JOURNAL

OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

VOLUME 49 NUMBER 2 | ISSN 1077-3002 **Summer 2015**

WATERSHED MANAGEMENT AND STORMWATER

NEWEA
WORKING FOR WATER QUALITY

IN THE WATERWORKS INDUSTRY.

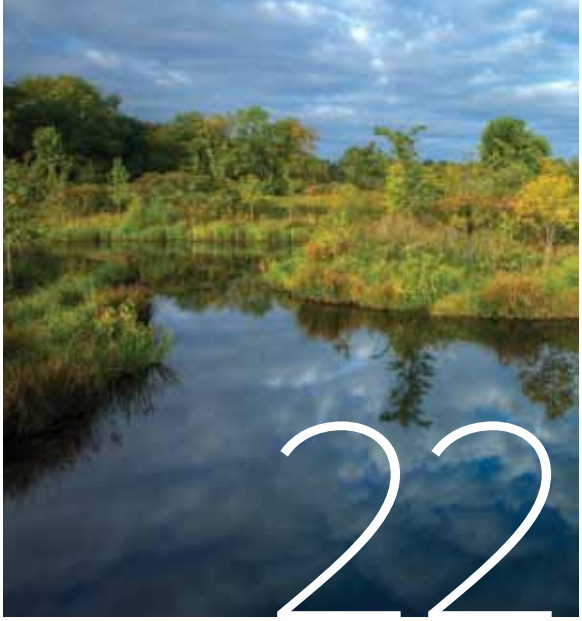
Since Everett J. Prescott founded the company in 1955,
we've continually made a splash introducing new products and services. Others may try to copy what we do, but so far none has succeeded in delivering the quality customers count on from Team EJP.

Just last year, for example, we introduced a whole new program for specifying waterworks, Beyond SPECS. It goes beyond materials and dimensions to encompass the expertise, safety training, and 24/7 service you need today.

1-800-EJP-24HR • EJPRESCOTT.COM

TEAM EJP
MAKING A SPLASH FOR 60 Years
1955 - 2015

WATER, WASTEWATER & STORMWATER SOLUTIONS



JOURNAL OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

VOLUME 49 NUMBER 2 | ISSN 1077-3002 SUMMER 2015

Contents

On the cover: Of the more than 20 large-scale infrastructure projects completed since 1998 by the Cambridge, Mass. Department of Public Works, the Alewife Stormwater Wetland is considered the "gem."

NEWEA Journal ISSN #1077-3002
Published four times annually by New England Water Environment Association, Inc.
This is Volume 49 Number 2
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
Helen Gordon
hgordon@woodardcurran.com

Journal Committee
Alan Slater, Alexandra Doody
Charles Tyler, Dan Coughlin
Don St. Marie, James R. Barsanti
Joseph Boccadoro, Mark French
Matthew Hross, Meredith Zona
Michael Sullivan, Susan Landon

Guest Editor
Alan Slater
alanslater@norwoodlight.com

Assistant Editor
Thomas J. Heinlein
heinleintj@cdmsmith.com

Graphic Designer
Robert Randazzo
randazzor@verizon.net

Photography Editor
Charles Tyler
charles.tyler@mwra.com

Photo credits:
Bronson Brook (page 39)
Paul Nguyen

Stream Crossings (page 40–41)
VT Fish & Wildlife Department, White River Partnership, VT Agency of Transportation

Bronson Brook (page 41)
Amy Singler)

D.C. Visit—People (pages 54–55)
Peter Goodwin

STORMY award winners (page 57)
Chuck Larson, NEWWA

NEWEA
WORKING FOR WATER QUALITY

OUR ASSOCIATION WAS ORGANIZED EIGHTY-SIX 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.

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 utilitiy 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 TODAY

- 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

2015 RATES

Professional	$157.00
Executive	$338.00
Corporate	$393.00
Academic	$156.00
Young Professional	$67.00
PWO	$96.00
Dual	$40.00
Student	$20.00

Water Environment Federation®
Preserving & Enhancing the Global Water Environment

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, Executive Director; Editor: Helen Gordon
Tax Status ..... No change during the preceding 12 months

Issue date for circulation data below: 08/20/2014			
Publication title: 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 county paid/requested mail subscriptions	0	0
	In-county paid/ requested mail subscriptions	2,200	2,000
	Sales through dealers & carriers	8	8
	Requested copies distributed by other mail classes	0	0
Total paid and/or requested circulation		2,208	2,008
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

Matt Formica
Project Manager
AECOM
Matthew.Formica@aecom.com

President's message

The spring months for NEWEA have been filled with many activities, outreach efforts, and technical events in support of our mission. On behalf of the membership, I offer sincere thanks to all the volunteers and the NEWEA staff for developing and executing these first-class programs. It is impressive to see the results of this collaboration and the overwhelmingly positive response by our membership. Highlights of the programs and accolades to those responsible are below.

NEWEA co-hosted successful legislative outreach events with our affiliated state associations (ASAs) at all six New England state capitals. The events were attended by 96 state legislators in addition to legislative staffers, state environmental protection department heads, numerous mayors, and many special interest groups. In addition to the state events, more than 20 NEWEA representatives participated in the annual Washington D.C. Fly-In in conjunction with April National Water Week. NEWEA hosted a Legislative Breakfast in D.C., featuring presentations on all facets of water environment issues by prominent speakers, including senators, congressmen, New England public utility executives, and the EPA Region 1 director, as well as representatives of New England Interstate Water Pollution Control Commission (NEIWPCC), the Water Environment Federation (WEF), and NEWEA. In addition, NEWEA conducted 24 office visits with our federal senators, congressmen, and associated staff.

