was sampled and analyzed by a third-party laboratory for dissolved and total copper.

The data from the jar tests, as summarized in Figure 2, show that all dosages of the polymer removed copper to below the effluent permit limit. The dissolved copper

Table 2. Percent contributions from each recycle stream to the influent load

Recycle Stream	Total Copper	Dissolved Copper	Total Nitrogen	Alkalinity
Filter backwash	2%	2%	1%	1%
Digester decant	12%	27%	5%	9%
Belt filter press filtrate	4%	2%	2%	2%

concentration was reduced from approximately 4 µg/L to less than 1 µg/L (greater than 75 percent removal), consistent with our understanding of the polymer's functionality. Once the dissolved copper was precipitated into a particulate form, the copper could then be removed by the filter. The data show an average reduction in total copper of approximately 50 percent following filtration. The less effective reduction in total copper indicates that the polymer's overall effectiveness at removing copper is limited by the filtration system's effectiveness at removing solids. During the jar test, we observed that the precipitated flocs were quite small, making filtration more challenging. Thus, if a more porous filter were used, more precipitated copper flocs would pass through the filter, and the percent removal in total copper would be lower while the percent removal in dissolved copper would likely remain the same.

Based on the successful results of the jar tests, a conceptual design for a permanent chemical feed system was developed. The design recommended dosing the polymer into the secondary settling tank launders, maximizing mixing and reaction time to precipitate the copper and develop floc particles before the denitrification filters, where the solids could be removed. The design included chemical feed pumps, bulk storage tanks, safety equipment, and other ancillary upgrades. In addition to the polymer, the conceptual design included equipment

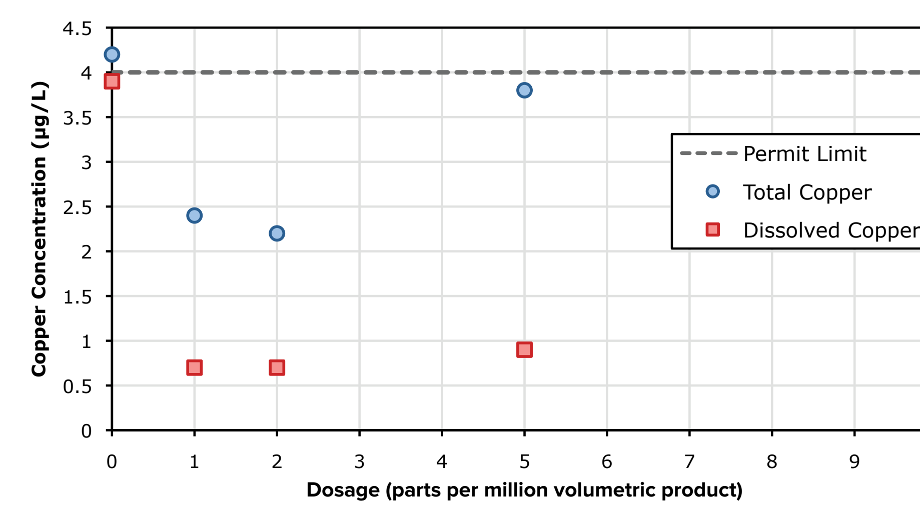


Figure 2. Polymer jar test data—dose response curve for total and dissolved copper

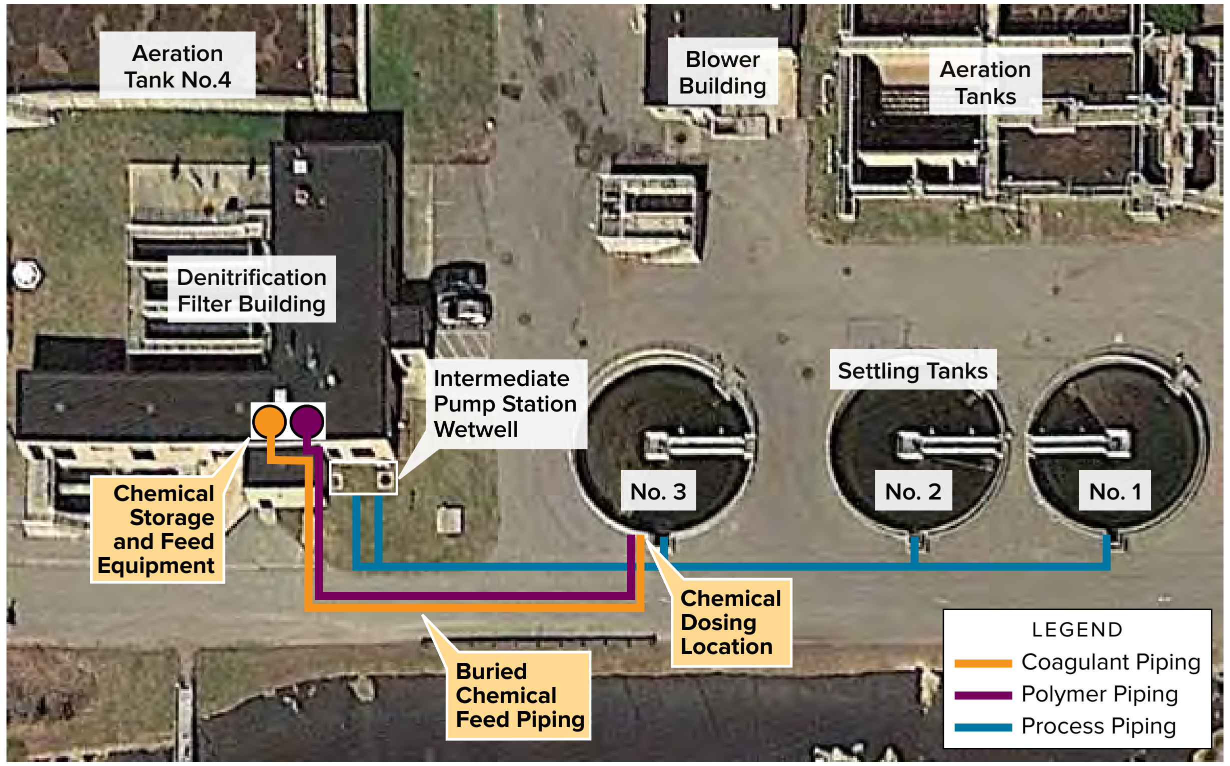


Figure 3. Scituate WWTF site overview with pilot test layout

for dosing a coagulant to aid in solids removal, as a necessary precaution if the precipitated floc were too small to be captured by the denitrification filters. The estimated construction cost for the chemical feed system was $500,000. Since this estimated cost was much less than the outfall relocation alternatives, the town moved forward with the chemical feed treatment alternative.

PILOT TEST IMPLEMENTATION AND DESIGN

Before the chemical feed system could be fully implemented, it was recommended that the polymer be pilot tested to confirm that the approach could effectively remove copper at full scale without adverse impacts on the WWTF. The full-scale pilot test aimed to confirm the following:

- Sufficient reaction time and mixing exists to precipitate dissolved copper
- Precipitated flocs can be removed effectively by the denitrification filters
- Additional solids loading does not significantly increase headloss and the backwash frequency of the denitrification filter
- The polymer has no adverse impacts on aquatic toxicity within the receiving waters
- The polymer has no adverse impacts on the WWTF's downstream processes, including the denitrification filters and UV disinfection

The implemented pilot test mimicked the recommended conceptual plan developed during the evaluation study. Figure 3 shows the layout of the pilot test within the WWTF site plan. The polymer was dosed into the secondary settling tank launder closest to the intermediate pump station to maximize the amount of time for the secondary effluent to mix and react with the polymer prior to being pumped to the denitrification filters. The temporary chemical storage and metering pump skids were located in the denitrification filter building. Chemicals were dosed using peristaltic pumps that were connected to the WWTF's SCADA system for flow-pacing. A PVC conduit housing ¾ in. (19 mm) tubing was run underground from the filter building to the settling tank. Photos 1–3 show the installed pilot test equipment.

A sampling and dosing schedule was developed to monitor pilot-test performance at various polymer dosages. Operators collected composite samples of the influent, secondary effluent upstream of the polymer addition point, and the final effluent three times per week throughout the pilot test. Each sample was analyzed for total and dissolved copper, total nitrogen, alkalinity, and pH. The pilot test was operated for one week at each of the following polymer dosages: 0.5, 1, 2, and 5 parts per million as volumetric product (ppmvp). In addition, the final two weeks of the pilot test were dedicated to dosing the polymer at 1 ppmvp along with two different coagulant dosages. For each weekly trial, the sampling data were averaged to better represent the performance at each polymer dosage. Finally, a whole effluent toxicity (WET) test was performed during the week when the pilot was operating at the highest polymer dosage to determine whether the polymer is toxic to aquatic life in the receiving water.

Photo 1. Temporary chemical feed pump skids and storage

Photo 2. Buried chemical feed piping looking toward the filter building

Photo 3. Dosing location into settling tank launder

PILOT TEST RESULTS

The pilot test was operated for seven weeks from January through March 2018. The test ran smoothly throughout; no complications occurred with the temporary equipment that might have skewed the pilot performance. Figure 4 shows the average total and dissolved copper concentrations observed for each of the various polymer dosages tested. The secondary effluent data represent the average copper concentration just upstream of the polymer addition point. The error bars represent the standard deviation in each set of data.

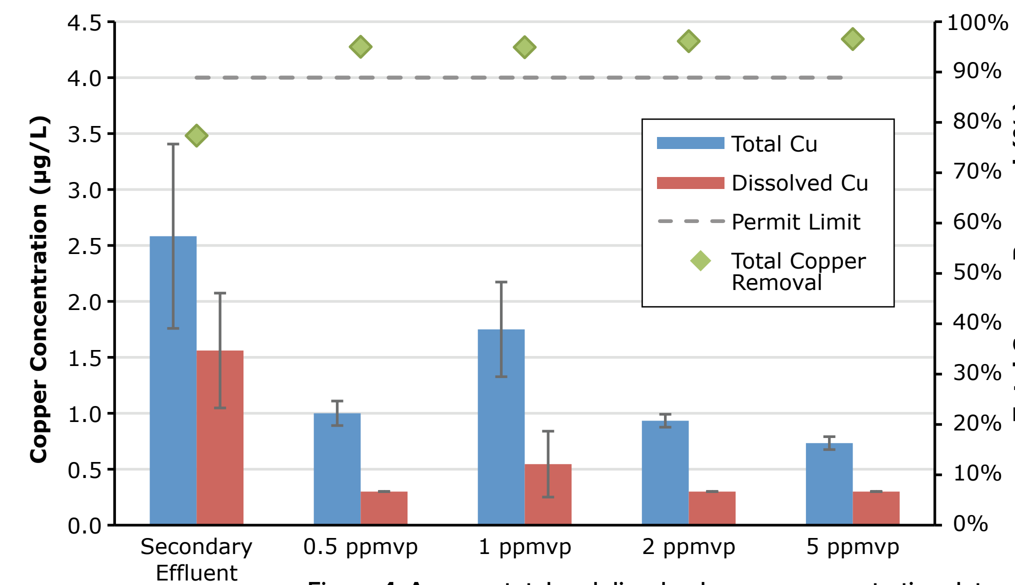


Figure 4. Average total and dissolved copper concentration data observed during the pilot test for each target polymer dose

The data show that the polymer reduced both total and dissolved copper concentrations. On average, the total copper concentration was reduced by 58 percent by the polymer and filters alone, while the dissolved concentration was reduced by 74 percent. Across the entire facility, the total copper percent removal increased from 75 percent historically to 95 percent during the pilot test. No final effluent sample exceeded the permit limit for total copper with the use of the polymer.

Important to note, the average secondary effluent copper concentrations were below the permitted value prior to chemical addition. During the test period, several major storms battered New England leading to flooding and higher than typical flows at the Scituate WWTF. The higher flows diluted the influent total copper concentration from a historic average of 63 µg/L to 25 µg/L during the pilot test. It could be argued that the pilot test was inconclusive because the copper concentration before polymer dosage met permit. However, the data still showed a significant reduction in copper, especially in dissolved copper concentrations, suggesting the copper was reacting, precipitating, and being removed by the filters as hypothesized. Based on these results, the polymer is believed to be able to reduce the total copper concentration below the permit even when the upstream concentrations rise.

The data in Figure 4 also show that effluent copper concentrations did not appear to differ significantly as a function of the polymer dose. Namely, no additional copper removal occurred at higher dosages. The apparent difference for the 1 ppmvp dose is a function of higher influent copper concentrations compared to those in the other sampling weeks. In addition, there appeared to be no noticeable benefit to dosing the coagulant along with the polymer. It was therefore recommended that the town continue to dose only the polymer at a dosage of 1 ppmvp.

Last, the pilot test eased several other operational concerns of dosing the polymer. Plant operators reported that they did not see an increase in the backwash frequency of the denitrification filters, indicating that the solids loading from the

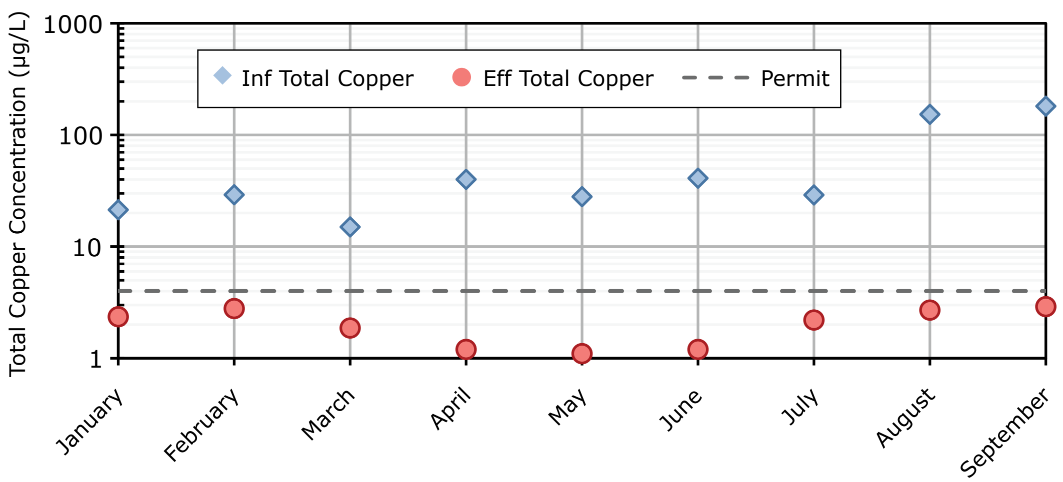


Figure 5. Average monthly influent and effluent total copper concentrations observed since polymer was added to the treatment facility

precipitated polymer did not reduce the filters' hydraulic capacity. Total nitrogen data collected during the pilot across the denitrification filters showed that denitrification performance was not affected by the upstream chemical addition. Most important, the WET test results indicated that the polymer was not toxic to the aquatic life in the receiving waters.

Given the successful results of the pilot test, the town has continued to operate the temporary polymer chemical feed system continuously to achieve permit compliance. Figure 5 shows the monthly average influent and effluent total copper concentrations since the implementation of the temporary full-scale chemical feed system for the pilot test. As can be seen, the effluent total copper concentration has met the permit requirements in every month. More important, the polymer has aided in removing copper below the permit limit even as the influent copper concentration has increased in the months following the pilot test. This observation helps demonstrate one of the unresolved concerns from the pilot test and therefore has assured the town operators that they can continue to meet the copper permit.

CONCLUSIONS

The town of Scituate's efforts to meet its low-level copper permit demonstrate that removing metals from municipal wastewater requires multi-faceted and facility-specific solutions. Although not considered feasible in Scituate, source reduction alternatives, such as identifying point sources and evaluating drinking water contribution, can be highly effective at reducing the influent metals load to a WWTF and should be considered. Before considering alternatives for improving treatment at the WWTF, the town completed an extensive sampling program, which was critical to understanding the fate of copper through the facility and helped to identify a feasible treatment solution. Following the recommendations of the detailed alternatives' evaluation, the town implemented a chemical feed solution—the most cost-effective alternative. Since full-scale dosing of the specialty sulfide-based polymer, the WWTF has continuously met its total copper permit limit without any adverse impacts to the WWTF or to the environment.

ACKNOWLEDGMENTS

Thank you to the dedicated WWTF staff who installed and operated the pilot test, conducted the sampling programs, and provided data and insight into the WWTF operations. The project would not have been as successful without their effort.

In addition, thank you to the rest of the Tighe & Bond project team, including Ian Catlow, Michael Schrader, Tracy Adamski, and Pat Sheridan, for contributing to the project as well as to Chris Laurello from Suez Water Technologies and Solutions for his help with the jar tests and information and recommendations about the polymer.

ABOUT THE AUTHORS

- Austin Weidner is a project engineer at Tighe & Bond focusing on water and wastewater projects. His experience includes evaluation and design of wastewater treatment systems, nutrient and metals removal, and sustainability. He received a Master of Science degree in Environmental and Water Resources Engineering from The University of Texas at Austin and a Bachelor of Science in Civil and Environmental Engineering from Lafayette College.
- William Branton is interim supervisor and chief operator for Scituate's Sewer Division. In his role, he oversees all regulatory functions as well as operations of the town's wastewater treatment plant, nine pump stations, and collection system. He is dedicated to developing and implementing new standards for wastewater treatment and operations. Mr. Branton began his career in wastewater in 2012 with the town of Scituate. Prior to working for the town, he was a full-time student at the UMass Lowell.
- Sarah Keithley is a staff engineer at Tighe & Bond. Her experience includes water and wastewater treatment process evaluation, distribution system water quality modeling, and collection system assessment. She received Master of Science and PhD degrees from the University of Texas at Austin.

Piloting innovation in the waters of Boston

JONNAS JACQUES, PE, Kleinfelder, Boston, Massachusetts
AMY SCHOFIELD, Boston Water and Sewer Commission, Boston, Massachusetts
DAVID PETERSON, PE, Kleinfelder, Boston, Massachusetts

ABSTRACT | Drone technology has rapidly expanded into the commercial market in recent years. Drones, more formally known as unmanned aerial vehicles (UAVs), have been integrated into the data collection and inspection services of many firms around the world. The development of smaller-scale drones has facilitated the implementation of drones as remote-controlled inspection tools. Their use has been seen predominantly in building envelope and overland transmission pipeline evaluations. Only a few instances are found of this technology being used for assessing underground pipelines, culverts, and conveyance conduits such as combined sewer overflow (CSO) outfalls. This article discusses the two-part illicit discharge detection and elimination inspection that reimagined the use of UAV technology to investigate illicit connections within the Boston Water and Sewer Commission's Fort Point Channel CSO 070 outfall.

KEYWORDS | Drones, UAV, illicit discharge detection and elimination inspection (IDDE), pipeline inspection, tidal influence

INTRODUCTION

A 2014 study of Boston's Fort Point Channel (FPC) found the channel to be degraded by contamination from sewage, bacteria, oils, grease, and floatables. Because of these contaminants, the FPC did not meet the water quality objectives of a Class SB combined sewer overflow (CSO) receiving water as defined by the Massachusetts Surface Water Quality Standards. The study found that during dry-weather conditions, sampling site SW1 (see Figure 1) at the upstream (southern) end of the FPC exceeded the water quality standard for *Enterococcus* (104 MPN/100mL) 65 percent of the time over the 143 samples taken. The remaining downstream sample locations in the FPC (SW3-SW8, see Figure 1) complied with the standards between 92 percent and 100 percent of the time. The study found the CSO 070 outfall to be the primary contributor to the FPC's dry weather water quality issues. Furthermore, the study recommended that the Boston Water and Sewer Commission (BWSC) investigate the CSO 070 combined sewer system for illicit sources of bacterial contamination.

Two large outfall pipelines—the Roxbury Canal conduit (RCC) and the Dorchester Brook conduit (DBC) in the BWSC CSO 070 combined sewer system that drains into the FPC—were constructed in the 1960s. These pipelines are reinforced-concrete box culverts that convey a combination of groundwater base flow, storm flow from the local drainage catchment, and combined sewer flow during large storm events to the FPC through the CSO 070 outfall as illustrated in Figure 2. The RCC/DBC pipeline dimensions vary from a 15 ft (4.2 m) wide by 10 ft (3 m) high, single-barrel culvert at the upstream end of the RCC to twin-barrel culverts, each 20 ft (6.1 m) wide by 15.5 ft (4.7 m) high at the CSO 070 outlet to the FPC. Water levels within the conduits are greatly influenced by tide fluctuation, as the FPC is hydraulically connected to Boston Harbor.

The FPC project area is divided by Interstate 93 (I-93), an elevated, congested highway, and numerous railroad tracks that shepherd daily commuters to Boston's South Station. The area includes various municipal, commercial, industrial, and institutional sites that require access for inspection to be coordinated. This highly developed, urban environment within about 1 mi (1.6 km) of the FPC overshadows the relatively flat nature of the local topography. Grades rest at an elevation of approximately 17 ft (5 m) on the Boston City Base (BCB) datum, and the RCC and DBC pipeline crowns are buried roughly 7 ft (2 m) below grade. Between their single- and double-barrel configurations, the RCC and DBC pipelines extend more than 12,000 lf (3,658 m).