NEWEA believes these events are vital not only to highlight the importance and value of what we do as water quality professionals but also to build relationships with the legislators and their staff so that they can be educated and encouraged to use NEWEA as a resource when they are developing policy or voting on legislation that affects the water environment and our industry. Many thanks to Peter Grose, NEWEA's Government Affairs Committee chair, his committee, and each of our NEWEA state directors and their ASA colleagues for their hard work and success in pulling together these important events

We also held our annual planning session in early March, organized and facilitated by NEWEA president-elect Ray Willis. This day-and-a-half workshop focused on the financial sustainability of our association. While our association is in a good financial position, a holistic review was warranted of our expenses, revenue, and investments. This review was done not only to assess and ensure our ability to maintain the financial sustainability of NEWEA but also to determine the best methods to improve our financial health to allow us to continue and grow the association's many great initiatives. Thank you, Ray, and all who participated for a productive session.

(from left) Matt Formica, U.S. Representative Michael Capuano, Jim Barsanti and Bruce Tobey

In conjunction with April National Water Week, NEWEA hosted a Legislative Breakfast in D.C., featuring presentations on all facets of water environment issues

An Industrial Wastewater and Water Reuse Specialty Conference was held at the University of Hartford in late April. This event featured several concurrent sessions, a vendor exhibit space, and a rare tour of the UTC Aerospace Systems wastewater facility. Speakers, vendors, and attendees discussed the technical aspects, differences, and symbiotic relationships of industrial wastewater treatment and reuse. The attendance and interest in these topics exceeded all expectations. Many thanks to Lisa Andrews and Ed Whatley, the respective NEWEA Industrial Wastewater and Water Reuse Committee chairs, their committees, and their council director, Virgil Lloyd, for planning this highly successful event.

In April and May NEWEA's WEF delegates and a few others attended three of this year's WEF Member Association Exchange (WEFMAX) events hosted around North America. Representatives of the 75 WEF member associations convene at these events to learn from each other and to gain ideas to help strengthen their associations. While NEWEA takes valuable lessons from the other associations at these events, it is clear that NEWEA is one of the most revered and well-respected member associations in WEF and that we unquestionably lead the industry in many areas.

Other successful events held last quarter included the NEWEA Young Professionals (YP) "Poo and Brew" event together with the YP group from the New England Water Works Association. This event raised money for Water for People and featured a tour of the Deer Island wastewater treatment facility and libation sampling at the Mystic Brewery in Chelsea, Mass. Great work by the crew, led by Justin Skelly, NEWEA's YP Chairman.

All these programs and more were conducted over just a few short months. I look forward to the next few months and all the programs NEWEA has yet to offer. A couple of events to highlight include a 1-day facility tour and associated technical presentations at the Mattabassett District water pollution control facility in Cromwell, Conn., and the annual NEWEA Spring Meeting and Technical Exhibit in Bretton Woods, N.H. Finally, please note that the call for abstracts is out for the (snowless, we hope!) January 2016 Annual Conference in Boston. I encourage everyone to submit an abstract, not only to showcase your important work but also to be a part of NEWEA's mission of advancing knowledge and innovation to our membership and the industry. Please visit the NEWEA webpage/calendar for other upcoming events and programs over the next few months.

Best wishes for a happy, healthy and safe summer to you and your families.

NEWEA
WORKING FOR WATER QUALITY

From the Editor

Ah! The summer is upon us. What that means to me as a New Englander is the seashore. Two of our three articles revolve around Cape Cod water resources. We all know that New England has some of the oldest infrastructure in the nation, and it is getting older every day. It is important for our profession to work with communities to identify new and sustainable ways in which to improve our infrastructure. The feature articles present innovative ways of dealing with the water cycle.

Helen T. Gordon
P.E., CTAM, BCEE
Senior Vice President
Woodard & Curran
hgordon@woodardcurran.com

Our first article focuses on the city of Cambridge's approach to combined sewer and stormwater management. This paper presents the award-winning Alewife Stormwater Wetland Project. The project is part of a larger sewer separation program in the Alewife watershed. This wetland incorporates conventional and bioengineered solutions. The main purpose was to reduce combined sewer overflows and attenuate stormwater. An added byproduct of the design is that it significantly improves the quality of stormwater discharged to the Little River. I encourage you to visit the site in Cambridge via its multi-use pathway immediately adjacent to the wetlands. The pathway connects the Minuteman Bikeway and the Alewife red line subway station. There is informational signage at the site as well.

The second article fits in well with the summer issue of the *Journal* as it presents a famous Cape Cod seaside community dealing with the challenges of beach closures. Provincetown has coupled expansion of its wastewater collection system with a comprehensive multi-year stormwater management program to improve Provincetown Harbor water quality. As with older communities in the Northeast the streets can be narrow, making it a challenge to collect and treat stormwater effectively. To overcome this Provincetown reconstructed Commercial Street, the town's "Main Street," using porous pavement laid over a stone reservoir bed. The result was a reduction in beach closures.

With sustainability in mind, the third article challenges us all to rethink engineering approaches to our infrastructure challenges. Historically when we think of stream crossings our focus has always been getting people and cars across the stream while forgetting that we were potentially inhibiting aquatic organism mobility to allow for a healthy ecosystem. The author presents four culvert reconstruction case studies presenting best practices for rethinking the design layouts.

Speaking of Cape Cod, when will we see the end to the continued discussion of what to do with the wastewater that is negatively affecting our estuaries and harbors? In 1978 an Area Wide Water Quality Management Plan (Section 208 Plan) was developed by the Cape Cod Planning and Economic Development Commission (CCPEDC). Since then the population on the Cape has increased more than 60 percent. In 2013, the Massachusetts Department of Environmental Protection (MassDEP) tasked the Cape Cod Commission (formerly CCPEDC) with updating the Section 208 Plan and helping the 11 watershed groups answer this question effectively. The commission came up with a decision support tool for each of the watershed groups to use while implementing an adaptive management framework to solve issues of nutrient loading. This technology matrix includes traditional and non-traditional technologies. Watching how communities implement their various programs using this new tool will be interesting.

I invite you all to share your wonderful projects with the rest of the membership by submitting an abstract for publication in the *Journal*. The upcoming fall issue will focus on asset management and Annual Conference papers, while the winter issue will report on operations, regulatory, and gizmos and gadgets topics. Both issues will allow for a myriad of topics, so get writing!

Thank you to guest editor Alan Slater. As some of you know, Alan recently retired from MassDEP (an early retirement) and still volunteered to remain on the committee and be a guest editor. That is a demonstration of his true dedication to his profession.

Helen Gordon, *Journal* Committee Chair and Editor

TECHNOLOGY SALES ASSOCIATES, INC.

PROCESS EQUIPMENT FOR THE WATER & WASTEWATER TREATMENT INDUSTRY

44 Central Street
Unit 5
Berlin, MA 01503
Tel: 978-838-9998
Fax: 978-838-9897

Mike Caso x13 – Cell: 508-878-7641
Rob Trzepacz x12 – Cell: 603-848-3950
Website: www.techsalesne.com

MANUFACTURERS REPRESENTATIVE
NEW ENGLAND STATES

WATER FILTRATION EQUIPMENT

GE Water & Process Technologies/Zenon
Ultrafiltration Membrane Technology, Pressure and Suction Driven

Leopold/Xylem
DAF Technology, Underdrains, Filtration

Wedeco/Xylem
UV Systems – Low & Medium Pressure, Ozone Generation Equipment

Johnson Screens
Intake Screen, Triton Underdrains

Wigen Water Technologies
Greensand Filtration/Iron & Manganese Removal, Package Membrane Systems – Micro, RO and Nano Filtration, GAC Contactors, ION Exchange Systems

Orica Watercare
Miex Ion Exchange, TOC/DOC Removal Process

Atlantium Technologies
UV Disinfection Systems – 4 Log

Norit America
Carbon Filter Media

WASTEWATER PROCESS EQUIPMENT

Aqua-Aerobic Systems
SBR Technology, Aerators, Mixers
Cloth Media Filtration with 5 & 10 Micron Cloth Media
AquaDisk & AquaDiamond

GE Water & Process Technologies/Zenon
MBR - Membrane Bioreactor Technology

Leopold/Xylem
Tertiary Filtration & Denitrification Filters
DAF – Dissolved Air Flotation

Monroe
Clarifiers, Incline Plate Settlers, Odor Control

Komline Sanderson
Belt Press, Sludge Driers, Plunger Pumps

EnviroMix
Energy Efficient Large Bubble Mixing Systems

Mixtec
Mixing Systems, Anoxic & Aerobic Mixing

Amiad
Automatic Self-Cleaning Filters, In-Line Strainers

APG-Neuros
Turbo Blowers, Direct Drive, High Efficiency

Aerisa
Odor Control, Ion Exchange

Howden
Variable Vane Turbo Blowers, Gear Driven

Ovivo/Eimco/Bracket Green
Clarifiers & Drives, Carrousel BNR Oxidation Ditch, Anaerobic Digestion-Gas Holder Membranes, Digester Mixing-Linear Motion Mixer, Gas Mixing, Covers-Fixed, Floating & Membrane, Headworks Equipment, Fine Screens, Jeta Grit, Bosker CSO Screen, Bracket Green Perforated Plate

Wedeco/Xylem
UV Systems, Horizontal Configuration, Ozone Generation Equipment, Advanced Oxidation Processes

UltraTech
UV Systems – Vertical Configuration and Closed Vessels

Enviro-Care
Headworks Equipment, Multirake Screens, Septage Systems, Perforated Fine Screening

Hydro-Dyne Engineering
Headworks Screens, Washpactor, Grit Systems

Varec Biogas
Biogas Safety & Handling Equipment, Gas Conditioning Systems, Gas Flares, Drip Traps

Dutchland Inc.
Precast Post-Tensioned Concrete Structures, Round & Rectangular Tanks & Covers

Guardian Environmental Products
Troll Collector System – Rectangular Chain and Flight Primary Clarifier Equipment

PROCESS CONTROL EQUIPMENT

REXA Electraulic Valve Actuation
Reliable, Low Maintenance, Precision Positioning Rotary, Linear Actuators and Drives

Blue In Green
Bubble-Free Gas Saturation and Delivery Systems, Oxygen, Ozone, Carbon Dioxide

Aquanox
Stainless Steel Gates

Thirsty Duck
Buoyant Flow Control Devices

ZAPS Technologies
Real Time Water Quality Monitoring

FES-FRP Engineering Solutions
Weirs, Troughs, Covers, Handrails, Structures, ClimateWalls, Floor Grating

Industry news

Exposure of fish cells to coal-tar-sealant runoff damaged their DNA and impaired the ability of the cells to repair DNA damage

COAL-TAR-SEALANT RUNOFF CAUSES TOXICITY AND DNA DAMAGE

U.S. Geological Survey News Release

Runoff from pavement with coal-tar-based sealant is toxic to aquatic life, damages DNA, and impairs DNA repair, according to two studies by the U.S. Geological Survey (USGS) published in the journals *Environmental Science and Technology* and *Science of the Total Environment*.

Pavement sealant is a black liquid sprayed or painted on the asphalt pavement of parking lots, driveways, and playgrounds to improve appearance and protect the underlying asphalt. Pavement sealants that contain coal tar have extremely high levels of polycyclic aromatic hydrocarbons (PAHs). Coal tar is a known human carcinogen; several PAHs are probable human carcinogens, and some are toxic to fish and other aquatic life.

Rainwater runoff collected as long as 3 months after coal-tar-sealcoat application caused 100-percent mortality to minnows and water fleas, which are part of the base of the food chain, when the test organisms were exposed to ultraviolet radiation to simulate sunlight. The full study, reported in the scientific journal *Environmental Science and Technology*, is available online.

Exposure of fish cells to coal-tar-sealant runoff damaged their DNA and impaired the ability of the cells to repair DNA damage. "The simultaneous occurrence of DNA damage and impairment of DNA repair has important implications for cell health," said Sylvie Bony, who led the study at the Ecole Nationale des Travaux Publics de l'Etat (ENTPE), a French research agency in Lyon, France. The study is reported in the scientific journal *Science of the Total Environment*.