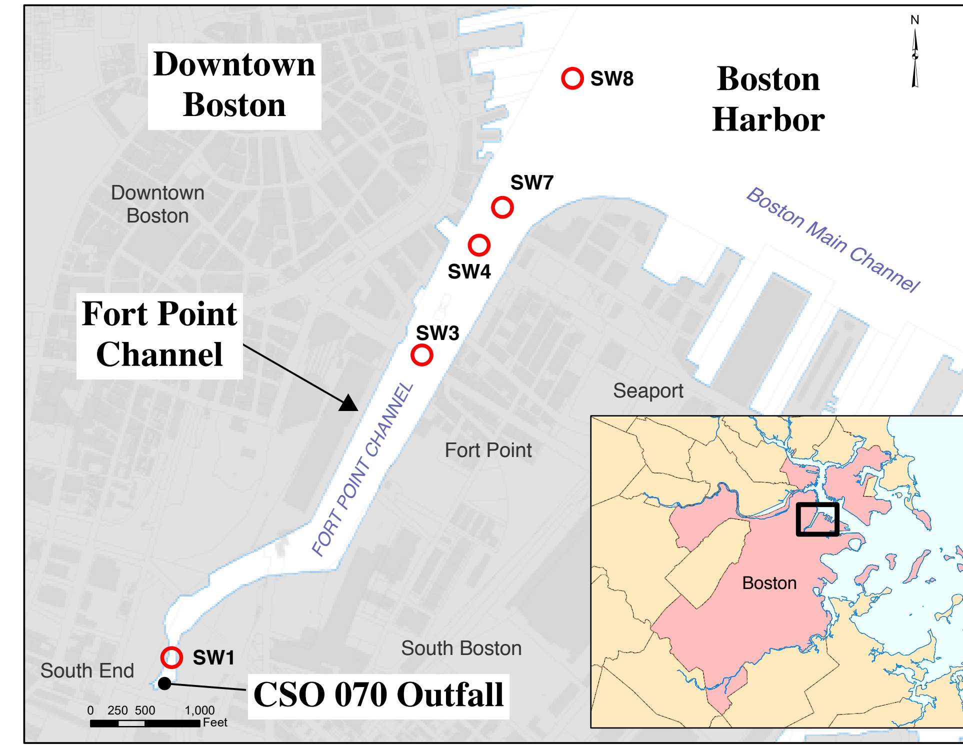


Figure 1. Fort Point Channel sampling sites

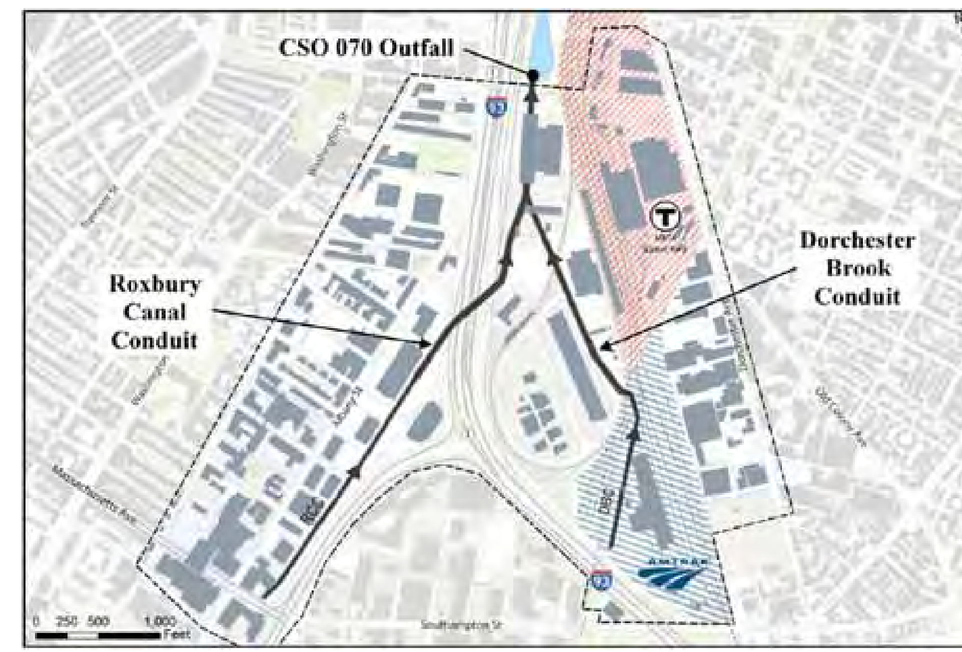


Figure 2. Fort Point Channel project area

DESCRIPTION OF WORK

An illicit discharge detection and elimination (IDDE) program, known as the FPC CSO 070 project, was developed in 2017 to investigate these water quality issues and their sources of contamination within the CSO 070 combined sewer system. The project's objectives are as follows:

- Improve the BWSC's understanding of the CSO 070 collection system configuration, connectivity, and functionality
- Identify specific source(s) of illicit connections, direct cross-connections, or indirect connections between the sanitary and storm-drainage networks contributing to water quality issues
- Develop recommendations for eliminating confirmed illicit connections and, if needed, identify areas for additional study

The CSO 070 system investigation included pipeline inspections, building inspections and dye testing, and manhole water quality grab sampling for laboratory analysis. Central to the pipeline inspections were obtaining internal digital video information of the RCC and DBC pipelines (see Figure 3—next page) and confirming their connectivity to the rest of the drainage system. Although the BWSC's mapping was relatively accurate, these inspections were to identify and inspect any undocumented, existing connections.

Early on, the BWSC understood that conventional inspection would be difficult given the limited access into the conduits, the conduit configurations, and the complex behavior of the tidally influenced water levels. Records of the conduits show that concrete access panel slabs were constructed every 1,000 ft (300 m) or so along each pipeline's alignment. Field reconnaissance found these slabs to be deteriorated and unusable for inspection. Furthermore, access manholes were constructed every 300 ft (91 m) along the pipeline alignments, flanking the conduits at either side as depicted in Figure 4 (next page), and the non-centered location of the manholes limited access into the center of the pipelines.

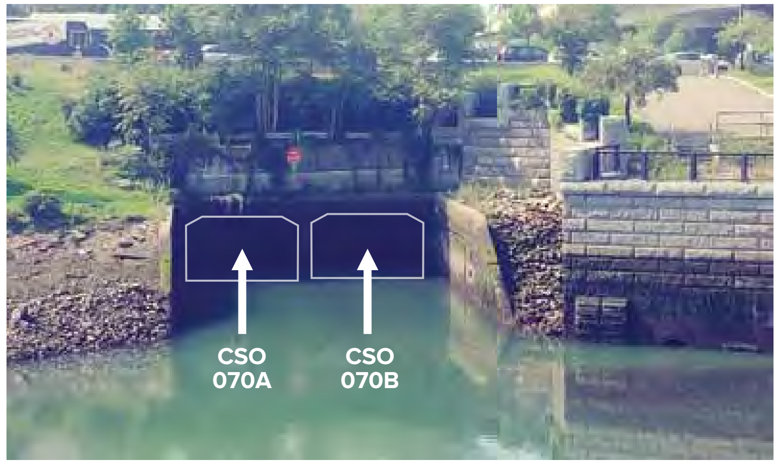


Figure 3. Boston's Fort Point Channel looking upstream into CSO 070

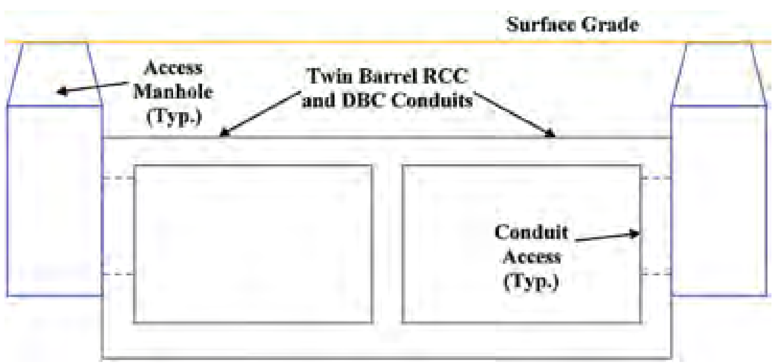


Figure 4. Sketch of Roxbury Canal and Dorchester Brook conduits

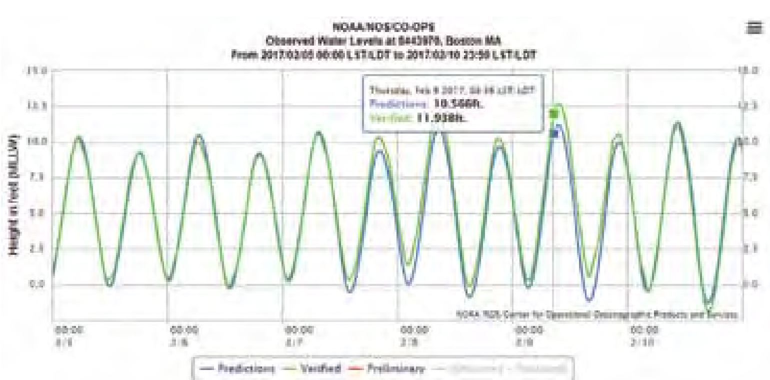


Figure 5. NOAA tide charts for Fort Point Channel/Boston Harbor

The outfall pipelines are hydraulically connected to Boston Harbor and have no tide gates. Confined-space entry (CSE) investigations of the conduits identified the complex behavior of the tidally influenced water levels. The water levels within the outfall pipelines change constantly with the daily tide cycle, varying up to approximately 13 ft (4 m) vertically from a BCB elevation of roughly 11.5 ft (3.5 m) to -1.5 ft (-0.5 m). As shown in Figure 5, during high tide, both outfall conduits are effectively submerged and inaccessible. The CSE investigation found that crews had roughly 4 to 5 hours for insertion and extraction before the workspace within the conduits was submerged by tidal waters.

In addition to the challenge posed by the tidal waters, the outfall pipelines also contain several feet of sediment, consisting of sand and gravel washed down from the drainage and organic backwash from the Boston Harbor, that has built up over more than 50 years of operation. The sediment changes from loose sludge to hard-packed deposits over the length of the two outfall pipelines. Given the challenges to inspection described above, an innovative approach was needed.

METHODOLOGY

Closed-circuit television (CCTV) has been the primary method in the United States of visually inspecting and capturing photographic data of a pipeline's interior. Advancements over the years in pipeline traversing units, camera systems, and inspection software have further enhanced this technology. These advancements include the following:

- **Laser scanning**: recording pulses of light to measure the internal pipeline
- **Sonar inspection**: measuring sediment levels under the pipeline's flow line
- **Thermal imagery**: sensing temperature readings of the pipeline's surface and objects within
- **3D rendering software**: processing captured imagery of the pipeline into a 3D model

These advancements, however, have increased the cost of using CCTV technology. Typically, contractors rely on their volume of pipeline inspection work to make advanced inspection technology cost-effective, with only limited, occasional use of it in larger, more-complex systems to inspect a small part of the network. The higher cost is typically driven by the need for personnel to enter these larger pipelines to perform manual inspections and equipment deployments. One innovative—and safer—alternative to manned-entry inspections is drone technology. Drones can perform similar inspections to conventional equipment, and they offer more-versatile maneuverability in these more complex and dangerous environments.

Drone technology is not new to pipeline inspections, having been used in the oil and gas pipeline industries for both internal and external inspections. Drones have been used, however very rarely, to inspect water resource infrastructure pipelines around the world. One example is in Spain where the Spanish firm Fomento de Construcciones y Contratas, S.A. (FCC) is using drones to inspect the 938 mi (1,500 km) sewer system in Barcelona (Freyberg, 2017). Another example is in Melbourne, Australia, where drones are being used in regional drinking water infrastructure inspection and maintenance (Goldsmith, 2015). And now in the United States, the FPC CSO 070 project is among the first in this country to similarly pilot drones for pipeline inspection.

| PILOTING INNOVATION IN BOSTON |

APPROACH

Implementing any of the conventional approaches to inspect the RCC and DBC conduits would have been difficult given the conditions; hence, drones were piloted as one potentially viable and cost-competitive alternative to conventional CCTV pipeline assessment. Three approaches, using a combination of technologies, were devised:

1. The project team attempted to pilot a drone through the conduits with just the bare necessities for accessories: a camera and a lighting system. An onsite crew provided additional lighting.
2. The project team constructed a remote-controlled boat, affixed with its own camera and lighting system, to supplement the drone inspection approach. The lighting crew was not used during this inspection attempt.
3. The project team strung a wire rope through the conduits that would be tethered to a pontoon-mounted camera and lighting system and pulled throughout the conduits.

The drone used for the inspections (photo 1) was provided by the operator. When using these technologies, it is important to provide for safe access through a limited number of locations, to work around sediment levels, and to accommodate a shortened work window due to tidal conditions. Each approach used to inspect these conduits had benefits and opportunities for improvement, and the successes identified in one approach could be used to alleviate the challenges of another approach. In turn, this sharing of information improved the technical feasibility and cost-effectiveness of all approaches used.

The objectives of the drone/remote-controlled inspection approaches included the following:

- Gain access and make a safe entry into RCC and DBC conduit manholes
- Understand the tidal influence on the conduits
- Photograph the inside of the conduits, including piped connections
- Test multiple approaches to lighting the interior of the conduits
- Demonstrate that a quadcopter drone can fly within the conduit
- Develop a 3D model of the conduit, if conditions permit

Through these drone inspection demonstrations, the project team anticipated using the drone's versatility to meet other IDDE objectives. If active flow was detected coming through a lateral during dry weather, the drone could perform a close-up inspection of the lateral piping for illicit indicators. The drone would also allow for the visual inspection and documentation of conditions from various angles. In the event of debris or obstructions, the drone could maneuver in and around areas of interest to obtain point-specific data.

Photo 1. Drone used for inspections (typical)

Photo 2. Lateral detected through drone inspections

Drones also can be outfitted with any combination of advanced pipeline inspection tools, including laser scanning, sonar, thermal imaging, and 3D rendering. Software would compile the digital photography and video data from the drone inspection to generate a 3D model of the inspected pipeline. The FPC project team intended to use the model of the RCC and DBC conduits to determine the locations of any detected laterals. If necessary, the project team could perform follow-up IDDE investigations upstream of these identified laterals to determine dry-weather, illicit sources.

RESULTS

Through these drone demonstrations, both the UAV and remote-controlled boat methodologies showed they could successfully inspect large outfall pipelines when other traditional methods are unavailable. Photo 2 illustrates a lateral inspected by the UAV. The first and second drone demonstrations inspected 300 ft (91 m) and 250 ft (76 m) of conduit, respectively. The limited production from these approaches was due to unforeseen circumstances with available equipment and the tides. Proper

Table 1. Cost comparison of pipeline inspection approaches

Inspection Type	Total Daily Cost ($)	Inspection Length ft (m)	Unit Cost $/ft ($/m)	Required Production ft (m)	New Unit Cost $/ft ($/m)
Drone demo #1	8,760	300 (91)	29.20 (95.80)	>1,850 (564)	<4.73 (15.52)
Drone demo #2	5,100	250 (76)	20.40 (66.93)	>1,100 (335)	<4.63 (15.19)
Pontoon*	4,750	1,000 (305)	4.75 (15.58)	n/a	n/a

*Vendor-quoted price and production

planning was critical to maximize the work windows between high-tide cycles. Other findings from the drone demonstrations included the following:

- The video quality output depended on adequate lighting while maintaining a centered and stable camera position within the conduits. Powerful lighting systems affixed to the drone are needed to capture quality video and photo data.
- The drone could easily eclipse inspection speeds of 30 ft/min (9 m/min) and greater.
- The slight air flow within the conduits caused the drone to rotate horizontally on its own. The changing air flow conditions were related to the tidally fluctuating water levels.
- The sediment within the conduit was a fine, loose material that prevented stable footing, and the debris build-up throughout the conduit was apparently from leftover construction. Inspections using conventional crawler equipment would not have been feasible.
- During the beginning and end of the 5-hour tidal work window, the water levels were found to rise and fall at a rate of roughly 1 ft (30 cm) every 30 minutes.
- Owing to the uniform concrete conduits and lack of distinguishing marker points, the 3D rendering software could not develop a model of the conduit pipelines.

Ultimately, the decision to implement the drone inspection approach would be driven by cost, regardless of the drone's capabilities. In Table 1, the costs to perform the two drone demonstrations are compared to the unit cost to perform the inspections using a pontoon camera system. As depicted, the unit price to perform the drone inspections decreased between the first and second demonstrations following some adjustments. However, the drone inspection unit costs were still an order of magnitude greater than those of the pontoon camera. Thus, further attempts to refine the drone inspection approach were dismissed in lieu of the quoted pontoon inspection method. Nonetheless, an increase in the daily production rates of the drone approaches is feasible with proper planning and refinement and, therefore, a drone inspection can be cost-competitive with conventional inspection methods.

The drone demonstrations accomplished the IDDE objective of pipeline inspection, and, with future advancements to the technology, more opportunities will arise to incorporate drones in other water resource assessments. The drone approach demonstrated a cost-competitive alternative to conventional inspection methods, and, with enough initial investment, water utility providers may add drone technology to their system-management tools.

DISCUSSION

To foster continuous learning and innovation, recommendations for consideration in drone inspection include the following:

- **Site Inspections**. Crews should perform field reconnaissance to confirm the condition of pipelines planned for inspection. Drone inspection should address the challenges of each pipeline. Also, access into the pipelines should be evaluated as it may require additional scaffolding and staging equipment to establish a safe work area.
- **Pipeline Conditions**. Stormwater and combined sewer outfall pipelines hydraulically connected to tidally influenced waterbodies will experience fluctuating water levels. Similarly, the flow conditions within these pipelines should be evaluated so that the proper controls may be in place to safely perform drone inspections.
- **Drone Accessories**. Various advanced inspection tools that may be necessary for successful pipeline inspection projects, and the drone itself should have the necessary features to gather the intended data. The drone demonstrations found lighting critical to successful data capture during inspections. For large pipelines and conduits, drones should have a heavy-duty lighting system for proper illumination (greater than 1,000 lumens is recommended).
- **Data Collection/Telemetry**. The underground environment is not always conducive to relaying signals for GPS/video telemetry. Accessories for repeating signal data or boosting signal strength may be required given the pipeline configuration. When possible, the data collected should be relayed and stored on the drone pilot's controller. Data stored directly within the drone risks being lost due to a drone failure or crash.
- **3D Modeling**. Developing a 3D model is difficult when only photogrammetry is used. The uniform appearance of underground pipelines hinders the 3D software's capability to stitch video and photographic data together in order to render a complete model of the pipeline. Instead, laser scanning and/or defined marker points along the pipeline in tandem with digital photo capturing may improve 3D model development.

CONCLUSION

As the feasibility of using drone technology for pipeline inspections progresses, applications exist today that may be considered. For water utility providers, these include CSO storage tunnels, stormwater outfalls, and water transmission aqueducts. Although suitable for inspections in less complex pipeline systems, drone inspections show the most apparent benefits in larger systems with more-complex pipe networks. Drone inspection technology may alleviate the risks in performing maintenance on these large, critical infrastructure elements of our water resource systems. In general, the conditions in which implementing a drone inspection should be considered include pipelines 60 in (150 cm) in diameter or greater that have the following attributes:

- Stagnant flows, no flow, or flows difficult to bypass
- Tidal influences
- Sediment build-up
- Odd cross-sections
- Limited access points

In summary, proper planning and preparation are key to successful drone inspections. These inspections can be cost-competitive with conventional pipeline inspection technologies when high production rates are met. Drones used in underground pipeline inspections should be outfitted according to the environment where the inspection occurs. Advancements in pipeline inspections are driven by the challenges faced when investigating the unique pipeline infrastructure of the modern world. With that in mind, the future holds many opportunities for the use of drone inspection technology to become more widespread.

REFERENCES

- CUES, Inc. (2018). CUES Broadest Product Line in the Industry. Available from: www.cuesinc.com/Products.html. Accessed September 21, 2018.
- Freyberg, T. (October 2017). Game of Drones for Barcelona Sewer Inspection. Water & Wastewater International. waterworld.com/articles/wwi/2017/10/video-game-of-drones-for-barcelona-sewer-inspection.html.
- Goldsmith, M. (February 2015). Aerial Drones: the Future of Asset Inspection. Utility. utilitymagazine.com.au/aerial-drones-the-future-of-asset-inspection.
- Iseley, T. and Behbahani, S. (May 2018). TTC Leads the Way in Advancing Pipeline Condition Assessment (PCA) with Drone Technology. Trenchless Technology Center, Louisiana Tech University.

ABOUT THE AUTHORS

- Jonnas Jacques is a project engineer at Kleinfelder with experience in the assessment, design, construction, and rehabilitation of municipal, water resource infrastructure. He is knowledgeable in the effective application of various traditional and trenchless technologies, with a focus on wastewater and stormwater pipeline rehabilitation. Mr. Jacques is OSHA HAZWOPER and confined-space-entry certified. He also has been trained through National Association of Sewer Service Companies' (NASSCO's) Pipeline Assessment Certification Program (PACP), Manhole Assessment and Certification Program (MACP), and Cured-in-Place Pipe (CIPP) Inspector Training and Certification Program (ITCP) certification programs. Mr. Jacques holds a Bachelor of Science in Civil Engineering from Northeastern University.
- Amy Schofield is a project manager at the BWSC where she has been employed for 30 years. She has a Bachelor of Science in Geography from Bridgewater State University. She holds a Mass Grade 2 Drinking Water Distribution license and a Mass Grade 4 license in wastewater treatment. Ms. Schofield has been managing illicit discharge detection and elimination and water quality sampling projects for the BWSC for more than 25 years, including the recent investigation to identify illicit sanitary connections in the CSO 070 system.
- David Peterson is a project manager at Kleinfelder. His entire career has focused on municipal wastewater engineering and consulting. His experience has been in planning, design, and construction of new or rehabilitated wastewater collection system infrastructure and wastewater treatment plants. Mr. Peterson has managed numerous wastewater facility and pipeline assessments, infiltration/inflow studies, IDDE studies, capital improvement plan development, and design and construction of upgrades.

Turners Falls main drain and siphon rehabilitation

RYAN GRAHAM, CDM Smith, East Hartford, Connecticut

ABSTRACT | Turners Falls, an industrial village in the town of Montague, Massachusetts, relies heavily on hydropower from a canal and dam on the Connecticut River to drive paper mills, hydroelectric dams, and the town's financial well-being. A 32 in. by 48 in. (81 cm by 122 cm) double-brick-wall drain line was built in the late 1800s under this canal for conveyance of sewage and stormwater flows and a 5 ft (1.5 m) elliptical concrete double barrel siphon was incorporated in 1914 upon expanding the canal. Assessment of the drain line in 2014 revealed the pipe was in poor condition, with many bricks missing throughout the invert, and longitudinal fracturing that allowed substantial infiltration from the canal above. It was also discovered that the double-barrel siphon was nearly full of sand and debris, and experiencing substantial infiltration through cast-in-place concrete cold joints.

Owing to the critical nature of the infrastructure, the town evaluated the structural integrity and determined appropriate rehabilitation methods to avoid catastrophic failure. A combination of trenchless alternatives was evaluated and eventually implemented to rehabilitate the main drain and siphon, including cured-in-place pipe lining, invert repair, and siphon cleaning. This paper describes the infrastructure rehabilitation implemented as well as lessons learned in rehabilitating this large-diameter drain and siphon.

KEYWORDS | Cured-in-place pipe (CIPP), brick, drain, invert, repair, rehabilitation, siphon, trenchless

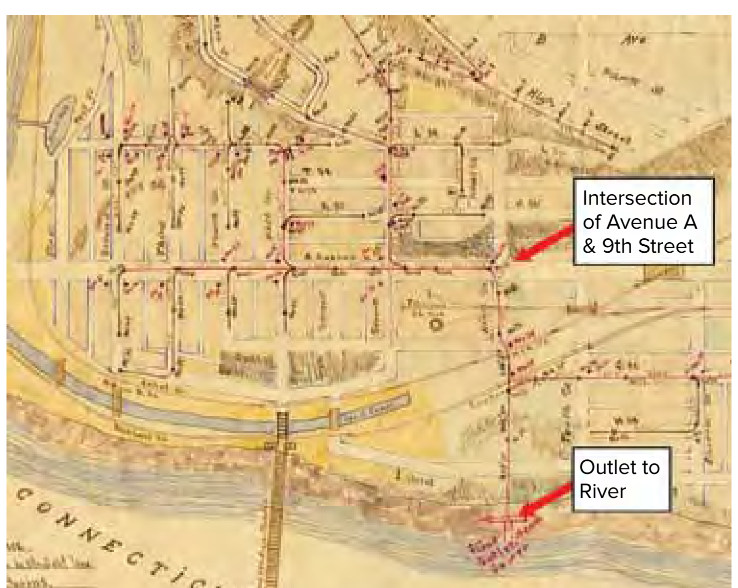


Figure 1. Original plan drawing for the town of Montague sewer system (circa 1886)

The town of Montague's sewer system, designed and constructed in the late 1800s, has, without a doubt, outlasted its initial design life, but has slowly deteriorated over time. Plan drawings, which were drawn by hand and dated 1886, show that the sewer system, like many collection systems of that time, conveyed both storm and sanitary flows to the Connecticut River. Montague was once a booming and industrious mill town, and a canal was built alongside the Connecticut River that was used to power paper mills and later create hydro electric power. Originally, the canal was branched off from the Connecticut River, and stopped a few hundred feet (a few dozen meters) before the 32 in. by 48 in. (81 cm by 122 cm) double-brick-wall drain. Not until 1914 was the canal extended past the brick drain. When the canal was expanded, part of the brick drain had to be eliminated, and a double-barrel, concrete siphon replaced it. The siphon was built beneath the canal from one side of the canal to the other. Figure 1 shows the original sewer system plan drawings before the siphon was installed. With the installation of the siphon came the division of the brick drain into the "upper drain" and "lower drain" sections.

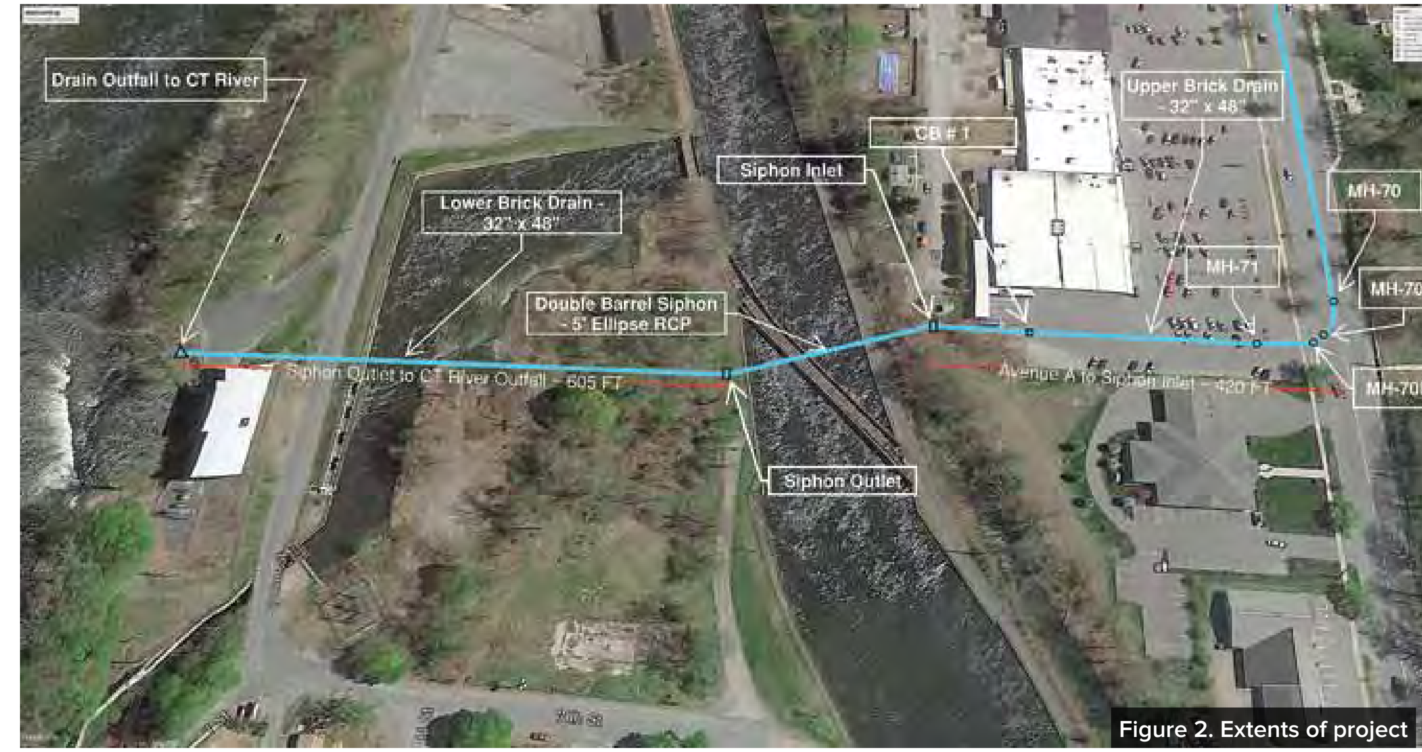


Figure 2. Extents of project

The design to rehabilitate the double-brick-wall drain line and double-barrel concrete siphon began with investigations of the pipeline via closed-circuit television (CCTV) inspection, as well as manned entry inspections spanning from the intersection of Avenue A and 9th Street to the Connecticut River outfall. These inspections revealed the critical condition of the almost 130-year-old pipeline. For the brick pipeline, notable fractures existed between bricks where grout was missing in the crown of the pipeline and, in some instances, bricks were missing entirely. This condition was also evident in the invert of the pipeline for both the upper drain and lower drain sections. The invert was heavily eroded due to more than a century of coarse sands and materials flowing over the invert and out to the Connecticut River. The invert was entirely missing in places, meaning both layers of the double-layer brick were washed out or eroded away. Photo 1 shows the deterioration to the invert of the upper drain.

Also, the siphon was almost entirely full of sediment and debris. Before a complete inspection could be performed, flows from the siphon had to be bypassed, and the siphon had to be cleaned.

The inspections determined that the project would require three main tasks:

1. Rehabilitate the upper section from Avenue A to the siphon inlet chamber
2. Clean the two siphon barrels and install stop logs to divert flow through one barrel
3. Install a fiberglass epoxy cured-in-place pipe (CIPP) liner inside the lower section from the siphon outlet chamber to the Connecticut River outfall

Photo 1. Extent of invert deterioration due to over a century of erosion

Figure 2 shows the extents of the project. Important to note is the spur canal to the west of the main canal and the location of the lower drain directly below this spur canal. This section caused much alarm, as the pipeline was in the worst condition at this location, experiencing gushing, running, and dripping infiltration, along with severe mineral deposit accumulation. If this section of the lower drain were to fail, and its failure appeared imminent, it would be catastrophic for the town. If the lower drain collapsed, it would act as a siphon for the rest of the canal and inevitably drain the canal while eroding away the land west of it, including a hydroelectric dam for First Light power company. Most of the town's tax revenue comes from the canal, either from power companies or paper mills, so it was crucial that the lower drain remain operable.

Task 1. Upper Drain Rehabilitation

Rehabilitation of the upper drain removed loose bricks from the invert and applied an abrasion-resistant, fiber-reinforced concrete flowable fill to reshape the invert to its original dimensions. This was done by first cutting key-holes into the pipe walls at the 4 o'clock and 8 o'clock positions. The fiber-reinforced concrete flowable fill was then pumped into the invert and spread and smoothed by trowel from the 4 o'clock to 8 o'clock positions. A helmet-mounted

Photo 2. Rehabilitated upper drain invert restored to original shape

Photo 3. Two piles of sediment and debris (car for scale) along with bricks and miscellaneous debris that were removed from the siphon barrels

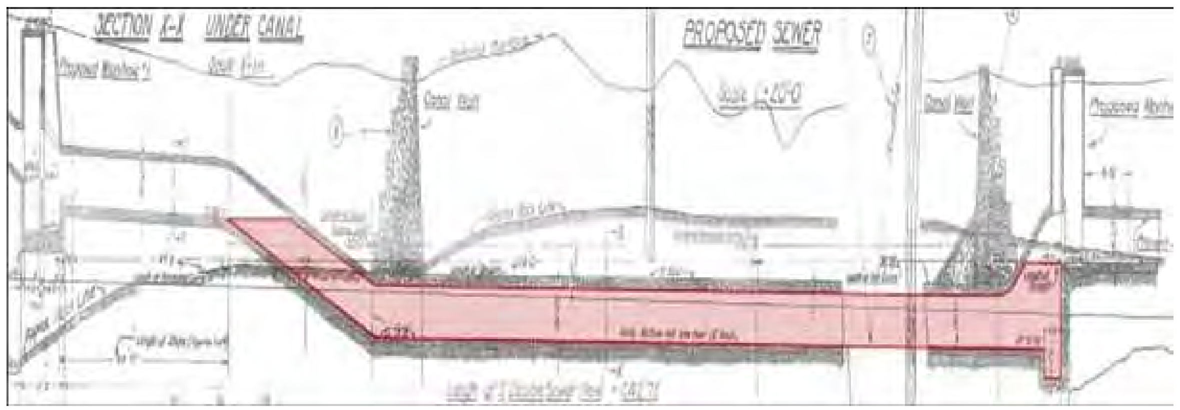


Figure 3. Estimated extent of debris in siphon barrels

camera allowed inspectors to monitor the work. Photo 2 shows the finished product. The invert was successfully repaired and restored to its original shape.

Task 2. Siphon Cleaning and Rehabilitation

The double-barrel concrete siphon is also more than a century old; therefore, a proper inspection was important to assess any structural defects. As with the lower drain, if the siphon were to fail, it would be catastrophic for the town. The inspection revealed that the siphon was full of sediment and debris. The siphon was estimated to be filled entirely, as the sediment was visible at the siphon inlet chamber. Figure 3 shows this estimate.

Realistically, the inlet chamber was where most of sedimentation occurred in the siphon, and the siphon was not entirely filled with sediment and debris. However, a sediment quantity of the entire siphon for both barrels had to be assumed as there was no way to verify the amount of sediment without removing it. Although the siphon was designed with sediment sump pits to catch debris, it had not been maintained for 60 years; also, in 1954, an asbestos cement force main was installed in the northern barrel and encased with concrete—two important reasons to assess the siphon. Any deterioration of the concrete would expose the force main, putting it at risk of deterioration and potential failure.

The project was allowed only one week to complete the siphon cleaning, siphon rehabilitation, and lower drain rehabilitation. The canal is taken offline and drained for one week at most per year to dredge the sediment and maintain the spur canal. It was deemed safer to perform the work during this time with lower risk of a pipe collapse as there was less hydrostatic pressure on the siphon and lower drain.

The siphon was cleaned by first bypassing flows from the siphon inlet chamber to the canal and then installing temporary, wooden stop logs at the siphon's southern barrel. This allowed flows to be conveyed strictly through the northern barrel so that the southern barrel could be cleaned and inspected.

The contractor used a combination of a high-pressure jet and vacuum truck, more commonly referred to as a "jet-vac" truck, to remove sediment and debris from the southern siphon barrel. Following cleaning, the siphon had to be further rehabilitated. A 60 ft (18.3 m) long crack was discovered in the siphon wall that appeared to be an old cold joint in the concrete from the original construction. The pipe was cleaned, and infiltration was stopped with a chemical grout that was pumped into the soil matrix surrounding the siphon barrel. Additionally, a hydrophilic grout was hand-applied to the surface.

The northern barrel was next to be cleaned and assessed for deterioration. The temporary, wooden stop logs were removed from the southern barrel in the siphon inlet chamber and installed in the chamber's northern barrel. This redirected flows to the southern barrel, allowing the northern barrel to be cleaned and inspected. The jet-vac truck was set up at the siphon outlet chamber. Overall, between

Photo 4. Deterioration of force main concrete encasement in the siphon northern barrel

Photo 5. Rehabilitated concrete encasement of force main in siphon northern barrel

Photo 6. Cleaned and fully operational northern siphon barrel

Photo 7. Extent of deterioration to lower drain

the two siphons, approximately 83 yd^3 (64 m^3) of sand and debris were removed and transported to the town's transfer station. Photo 3 shows the significant amount of sediment and debris removed from the siphon barrels (note the car for scale) as well as all the bricks that had eroded away and washed out from the invert in the upper drain and become trapped in the siphon barrels.

The inspection of the northern barrel determined heavy deterioration of the concrete encasement for the asbestos cement force main, as can be seen in photo 4. The concrete encasement had been subject to abrasive conditions due to sediment and debris slowly eroding it away over the past 60 years.

Rehabilitation would include surface preparation of the concrete via high-pressure water blasting followed by application of an abrasion-resistant, fiber-reinforced concrete flowable fill. This was done to ensure a protective layer to the concrete encasement that will last many years. Photo 5 shows the rehabilitated concrete encasement.

Budgetary constraints prevented further rehabilitation of both siphon barrels. Noticeable infiltration still occurs in both siphon barrels, particularly the northern barrel, as infiltration continued from the cold joints, which were not grouted and sealed. The siphon will require further rehabilitation in the future. However, it will be much easier to perform this work, as permanent, aluminum stop-log frames and tongue-in-groove-style stop logs were installed in the southern siphon barrel, while stop-log frames were installed in the northern barrel. This will allow one siphon barrel to be offline for maintenance. Moreover, the increased flow through one barrel will help keep sediment in suspension due to the heightened flow velocity and prevent sedimentation from occurring in the belly of the siphon barrels. For now, the siphon is cleaned and fully operational again, as is depicted in photo 6.

Task 3. Lower Drain Rehabilitation

Task 3 was the most critical and most complex part of the project, consisting of extensive pipeline preparation before a CIPP liner could be inverted through the heavily deteriorated lower drain. Inspections showed substantial infiltration entering the pipeline from where it traversed beneath the spur canal. Most important was a section in the crown of the pipe that was missing bricks. Flows were bypassed from the siphon inlet and outlet chambers during the week the canal was offline. Water was discovered to be gushing in through what appeared to be a 4 in. by 4 in. (10 cm by 10 cm) hole in the crown of the pipe directly beneath the spur canal. Also occurring were extensive scaling and buildup of mineral deposits throughout the lower drain, reaching up to 3 in. (8 cm) thick in some areas. Photo 7 depicts the extent of deterioration and mineral deposit buildup in the lower drain.

Two rehabilitation methods for the lower drain were considered: 1) a spin-cast, concrete polymer and 2) a CIPP liner. In either case, transitions in pipe shape and material had to be determined. The lower drain transitions from a 32 in. by 48 in. (81 cm by

Photo 8. Gushing infiltration in lower drain beneath spur canal

122 cm) double-brick-wall pipeline to a 30 in. (76 cm) reinforced-concrete pipe approximately 30 ft (9.1 m) from the Connecticut River outfall. Ultimately, CIPP lining was chosen, as it was estimated to be more cost-effective.

Prior to CIPP lining, extensive pipe preparation was required to ensure a proper cure for the liner. Mineral deposits were removed by hand chipping with masonry hammers and collecting the material in buckets. Infiltration was gushing into the pipe in some areas, so gushers and runners were sealed with a chemical grout. Owing to the heavy deterioration of the pipeline, fully stopping active infiltration was difficult. Once the water was grouted and sealed in one location, it would find a defect in a different location to enter the pipeline. Photo 8 shows the extent of infiltration in some spots of the lower drain beneath the spur canal.

Steam curing was the preferred curing process to avoid discharging hot curing water to the Connecticut River. Temperature-sensing wire was laid through the invert of the pipeline to analyze and record temperatures during curing. Once the temperature sensors were installed, hydrophilic end seals were installed at the siphon chamber outlet and the Connecticut River outlet, and a pre-liner was inverted and kept inflated in the lower drain. The end seals were installed to prevent infiltration from traveling between the host pipeline and CIPP liner

Photo 9. Installation of hydrophilic end seals and pre-liner

and making its way into the manhole structures. The pre-liner was installed to help prevent resin washout in the CIPP liner during inversion and curing. Photo 9 depicts the end seals and pre-liner.

The CIPP liner was delivered via refrigerated truck, and was inverted and steam-cured via the siphon outlet chamber. Photo 10 depicts the inversion and steam curing processes.

The liner was successfully inverted and cured, providing essentially a new pipe within the existing pipeline. The lower drain is now structurally sound and the risk of collapse is minimal. Photo 11 shows the inside of the finished product in the lower drain.

Once the CIPP liner was installed, a transition from the siphon outlet chamber to the CIPP liner was needed due to differences in shape. A smooth transition was made by filling the voids around the CIPP liner with a rapid-setting, cementitious patching material and then applying an epoxy top layer coating to create a quality seal between the siphon outlet chamber and the CIPP liner. This ensured a smooth transition and sealed connection along the transition. Photo 12 shows the final product with epoxy coating applied.

After lining with CIPP, the temporary stop logs were removed and replaced with permanent aluminum, tongue-in-groove-style stop logs at both the siphon barrel entrance and exit on the southern barrel. Stop log guide rails were also installed at both the siphon barrel entrance and exit on the northern barrel. The ability to isolate either barrel enables the town to take one siphon barrel offline at a time for future rehabilitation or cleaning.

LESSONS LEARNED

A temperature-gauging system was specified to monitor the CIPP liner's steam curing process. Although this system was installed, the connection between half of the temperature-sensing strip and the computer became disconnected, allowing only half of the pipeline to collect temperature-sensing data. This was likely due to the brittle nature of the temperature-sensing wire that was laid in the invert

Photo 10. Inversion and steam curing of CIPP liner via siphon outlet chamber

Photo 12. Smooth transition sealed with epoxy coating to ensure a good seal and abrasion resistant surface

Photo 11. Cured-in-place pipe liner successfully inverted and cured in the lower drain

of the channel. Owing to the irregularities in the channel, the wire was probably caught in a pinch point upon inversion of the liner, resulting in a break in the wire. The temperature-sensing system is expensive but also necessary for larger-diameter CIPP lining curing; however, due to the disconnect, these data were not very useful on this project. What was used instead were the temperatures being monitored using sensors at the pipeline's inlet and outlet. These were recorded by hand every half-hour to ensure the liner was reaching and maintaining sufficient curing temperatures. For lining projects that focus on large-diameter-pipe rehabilitation, controlling where the temperature monitoring wiring is located within the pipe is essential. Ideally, it should not be laid in the invert of a pipeline that has severe deterioration resulting in uneven spacing or in pipelines with offset joints, where the temperature-sensing wiring is prone to snapping when pressure is applied to it.

Routine maintenance should be performed by cleaning the siphon sumps. These are designed to catch sediment and debris but must be routinely maintained and cleared of debris so that sediment and debris are prevented from traveling down the siphon and becoming stuck in the siphon belly. Keeping one siphon barrel offline will create a higher flow velocity through the siphon; this should help any sediment or debris that does pass by the sump to make its way through the siphon barrels to the sumps in the siphon outlet chamber.

The pre-liner is prone to tearing during inversion of the CIPP liner, especially in pipes with shape irregularities or pinch points. This may lead to potential resin washout in heavily infiltrating pipelines.

CONCLUSION

Given the time constraints and condition of the pipeline, the project was a success. The upper drain invert was repaired using a fiber-reinforced flowable fill, which was then packed and smoothed to reshape the pipe invert. Both the northern and southern siphon barrels were cleaned, and approximately 83 yd^3 (64 m^3) of sediment and debris were removed. Both siphon barrels also underwent minor rehabilitation; however, all recommended rehabilitation could not be performed because of budgetary constraints. In the future, further work must be performed on the siphon. Permanent aluminum stop logs were installed in the siphon inlet chamber so that one or the other of the two siphon barrels can be offline at all times, allowing access for maintenance and future rehabilitation. The lower drain had mineral deposits removed, gushing and running infiltration grouted and sealed, a pre-liner installed, and a CIPP liner installed. A smooth transition was made between the siphon outlet chamber and the lower drain via a fiber-reinforced concrete undercoat and epoxy topcoat. Completion of this project will enable the main drain, canal, and spur canal to serve the town of Montague well for years to come.

ABOUT THE AUTHOR

Ryan Graham is an environmental engineer at CDM Smith in East Hartford, Connecticut. He is a registered professional engineer-in-training and holds a master's degree in environmental engineering. Part of CDM Smith's Water Services Group, Mr. Graham works primarily on wastewater and drinking water conveyance design and rehabilitation.

Pairing effluent discharge modifications and treatment process upgrades to meet permit requirements and manage high flows

ROBERT POLYS, PE, Woodard & Curran, Portland, Maine
MAX KENNEY, EIT, Woodard & Curran, Portland, Maine

ABSTRACT | Peak wet weather flows and more stringent nutrient limits are stressing the capacity of water resource recovery facilities (WRRFs) in New England and across the United States. In the city of O'Fallon, Missouri, the effluent pump station at the WRRF discharges treated effluent through an outfall approximately 6 mi (9.7 km) to the Mississippi River, but the pumping system and outfall undergo reduced hydraulic capacity under river flood conditions. The resulting backups in upstream unit processes pose environmental and safety risks to WRRF staff. To address the issue, Missouri's Antidegradation Implementation Procedure was used to obtain what is believed to be the first secondary high flow treated effluent outfall to a separate waterbody in the state's history, allowing O'Fallon to cost-effectively upgrade the WRRF and manage high flows. Examples of similar high flow outfalls in New England were used to support the city's successful application.

KEYWORDS | Antidegradation, discharge, high flow, limits, outfall, permitting

Location of O'Fallon, Missouri

INTRODUCTION

Economic and population shifts, aging infrastructure, and new discharge permit limits drive wastewater utilities to expand treatment capacity, develop new discharge locations, and reconfigure assets to increase flexibility. The city of O'Fallon, Missouri, recently faced these challenges, when a hydraulic capacity limitation in the effluent pump station at its water resource recovery facility (WRRF) and outfall force main to the Mississippi River required upgrades to accommodate high flows. In parallel, the WRRF faced more stringent effluent ammonia limits in its next discharge permit renewal cycle. Addressing a hydraulic capacity limitation as well as new permit limits cost-effectively was a daunting task.