The studies address the concern that rainfall runoff occurring within hours or days of coal-tar-based sealant application may be toxic to fish and other organisms in streams. The two studies collected and tested simulated runoff at various times beginning just hours after coal-tar-sealant application.

"The USGS has been studying coal-tar sealcoat as a source of PAHs for 10 years, and findings from these two studies are consistent with what is known about toxicity and genotoxicity of these chemicals," said USGS scientist Barbara Mahler.

A previous publication detailed the chemical concentrations in runoff from coal-tar-sealed pavement at a range of times following sealant application. The results, reported in the scientific journal *Environmental Pollution*, are available online.

Coal-tar sealants have significantly higher levels of PAHs and related compounds compared to asphalt-based pavement sealants and other urban sources, including vehicle emissions, used motor oil, and tire particles. Previous studies have concluded that coal-tar sealants are a major source of PAHs to lake sediments in commercial and residential settings, and that people living near pavement sealed with coal-tar sealant have an elevated risk of cancer.

To learn more, visit the USGS website on PAHs and sealcoat.

CHLORINE USE IN SEWAGE TREATMENT COULD PROMOTE ANTIBIOTIC RESISTANCE

American Chemical Society News Release

Chlorine, a disinfectant commonly used in most wastewater treatment plants, may be failing to eliminate pharmaceuticals from wastes. As a result, trace levels of these substances get discharged from the plants to the nation's waterways. And now, scientists are reporting preliminary studies that show chlorine treatment may encourage the formation of new, unknown antibiotics that could also enter the environment, potentially contributing to the growing problem of antibiotic resistance.

The research, presented on March 22, 2015, at the 249th National Meeting & Exposition of the American Chemical Society (ACS), suggests that a re-evaluation of wastewater treatment and disinfection practices is needed.

"Pharmaceuticals that get out into the environment can harm aquatic life, making them react slowly in the wild and disrupting their hormone systems," notes Olya Keen, Ph.D. She adds that increased antibiotic exposure, even at low levels in the environment, can lead to development of antibiotic-resistant microbes and a general weakening of antibiotics' abilities to fight bacterial infections in humans.

"Treated wastewater is one of the major sources of pharmaceuticals and antibiotics in the environment," says Keen. "Wastewater treatment facilities were not designed to remove these drugs. The molecules are typically very stable and do not easily get biodegraded. Instead, most just pass through the treatment facility and into the aquatic environment."

But besides failing to remove all drugs from wastewater, sewage treatment facilities using chlorine may have the unintended consequence of encouraging the formation of other antibiotics in the discharged water. Keen, graduate student Nicole Kennedy, and others on her team at the University of North Carolina at Charlotte ran several lab experiments and found that exposing doxycycline, a common antibiotic, to chlorine in wastewater increased the antibiotic properties of their samples.

"Surprisingly, we found that the products formed in the lab sample were even stronger antibiotics than doxycycline, the parent and starting compound," she adds. Keen has not yet identified all the properties of these "transformation products," and that research is now underway. She notes that these compounds could turn out to be previously unidentified antibiotics.

Keen explains that the best solution may be to decrease the amount of these drugs that reach a treatment plant in the first place. Currently, disposal of pharmaceuticals is not regulated, however. So she urges a greater emphasis on collecting and incinerating old pharmaceuticals, rather than dumping them down the drain or placing them in the trash, which can lead to harmful environmental exposures.

In addition, this research has applications to drinking water treatment systems, most of which also use chlorine as a disinfectant. To purify drinking water, chlorine must remain in the distribution piping system for hours, which blocks microbes from growing. But this also provides ample time for chlorine to interact with pharmaceuticals that may be in the water, encouraging development of new antibiotic compounds.

Keen acknowledges funding for this research from the University of North Carolina at Charlotte and the National Science Foundation.

ACS is a nonprofit organization chartered by the U.S. Congress. With more than 158,000 members, ACS is the world's largest scientific society, providing access to chemistry-related research through its multiple databases, peer-reviewed journals, and scientific conferences.

SETTLEMENT ENSURES THAT LAWRENCE ADDRESSES WASTEWATER AND STORMWATER DISCHARGES

EPA Region 1 News Release

Under the terms of a Consent Decree lodged April 29, 2015, in federal court to address violations of the Clean Water Act, the city of Lawrence will focus on conditions that result in sewer overflows and contaminated stormwater. The Consent Decree is the result of a federal enforcement action brought by the U.S. Department of Justice, on behalf of the U.S. Environmental Protection Agency (EPA). The complaint alleges that Lawrence discharged untreated sewage without permit authorization and violated conditions of its permit controlling stormwater discharges.

The Consent Decree imposes a schedule for Lawrence to develop sewer system management programs to investigate and rehabilitate its assets, minimizing the discharge of untreated sewage

"This settlement ensures progress will be made in controlling major sources of pollution to the Merrimack River," said Curt Spalding, administrator of EPA's New England region. "We welcome this progress toward restoring the river and look forward to the day when it is safe for all kinds of recreation."

"Unlawful discharges of pollutants from cities and towns during storm events remain among the most significant challenges to improving water quality in New England," said U.S. Attorney Carmen M. Ortiz. "By entering into this Consent Decree, the city of Lawrence has agreed to take significant steps to improve water quality and the quality of life along the Merrimack River corridor."

The Consent Decree to resolve the enforcement action imposes a schedule for the city to develop sewer system management programs to investigate and rehabilitate its assets, minimizing the discharge of untreated sewage. In addition, the city will institute programs to detect and eliminate sources of wastewater contamination of its stormwater system, as well as control runoff from land redevelopment projects. Preventing sewage from contaminating surface waters of the United States is one of EPA's National Enforcement Initiatives. Municipal wastewater presents significant health threats to those using contaminated waters for recreational use and downstream drinking water systems.

The Consent Decree, lodged in the U.S. District Court for the District of Massachusetts, is subject to a 30-day public comment period and approval by the federal court. Once it is published in the Federal Register, a copy of the consent decree will be available on the Justice Department website at usdoj.gov/enrd/Consent_Decrees.html.