The O'Fallon WRRF treats flow from around 16,000 customers. The collection system consists of approximately 200 mi (322 km) of interceptor and collector lines up to 48 in. (122 cm) in diameter, 6,000 manholes, and 18 wastewater pumping stations. O'Fallon's WRRF's permitted capacity is 11.25 mgd (42.6 ML/d), and the average day flow currently is 7.5 mgd (28.4 ML/d). During sustained precipitation events the WRRF sees consistent flows of more than 16.5 mgd (62.5ML/d). Constructed in 1984, the WRRF meets secondary treatment standards and uses the following unit processes:

- Preliminary treatment via coarse screening and grit removal
- Primary treatment
- Secondary treatment using a biofilter/activated sludge (BF/AS) treatment process
- Disinfection via an in-channel UV disinfection system
- Effluent pumping station and outfall to the Mississippi River
- Solids handling with secondary sludge thickening, blended sludge dewatering, and thermal lime pasteurization to produce Class A biosolids

During flooding events in the Mississippi River, high water elevations drive up the static discharge pressure on the effluent pump system, significantly reducing its hydraulic capacity. The city's effluent pump station has a capacity of approximately 12.75 mgd (48.3 ML/d) when the Mississippi River is under flood conditions—typically occurring up to five times per year. It includes four, 150-hp (112 kW), variable speed, submersible centrifugal pumps that discharge into a 6 mi (9.7 km), 30 in. (76 cm) discharge force main. No space is available for additional pumps in the building.

The hydraulic capacity limitations have resulted in flooding at the upstream ultraviolet (UV) disinfection system, including the power distribution modules and associated electrical gear, compromising process equipment, electrical systems, controls systems and permit compliance during these periods. At times the UV bank power distribution modules, disconnects, and other associated electrical gear have been completely submerged due to the backup of flow, endangering WRRF staff.

The city and WRRF staff maximize the WRRF hydraulic capacity to manage sustained high flow conditions. Staff run all available treatment unit processes to ensure high-quality effluent is discharged during sustained high flow events. The WRRF also has two offline influent equalization basins. During high flow conditions a portion of the influent flow is diverted to the basins, which have a combined capacity of 7.78 MG (29.5 ML), to assist with treatment performance under high flow conditions and to alleviate some of the high flow from the effluent pump station. Historically, even with these wet weather management capabilities and unit processes, the effluent pump station capacity still limits discharge of treated effluent offsite. The city also self-performs collection system improvements each year via sewer lining and other capital improvement projects to minimize extraneous flows.

Figure 1. O'Fallon Water Resource Recovery Facility

The city has examined several alternatives over the years to resolve the effluent pump station's hydraulic capacity limitations. Previous recommendations included installing larger, higher-capacity pumps that could meet the high flow and pressure requirements to discharge all treated effluent to the Mississippi River. This solution, however, had an unaffordable up-front capital cost and required new electrical service and distribution equipment to support it.

During the most recent facilities planning, the city looked for a more cost-effective solution. Reactivation of the nearby Peruque Creek outfall was considered. In the early 1990s, when the WRRF installed the current effluent pump station and a force main to the Mississippi River, the outfall to the Peruque Creek—the original receiving water for the WRRF's treated effluent—was abandoned. Although the creek is a much smaller receiving waterbody than the Mississippi River and minimally dilutes the WRRF effluent, especially during dry weather conditions, one advantage is that it is adjacent to the WRRF. Thus, it presented a potentially favorable alternative as a supplemental discharge location for high flows during wet weather events. It would receive fully treated and disinfected flow, so it would not be a considered a bypass or blending approach to the hydraulic capacity issue.

The evaluation developed opinions of probable costs and benefits for numerous treatment technology alternatives, no-discharge alternatives, and high flow discharge alternatives. The discharge alternative evaluation was critical for permitting the antidegradation application as well as for ensuring the most robust and cost-effective solution.

In parallel with the discharge issue, the city also needed to upgrade its secondary treatment process to improve ammonia removal performance for its upcoming discharge permit. The city renewed its current Missouri State Operating Permit (MSOP) in 2016. The 2016 permit included a five-year compliance schedule to meet more stringent effluent ammonia–nitrogen limits that the current WRRF cannot achieve. In addition, the EPA has established ammonia water quality standards for the protection of aquatic mussels and gill-breathing snails. Missouri Department of Natural Resourses (MDNR) has indicated that these criteria may be applied to future MSOPs. As a result, the WRRF upgrade will meet these more stringent ammonia limits if they are implemented.

The recommended solution to the city's high flow discharge limitation and more stringent permit limits combined a new high flow discharge to Peruque Creek and an upgrade of the secondary treatment process to biological nutrient removal (BNR) to achieve ammonia removal and flexibility for future total nitrogen and phosphorus removal. This recommendation was the most cost-effective for meeting both current and future discharge permit requirements. Of note is that the high flow discharge outfall alternative to Peruque Creek was possible in part due to the need for the secondary treatment system upgrade, which provided treatment critical to meeting the proposed limits for the high flow discharge to the creek. The solution is believed to be the first of its kind in Missouri and will save the city approximately $7 million compared to other alternatives for handling its high flows.

FIRST STEP: ANTIDEGRADATION ANALYSIS

Working with the city to pursue a high flow outfall to Peruque Creek was only one element in solving the WRRF's high flow problems. The U.S. Code of Federal Regulations (CFR) mandates that all states have an antidegradation policy. Each state then implements policies and governs applications and approvals. The antidegradation analysis is used by each state to evaluate whether a proposed discharge will meet water quality standards. Social and economic importance of a discharge may also be analyzed to justify some degradation of water quality in the receiving stream. Although each state implements its antidegradation policies differently, all are used in the evaluation of new and expanded discharges. States such as Missouri and Massachusetts, along with several others, require that the permittee prepare a report justifying the proposed discharge and evaluating alternatives. Missouri requires that all new or expanding wastewater discharges are required to complete the antidegradation application process and create a report of the findings. The antidegradation process is intended to determine if the proposed discharge will meet state water quality standards and justify the need and economic benefit of the discharge. The receiving water's ability to properly support and assimilate the proposed discharge while also maintaining its classified beneficial uses is also of paramount importance.

O'Fallon's first step in the antidegradation process was to determine the appropriate analysis required for Peruque Creek. Missouri's Antidegradation Implementation Procedure (AIP) includes three levels of review based on the waterbody. The following are the application levels and how they relate to different designated waterbodies:

- Tier 1 Review—Applicable to waterbodies listed on the state's 303D list as impaired
- Tier 2 Review—Applicable to waterbodies where water quality is better than applicable water quality standards
- Tier 3 Review—Applicable to waterbodies listed as Outstanding National Resource Waters or Outstanding State Resource Waters

Flow, stream classification, and beneficial uses as determined by the state were all used to determine that a combined Tier 1 and Tier 2 review would be conducted, most notably due to the water quality within Peruque Creek being better than the applicable water quality standards for all constituents except for dissolved oxygen (DO). Peruque Creek is listed on the state's 303D list as impaired for DO. As a result, the DO portion of the antidegradation application was reviewed as Tier 1 while the rest of the report was reviewed as Tier 2. As with many states in New England, antidegradation in Missouri is evaluated pollutant by pollutant.

Based on the review required, proposed effluent limits for the new discharge had to be determined. Missouri allows the permittee to determine and propose effluent limits for the discharge that are protective of state water quality standards. This approach presented a unique opportunity for the proposed limits to protect water quality while also being attainable by the city given its concurrent WRRF upgrade project to achieve improved nutrient removal.

Despite having a watershed that spans several communities, Peruque Creek is considered a small stream with an average daily flow of approximately 45 ft³/s (1,274 L/s). Key to the antidegradation analysis was to correlate the proposed discharge limits with flows representative of the creek when the high flow discharge would be used (when the creek was also at high flow conditions).

| PERMIT REQUIREMENTS AND HIGH FLOWS |

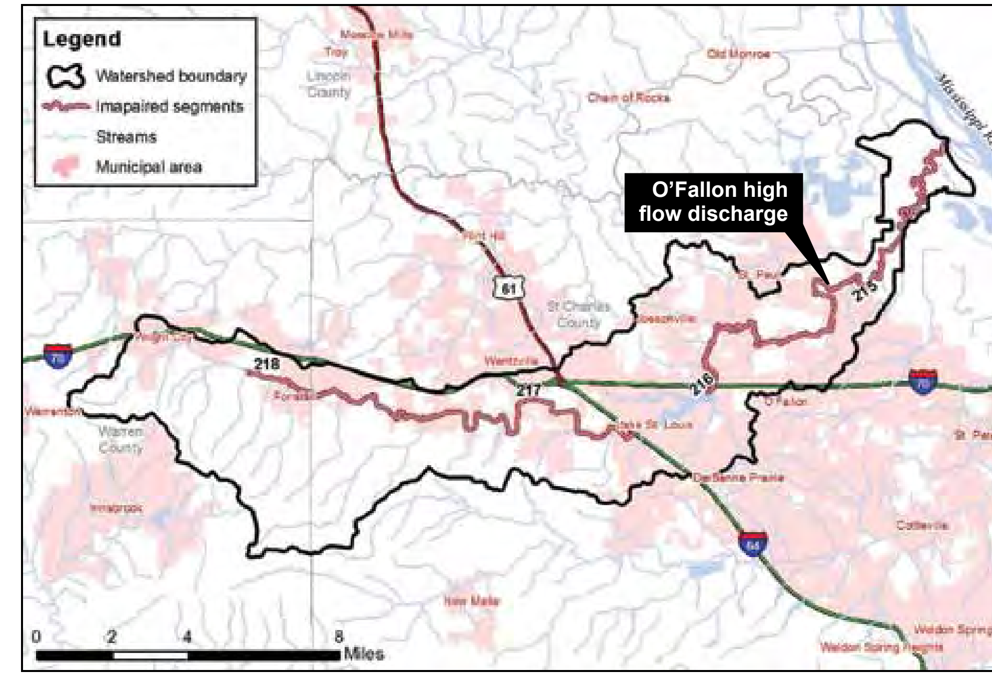


Figure 2. Peruque Creek watershed

Working with historical WRRF data and city staff, it was determined that when O'Fallon experiences more than 2 in. (5.1 cm) of rain in one day or more than 3 in. (7.6 cm) of rain over three days, the effluent pump station has historically become hydraulically limited and flows to the WRRF have exceeded 16.5 mgd (62.5 ML/d). United States Geological Survey (USGS) stream gauge data was then used to correlate this information to National Oceanic and Atmospheric Administration (NOAA) rainfall data to determine the representative stream flow when the proposed outfall would require use. The analysis resulted in a stream flow of approximately 704 ft³/s (19,935 L/s) when the proposed high flow discharge would be required. This representative stream flow was used to determine the proposed permit limits. MDNR was receptive to this analysis and ultimately agreed with the approach in determining the representative stream flows that would occur when treated effluent is being discharged to the creek.

Existing water quality studies, other WRRF discharge permits to Peruque Creek, and historical stream flow data from USGS were all used in developing the proposed high flow discharge effluent limits. Reviewing other municipalities that discharge to the same waterbody type offered a comparable range of potential permit limits already accepted by the state at both low and high flow conditions.

Limits were established in accordance with MDNR water quality-based standards for surface waters of the state. These vary by waterbody and by specific criteria such as water used for whole body recreation, such as swimming and water skiing, or water used for wildlife and livestock watering. Technology-based standards were also analyzed.

Numerous references and tools were used to develop the proposed permit limits. Documents such as the state's AIP and EPA permit limit calculators for metals and ammonia helped to ensure the proposed limits would be acceptable by the state. Peruque Creek is listed as impaired for DO by the state and the proposed daily minimum limit for DO had to ensure that Peruque Creek's water would not drop below the state's water quality standard (WQS) of 5 mg/L. The Streeter–Phelps equation was used to develop the DO sag curve for the creek and determine the DO daily minimum limit that Peruque Creek could assimilate without dropping below the WQS threshold. The DO sag curve shows what happens to a stream's background DO level when the discharged effluent is introduced and becomes mixed and diluted over time. It was determined that a daily minimum limit of 5 mg/L DO would not result in the creek water quality dropping below state WQS.

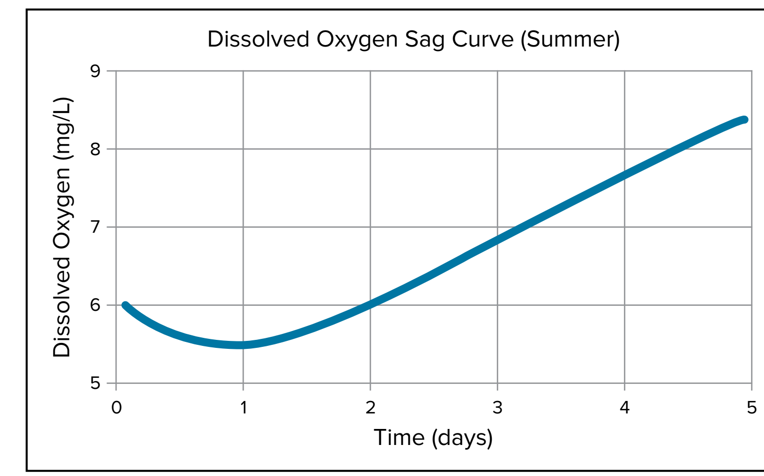


Figure 3. Dissolved oxygen sag curve

Figure 3 shows the dissolved oxygen sag curve calculated using the Streeter–Phelps equation for Peruque Creek during summer months with the proposed maximum day five-day biochemical oxygen demand (BOD5) discharge limit of 45 mg/L with a high flow discharge of 4.53 mgd (17.1 ML/d) and calculated mixing zone stream flow per state requirements of 176 ft³/s (4,984 L/s).

Table 1 (next page) represents the proposed effluent limits for the high flow discharge to Peruque Creek included with the antidegradation application. The state approve the limits and included them as preliminary permit limits in its acceptance letter.

Table 1. Peruque Creek high flow discharge permit limits

Parameter	Units	Final Effluent Limits			Monitoring Requirements	
		Daily Maximum	Weekly Average	Monthly Average	Measurement Frequency	Sample Type
Flow[1]	MGD	(Note #1)	—	—	once/day	(Note #1)
BOD_5,[2]	mg/L	—	45	—	twice/week	24 hr Comp.
TSS[2]	mg/L	—	45	—	twice/week	24 hr Comp.
pH Units[3]	SU	6.5-9.0	—	—	once/day	Grab
E. Coli[4]	#/100mL	—	630	—	twice/week	Grab
Ammonia-N (4/1 to 9/30)	mg/L	23.8	—	—	once/month	Grab
Ammonia-N (10/1 to 3/31)	mg/L	23.8	—	—	once/month	Grab
Oil and grease	mg/L	15	—	10	once/month	Grab
Total phosphorous	mg/L	Monitor	—		once/quarter	Grab
Total nitrogen	mg/L	Monitor	—		once/quarter	Grab
Copper[1] (total recoverable)	μg/L	Monitor	—	Monitor	once/quarter	Grab
Zinc[1] (total recoverable)	μg/L	Monitor	—	Monitor	once/quarter	Grab
Dissolved oxygen[5]	mg/L	5.0 mg/L[5]	—	—	once/day	Grab

1. Monitoring requirement only during wet weather discharge events.
2. A 24-hour composite is composed of 48 aliquots (samples) collected at 30-minute intervals by an automatic sampling device.
3. pH is measured in pH units and is not to be averaged.
4. Final limitations and monitoring requirements for E. Coli are only applicable for the recreational season from April 1 through October 31. The Monthly Average Limit for E. Coli is expressed as a geometric mean. The weekly Average for E. Coli will be expressed as a geometric mean if more than one sample is collected during a calendar week (Sunday through Saturday).
5. DO limit is a Daily Minimum Limit.

These permit limits ensure protection of water quality and are attainable for the city.

After determining the proposed effluent limits for the new high flow discharge to Peruque Creek, the alternatives to the proposed discharge were to be reviewed. The MDNR AIP required that two types of alternatives be explored: non-degrading and less degrading.

LESS-DEGRADING ALTERNATIVES EVALUATION

A less-degrading alternative is considered a different method of treatment/discharge that would result in higher-quality effluent being discharged to the same waterbody. All alternatives considered revolved around the secondary treatment process upgrades to the WRRF happening in parallel with the proposed high flow discharge outfall. Three less-degrading alternatives in addition to the base project were considered systematically to identify which alternative would best meet the city's needs and still be affordable. The four alternatives evaluated were as follows:

- Base Case—Activated sludge with BNR (BNR AS)
- Less-Degrading Alternative #1—BNR AS with tertiary filtration
- Less-Degrading Alternative #2—BNR AS with tertiary filtration and chemical addition
- Less-Degrading Alternative #3—Membrane bioreactor (MBR)

All alternatives were determined to be viable for meeting the proposed effluent limits for the high flow discharge to Peruque Creek. To determine the affordability of the less-degrading alternatives, anticipated life cycle costs (LCC) were developed.

The LCC evaluations considered capital costs as well as operational costs over the design life for each alternative. Capital costs following the initial investment were also considered by accounting for the replacement cost of short-lived assets with a design life shorter than the overall project basis of 20 years. In addition, the salvage value of the remaining assets at the end of the project's 20-year period was subtracted from the initial investment and for replacement cost. The net present value (NPV) of operational and maintenance costs was then added to the capital investment to arrive at a total LCC.

Construction capital cost estimates were developed by obtaining equipment component budget prices from vendors, developing cost estimates for concrete and structures directly associated with the various treatment alternatives, and estimating costs for components such as yard piping or other supporting systems unique to an alternative. The treatment alternative cost estimates, evaluation, and comparisons were conducted by sizing each process for design maximum month flows and loading as well as the anticipated effluent limitations. Capital as well as operation and maintenance (O&M) and replacement costs for short-lived components of the alternatives were also developed for each alternative.

Table 2 summarizes the LLC of the base project and the three less-degrading alternatives considered.

Table 2. LCC comparison of less-degrading alternatives

Parameter	BNR Activated Sludge	BNR Activated Sludge with Tertiary Filtration	BNR Activated Sludge with Tertiary Filtration and Chemical Addition	Membrane Bioreactor
Practicability	Yes	Yes	Yes	Yes
Total initial capital cost ($)	29,720,000	43,579,000	46,684,000	48,872,000
Present value of O&M costs ($)	7,270,000	7,358,000	15,141,000	14,133,000
Present value salvage value ($)	(2,101,000)	(2,252,000)	(2,888,000)	(1,493,000)
Total present worth ($)	34,889,000	48,685,000	58,937,000	61,512,000
Base-to-alternative cost ratio	1.00	1.40	1.69	1.76
Total annual costs ($)	411,000	416,000	856,000	799,000
Economically efficient	Yes	No	No	No

Important to note, the initial capital costs in the table include the total project costs, including construction, engineering, permitting, survey, geotechnical, contingency, and other costs. The initial capital costs presented also include the direct costs of the treatment alternatives. Upgrades to supporting systems common to the alternatives have also been included. Total annual costs include annual O&M costs for the WRRF as well as short-lived assets with each alternative. Alternatives at or below 120 percent of the base project cost were considered economically efficient and affordable for the city per the Missouri AIP.

As shown in Table 2 the O&M costs for the MBR and BNR AS with tertiary filtration and chemical addition alternatives are much higher than the BNR AS and BNR AS with tertiary filtration alternatives. This was due to the higher annual electricity use along with added costs for membrane replacement, chemical use, additional unit processes, and other short-lived assets. The MBR and BNR AS with tertiary filtration and chemical addition alternatives also have a higher annual chemical usage cost compared to the BNR AS and BNR AS with tertiary filtration alternatives. The O&M costs for the with-filtration alternative are slightly higher than the BNR AS alternative mainly due to the additional tertiary filtration unit process.

The initial capital costs for the MBR alternative are the highest due to the high cost of the membrane equipment and the additional associated supporting equipment. The capital costs for the BNR AS with tertiary filtration and chemical addition alternative are the second highest due to the additional chemical systems required for this alternative.

The BNR AS-related alternatives have higher residual salvage values compared to the MBR alternative. This is due to the concrete tankage, splitter structures, and yard piping, as these components have a usable life that exceeds the 20-year planning period. The MBR alternative is equipment intensive, and the associated equipment has a usable life closer to the 20-year planning period, resulting in a lower salvage value. The membrane cartridges will also need replacing at the end of the 20-year planning period and as such the cartridge component of the MBR alternative will have no residual salvage value. The BNR AS with tertiary filtration and chemical addition alternative has the highest residual salvage value due to the additional chemical feed unit processes and supporting system buildings.

BNR AS with tertiary filtration, BNR AS with tertiary filtration and chemical addition, and the MBR alternatives far exceed the 120 percent LCC threshold of the base project. As a result, none of the less-degrading alternatives evaluated were considered economically efficient for the city.

NON-DEGRADING ALTERNATIVES EVALUATION

As part of the antidegradation evaluation, the Missouri AIP also requires evaluation of non-degrading alternatives in comparison to the proposed high flow discharge to Peruque Creek. A non-degrading alternative is considered a different method of disposal for the treated effluent that would ultimately not result in any increase in flow or pollutant load being discharged to the receiving stream. Several non-degrading alternatives were analyzed and determined to not be feasible for the city's high flows, including land application with seasonal storage, subsurface disposal, alternative discharge locations, regionalization, and improved O&M. A common factor causing the previously listed non-degrading alternatives to be determined as non-viable was a lack of land area and difficulties in transporting the high flows. Two non-degrading alternatives evaluated were considered viable and further examined to determine their LCC:

- Additional effluent pump capacity. This alternative would construct a new high flow effluent pump station to continue discharge of all effluent flows to the Mississippi River. The pump station was assumed to be a dry well/wet well arrangement with reuse of an on-site building as the dry well. The new pump station would include two

Table 3. Non-degrading alternatives LCC comparison

Parameter	Peruque Creek High Flow Discharge	Additional Effluent Pump Station Capacity	Parallel Effluent Pump Station Force Main
Practicability	Yes	Yes	Yes
Degrading/non-degrading	Degrading	Non-degrading	Non-degrading
Total initial capital cost ($)	3,400,000	8,000,000	12,873,000
Present value of O&M costs ($)	18,000	213,000	36,000
Present value salvage value ($)	(75,000)	(137,000)	(1,791,000)
Total present worth ($)	3,343,000	8,076,000	11,118,000
Base-to-alternative cost ratio	1.00	2.42	3.33
Total annual costs ($)	1,000	12,000	2,000
Economically efficient	Yes	No	No

high flow pumps, which would be configured in a lead/standby arrangement, thus allowing for a 100 percent redundant system. Previous engineering planning indicated that the pump station would require two 1,000 hp (745.7 kW) pumps. Significant and costly electrical improvements would be needed to the WRRF to support these new high-capacity pumps and associated electrical demands.

- Parallel effluent force main. This alternative would construct a new 30-in. (76 cm), 6-mi (9.7 km) long force main adjacent to the existing effluent force main to the Mississippi River. The second force main would parallel the existing force main and would connect to it prior to discharging into the Mississippi River. A parallel force main would reduce the dynamic head loss on the pumps caused by high flow conditions in the existing force main but would not reduce the static head conditions of the Mississippi River.

Table 3 includes a planning-level LCC summary for high flow discharge to Peruque Creek with the two viable non-degrading alternatives discussed above. The table assumes the base BNR AS project with all three discharge scenarios. As previously mentioned, a treatment process upgrade was required at the WRRF for both the Peruque Creek discharge as well as the Mississippi River discharge. Only the costs directly associated with the three discharge scenarios have been presented in the table for comparison.

Using the same criterion of 120 percent of the base project cost, both the additional effluent pump station capacity and the parallel force main to the Mississippi River were determined to be not economically efficient for the city.

PROPOSED SOLUTION

Based on the economic evaluation, technical comparison, and non-monetary factors, the high flow discharge to Peruque Creek was recommended to alleviate the hydraulic limitations of the effluent pump station. The antidegradation application to MDNR was submitted in the summer of 2017, including full permit limit calculations, stream flow and existing conditions determination, less-degrading alternatives evaluation, non-degrading alternatives evaluation, and socioeconomic impact analysis. The application recommended allowing the city to discharge excess flows not able to be pumped to the Mississippi River when the river was under flood conditions according to the National Weather Service. The USGS stream gauge in Grafton, Illinois, just upstream of the Mississippi River outfall, was used as the basis of river level analysis. Dates provided by the city of when backups had previously occurred were correlated to historical river gauge elevations to determine at what level the flow in the Mississippi River prevented the effluent pump station from pumping all the flow. This was also reviewed together with a pump hydraulics analysis.

An elevation of 18 ft (5.5 m) on the Grafton USGS stream gauge, the National Weather Service's flood state level, was found to be the point at which the effluent pump station would become limited. This level was put forth as important in the antidegradation application as being one of the criteria determining when the high flow discharge would be used, representing circumstances of high flows and flooding.

The proposed discharge to Peruque Creek was not recommended to be an alternative discharge location under low and average flow conditions due to the creek's typical stream flows. The typical creek flow would not be sufficient for assimilation of the WRRF's average or high effluent flows with the same permit limits currently imposed for the Mississippi River outfall. Discharging the full WRRF effluent flow to Peruque Creek was evaluated, but it was deemed unaffordable. The estimated LCC cost of WRRF upgrades to meet the projected limits for Peruque Creek for the full year-round effluent flow would be approximately $55 million, a cost that made keeping the existing Mississippi River outfall appealing from a permit limit and a total project LCC perspective.

The antidegradation evaluation proved that the proposed discharge would not result in degradation of water quality in Peruque Creek to be below water quality standards under high creek flow and justified the discharge for economic and safety reasons, and social importance to the city.

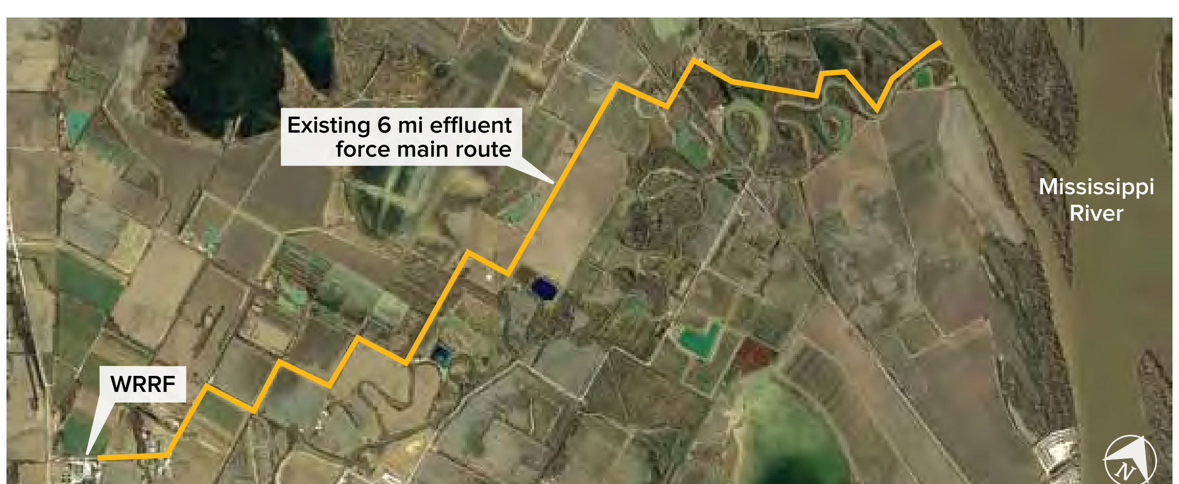


Figure 4. Location of O'Fallon WRRF and effluent force main to Mississippi River

APPROVAL

MDNR agreed with the findings of the antidegradation application. The proposed permit limits were approved, and the approach to send fully treated and disinfected high flows not able to be pumped to the Mississippi River to Peruque Creek was accepted. With MDNR approval, the high flow discharge to Peruque Creek will become, to the best of our knowledge, the first-ever permitted high flow outfall to a secondary receiving waterbody in Missouri. This alternative solution saved the city more than $7 million compared to other, more-traditional solutions.

This success is due to a proactive, open approach to working with local and state governments and agencies while developing the antidegradation application. The process started with discussions with MDNR before the application was submitted to determine whether the department would consider the proposed alternative and which aspects of the proposed solution were most important. This partnership continued throughout the application process. The parties maintained contact to keep the process moving and ensure a proactive response to issues or questions.

O'Fallon is not the first municipality in the country to use a high flow discharge. Two examples of communities managing high flows using secondary outfalls for their WRRFs are Easthampton, Massachusetts, and the Presque Isle Utilities District in Presque Isle, Maine. Both New England communities have a permitted secondary discharge to a separate waterbody used when the primary discharge is capacity limited. An antidegradation analysis and a secondary discharge evaluation give municipalities one more alternative for managing high flows. In the case of O'Fallon, this alternative was the most cost-effective, while protecting Peruque Creek and its beneficial uses.

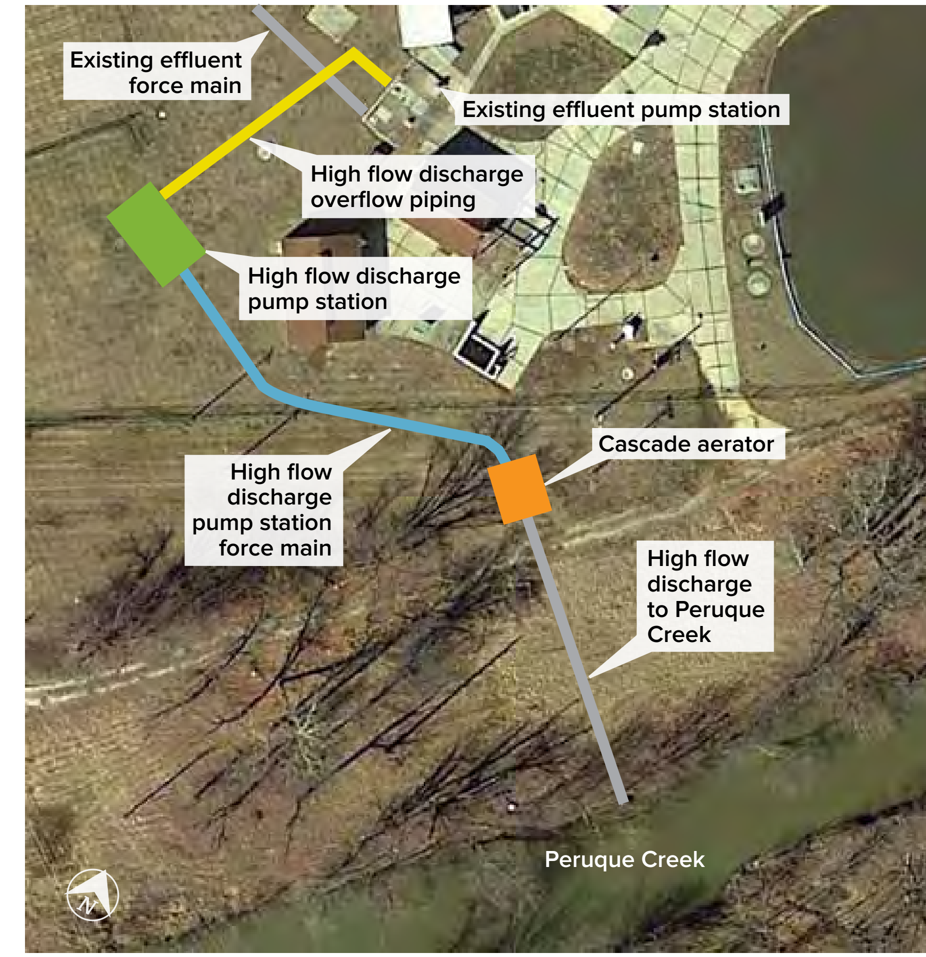


Figure 5. Proposed high flow discharge site plan

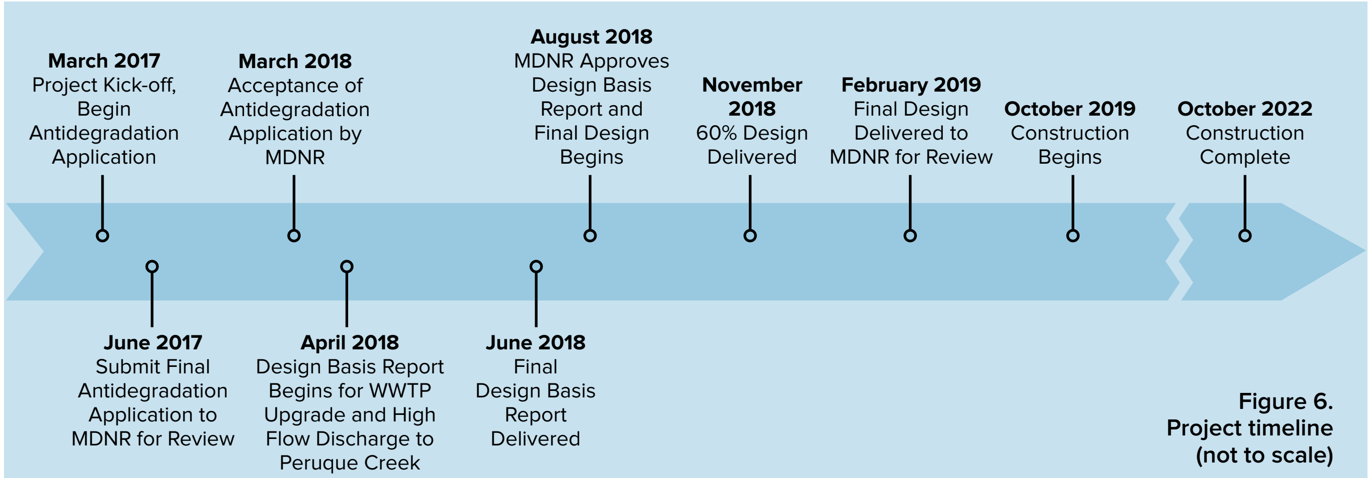


Figure 6. Project timeline (not to scale)

WHERE WE ARE—WHERE WE ARE GOING

With facility planning complete, final design of the WRRF upgrade and high flow discharge to Peruque Creek is under way. At 60 percent design, the opinion of probable capital cost of the high flow discharge to Peruque Creek is $1.6 million, further saving the city money over less cost-effective solutions. The overall project—a $31 million plant upgrade funded by the city—comprises the high flow discharge, secondary treatment system upgrades, and major electrical and controls upgrades to almost 75 percent of the facility.

High flows will be directed over an overflow weir gate at the existing effluent pump station and into a new high flow discharge pump station. The pump station will include a new wet well with three 20 hp (14.9 kW), variable speed, submersible centrifugal pumps in a lead/lag/standby configuration. The pumps will discharge to a 300 ft (91.4 m) long, 14 in. (36 cm) force main leading to a new cascade aerator, which will reintroduce oxygen back into the treated effluent before gravity flow into Peruque Creek via a new 24 in. (61 cm) outfall pipe to a discharge at the creek's edge. A cascade aerator has been included in the design of the high flow discharge so that water entering Peruque Creek has a daily minimum DO concentration of at least 5 mg/L to protect water quality. With this approach to solving the city's high flow problem, operating pump horsepower will be reduced from 1,000 hp (746 kW) to 40 hp (30 kW) (includes two pumps), and the force main length will be reduced from 6 mi (9.7 km) to just over 300 ft (91.4 m) compared to non-degrading alternatives previously presented to the city.

With the current schedule, final design is anticipated to be completed in February 2019 with construction beginning in the fall of 2019. Construction is scheduled to be completed and the WRRF and high flow discharge operational by October 1, 2022.

REFERENCES

- US EPA (2015), Code of Federal Regulations Title 40: Protection of the Environment, 131.12
- State of Missouri (1977), Code of State Regulations Title 10, Division 20, Chapter 7: Water Quality 7.031
- Missouri Department of Natural Resources (2016), Missouri Antidegradation Implementation Procedure

ABOUT THE AUTHORS

- Robert Polys, P.E., is a technical manager at the Portland, Maine office of Woodard & Curran. He has 10 years of experience and specializes in wastewater process design, designs of WWTFs, pumping stations, and collection systems. He has a Bachelor of Science in Civil and Environmental Engineering and a Master of Science in Environmental Engineering, both from UMass Lowell. He is a licensed professional engineer in several states and is a member of the NEWEA Small Community Committee and Maine Water Environment Association (MEWEA). He is the technical lead for the antidegradation application, capital improvement planning, and the current ammonia and high flow discharge upgrades project under design for the city of O'Fallon.
- Max Kenney is an engineer at Woodard & Curran in the water practice with two-and-a-half years of experience in environmental engineering and construction administration. Mr. Kenney has an environmental engineering degree from the University of New Hampshire and is an engineer-in-training in New Hampshire. Since joining Woodard & Curran, he has worked on a range of wastewater projects, including pump station rehabilitation, sewer collection system designs, WRRF upgrades, and capital improvement plans. Mr. Kenney is a member of NEWEA and is involved in the Young Professionals Committee of MEWEA.

NEBRA Highlights

NEBRA to hire new executive director

Current director to become projects lead and focus on PFAS through 2019—NEBRA will hire a new executive director in 2019 to replace Ned Beecher, who will become Projects Lead, advancing the work on perfluoroalkyl and polyfluoroalkyl substances (PFAS) related to biosolids, other residuals, and wastewater. NEBRA's board of directors voted on October 19 to support this work, after a successful fundraising campaign that brought in pledges to the "PFFund" of around $60,000. NEBRA's PFAS Advisory Group, which guides and reviews Mr. Beecher's work on PFAS, has been expanded to include stakeholders from around North America.

PFAS update—biosolids, residuals, and wastewater

PFAS conference—NEWEA's Residuals and Microconstituents (now Contaminants of Emerging Concern) committees produced a PFAS conference on October 15 at UMass Lowell. NEBRA participated in the conference, with Mr. Beecher facilitating an update on PFAS regulatory policies and actions around the Northeast. Shelagh Connelly (Resource Management, Inc.) described how the uncertainty around PFAS and the regulatory scrutiny of biosolids and land application by the New Hampshire Department of Environmental Services (NHDES) and others are negatively affecting biosolids programs.

PFAS having an impact on biosolids management programs—throughout the Northeast, PFAS has affected various biosolids programs:

- NHDES's close observation of several farms that have been using biosolids has led to at least two New Hampshire farmers withdrawing from biosolids recycling programs.
- The Vermont Department of Environmental Conservation withdrew approval for the use of paper mill residuals for reclamation of a Superfund mine site because of PFAS concerns.
- In Massachusetts, two landfills that have used paper mill residuals for capping closed portions stopped using the material [even though the Massachusetts Department of Environmental Protection (MassDEP) has not taken any action concerning PFAS in residuals and such use remains beneficial and acceptable].
- A composting facility in upstate New York put compost sales on hold for much of 2017 after its compost product and paper mill residual feedstocks—material not out of the ordinary for modern biosolids and paper mill residuals—were examined.

With the current regulatory uncertainty and public and legislative pressures, and absent strong leadership by EPA and some state agencies, biosolids management will continue to be affected. Wastewater facility managers should pay attention, as the market for managing solids could be disrupted. Ideally, states will recognize how uncertainty can affect the marketplace and issue statements affirming biosolids recycling.

NHDES begins setting drinking water MCLs for four PFAS—as required by a 2018 law, NHDES will propose Maximum Contaminant Levels (MCLs) for drinking water for perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS). The agency held stakeholder input hearings in mid-October and accepted written comments until November 9. NEBRA worked with other water quality groups and the New Hampshire Municipal Association to submit joint comments focused on the potential costs for municipalities if a low MCL is adopted, including not only for drinking water treatment but also for wastewater treatment and biosolids management, given the common presence of low levels of PFAS in these materials. Because, by law, an MCL automatically becomes an ambient groundwater quality standard, wastewater treatment facility operations may be affected if an MCL ends up in the 20 parts per trillion (Vermont's standard) or lower range.

In brief/en bref…

- The most recent Northeast Digestion Roundtable webinar addressed the state of anaerobic digestion in New England. See nebiosolids.org/ne-digestion-roundtable.
- In early October the Greater Lawrence Sanitary District (GLSD) in North Andover, Massachusetts, hired a new firm to run its heat drying operations.
- The Manchester, New Hampshire sewage sludge incinerator reached an agreement with EPA on reducing mercury emissions under EPA's new Maximum Achievable Control Technology (MACT) standards.
- Microplastics is of growing public concern, as recently reported by *The Times*, a British daily newspaper. A session at WEFTEC addressed questions around this issue, specifically: How are wastewater and biosolids management involved? Is this a significant issue for biosolids? Meanwhile, a Danish study of biosolids' role found more microplastics from ordinary agricultural practices than from biosolids. Dr. Sally Brown (University of Washington) addressed microplastics in a recent abstracts review available to NEBRA members.

Cambridge City Council's Health and Environmental Committee hears from city recycling program staff at a public hearing on October 9

Cambridge successfully diverts food scraps to co-digestion with biosolids at GLSD

A pilot food scraps collection program by the city of Cambridge, Massachusetts, has expanded to more participants and is supplying a facility in Charlestown, Massachusetts, that produces a slurry ready for digestion. The slurry is transported to GLSD, where it is co-digested with the facility's solids, producing energy and a heat-dried biosolids pellet fertilizer.

The Cambridge City Council Environment Committee recently heard concerns about the program, however, after the concern was raised in a WGBH radio story and mentioned later in the *Boston Globe*. At the October 9 hearing, NEBRA provided a fact sheet addressing the typical concerns about biosolids and pointing out the benefits of co-digestion. It noted that the GLSD co-digestion process is seen as a progressive example of resource recovery and community sustainability. As its new, fourth digester comes online, GLSD hopes to soon achieve net-zero electricity consumption. Biosolids recycling opponents also testified at the hearing, arguing that "centralized wastewater treatment is a mistake and sewage sludge is the always toxic byproduct."

Because co-digestion is an important option in managing organic residuals nationwide, EPA and MasDEP provided to the hearing letters of support for the Cambridge program. MassDEP and other state agencies have invested significantly in biogas renewable energy over the past decade, because it advances sustainability and supports the state regulation forcing the diversion of food scraps from landfills, where they generate significant greenhouse gas emissions (fugitive methane). Massachusetts is seen as a leader nationwide for its progress on organic waste diversion from landfills.

NEBRA and some members (e.g., GLSD) developed a response to testimony from program opponents and submitted it to the City Council. A tour of Waste Management's CoRE facility, where the engineered slurry is produced, and to the GLSD digestion operations, was held for Cambridge recycling staff, Recycling Advisory Committee members, and Vice Mayor Jan Devereux. NEBRA plans to testify at a future City Council Environment Committee meeting.

The success of the first six months of the Cambridge food scraps diversion program is summarized on the city's website. The community seems to generally support the program, and other stakeholders involved in the same co-digestion process elsewhere in the region, such as Boston's Zero Waste efforts have expressed enthusiasm over it.

Alan B. Rubin, 1941–2018

Alan B. Rubin, PhD, formerly of EPA and lead author of the Part 503 regulations, died from lymphoma on October 25 at the age of 77.

Dr. Rubin joined EPA when the water program was expanding rapidly because of the Clean Water Act. From 1984 until his retirement from EPA in January 2005, he was the lead staff person to the EPA's Office of Science and Technology, Health and Ecological Criteria Division, in which he led the development of the Part 503 rule and its implementation. His responsibilities included refinement and implementation of multimedia/multi-pathway chemical risk assessments, development of microbial operational standards for the Part 503 rule, and communication of the Part 503 rule and its technical basis to the states and the public to accelerate the rule's implementation.

Passionate about his work, Dr. Rubin remained so in retirement. He was known to exclaim excitedly: "The periodic table! It's so elegant, how it all fits together!" When he spoke about the Part 503 Rule, his familiarity with every detail was evident. This was his life work. As Andrew Carpenter, former president of NEBRA, noted when introducing him at the Northeast Residuals and Biosolids Conference in 2013, at which the 20th anniversary of the Part 503 Rule was celebrated, "even in contentious meetings, Alan was always eager to engage on this topic."

Dr. Rubin is survived by his wife, Hillary, and three children. A celebration of his life was held on November 19 at his favorite park, Meadowlark Gardens, in Vienna, Virginia. WEF is planning to celebrate his life at the WEF Residuals & Biosolids Conference next spring. See more about Dr. Rubin and the Part 503 Rule in the NEWEA Journal's Summer 2014 issue.