INTERACTIVE VIDEO AND POSTER DEMONSTRATE THE WATER TREATMENT CYCLE

Leonard Blanchette, General Manager, Brunswick Sewer District

In what may be a first in the country, the Brunswick Sewer District created an interactive poster and video of the water treatment cycle that incorporates smartphone technology. A 13-minute video was filmed, edited, and narrated by staff. The video begins with a typical household internal plumbing system that has been animated to show potable (clean) water going in and wastewater going out. The viewer is then guided on the journey wastewater takes through the public sewer system on its way to, and through, the treatment plant. The video covers, through actual clips, various parts of the District's collection system, including pipes, manholes, and pump stations. Once the flow reaches the treatment plant, the viewer is shown sequential processes the water goes through as it is treated at the District's 3.85 mgd (14.6 (mld) basic primary treatment and trickling filter secondary treatment processes. Treated water then flows through to the outfall into the Androscoggin River.

More amazing than the video is the interactive poster that staff created. The poster features a QR code at each station of the video that allows anyone with a smartphone to scan the corresponding code to view a short (1- to 2-minute) video of the featured portion of the water treatment cycle. The poster can be provided to area schools, and mounted in public buildings and anywhere else convenient for public viewing. A kiosk was constructed by the staff at the District's Water Street pumping station next to a highly used walking and biking path along the Androscoggin River. The pump station's fence was repositioned to provide space for the kiosk and two wooden benches. This provides a quiet resting spot for walkers, joggers, and bicyclists using the popular path.

This project was fully supported by the District's board of trustees as part of an ongoing program to educate and inform District rate payers and the public at-large about the workings of the municipal sewer system and its importance to the community. A no less important benefit is how the project showcases the quality of District staff and the work they do each day to operate and maintain the system.

This project was the brainchild of the District's assistant general manager, Robert Pontau, Jr., and is part of an employee goals program. He managed the project, giving staff the tools, equipment, software—and most important—the confidence to plan the project, script the message, film the episodes, and edit and narrate the video. The creativity of the staff soon became apparent as this group effort became a real educational asset for the Brunswick area and the Androscoggin River.

GLOW-IN-THE-DARK TAMPONS IDENTIFY SEWAGE POLLUTION IN RIVERS

University of Sheffield News Release, Sheffield, U.K.

The natural, untreated cotton in tampons readily absorbs chemicals commonly used in toilet paper, laundry detergents, and shampoos. These chemicals, known as optical brighteners, are used to enhance whites and brighten colours, and show up under ultraviolet (UV) light, a phenomenon often seen in glowing t-shirts under certain lighting in bars and clubs. Using a mixture of laboratory tests and field trials, the team from the University of Sheffield's Faculty of Engineering has shown that when tampons are suspended in water contaminated by even very small amounts of detergents or sewage, they will pick up optical brighteners and glow under UV light. The findings were published on March 31, 2015, in the Water and Environment Journal.

Professor David Lerner, who led the study, explains: "More than a million homes have their wastewater incorrectly connected into the surface water network, which means their sewage is being discharged into a river, rather than going to a treatment plant. Unfortunately, it's very difficult to detect where this is happening, as the discharge is intermittent, can't always be seen with the naked eye, and tests are complex and expensive. The main difficulty with detecting sewage pollution by searching for optical brighteners is finding cotton that does not already contain these chemicals. That's why tampons, being explicitly untreated, provide such a neat solution. Our new method may be unconventional—but it's cheap and it works."

The study, funded through the Engineering and Physical Sciences Research Council, used laboratory trials to determine how much detergent would need to be in the water to be picked up by the tampon test. When a tampon was dipped for just 5 seconds into a solution containing 0.01 mL of detergent per liter of water—over 300 times more dilute than would be expected in a storm drain pipe—the optical brighteners could be identified immediately, and continued to be visible for the next 30 days. The technique was then tested in the field by suspending tampons for 3 days in 16 surface water outlets running into streams and rivers in Sheffield, and then testing the tampons under UV light. Nine of the tampons glowed, confirming the presence of optical brighteners—and therefore sewage pollution.

With the help of Yorkshire Water, the team followed the storm drain pipe network back from four of the nine polluted outlets they had identified, dipping a tampon in at each manhole to see where the sewage was entering the system. They successfully isolated the sections of each network where the sewage originated, narrowing down the households that would need to be inspected. A follow-up visual inspection in one area immediately revealed a house where sanitary discharges were connected to the storm drain system.

"Often the only way to be sure a house is misconnected is through a dye test—putting dye down a sink or toilet and seeing where the coloured water appears in the sewer," says Mr. Lerner. "It's clearly impractical for water companies to do this for all the households they supply, but by working back from where pollution is identified and narrowing it down to a particular section of the network, the final step of identifying the source then becomes feasible."

Pollutants found in domestic wastewater change the bacterial and invertebrate life in rivers, encouraging pollutant-tolerant species and leading to the build-up of "sewage fungus," which is visible as a grey lining on the river bed. Wastewater discharges can also carry pathogens such as norovirus. Most misconnected households are unaware they are discharging their wastewater into the storm drain system and, once it has been identified, immediately rectify the problem. Local authorities can complete the work and charge it back to the household, but this is rarely done.

Now that Mr. Lerner has proved his method works in the field, he hopes to try it at a larger scale to identify all the sources of sewage pollution on the Bradford Beck, the river which runs through the city of Bradford, U.K.

DUKE ENERGY SUBSIDIARIES PLEAD GUILTY AND ARE SENTENCED FOR CLEAN WATER ACT CRIMES

The companies will pay a fine and conduct community service and wetlands mitigation

WASHINGTON—Three subsidiaries of North Carolina-based Duke Energy Corporation, the largest utility in the United States, pleaded guilty in May 2015 to nine criminal violations of the Clean Water Act at several of its North Carolina facilities and agreed to pay a $68 million criminal fine and spend $34 million on environmental projects and land conservation to benefit rivers and wetlands in North Carolina and Virginia. Four of the charges are the direct result of the massive coal ash spill from the Dan River steam station into the Dan River near Eden, N.C., in February 2014. The remaining violations were discovered as the scope of the investigation broadened based on allegations of historical violations at the companies' other facilities.

Under the plea agreement, both Duke Energy Carolinas, LLC and Duke Energy, Inc. Progress must certify that they have reserved sufficient assets to meet legal obligations with respect to its coal ash impoundments within North Carolina, obligations estimated to be approximately $3.4 billion.

The EPA's Office of Enforcement and Compliance Assurance, EPA's Office of Inspector General, the Justice Department's Environment and Natural Resources Division, the three U.S. Attorney's offices in North Carolina, the Internal Revenue Service (IRS) Criminal Investigations, and the North Carolina State Bureau of Investigation (SBI) made the announcement following a plea hearing at the federal courthouse in Greenville, N.C. today.

"The massive coal ash spill into North Carolina's Dan River last year was a crime, and it was the result of repeated failures by Duke Energy's subsidiaries to exercise controls over coal ash facilities," said Assistant Attorney General John C. Cruden of the Justice Department's Environment and Natural Resources Division. "The terms of these three plea agreements will help prevent this kind of environmental disaster from recurring in North Carolina and throughout the United States by requiring Duke subsidiaries to follow a rigorous and independently verifiable program to ensure they comply with the law."

"Duke Energy's crimes reflect a breach of the public trust and a lack of stewardship for the natural resources belonging to all of the citizens of North Carolina," said U.S. Attorney Thomas G. Walker for the Eastern District of North Carolina. "The massive release at the Dan River coal ash basin revealed criminal misconduct throughout the state—conduct that will no longer be tolerated under the Judgment imposed by the court today."

On February 20, 2015, the three U.S. Attorney's offices in North Carolina filed separate criminal bills of information in their respective federal courts, alleging violations of the Clean Water Act at the following Duke facilities: the Dan River steam station (Rockingham County), the Cape Fear steam electric plant (Chatham County), the Asheville steam electric generating plant (Buncombe County), the H.F. Lee steam electric plant (Wayne County), and the Riverbend steam station (Gaston County). The alleged violations included unlawfully failing to maintain equipment at the Dan River and Cape Fear facilities and unlawfully discharging coal ash and/or coal ash wastewater from impoundments at the Dan River, Asheville, Lee, and Riverbend facilities.

As part of their plea agreements, Duke Energy Business Services LLC, Duke Energy Carolinas, and Duke Energy Progress will pay a $68 million criminal fine and a $24 million community service payment to the National Fish and Wildlife Foundation for the benefit of the riparian environment and ecosystems of North Carolina and Virginia. The companies will also provide $10 million to an authorized wetlands mitigation bank for the purchase of wetlands or riparian lands to offset the long-term environmental impacts of its coal ash basins. In addition, they will pay restitution to the federal, state, and local governments that responded to the Dan River spill and be placed on supervised probation for 5 years.

Duke's subsidiaries operating 18 facilities in five states, including 14 in North Carolina, will also be required to develop and implement nationwide and statewide environmental compliance programs to be monitored by an independent court-appointed monitor and be regularly and independently audited. Results of these audits will be made available to the public to ensure compliance with environmental laws and programs. The companies' compliance will be overseen by a court-appointed monitor who will report findings to the court and the U.S. Probation Office as well as ensuring public access to the information.

Alewife stormwater wetland—the "gem" of Cambridge's stormwater management program

CATHERINE WOODBURY, OWEN O'RIORDAN, KATHY WATKINS, Cambridge Department of Public Works
DAVID BEDOYA, EMERSON OLANDER, WILLIAM PISANO, DENNIS CARR, MWH Global, Inc.

ABSTRACT | Over the past 20 years, the city of Cambridge has taken a rigorous approach to combined sewer and stormwater management. In tandem with sewer separation, it is constructing drainage systems to relieve broad community flooding problems, address long-term operations and maintenance, and enhance water quality in local receiving waters. As a result, rivers are becoming cleaner, and in areas where stormwater management improvements have occurred, flooding has diminished measurably. In achieving this, Cambridge has met the Massachusetts Water Resources Authority's (MWRA) court-ordered start dates for the sewer separation work in the Alewife watershed area, exceeded the Massachusetts Department of Environmental Protection's (MassDEP's) expectations for removing illicit connections and common manholes, and become a regional leader in stormwater management. The city believes it has done this in a manner that, while at times unavoidably and extraordinarily disruptive, has been genuinely sensitive to and considerate of community needs.

Since 1998, more than 20 large-scale infrastructure projects with a construction value of approximately $245 million were completed by the Cambridge Department of Public Works (CDPW) and a number of innovative, stormwater management approaches have been successfully implemented. Of the stormwater management projects executed by Cambridge, the Alewife Stormwater Wetland is the "gem." This project has won several engineering prizes for innovation, community enhancement, and flood attenuation, and is part of a larger sewer separation program in the Concord Avenue, Huron Avenue and Fresh Pond Parkway triangle, which is tributary to the CAM 004 combined sewer overflow (CSO) outfall at the Alewife Brook.

KEYWORDS | Alewife, Cambridge, CAM 004, CSO, private property inflow, stormwater, sewer separation, wetland

CAM 004 PROGRAM

In the 1980s, the Environmental Protection Agency's (EPA's) Boston Harbor Cleanup Program mandated that the MWRA implement a CSO control program in the Alewife Brook basin. The brook's headwaters are in Cambridge, Belmont, Arlington, and Somerville. Within Cambridge, the CAM 004 catchment is one of the largest contributing areas to the Alewife Brook and is densely developed—420 acres (ac) [170 hectares (ha)] with mostly residential and commercial land uses. This area has historically experienced severe flooding and CSOs from the regional sewer interceptors that convey flow to MWRA's Deer Island Wastewater Treatment Plant. In the 1980s, the area was typified by 63 CSO activations to the Alewife Brook each year, made up of 53 million gallons (MG) [200,000 cubic meters (m^3)] annually. Beyond CSOs, the impact of stormwater was significant. Comparatively small (2-year return period) storms flooded CAM 004 roadways and produced objectionable sewer system overflows (SSOs) and backups into basements. These impacts were amplified during larger (5-year) storms when flooding damage occurred along the Alewife Brook.