Ned Beecher, Executive Director
Tamworth, N.H.
603-323-7654 | info@nebiosolids.org

For additional news or to subscribe to NEBRAMail, NEBRA's email newsletter, visit nebiosolids.org

nebra
North East Biosolids & Residuals Association

Spotlight: **Young Professionals**

Over the next few issues we will profile a few of the young professionals who are taking resource recovery forward in New England. As the "Baby Boomer" generation ages and retires, the challenges and opportunities for the younger generation are enormous. For this initial spotlight piece, *NEWEA Journal* recently spoke with two such highly respected young professionals about their experience in the water environment industry: **Paula Drouin**, laboratory manager at the Lewiston-Auburn Water Pollution Control Authority (LAWPCA) and 2018 president of the Maine Water Environment Association (MEWEA), and **Alex Buechner**, superintendent of the Biddeford Wastewater Treatment Facility and leader of Maine's Operations Challenge team for the last few years.

Journal *How did you come to enter the clean water profession? Did schooling play a role in your decision to work at a wastewater treatment facility?*

Paula Drouin (PD): Like many people in this industry, I saw there was a job opening and applied for it. I had just finished my undergraduate degree in Natural and Applied Sciences. This would not have been a field I would've sought out, mainly because I wasn't aware of the science-related positions available. But I was lucky enough to see the opportunity and now have a very rewarding career.

Alex Buechner (AB): I did not set out to become a wastewater operator. A family friend got me an interview with CH2M Hill/OMI, a company I had never heard of, at this mysterious water treatment facility in Biddeford that I had never noticed or ever really given any thought to. Like so many others, I took my utilities for granted, and it had never crossed my mind to wonder where my water came from or where it went after I used it. With no skills and minimum education, I was hired as a utility worker by the company contracted to run Biddeford's wastewater facilities. I mainly mowed lawns and cleaned up gross messes at the treatment plant. At first it was just another job, a way to make money. But as I learned more about the process, I developed a great appreciation for all the work it takes to protect our waterways. That appreciation led to eagerness to learn and contribute as much as I could, and that mentality has led me to where I am today. I consider myself very fortunate to have accidentally landed a job in a field that is interesting and challenging, and contributes so much.

■ *How long have you been in the water environment field and why did you decide that this work would make a good long-term career for you?*

PD: I have been in the water environment field just over 10 years (wow!). Being a lab supervisor allows for interesting and important work, but that is not what has kept me in the field. What made this a career choice for me (and not just a job) are the amazing people I have met along the way. Through their willingness to 1) be directly welcoming to someone new and 2) share knowledge whenever possible, I have developed my laboratory skills and am on a path of professional growth through being active in MEWEA and NEWEA. Also important to me is the fact that my employer supports my involvement with MEWEA and NEWEA (this is huge, employers take notice!). What I have gained and continue to gain through association activities is invaluable.

AB: Next December will mark 15 years for me. It took me a while to see fully that this was a career and not just a job. The turning point happened when the city took back the operations of the treatment facilities from OMI in 2009. Some of the staff, including the chief operator of 20 years, decided to stay with the company and not to take the jobs offered by the city. This could have left Biddeford vulnerable to failure if the positions hadn't been filled by the talented and dedicated crew that I have the pleasure of working with today. It was at this time that I made the decision that, in order to help fill the void that was left when the previous staff moved on, I was going to commit to understanding as much as I could about what we do. It was at this same time that I stopped feeling embarrassed to admit that I worked in a field that people sometimes look down on because it sounds "dirty" or "gross," and became proud to tell people about what I do for a living.

■ *Do you talk with people outside the profession about what you do for work? What do you receive for reactions from people about your work?*

PD: I do if I am asked what my career is. I like to mention how we use microorganisms to do the bulk of the work, and that usually gets a positive response and more questions. Our field is not well-known or even often thought about, but once someone realizes that there is a lot of science, decision-making, and environmental protection involved, it changes their perception.

AB: Yes! All the time! To the point of annoying my friends and family. When I think back to how ignorant I was of all this 15 years ago, it embarrasses me. How can it be so few people know even the smallest detail about where their water comes from or how it is treated once it's dirty? About one of the few things in our chaotic lives that we actually need to stay alive? It is a part of my mission to help others avoid this embarrassment.

■ *What benefit do young professionals gain from being involved in MEWEA or NEWEA?*

PD: Professional development at any level they want. Getting involved in a committee is a fun way to meet new people and learn new things, and from there, a YP (young professional) can get involved with different committees, or even consider becoming a chairperson or member of the Executive Committee.

AB: The biggest benefit has to be getting involved with a group of experienced and dedicated people in this field. The things that I have learned from speaking with other wastewater professionals whom I have met through the association and through our Operations Challenge team cannot be matched by reading textbooks or sitting in classrooms. And many of the people I have met through the associations I now consider as friends. Whenever things start to get monotonous at work and I start to feel like I'm just going through the motions, a NEWEA conference or an Ops Challenge trip to WEFTEC always restores my passion to learn and boosts my appreciation for my job.

■ *What challenges do you see for the water environment profession in the near future?*

PD: Attracting and retaining skilled people. In our profession, we are very much out of public sight and out of the public mind. I don't think I've met one person in this field who didn't just stumble into it or know someone who got them interested. I remember growing up and having an awareness of the mail delivery person, the oil delivery person, the workers directing traffic when the road was being paved, and the workers up in the power lines. But I never considered where water came from, or where it went, or even that people were involved! We need to figure out how to make the invisible more visible, and in a way that relays the value of what we do.

AB: An aging work force, aging infrastructure, and a growing complexity to treatment processes will all be challenges in the future. Fortunately, the solutions to these problems start with the same thing: public education. We need to bring these jobs out of the shadows and into the public eye so that young people will be more inclined to consider a career in this field and so that the tax-paying citizens will appreciate the value that we get from improving and maintaining treatment systems.

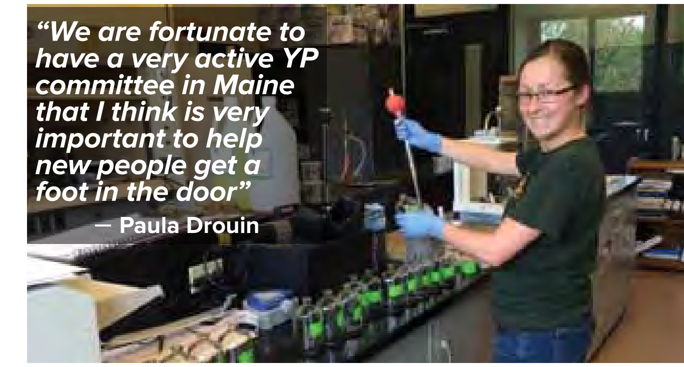
■ *What advice would you give to students or young people considering a career in the environmental field?*

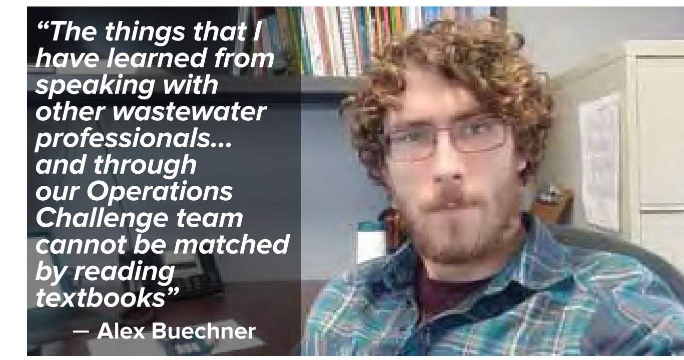
PD: Get involved in a state or regional association if you can! Any questions or issues you may face can usually be answered by someone who has been in the field for a while. It will also get you connected so you can stay in the loop regarding future career opportunities and advancements.

AB: General advice? At the risk of coming across as one of those individuals who quote people, I think Abraham Lincoln said it best: "Whatever you are, be a good one."

■ *Thinking back, was there a particular person who helped you feel welcome in the field or served as a mentor to help your progress?*

PD: Vivian Matkivich, who was the pretreatment and safety coordinator at LAWPCA. Not only did she help me learn how to work in the lab, she was instrumental in getting me involved with MEWEA and NEWEA. Attending a convention where you don't know anyone can be nerve-wracking, but she introduced me to a great many people which made it easier because I could always find that one face in the crowd to connect with. Though she is retired now, she is still a good friend of mine.





AB: I would not be where I am today if it wasn't for what I have learned from the people I have worked with, participated in Ops Challenge with, and met through being involved with MEWEA and NEWEA. All of these people continue to teach and motivate me in countless ways, especially the friends I have made through Ops Challenge.

■ *Do you have any suggestions concerning what steps NEWEA and the state associations could take to attract young people to this line of work?*

PD: We are fortunate to have a very active YP committee in Maine that I think is very important to help new people get a foot in the door. The YPs hold a number of events that are both social and professional, some of which involve interaction with the public. Also, I have heard wonderful things about the Young Professionals Summit that has been held at NEWEA's Annual Conference in January, so I would continue to hold events like that and be receptive to the feedback given by the YPs who attend. At the state and regional levels, we must have an environment that is welcoming to new professionals of any age, and our outreach to the public must be designed in a way that truly shows the value of what we do, because that is what will make careers in our field more desirable.

AB: Don't stop talking about it. Never stop. Especially when it comes to young people. Job fairs, poster contests, school visits, tours; all that stuff. It is in everyone's best interest for the general population to have a better understanding and appreciation of the things they rely on to go about their day confident that they aren't going to die from cholera or dysentery. I started an education program here in Biddeford four years ago where I spend two days a year talking to middle school kids about my job and about how wastewater collection and treatment works. It is fun and rewarding, and I would consider it a great achievement if even one of those kids grew up to be a wastewater professional.

Young Professionals help build rain garden

NEWEA's Young Professionals (YP) Committee participated in its first service project earlier this year. YP members teamed up in the Common Fence Point (CFP) neighborhood in Portsmouth, Rhode Island, with Eastern Rhode Island Conservation District, NEWEA volunteers, local businesses, and CFP neighbors to construct a rain garden at the CFP Community Center.

A rain garden is a depressed area in the landscape that collects rain water from a roof, driveway, or street and allows it to infiltrate the ground. The service project was completed as part of the YP Committee's goal to locate and build green infrastructure that would have an impact on a community and promote environmental sustainability.

Funding was provided by the van Beuren Charitable Foundation through the Rhode Island Green Infrastructure Coalition (RIGIC). Sara Churgin, district manager of the Eastern Rhode Island Conservation District and primary project coordinator, suggested after learning about the community through the van Beuren Foundation that the NEWEA YP group build a rain garden there. Once the project and location were determined, the group worked relentlessly over a two-week period to develop the rain garden design and organize the day of the event.

More than 45 volunteers attended the event, held on June 2, most being residents of the community—an incredible display of community companionship. Six residents stood out for their dedication to the project:

- Conley Zani, president of the CFP community, was instrumental in reaching out to the community for help through word of mouth and social media.
- Dan Woods (Woods Septic), Dave Camara, and Kevin Rocha helped excavate and grade the rain garden and surrounding areas with their heavy machinery.
- Jeff Culpan (Anchor Plumbing) installed a new hose bib at the Community Center for a source of water to connect a sprinkler that would water the new rain garden.
- Barbara Jones, a University of Rhode Island master gardener, directed volunteers for the planting layout of the garden and instructed individuals on how to plant the individual flora.

Other residents helped move loam and mulch, build a rip-rap spillway, and plant various shrubs and flowers, consisting mostly of bearberry, milkweed, and azaleas. The rain garden project was completed in about 7 hours, much faster than expected and solely attributed to the terrific community support.

The 760 ft^2 (71 m^2) rain garden will capture around 50 percent of the runoff from the Community Center roof that would otherwise infiltrate the ground and discharge eventually into Mt. Hope Bay without any treatment. Two roof leaders were tied together with new Schedule 40 PVC drain pipe and discharged into the rain garden. The rain garden was constructed using 4 in. (10 cm) of 50/50 loam/compost mix and 3 in. (7.6 cm) of pine bark mulch. Approximately 400 Rhode Island native plants were planted within the garden bed. Native plants were used in the rain garden because they are adapted to the local environment and require far less water. A small rip-rap spillway was also constructed to allow for the release of water that may build up in the garden during heavier rain events.

Since the day of the event, the community has taken a special interest in the rain garden and added about $4,500 of more plants and other materials! New flowers have been added to the rain garden perimeter, and large stones have been installed to stabilize the slopes. The rain garden has become a reflection of the comradery of the CFP community.

The project was the culmination of planning and design led by the YP committee over the previous several months. It was a great experience for the group to help a community that was engaged and willing to help make a great product. Throughout the day, several residents mentioned how the Community Center used to be the focal point. Movie nights, dances, and impromptu neighborhood parties used to be a staple there, but those have become rare in recent years. Ms. Zani and other board members have stressed bringing back that sense of companionship, and the Community Center's rehabilitation has been central to doing so.

Thank you to Narragansett Engineering, Inc. (NEI), primary engineer for CFP that contributed design plans for the construction and grading of the rain garden. The event was sponsored by Pare Corporation, Kleinfelder, Narragansett Water Pollution Control Association (NWPCA), and NEWEA.

More information about the organizations involved in this project can be found at their websites:

- CFP Community—commonfencepoint.org
- van Beuren Charitable Foundation—vbcfoundation.org
- Rhode Island Green Infrastructure Coalition—greeninfrastructureri.org
- EPA Rain Garden Information—epa.gov/soakuptherain/soak-rain-rain-gardens

Before

NEWEA Young Professional volunteers Ben Stoddard, Jonnas Jacques, Debbie Cheng, Kate Roosa, and Kenneth Yu

WEF Delegate Report

At the October 2018 WEFTEC in New Orleans, the NEWEA WEF delegation—outgoing delegate Susan Sullivan (executive director of the New England Interstate Water Pollution Control Commission), Fred McNeill (chief engineer of the Environmental Protection Division for the city of Manchester, New Hampshire), Matt Formica (past NEWEA president and a senior project manager at AECOM), and incoming delegate Susan Guswa (municipal wastewater practice leader at Woodard & Curran)—promoted New England's needs and issues nationally while helping to develop and implement WEF's goals and objectives. NEWEA's delegates are members of WEF's house of delegates (HOD), the deliberative and representational body of the organization. The HOD advises WEF on strategic direction and public policy development.

At the conference and throughout the year, NEWEA's WEF delegates participate in HOD meetings, workgroups, and committees, coordinating with other WEF HOD committee members. Here is a snapshot of HOD committee achievements for 2018:

- The Budget Committee completed review of the WEF budget to ensure consistency with the WEF business and strategic plans. Participants from the 2018 WEF Member Association Exchange events (WEFMAXs) provided recommendations to the committee on budgeting and dues strategy.
- The Nominating Committee solicited nominations and filled workgroups/committees for the upcoming year. Mr. Formica participated on the HOD Nominating Committee.
- The Outreach Committee developed a delegate "job description" and enhanced the HOD orientation video content using feedback from a mentoring survey and a role-of-the-delegate exercise.
- The WEFMAX Committee has identified future host locations. In 2019, the following Member Associations (MAs) will each host a WEFMAX: Alabama Water Environment Association, Arizona Water Association, British Columbia Water and Waste Association, and Kentucky–Tennessee Water Environment Association. Keep an eye out on the WEF website for more information about these meetings. NEWEA looks forward to hosting a WEFMAX in 2022.
- The Steering Committee initiated a new delegate mentoring program and developed a new dashboard for committee organization and recording in 2018. Ms. Sullivan, NEWEA's senior delegate for 2018, completed her term on the Steering Committee.

HOD workgroup accomplishments in 2018 included the following:

- The Membership Relations Workgroup prepared and presented the WEFTEC Membership Initiative and Reciprocal Program at WEFMAX meetings. It also developed a worksheet communicating the Membership Dues strategy.
- The Operator's Initiative Workgroup worked with WEF's Operator Advisory Panel (OAP) to promote the role of professional operators. It developed and presented operator-focused discussions at WEFMAX and prepared a social media toolkit for the Operator Ingenuity contest. The group also developed a Living Wage flyer. Mr. McNeill serves on the committee and the OAP.
- The Student Chapter Workgroup conducted a national census of student chapters and gathered information from the MAs about their active student chapters and barriers to adding new or continuing active and engaged chapters. They analyzed roadblocks, challenges, and successes at student chapters and provided feedback to the Students-and-Young-Professionals and Governance committees on student chapter policies and procedures. Mr. Formica contributed to several workgroup deliverables.

In the upcoming year NEWEA's representation in the HOD will be even stronger. Ms. Sullivan has been selected by WEF to become a delegate-at-large, and as such will serve in the HOD for another three-year term.

The 2019 Water Week is scheduled for April 1–5, and the National Water Policy Fly-In will be April 2–4, in Washington, D.C.

Planned activities for the 2019 WEF HOD workgroups include:

- The Membership Relations Workgroup will investigate increasing the diversity of WEF membership and drawing more widespread demographics into the water profession. It will provide feedback to the board of trustees on membership structures and develop materials to communicate recommended membership structures to WEF. Ms. Guswa will participate in this effort.
- The MA Resources Workgroup will identify and compile resources available to assist MAs in promoting and supporting its members. It will provide a toolkit available to MA leaders and staff. Mr. Formica will participate in this project.
- The Operators Workgroup will work with the OAP to promote operators and survey MAs on operator workforce development. Mr. McNeill, a licensed WWTP operator and manager of a northern New England wastewater utility, provides real-world experience to this important workgroup as it continues to assist the OAP in promoting and supporting the professional operator. The OAP does so through promotional materials to support and encourage participation in WEF operator-oriented programs and services, including the Operator Ingenuity Contest.

NEWEA's WEF delegates also will represent NEWEA on 2019 HOD and other committees:

- Ms. Sullivan will chair the legislative subcommittee for WEF's Government Affairs Committee. This WEF group will coordinate efforts with National Association of Clean Water Agencies (NACWA), WateReuse, and the Water Research Foundation (WRF) on the 2019 Water Week and National Water Policy Fly-In. Water Week is scheduled for April 1–5, 2019, and the National Water Policy Fly-In will be April 2–4, 2019, in Washington, D.C.
- Ms. Sullivan will also serve on the HOD Budget Committee this year.
- Mr. Formica will chair this year's HOD Nominating Committee and will complete his two-year service on the five-person WEF sub-nominating committee, which vets and recommends the next WEF vice president and trustees to the WEF executive board.
- Ms. Guswa will serve on HOD's WEFMAX Committee. This committee manages the four WEFMAX meetings to be held in the spring throughout North America. WEFMAX meetings provide a forum for MA leaders to exchange success stories, experiences, and initiatives on how the MAs can improve their operations as well as their programs and services for members.
- Mr. McNeill will continue with the Operations Workgroup. The workgroup will assist WEF in surveying MAs on operator workforce development and in reviewing operator training materials (both WEF and MA developed) to provide a gap analysis for content. The workgroup will also assist in other WEF operator initiatives as needed.

The NEWEA WEF delegates look forward to another great year of working on issues that are important to our membership and our profession. #WatersWorthIt

Annual Conference & Exhibit Preview

January 27–30, 2019 • Boston Marriott Copley Place, Boston, Massachusetts

It's the Year of the Volunteer! This year's theme focused on how all of us, as members of NEWEA, can do more in spreading the word that Water's Worth It! Thank you to everyone who raised your hand. As an organization, we were very successful in "going all in" and we have several sessions at this year's Annual Conference to highlight these efforts.

This premier water quality event and exhibit features 34 technical sessions, two poster sessions that showcase the work of both student and water quality professionals, and two floors of exhibitors featuring the industry's latest products. In keeping with this year's theme, find out about how YOU can help spread the word—check out the Government Affairs session on Monday morning and see how we are conversing with federal, state and local legislators and decision makers, stop into the Public Education session and learn how you can share the message with the next generation, or inquire about joining one of NEWEA's many committees.

Monday is innovation day. We encourage you to visit the professional poster board session on the 4th floor on your way to and from the exhibit hall, attend any number of our technical sessions and roundtable discussions, or stop in at the Innovation Pavilion hosted by the NEWEA Innovation Task Force. The afternoon winds down with the first of two Exhibit Hall receptions.

Tuesday is the day we celebrate the operators—NEWEA Operator Day – including a full program of technical sessions geared towards operators, the Operator Ingenuity technical session on Tuesday morning, the Operator's Reception at noon and countless networking opportunities at the Exhibit Hall Reception in the afternoon.

The final day of the conference features a full day of technical sessions and exhibits, our lunch-time awards ceremony recognizing outstanding efforts in our industry, and the passing of the gavel to the 2019 NEWEA President, Raymond "Sonny" Vermette of the city of Dover, New Hampshire. The Awards Luncheon sells out annually, so don't miss out! We hope you take advantage of all the 2019 Annual Conference has to offer and use this occasion to catch up with old acquaintances and cultivate new ones.

Enjoy the 2019 conference!