The Alewife CSO Long-Term Control Plan (LTCP) was established in the 1990s, which called for full sewer separation of the CAM 004 catchment and partial separation in other areas. The LTCP's mission was to reduce the annual number and volume of CSO activations discharging into Alewife Brook, though it did not mitigate upstream flooding in the developed areas of CAM 004 and had the potential to exacerbate flooding in Alewife Brook with newly separated stormwater.

In 1998, Cambridge began detailed studies for sewer separation of the CAM 004 area and developed its first hydraulic stormwater model. The software allowed an integrated analysis of the watershed's natural and piped systems. Two objectives were then added to the LTCP: (1) manage flooding in the CAM 004 area for the 10-year storm and (2) attenuate the peak discharge of separated stormwater to Alewife Brook to not exceed existing peak flow conditions (Olander and Pisano, 2014).

When the first phase of design for the sewer separation program started, it became clear that to satisfy peak flow attenuation requirements storm-water storage of approximately 3.5 MG (13,000 m^3) was necessary. The consequences of not providing such storage were dire and risked continued street flooding that could breach nearby Fresh Pond. The city developed Fresh Pond for potable water use in 1856, and it now serves as the 1,500-million-gallon (5.7-million-cubic-meter) terminal raw water reser-voir for the city's 24 mgd (1.05 m^3/s) water treatment plant constructed in 2000.

After exploring various options, the only possible location for such a large storage volume was a state-owned area within Alewife Reservation near

Engineered surface flow channel along Palmer Street near Harvard Square

Installation of bending weir in Binney Street combined sewer

Construction of stormwater retention tank in Agassiz neighborhood

the CAM 004 outfall, historically part of Sir William Brewster's The Great Swamp. The site featured scrub/shrub wetland and bottomland hardwoods suffering from a century of urban impact. Figure 1 provides an overview of the CAM 004 catchment and its relevant features.

Using state-owned land within Alewife Reservation required legislative action, which was acquired by establishing a partnership between the Massachusetts Department of Conservation and Recreation (DCR), MWRA, and the city of Cambridge. As such, DCR would not approve a conventional stormwater detention basin and helped lead the design toward a more ecological and sustainable infrastructure. The solution evolved into an engineered stormwater wetland that would integrate flood protection, ecological restoration, and recreational and educational opportunities.

PHASED PROJECT DESCRIPTIONS

The Alewife Stormwater Wetland is the second major project completed as part of the CAM 004 sewer separation program. The wetland, depicted in Photo 1, was officially inaugurated and opened to the public in October 2013. Ten years earlier, a first phase of the CAM 004 program was constructed, which separated large combined sewers along Fresh Pond Parkway. Construction of this first project was complex and required the weaving of new sewers and drains through 14 major utility transmission lines under the four-lane parkway.

The third and final phase of the program consists of separating the most upstream 220 ac (89 ha) of the catchment, which is densely populated with residences. Work has been divided into three construction contracts—Huron A, Huron B and Concord Avenue Sewer separation is proceeding with upward of 16 simultaneous crews, and sewer separation-related infrastructure must be complete by December 2015. Presently, separation of Huron A is complete while work in Huron B and Concord Avenue is ongoing. Until this upstream separation is completed, the wetland will be fed by other separated Alewife Brook catchment areas.