Janine Burke-Wells, NEWEA President
Amy Anderson, NEWEA Program Committee Chair

Conference Events

SUNDAY, JANUARY 27

Registration—4th Floor .... Noon – 4:00 PM

MONDAY, JANUARY 28

Registration—4th Floor .... 7:00 AM – 6:00 PM
Technical Sessions 1–6 .... 8:30–10:30 AM
Technical Sessions 7–12 .... 2:00–4:30 PM
Exhibits .... 10:30 AM – 6:30 PM
Opening Session .... 11:00 AM
Exhibit Hall Reception .... 4:30–6:30 PM

TUESDAY, JANUARY 29

Registration—4th Floor .... 7:00 AM – 6:00 PM
Exhibits .... 8:00 AM – 6:30 PM
Technical Sessions 13–18 .... 9:00 – 11:30 AM
Technical Sessions 19–23 .... 1:30–4:00 PM
Exhibit Hall Reception .... 4:00–6:30 PM

WEDNESDAY, JANUARY 30

Registration—4th Floor .... 7:30 AM – 2:00 PM
Exhibits .... 8:00 AM – 1:00 PM
Awards Presentation & Gavel Passing ... 11:00 AM
Technical Sessions 24–29 .... 8:30–11:00 AM
Technical Sessions 30–34 .... 1:00–3:00 PM

Conference Registration

Register online/ download a complete conference program at newea.org
Phone: 781-939-0908

Early registration before January 4

Event Hotel

Boston Marriott Copley Place Hotel
110 Huntington Ave.
Boston, MA 02116
617-236-5800

SINGLE—$204
DOUBLE—$224

Conference Exhibitors

ABBA Pump Parts & Service
ABEL Pumps
ADS Environmental Services
Advanced Drainage Systems, Inc.
Airvac - a brand of Aqseptence Group
AP/M CentriPipe
Aqua Solutions, Inc.
Aries Industries Inc
Asahi/America, Inc.
Associated Electro-Mechanics, Inc.
Atlantic Fluid Technologies, Inc.
BAU Hopkins
BDP Industries
Blake Equipment Co.
BMC Corp.
BNC Insurance Agency
Boyson and Associates, Inc.
Carl Lueders & Company
Carlsen Systems
Casella Organics
Coyne Chemical Environmental Services
Cretex Specialty Products
CSI Controls
CSL Services
CUES, Inc.
David F Sullivan & Assoc., Inc
Denali Water Solutions
Diversified Infrastructure Services, Inc.
DN Tanks
Duke's Root Control
Duperon Corp
Eastern Pipe Service LLC
EOSI
eRPortal Software, Inc.
EST Associates
Evoqua Water Technologies
F. R. Mahony & Associates, Inc.
F.W. WEBB Co. - Commercial & Ind Pump Div.
F.W. WEBB Co. - Process Controls DIv.
Flottweg Separation Technology
Flow Assessment Services LLC
FLOW TECH INC
FlowWorks, Inc.
Ford Hall Company
G.A. Fleet
G&G Enterprises
Gabriel Novac & Assoc.
Green Mountain Pipeline Services
Grignard Company LLC
Groth
Grundfos Water Utility, Inc
Hach Company
HammerHead Trenchless Equipment
Hayes Pump, Inc.
Hazen and Sawyer
Hidrogeron & Glasco
Hobas Pipe USA
Holland Company, Inc.
Innovyze
ITpipes
J.F. McDermott Corporation
J&R Sales and Service, Inc.
JWB Co
Kemira
Kubota
LandTech Consultants Inc.
LMK Technologies
Lystek International, Inc.
Maltz Sales Company
Mechanical Solutions Inc.
Milliken Infrastructure Solutions
National Filter Media
National Water Main Cleaning Co.
Netzsch & Hiller
New England Environmental Equipment
Oakson, Inc.
Ober-Read & Associates
Orenco Systems Inc.
P&H Senesac, Inc.
Performance Chemicals, LLC
Philadelphia Mixers & Verder
POND Technical Sales
Primex Controls
Pump Systems, Inc.
Pure Technologies U.S. Inc.
QED Environmental Systems, Inc.
R.H. White Construction Co., Inc.
Rain for Rent
VersaFlex/Raven
RCAP Solutions, Inc.
REA resource recovery systems
Rezatec
Rockwell Automation
Rotork Controls
Russell Resources, Inc.
Saf-T-Flo
Scavin Equipment Co. LLC
Seepex Inc.
SNF Polydyne
Spencer
Spire Metering Technology
Sprayroq, Inc.
Stacey DePasquale Engineering, Inc.
Spencer Turbine Co.
StormTank
StormTrap
SUEZ
Sullivan Associates/RITEC
Synagro Northeast, LLC
Technology Sales Associates, Inc.
Ted Berry Company
The MAHER Corporation
Thermal Process Systems
Titus Industrial Group Inc
Trumbull Industries, Inc.
Underground Inspection Technologies
Unison Solutions
United Concrete Products, Inc.
United Rentals Fluid Solutions
USABLUEBOOK
USP Technologies
Walker Wellington LLC
Wescor Associates, Inc.
WESTECH
WhiteWater, Inc.
Williamson Pump & Motor
Worcester Polytechnic Institute
Xylem Dewatering Solutions Inc - Flygt Pumps
Xylem Dewatering Solutions Inc - Godwin Pumps

2019 Award Recipients

NEWEA Awards

Alfred E. Peloquin, CT	Michael Bisi
Alfred E. Peloquin, ME	André Brousseau
Alfred E. Peloquin, MA	David Duest
Alfred E. Peloquin, NH	John Adie
Alfred E. Peloquin, RI	Michael Spring
Alfred E. Peloquin, VT	Wayne Elliott
Asset Management	Plymouth Village Water and Sewer District
Biosolids Management	James Taylor and the Merrimack Biosolids Composting Team
Clair N. Sawyer	Annalisa Onnis-Hayden
Committee Service	Joy Lord
E. Sherman Chase	John Vetere
Elizabeth A. Cutone Executive Leadership	Alan Taubert
Energy Management Achievement	Town of Fairfield, CT
Founders	Douglas Miller
James J. Courchaine Collection Systems	Angelo Salamone
Operator, CT	John Bodie
Operator, ME	Stacy Thompson
Operator, MA	Robert Delgado
Operator, NH	Leo Gaudette
Operator, RI	Charles Labbe
Operator, VT	Wayne Graham
Operator Safety	David Aucoin
Past President's Plaque and Pin	James Barsanti
Paul Keough	Andrew Bramante
Public Educator	Christian Lund
Wastewater Utility	York Sewer District
Young Professional	Allison Fisher

NEWEA Recognition (Stockholm Junior Water Prize)

CT	Verna Yin
ME	Mei Tian
MA	Elise Mizerak
NH	Meghana Avvaru
RI	Margaret O'Brien
VT	Aida Arms

WEF (presented at WEFTEC)

Operations Challenge Division II Process Control	Franken Foggers, CT
Operations Challenge Division II Process Control and Lab	Ocean State Alliance, RI
WEF Fellow	James Courchaine
WEF Student Design Competition Water Environment Division	Northeastern Uniiversity

WEF—MA Awards

Arthur Sidney Bedell	Howard Carter
George W. Burke, Jr.	UConn Reclaimed Water Facility
Laboratory Analyst Excellence	Stephanie Rochefort
WEF Service	Susan Sullivan
WEF Life Membership	John Struzziery
William D. Hatfield	Francis Russo

Specialty conferences, training, and networking events

A Teacher Training Workshop and Tour was held at the MWRA's Deer Island facility in Winthrop, Massachusetts

WATER REUSE CONFERENCE

NEWEA's Water Reuse Committee held a Specialty Conference on August 10, 2018, at the University of Connecticut's (UConn's) Nathan Hale Inn in Storrs, Connecticut, where 40 meeting registrants participated.

The technical presentations commenced on Friday, August 10, with NEWEA Water Reuse Committee Chair Nick Ellis and NEWEA President Janine Burke-Wells providing the Welcome and Opening Remarks to meeting attendees.

In addition to the conference, an optional facility tour to UConn's reclaimed water facility was offered in the afternoon.

TECHNICAL PRESENTATIONS

Wastewater Reuse Pilot: Innovation & Acceleration
- Michael Murphy, Massachusetts Clean Energy Center

Integrated Water Management at the Pinehills Community, Plymouth, MA
- Neal Price, Horsley Witten Group

Federal Guidance on Development of Potable Reuse
- Greg Wetterau, CDM Smith

UConn Early Adopter of Sustainability Practices
- Jay Sheehan, Woodard & Curran

PUBLIC EDUCATION TEACHER TRAINING

NEWEA's Public Education Committee held a Teacher Training Workshop and Tour on Tuesday, August 14, 2018, at the Massachusetts Water Resources Authority's (MWRA's) Deer Island facility in Winthrop, Massachusetts. The event attracted 45 New England teachers and educators to participate.

The program commenced with NEWEA Public Education Committee Chair Lenny Young, NEWEA President Janine Burke-Wells, and MWRA's Ethan Wenger providing the Welcoming and Opening Remarks to attendees.

Attendees participated in a walking tour of MWRA's Deer Island Treatment Plant followed by three concurrent workshops, which included a Deer Island laboratory tour, a NEWEA school program and watershed/floodplain models workshop, and a hands-on World Water Monitoring Challenge workshop.

YOUNG PROFESSIONALS NETWORKING EVENTS

NEWEA's Young Professionals Committee hosts a popular multi-discipline networking event aptly named Poo & Brew. This event features a tour of a local wastewater treatment facility followed by networking at a brewery. These events are open to organization members and non-members who are professionals in the early stages of their water industry careers.

Sponsored by: AECOM; Aqua Solutions; ARCADIS; Black & Veatch; Brown and Caldwell; CDM Smith; Dewberry; Edward Nazaretian Memorial Fund; Flow Assessment Services; FlowTech; Hazen and Sawyer; Lystek International, Inc.; Tata & Howard; Ted Berry Company; The MAHER Corporation; Tighe & Bond; Weston & Sampson.

POO & BREW #15—A tour of the Greater New Haven's East Shore Water Pollution Abatement Facility was featured, followed by networking at Stony Creek Brewery in Branford, Connecticut. More than 30 attendees participated in the event held on Saturday, June 9, 2018. Co-hosted with Connecticut Association of Water Pollution Control Authorities and New York Water Environment Association.

POO & BREW #16—A tour of the Portland Water District East End Wastewater Treatment Facility was featured, followed by networking at Rising Tide Brewery in Portland, Maine. More than 20 attendees participated in the event held on Thursday, June 21, 2018. Co-hosted with Maine Water Environment Association.

POO & BREW #17—A tour of the Athol, Massachusetts Wastewater Treatment Plant was featured, followed by networking at Honest Weight Artisans Beer in Orange, Massachusetts. More than 30 attendees participated in the event held on Thursday, September 6, 2018.

POO & BREW #18—A tour of the Manchester, Connecticut Hockanum Water Pollution Control Facility was featured, followed by networking at Labyrinth Brewery in Manchester. More than 40 attendees participated in the event held on Friday, November 16, 2018.

COLLECTION SYSTEMS CONFERENCE

NEWEA's Collection Systems Committee held a specialty conference and exhibit on Monday, September 10, 2018, at the Holiday Inn, Boxborough, Massachusetts. Meeting registrants included 119 attendees and 14 exhibitors.

The technical presentations commenced on Monday, September 10, 2018, with NEWEA Vice President Jennifer Lachmayr and NEWEA Collection Systems Committee Chair Peter Garvey providing the Welcome and Opening Remarks.

KEYNOTE
- James Courchaine, Tata & Howard, Inc.

MORNING SESSION
Moderators:
- Ben Stoddard, Kleinfelder
- Robert Montenegro, Grundfos

Moving Beyond the I/I Plan
- Laurie Perkins, Wright-Pierce

Evolution of a CMOM Program in Waterbury, CT
- Julie Silva, Woodard & Curran

Scattergraphs Used to Reduce Scattered Results
- Matthew Brown, ADS Environmental Services

Private Inflow—Best Practices for Access and Source Identification
- Steve Perdios, Dewberry
- Michael Hanley, Dewberry

AFTERNOON SESSION
Moderators:
- Bob Domkowski, Xylem
- Scott Lander, Retain-It

Trimming the Fat (Part 2)—Over a Decade of Progress
- Frank Occhipinti, Weston & Sampson
- Dylan Ludy, City of Worcester, MA DPW
- Ian Weyburne, City of Worcester, MA DPW

Improving Private Inflow Inspection and Data Management with GIS
- Lucas Smith-Horn
- Daniel Thompson, CDM Smith

Stacey's Brook Comprehensive Sewer Rehabilitation—a Phased Approach to Reduce Collection System Infiltration and Improve Surface Water Quality
- Dan Scott, Kleinfelder
- Cecilla Carrion-Carmona, Kleinfelder

Prevention of Fat, Oil, and Grease (FOG) Buildup in an Explosion-Proof Pump Station Environment Through Consistent Dosage of a Plant-Based Formulation by Means of a Pump-Less Liquid Dispensing System
- Dr. Christian Zeigler, Protein Matrix LLC
- Aaron Fox, Lowell, MA Wastewater

EXHIBITORS
CUES
Duke's Root Control
F.R. Mahony & Associates
Flow Assessment Services
Green Mountain Pipeline Services
JWB Co/Hach Flow Group
LMK Technologies
Maltz Sales Co.
Municipal Sales, Inc.
NEIWPCC
Righter Group, Inc.
RJN Group, Inc.
Titus Industrial Group, Inc.
Underground Inspection Technologies

SPONSORS
AECOM
Aqua Solutions
ARCADIS
CDM Smith
Dewberry
Duke's Root Control
Environmental Partners Group
EST Associates
Flow Assessment Services
Fuss & O'Neill
Hayes Pump
Hazen and Sawyer
Hoyle, Tanner & Associates, Inc.
JWB Co/Hach Flow Group
Kleinfelder
Tata & Howard
Ted Berry Company
Tetra Tech
The MAHER Corporation
Tighe & Bond
Weston & Sampson
Woodard & Curran
Wright-Pierce

RESIDUALS & MICROCONSTITUENTS CONFERENCE

NEWEA's Residuals Management and Microconstituents Committees held a joint one-day specialty conference and exhibit on October 15, 2018, at the UMASS Conference Center & Inn in Lowell, Massachusetts. Meeting registrants included 71 attendees and four exhibitors.

The technical presentations commenced on Monday, October 15, 2018, with NEWEA Past President James Barsanti, NEWEA Residuals Management Chair Natalie Sierra, and NEWEA Microconstituents Committee Chair Rachel Watson providing the Welcome and Opening Remarks.

KEYNOTE
- Laurel Schaider, Silent Spring Institute

SESSION 1: STATE OF PFAS REGULATIONS

Update and discussion on PFAS regulations from New England and other states. Speakers included: Carla Hopkins, Maine DEP; Brandon Kernen, New Hampshire DES, and Eamon Twohig, Vermont DEC. Facilitator: Ned Beecher, NEBRA

SESSION 2: IMPACTS FROM PFAS REGULATIONS IN NEW ENGLAND

What has PFAS done to Land Application in the Northeast?
- Shelagh Connelly, RMI

Update on NEBRA's Regional PFAS Education and Outreach Efforts
- Ned Beecher, NEBRA

Wastewater Treatment Plants as a Source of PFASs to the Environment
- Charlotte Wagner, Harvard University

SESSION 3: PFAS ANALYSIS AND TREATMENT

PFAS Analysis of Soils—What to Expect and How to Evaluate the Data
- Lisa Krowitz, TRC

Detailed Site Investigation of Unsaturated and Saturated Zones for PFAS
- Allan Horneman, Arcadis

PFAS ConfirmedNow What Do We Do?
- Marilyn Wade, Brown and Caldwell

SESSION 4: PFAS CHALLENGES FOR PROFESSIONALS

Regulatory, Technical and Communication Challenges for Licensed Environmental Remediation Professionals
- Ted Toskos, Woodard and Curran

Pfacts verses Pfear on PFAS—Separating PFAS from Fiction
- Lisa Campe, Woodard & Curran

EXHIBITORS
David F. Sullivan & Associates
Lystek International
NEIWPCC
Vista Analytical Laboratory

SPONSORS
AECOM
Aqua Solutions
ARCADIS
Black & Veatch
Brown and Caldwell
CDM Smith
David F. Sullivan & Associates
Fuss & O'Neill
Hoyle, Tanner & Associates
Lystek International Inc.
NEFCO
Small Water Systems Services LLC
Stantec
Synagro Northeast
Tata & Howard
The MAHER Corporation
Tighe & Bond
Woodard & Curran
Wright-Pierce

CSO/WET WEATHER ISSUES CONFERENCE

NEWEA's CSO/Wet Weather Issues Committee held a Specialty Conference, Exhibit, and Tour on October 29–30, 2018, at the Holiday Inn by the Bay, in Portland, Maine. Meeting registrants included 119 attendees and 13 exhibit displays.

The technical presentations commenced on Monday, October 29, with NEWEA CSO/Wet Weather Issues Committee Chair Ivonne Hall and NEWEA Connecticut State Director Virgil Lloyd providing the Welcome and Opening Remarks.

In addition to the conference, an optional facility tour was offered to Portland's Water Control Pollution Facility and a networking reception was held in the exhibit area on October 29.

TECHNICAL PRESENTATIONS

Monday, October 29

KEYNOTE

- Mohammed Billah, U.S. EPA Office of Wastewater Management, Water Permits Division

Moderator:
- Ivonne Hall, CT DEEP

PANEL DISCUSSION

Lessons Learned from Integrated Planning in New England Cities Applied to Portland, ME

Panelists: Nancy Gallinaro, Portland, ME; Megan Moir, Burlington, VT; and Josh Schimmel, Springfield, MA

Moderators: Dan Bisson, Tighe & Bond and Kirk Westphal, Kleinfelder

SESSION: PLANNING FOR CHANGE

Moderators:
- Peter Frick, ADS Environmental Services
- Greg Heath, AECOM

Taunton CSO Abatement—Past, Present, and Future
- Michael Andrus, BETA Group

Rushville, IN—First Cloth Media Filtration Case Study for Combined Tertiary Treatment and Wet Weather Flows
- John Dyson, Aqua-Aerobic Systems, Inc.

Planning for Change—New Haven's CSO LTCP Implementation
- Thomas Sgroi, Greater New Haven WPCA

Asset Management Planning is "Planning for Change"
- Joseph Laplante, Narragansett Bay Commission

TECHNICAL PRESENTATIONS

Tuesday, October 30

Two concurrent sessions were held in the morning and afternoon.

CONCURRENT SESSION: INNOVATING FOR CHANGE

Moderators:
- Mike Bonomo, ADS Environmental Services
- Josh Schimmel, Springfield W&S

Innovative Business Case Evaluation Guides Portland, ME
- Kate Mignone, AECOM

A National Review of Innovative and Integrated Stormwater Management Initiatives
- Dahlia Thompson, Hazen and Sawyer

Targeting O&M through Model Calibration
- Laurie Kellndorfer, CDM Smith

New Standards to Find & Measure Infiltration and Test & Certify Cured-In-Place Pipe (CIPP)
- Chuck Hansen, Electro Scan Inc.

Green Stormwater Infrastructure (GSI), a Demonstration Project to Address CSOs
- Christopher Feeney, Stantec

CONCURRENT SESSION: TOOLS FOR CHANGE

Moderators:
- Steve Perdios, Dewberry
- Wendy Leo, MWRA

Leveling with "Right to Know"—How Level Only Monitoring Devices are Assisting Communities with Stringent Public Notification Rules
- Matthew Brown, ADS Environmental Services

Green Stormwater Infrastructure for CSO Control—A Case Study of Philadelphia's Approach
- Bernadette Callahan, Stantec

Flow Monitoring—Lost Data
- David Brown, Hach

Man, Machine or Both!
- Alexis Holmdal, Stantec
- Matthew Matala, Stantec

Evaluating the Progress of Multi-Decade CSO Abatement Programs
- Michael Riley, Maine DEP

CONCURRENT SESSION: WE BELIEVE IN CLIMATE CHANGE

Moderators:
- Peter Frick, ADS Environmental Services
- Ivonne Hall, CT DEEP

The Language of Climate Change: Shaping Public Preparedness
- Christopher Balerna, Kleinfelder

Planning for Extremes—When, Where and How Much
- Indrani Ghosh, Kleinfelder
- Alicia Hunt, City of Medford, MA

Large Scale Problems Require Large Scale Solutions

David Bedoya, Stantec

Jennifer Perry (CT DEEP), Portland Firefighter Stephen Coppi, and Janice Moran pose after a fire alarm briefly interrupted the conference

Responding to Winter Storm Riley—The City of Quincy's Emergency Reconstruction Efforts
- Marina Fernandes, Tighe & Bond

Urban Resilience—Planning Ahead of Major Storm Events
- Ian Belczyk, Xylem

CONCURRENT SESSION: INTEGRATING FOR CHANGE

Moderators:
- James Drake, CDM Smith
- Kate Mignone, AECOM

Springfield Water and Sewer Commission Integrated Planning Implementation—Don't Let Compliance Initiatives Bankrupt Your Organization or Build the Wrong Project
- Matthew Travers, Stantec

Newmarket's Battle Between Capital and Compliance
- Renee Bourdeau, Horsley Witten Group

Stretching Towards the Finish Line—A 10-Year Journey with Lebanon, NH's CSO Program
- Ryan Wingard, Wright-Pierce

Recommendations from the New York City DEP's CSO Long-Term Control Plans
- Donald Walker, AECOM

New York City DEP's CSO Long-Term Control Plans Sampling Program
- Aimee Boulet, AECOM

EXHIBITORS

ACF Environmental
ADS Environmental Services-Idex
Atlantic Fluid Technologies
BAU Hopkins
CSL Services, Inc.
Flow Assessment Services LLC
Green Mountain Pipeline Services
McIntosh Controls Corp/SmartCover
New England Environmental Finance Center
StormTrap
Technology Sales Associates Inc.
WesTech Engineering, Inc.
ZCL | Xerxes

SPONSORS

CH2M is now Jacobs
Flow Assessment Services
WesTech Engineering, Inc.

Upcoming Meetings & Events

SAVE THE DATE

NEWEA 2019 Spring Meeting & Exhibit • June 2 – 5

PLANT OPERATIONS CONFERENCE
March 2019

NATIONAL WATER WEEK/DC FLY-IN
April 3 – 4, 2019
Washington DC

WATER FOR PEOPLE 5K ROAD RACE
May 4, 2019

NEWEA SPRING MEETING & EXHIBIT
June 2 – 5, 2019
Wentworth by the Sea, New Castle, NH

TEACHER TRAINING
August 2019

AFFILIATED STATE ASSOCIATIONS AND OTHER EVENTS

RI NWPCA ANNUAL HOLIDAY PARTY
December 6, 2018
Potowamut Golf Club, East Greenwich, RI

NHWPCA WINTER MEETING
December 14, 2018
Keene, NH WWTF

NHWPCA LEGISLATIVE BREAKFAST
March 6, 2019
Holiday Inn, Concord, NH

This is a partial list. Please visit the state association websites and NEWEA.org for complete and current listings.

Measurement unit conversions and (abbreviations) used in the *Journal*

U.S.	International System of Units (SI)
Liquid volume	
gallon (gal)	liter (L)
cubic feet (ft^3)	cubic meters (m^3)
cubic yards (yd^3)	cubic meters (m^3)
acre-feet (ac ft)	cubic meters (m^3)
Flow	
million gallons per day (mgd)	million liters per day (ML/d)
for larger flows (over 264 mgd)	metric volume per day (m^3/d)
gallons per minute (gpm)	liters per minute L/m
Power	
horsepower (hp)	kilowatts (kW)
British Thermal Units (BTUs)	kilojoules (kJ) / watt-hours (Wh)
Velocity	
feet per second (fps)	meters per second (m/s)
miles per hour (mph)	kilometers per hour (km/h)
Gas	
cubic feet per minute (ft^3/min)	cubic meters per minute (m^3/min)

U.S.	International System of Units (SI)
Length	
inches (in.)	centimeters (cm)
feet (ft)	meters (m)
miles (mi)	kilometers (km)
Area	
square feet (ft^2) or yards (yd^2)	square meters (m^2)
acre (ac)	hectare (ha)
square miles (mi^2)	square kilometers (km^2)
Weight	
pounds (lb)	kilograms (kg)
pounds per day (lb/d)	kilograms per day (kg/d)
ton – aka short ton (tn)	metric ton or tonne (MT)
Pressure	
pounds/square inch (psi)	kiloPascals (kPa)
Inches water column (in wc)	kiloPascals (kPa)
feet of head (ft-head)	kiloPascals (kPa)

2019 NEWEA Executive Committee*

*Proposed 2019 NEWEA Executive Committee—pending the election vote at the annual business meeting of the membership on January 28, 2019, at the Annual Technical Conference and Exhibition

PRESIDENT
Raymond A. Vermette, Jr.
Dover, NH

PRESIDENT-ELECT
Jennifer K. Lachmayr
Wakefield, MA

VICE PRESIDENT
Virgil J. Lloyd
Manchester, CT

TREASURER
Clayton "Mac" Richardson
Lewiston, ME

PAST PRESIDENT
Janine Burke-Wells
Warwick, RI

EXECUTIVE DIRECTOR
Mary Barry

DIRECTORS—COUNCIL
Collection Systems and Water Resources
John M. Digiacomo
Natick, MA

Communications
Meg Tabacsko
Chelsea, MA

Meeting Management
Katelyn Biedron
Manchester, NH

Public Outreach
Justin Skelly
Worcester, MA

Treatment, Systems Operation and Management
Philip Forzley
Manchester, CT

DIRECTORS—STATE
William Norton
Fairfield, CT

Jeffrey McBurnie
Saco, ME

Justin deMello
Andover, MA

Steve Clifton
Portsmouth, NH

Scott Goodinson
Warwick, RI

Chris Robinson
Shelburne, VT

WEF DELEGATES
Frederick McNeill
Manchester, NH

Matthew Formica
Chelmsford, MA

Susan Guswa
Enfield, CT

James R. Barsanti
Framingham, MA

National Water Week—DC Fly-In

April 3 – 4, 2019
Capitol Visitor Center
Washington, D.C.

The NEWEA Congressional Briefing is the annual hallmark for the Association and its government affairs program. Mark your calendar to join us on April 3 – 4, 2019.

This is a great opportunity for our membership and elected officials to join together to discuss water, wastewater and stormwater infrastructure issues facing communities of the Northeast. We look forward to meeting with you and providing you with the latest information affecting our industry. Your involvement is critical—come to D.C. and be heard.

Attending the Briefing will allow:

- Opportunities to meet with senators, representatives and legislative staff
- Substantive discussion of federal clean water legislative initiatives and opportunity to provide feedback related to the impact that these initiatives have on our communities and the water quality industry
- A forum for presentation and discussion of the NEWEA Position statements
- Opportunities to learn about key federal regulatory initiatives
- A forum to provide comments directly to regulatory leaders from EPA's Washington, D.C. Headquarters

In addition to the Briefing Lunch, an important part of this day is holding individual meetings with senators and representatives on the Hill. If you plan to attend the briefing, the government affairs committee will work with you to schedule these individual appointments.

NEWEA
WORKING FOR WATER QUALITY

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION 2019 SPONSOR, ADVERTISER, PARTNER & DONOR PROGRAMS NOW ENROLLING

Sign up online at **newea.org/join-us** or pick up the applications at the **NEWEA booth**

MAKE 2019 THE YEAR YOU JOIN US

SPONSORS

Our sponsors' commitments are reflected in the strength and depth of our programs.

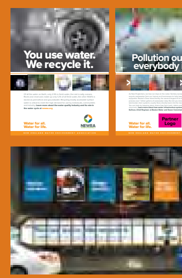
Educational and training programs are the core of NEWEA's commitment to preserving and maintaining New England's water environment Our sponsorship programs include more than 10 high visibility opportunities at our Annual Conference, Spring Meeting, Specialty Conference Series and Student and Young Professional Engagement events — all targeted to water quality industry professionals and those seeking to join our growing industry. We share innovative technology insights, training, and a friendly career-building network. We offer sponsorship program levels to suit businesses of every size and individuals who want to make an impact.

ADVERTISERS

With 50 years of experience reaching the water quality industry, we know your audience.

Since 1966, *JOURNAL of the New England Water Environment Association* has been a leading voice in the water quality industry Today, each quarterly issue averages nearly 76 news-packed pages. Advertisers benefit from themed editorial and targeted messaging opportunities. Regional events and member reports round out the content. Additionally, NEWEA Annual Conference & Exhibit Program reaches more than 2,500 industry-leading professionals for 72 hours every January. Get increased exposure for your company by advertising in multiple publications.

PARTNERS



Water for Life ads showcase the ideas, people and projects that keep the water environment New Englanders love safe and accessible.

Partner with NEWEA and our Water for Life campaign Together, let's raise awareness of important water quality-related issues and success stories. NEWEA is actively seeking advertising partners to help the Water for Life Campaign reach every corner of New England in 2019. If your company supports Storm Preparedness, Community Awareness and Infrastructure, we want to work with you to promote "Water Champions" and share their ideas and successes.

DONORS

We are always working for water quality — for the future, for everyone. Donate today.

NEWEA programs focus on education and creating a sustainable water environment for the future Our industry-wide and public events integrate sharing best practices, technology and networking, all for the betterment of our New England communities. We encourage students of all ages to learn about water, and to contribute to a healthy environment — as professionals or as responsible citizens. Financial donations can be directed to the areas most important to you. NEWEA leadership is available to work with you on the best use of your contribution.

NEWEA
WORKING FOR WATER QUALITY

New Members August–October 2018

Stephen Clark
CH2M (Jacobs)
Wethersfield, CT (PRO)

Brian E Gibson
Uxbridge, MA (PWO)

Jeffrey A Hetherington
Uxbridge, MA (PWO)

Thomas Jacobsen
Blue Delta Energy, LLC
New Haven, CT (PRO)

Santhosh Krishna
Amherst, MA (STU)

Michael Manfre
Mattabassett District
Cromwell, CT (PWO)

Dean A Preston
County of Washington Me
Machias, ME (PRO)

Scott Bender
University of Connecticut - WPC
Storrs, CT (PWO)

Julia Beni
Easthampton, MA (YP)

Thomas Buhl
East Haddam, CT (STU)

Jake Connors
Town of Uxbridge WWTF
Uxbridge, MA (PWO)

James Deangelis
New London, NH (PRO)

Aditi Deorukhakar
Tufts University
Medford, MA (STU)

Tim Grady
University of Connecticut - WPC
Storrs, CT (PRO)

Samuel Jeppson
Cambrian Innovation
Watertown, MA (YP)

Tao Jiang
Boston, MA (STU)

Kyle Kennedy
Globalcycle, Inc
East Taunton, MA (PRO)

Jennifer Lichtensteiger
NEIWPCC
Lowell, MA (PRO)

Joy Lord
Lisbon Falls, ME (PRO)

Dylan Ludy
City of Worcester DPW
Worcester, MA (PRO)

Philip McHenry
Durham, NH (STU)

Courtney Messer
Holliston, MA (YP)

Jonathan Miller
C.H. Nickerson & Co., Inc.
Torrington, CT (PRO)

Stanley Nolan
University of Connecticut - WPC
Storrs, CT (PRO)

Benjamin Pearson
City of Portland Public Works
Portland, ME (PRO)

Robert Peter
Meriden Public Utilities
Meriden, CT (PRO)

Erica Pudvelis
Storrs, CT (STU)

Alex Rappaport
Tufts
Cambridge, MA (STU)

Malar Shetty
Infiltrator Water Technologies
Old Saybrook, CT (PRO)

Allison Shivers
Tata and Howard Inc
Marlborough, MA (PRO)

Greg St Louis
City of Everett
Everett, MA (PRO)

Tyler Van Nostrand
bioprocessH2O
Portsmouth, RI (YP)

Michelle West
Horsley Witten Group
Sandwich, MA (PRO)

Ian Weyburne
City of Worcester DPW
Worcester, MA (PRO)

Raju Badireddy
Burlington, VT (ACAD)

Claudia Baptista
Malden, MA (YP)

Thomas Barr
Weston & Sampson
Chatham, MA (PWO)

Walter Chaffee
WSP
Boston, MA (PRO)

Shawn Comeau
City of Leominster
Leominster, MA (PWO)

John Ellersick
Next Rung Technology LLC
Somerville, MA (PRO)

Dennis Flores
Holyoke, MA (PWO)

Andrew Foerster
New Haven, CT (YP)

Justin Geoffroy
Dracut, MA (PWO)

Jordan Gosselin
NEWEA
Woburn, MA (YP)

Will Haskell
Gorrill Palmer
South Portland, ME (PRO)

Jesse Herman
CDM Smith
Providence, RI (YP)

Adam Higgins
Wright- Pierce
Andover, MA (PRO)

Paul Jessel
Kennebunkport Maine Wastewater
Kennebunkport, ME (PWO)

Matthew Lapointe
Barre, MA (PRO)

Pat McCormick
Town of Chelmsford
Chelmsford, MA (PWO)

Robert McDonald
Montague Waste Water Treatment
Montague, MA (PWO)

Neil Moran
Chelmsford, MA (PWO)

Nathan Parisi
Burlington, VT (STU)

Stephanie Rochefort
City of Somersworth WWTF
Somersworth, NH (PWO)

Philip Ruck
SEE, Inc.
Orono, ME (PRO)

Lindsay Silcox
Fuss & O'Neill, Inc.
Manchester, CT (YP)

Francis Stone
Boston, MA (STU)

Meredith Sullivan
CDM Smith Inc
Boston, MA (YP)

Jacquelyn Villinski
Maine Environmental Laboratory
Yarmouth, ME (PRO)

Ashley Walenty
City of Burlington
Burlington, VT (PRO)

Felicia Morrissette
NEFCO
North Quincy, MA (PRO)

Ty Wagner
Mattabassett District
Cromwell, CT (YP)

Academic (ACAD)
Affiliate (AFF)
Complimentary (COMP)
Corporate (COR)
Dual (DUAL)
Executive (EXEC)
Honorary (HON)
Life (LIFE)
Professional (PRO)
Professional WW/OPS (PWO)
Student (STU)
Young Professional (YP)

Thank you

TO ALL OUR 2018 ANNUAL SPONSOR PROGRAM PARTICIPANTS:

Platinum
ARCADIS

Gold
AECOM
Aqua Solutions
Brown and Caldwell
CDM Smith
Dewberry
EST Associates
Flow Assessment Services
Green Mountain Pipeline Services
Lystek International, Inc.
SUEZ
The MAHER Corporation
Weston & Sampson

Silver
Environmental Partners Group
Fuss & O'Neill
Hazen and Sawyer
Hoyle, Tanner & Associates, Inc.
NEFCO
Synagro Northeast
Tata & Howard
Ted Berry Company
Tetra Tech
Tighe & Bond
Woodard & Curran
Wright-Pierce

Bronze
ADS Environmental Services
AllMax Software, Inc.
David F. Sullivan & Associates
Duke's Root Control
GHD
Hayes Pump
Kleinfelder
Nitsch Engineering
Stantec

Build relationships with water industry leaders *and* make a positive impact on the water environment

Join NEWEA's 2019 Annual Sponsor Program

NEWEA offers companies the opportunity to promote their products and services throughout the year by participating in multiple sponsorship activities. Annual Sponsorships include:

- NEWEA Annual Conference
- NEWEA Spring Meeting & Golf Tournament
- NEWEA Golf Classic
- A web presence on NEWEA.org's sponsorship program page
- The option to customize sponsorship levels by selecting to participate in up to eight additional unique NEWEA events plus additional activities

Sponsorship Benefits:

- Increased corporate visibility and marketing opportunities before a wide audience of water industry professionals
- Relationship-building access to key influencers involved in advancing water industry services, technology, and policy
- Recognition as an environmental leader among peers and customers

For more information contact Jordan Gosselin
Email: jgosselin@newea.org
Phone: 781-939-0908

NEWEA
WORKING FOR WATER QUALITY

Advertiser Index

Upcoming *Journal* Themes
Spring 2019—**Stormwater**
Summer 2019—**Wastewater Treatment**
Fall 2019—**Collection Systems**
Winter 2019—**Safety**

NEWEA/WEF* Membership Application 2018

Personal Information (please print clearly)

Last name	M.I.	First Name	(jr. sr. etc)
Business Name (if applicable)			
Street or P.O. Box			(☐ Business Address ☐ Home Address)
City, State, Zip, Country			
Home Phone Number	Mobile Phone Number	Business Phone number	
Email Address			
☐ Check here if renewing, please provide current member I.D.			

***NEWEA is a member association of WEF (Water Environment Federation). By joining NEWEA, you also become a member of WEF.**

Employment Information (see back page for codes)

1. ORG Code	Other (please specify)	2. JOB Code:	Other (please specify)
3. Focus Area Codes		Other (please specify	
Signature (required for all new memberships)		*Date*	

Sponsorship Information

WEF Sponsor name (optional)	Sponsor I.D. Number	ACQ. Code for WEF use only | WEF 18

Membership Categories (select one only)

		Member Benefit Subscription	Dues
☐ **Professional Package**	Individuals involved in or interested in water quality	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$185
☐ **Young Professional Package**	New members or formerly student members with 5 or less years of experience in the industry and less than 35 years of age. This package is available for 3 years. Date of birth (mm/yy) ______	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$69
☐ **Professional Wastewater Operations (PWO) Package**	Individuals in the day-to-day operation of wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of < 1 mgd or 40 L/sec. License # ______	■ WE&T (including *Operations Forum*) ■ *WEF Highlights Online*	$109
☐ **Academic Package**	Instructors/Professors interested in subjects related to water quality.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$181
☐ **Student Package**	Students enrolled for a minimum of six credit hours in an accredited college or university. Must provide written documentation on school letterhead verifying status, signed by an advisor or faculty member.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$10
☐ **Executive Package**	Upper level managers interested in an expanded suite of WEF products/services.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *World Water* ■ *Water Environment Research* (Online) ■ *Water Environment Regulation Watch*	$353
☐ **Dual**	If you are already a member of WEF and wish to join NEWEA		$40
☐ **Corporate Membership** (member benefits for one person)	Companies engaged in the design, construction, operation or management of water quality systems. Designate one membership contact.	■ *WE&T* (including *Operations Forum*) ■ *Water Environment Research* (Print) ■ *Water Environment Regulation Watch* ■ *WEF Highlights Online*	$411
☐ **New England Regulatory Membership**	This membership category is a NEWEA only membership reserved for New England Environmental Regulatory Agencies, including: USEPA Region 1, CT Department of Energy and Environmental Protection, ME Department of Environmental Protection, MA Department of Environmental Protection, NH Department of Environmental Services, VT Department of Environmental Conservation, and RI Department of Environmental Management		$50

WEF Utility Partnership Program (UPP): NEWEA participates in the WEF Utility Partnership Program (UPP) that supports utilities to join WEF and NEWEA while creating a comprehensive membership package for designated employees. As a UPP Utilities can consolidate all members within their organization onto one account and have the flexibility to tailor the appropriate value packages based on the designated employees' needs. Contact WEF for questions & enrollment (703-684-2400 x7750).

Payment

☐ **Check or money order enclosed** Made payable to NEWEA 10 Tower Office Park, Suite 601 Woburn, MA 01801 For more information: 781.939.0908 Fax 781.939.0907 NEWEA.org	**Charge** ☐ Visa ☐ American Express ☐ Master Card ☐ Discover	Card # Signature Daytime Phone	Security/CVC Exp. Date
Billing Address (☐ check here if same as above)	Street/PO Box	City, State, Zip	

Depending upon your membership level, $10 of your dues is allocated towards a subscription to the NEWEA Journal.

NEWEA/WEF* Membership Application 2018

To help us serve you better, please complete the following:
(choose the one that most closely describes your organization and job function)

What is the nature of your ORGANIZATION?

(circle one only–required) (ORG)

1 Public/Private Wastewater Plants and/or Drinking Water and/or Stormwater

2 Public/Private Wastewater Only

3 Public/Private Drinking Water Only (e.g. municipality, utility, authority)

4 Industrial Systems/Plants

5 Consulting or Contracting Firm

6 State, Federal, Regional Government Agency

7 Research or Analytical Laboratories

8 Educational Institution

9 Manufacturer of Water/Wastewater/ Stormwater Equipment or Products

10 Water/Wastewater/Stormwater Product Distributor or Manufacturer's Rep.

11 Public/Private Stormwater (MS4) Program Only

12 Public Financing, Investment and Banking

13 Non-profits

99 Other ______________ (please specify)

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

1 Management: Upper or Senior

2 Management: Engineering, Laboratory, Operations, inspection, Maintenance

3 Engineering and Design Staff

4 Scientific and Research Staff

5 Operations/Inspection Maintenance

6 Purchasing/Marketing/Sales

7 Educator

8 Student

9 Elected or Appointed Public Official

10 Other ______________ (please specify)

What are your KEY FOCUS AREAS?

(circle all that apply) (FOC)

1 Collection Systems

2 Drinking Water

3 Industrial Water/Wastewater/ Process Water

4 Groundwater

5 Odor/Air Emissions

6 Land and Soil Systems

7 Legislation (Policy, Legislation, Regulation)

8 Public Education/Information

9 Residuals/Sludge/Biosolids/Solid Waste

10 Stormwater Management/ Floodplain Management/Wet Weather

11 Toxic and Hazardous Material

12 Utility Management and Environmental

13 Wastewater

14 Water Reuse and/or Recycle

15 Watershed/Surface Water Systems

16 Water/Wastewater Analysis and Health/ Safety Water Systems

17 Other ______________ (please specify)

Optional Items (OPT)

Years of industry employment? _______
1 (1 to 5) 2 (6 to 10) 3 (11 to 20)
4 (21 to 30) 5 (>30 years)

Gender? _______
1 Female 2 Male

Education level? (ED) _______
1 High School 2 Technical School
3 Some College 4 Associates Degree
5 Bachelors Degree
6 Masters Degree 7 JD 8 PhD

Education/Concentration Area(s) (CON) _____
1 Physical Sciences (Chemistry, Physics, etc.)
2 Biological Sciences 3 Engineering Sciences
4 Liberal Arts 5 Law 6 Business

Water quality professionals, with fewer than 5 years working experience and under the age of 35, are eligible to join WEF as an Active Member, while participating in the NEWEA/WEF Young Professionals Program. This program allows up to 50% off of the Active Member dues, valid for the first three years of membership. This program is available for new member applicants and Student Members.

***NEWEA is a member association of WEF (Water Environment Federation). By joining NEWEA, you also become a member of WEF.**

Represented in New England by:

Please visit our WEB SITE!

www.frmahony.com

f.r. mahony & associates inc.

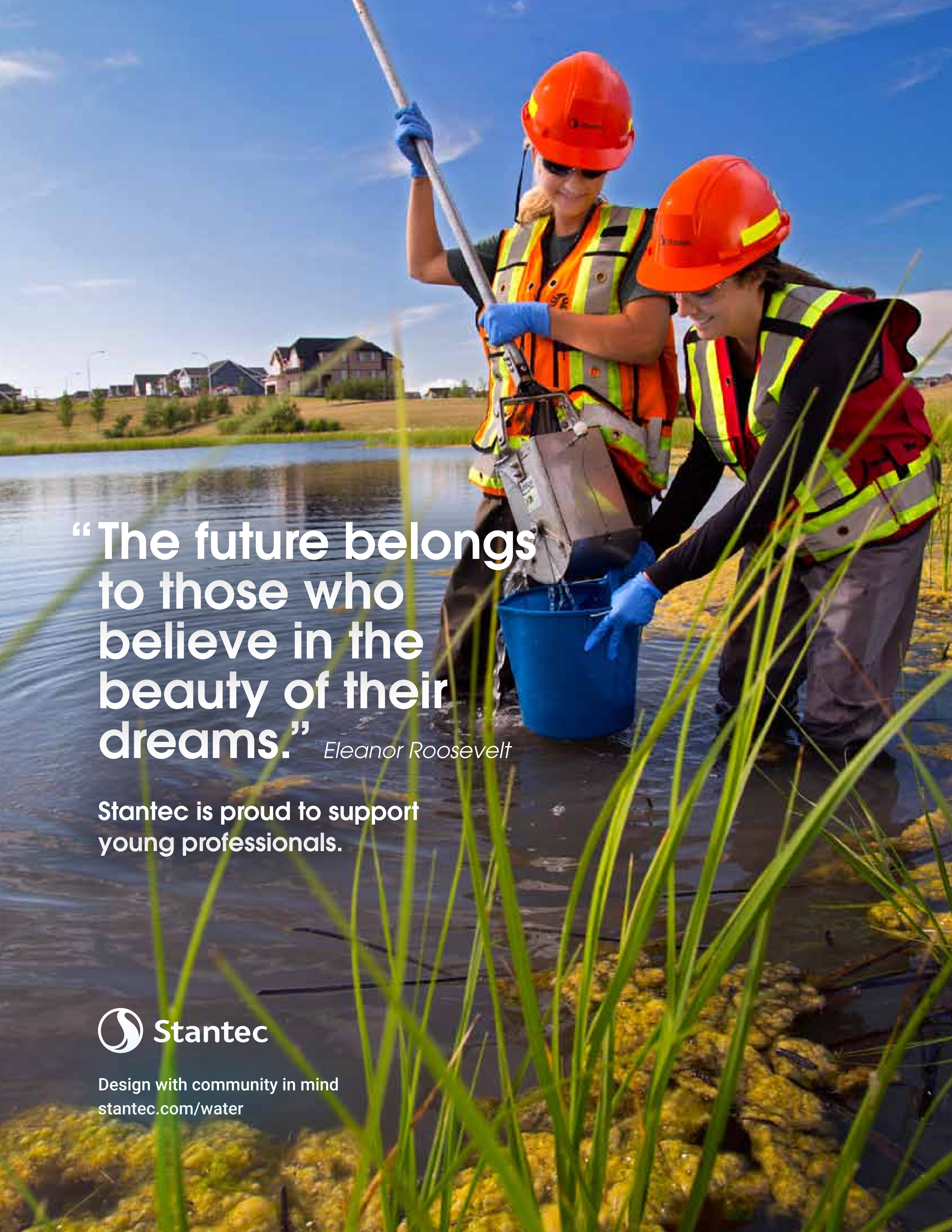
273 Weymouth Street • Rockland MA 02370

Contact ED QUANN c.781.820.6268

edquann@frmahony.com

t.781.982.9300 f.781.982.1056

Call or email for more information.


“The future belongs to those who believe in the beauty of their dreams.” Eleanor Roosevelt
Stantec is proud to support young professionals.
Stantec
Design with community in mind
stantec.com/water