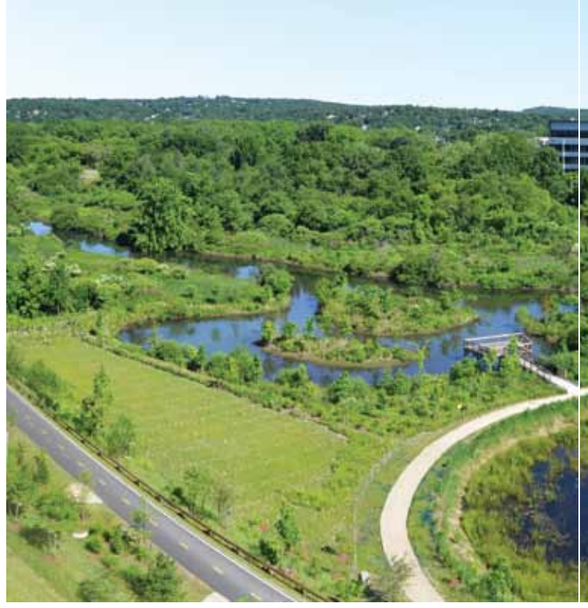


Photo 1. General view of the Alewife Stormwater Wetland

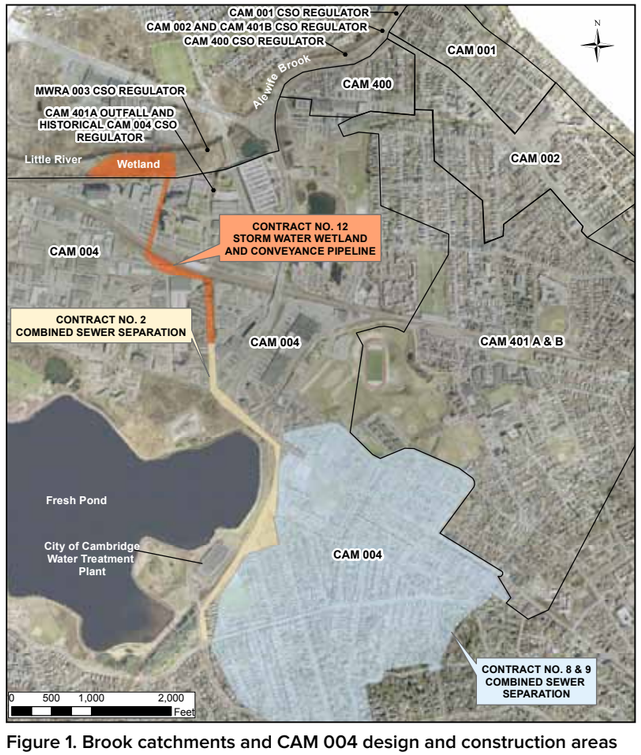


Figure 1. Brook catchments and CAM 004 design and construction areas

Benefits of the Alewife Stormwater Wetland

The Alewife Stormwater Wetland incorporates conventional and bioengineered solutions. As a stormwater management asset, it holds up to 3.3 MG (12,650 m^3) of runoff, enables upstream sewer separation, and ultimately will reduce CSO volumes by 43.6 MG (165,000 m^3) annually at program completion. Approximately 3,000 feet (920 meters) of 4-by-8-foot (1.2-by-2.4-meter) precast concrete box culvert convey upstream separated stormwater to the wetland. Flows first enter a 10,000-square-foot (930-square-meter) forebay, which traps floatables, sediment, and debris. Runoff then enters the wetland's 3.5 ac (1.4 ha) main basin via a natural berm and vegetated swale that regulates and screens the flow. An upland peninsula in the basin then forces the stormwater to flow in a circuitous route to maximize time for natural treatment prior to eventual overflow to the Little River (tributary to Alewife Brook).

Even though the main driver for the wetland was CSO reduction and stormwater attenuation, the wetland, with upstream systems such as rain gardens, deep sump catch basins equipped with hoods, or areas with porous pavement, is expected to significantly improve the quality of stormwater discharged to the Little River. Treatment mechanisms begin with sedimentation and floatables retention in the forebay, which captures sediments rich in nutrients and heavy metals from the upstream urban area. The main basin provides physical filtration by plant matter and removal of dissolved contaminants by microbial breakdown and plant uptake.

Other stormwater features of the wetland include an engineered oxbow to provide compensatory floodplain storage and passive hydraulic devices that allow the main basin to "self-water," maintaining the water level necessary for survival of the wetland plants. The city is also designing two water quality stations, one upstream and one downstream, to measure the wetland's water quality performance.

The Alewife Stormwater Wetland also has the function of ecological restoration by improving wildlife habitat within the reservation. An ecological assessment identified the DCR's desired natural conditions and landforms and targeted the eradication of invasive plants while re-establishing diminished native species (more than 120,000 wetland and 4,000 upland plantings). The resulting habitats include deep marsh, emergent marsh, high marsh, broadleaf floodplain, open water, and scrub/shrub and riparian woodland that provide a diverse ecological community with food and cover for wildlife. Several islands provide breeding grounds, and the oxbow channel connected to the Little River improves spawning habitat for migratory fish such as the endangered alewife and blueback herring.

Social benefits include passive recreational amenities such as interconnected trails for recreational walking, biking, and running, access for bird watching, nature walks, and scenic overlooks. A multi-use pathway immediately adjacent to the wetlands connects the Minuteman Bikeway and the Alewife red line subway station. Outdoor educational features include informational signage, a stone amphitheater, interpretive signage, engraved boulders, and a trail/boardwalk system, providing a close-up view of a functioning wetland and instruction for management of urban stormwater runoff.

These benefits typify what is becoming known as a multi-use infrastructure project, and are the outcome of an extensive public outreach campaign during planning and design. Numerous public meetings were held where multiple stakeholders such as residents, environmental groups, watershed associations, and adjacent communities provided significant input and expressed their interests. This public outreach has resulted in the community embracing the project and the understanding that it will bring added social and environmental benefits (Bedoya et al. 2015).

(left) The stone amphitheater in the wetland being enjoyed by children during an educational tour. (right) Bike path with interpretive signage.

Photo 2. Sediment accumulation in the Wheeler Street conduit

Photo 3. Construction of one of the stormwater flush vaults on Fresh Pond Parkway

Upstream Sewer Separation

The upstream CAM 004 area separation project's preliminary design phase uncovered several issues that changed the technical direction and complexity of the sewer separation program. Issues included management of severe sewer solids deposition along Fresh Pond Parkway and the need to control significant private property inflow (PPI) in upstream sanitary sewers to avoid SSOs after separation.

SEWER SOLIDS CONTROL ALONG FRESH POND PARKWAY

At the beginning of the CAM 004 program, severe solid and grease deposits nearly blocked the dry and wet weather combined trunk sewers along Fresh Pond Parkway. Pipe slopes for a ¾-mile (1.2-kilometer) stretch were nearly flat with less than 0.05 percent of slope. Both new sanitary and storm trunk sewers with similar slopes but with much larger hydraulic capacity were required. The old conduits needed to be replaced or restored to successfully allow proper drainage of future upstream, separated areas. Not doing so would mute the intended value of the upstream sewer separation. Consequently, new conveyance pipes along Fresh Pond Parkway were constructed while the combined sewers were cleaned and restored. This left a pipe system consisting of approximately 0.6 mile (1 kilometer) of sanitary trunk sewers, ranging from 18 to 24 inches (46 to 61 centimeters) in diameter, and 0.7 miles (1.1 kilometer) of storm drains, ranging from conduits 36 inches (91 centimeters) in diameter to 4-by-6-foot (1.2-by-1.8-meter) rectangular culverts.

To prevent future solid deposition in this new trunk line system, German-engineered, automatic sewer flushing systems for both sanitary and storm conduits were selected, designed, and constructed. Two sanitary and five stormwater flushing vaults were constructed between 1999 and 2000. In May 2002, performance testing of both the sanitary and storm flushing systems were evaluated by filling the vaults with a water truck and measuring downstream velocities at terminal locations. Average velocities of 4 ft/s (1.25 m/s) were noted at five locations with an average flush distance of 1,100 feet (335 meters). In addition to flushing regularly, the city cleans downstream stormwater grit pits semi-annually to further prevent solid deposition and blockages (Pisano et al, 2014). Photo 2 shows the historical condition of the Wheeler Street pipe immediately downstream of the parkway before the flushing system was implemented and before being cleaned, as well as construction of one of the stormwater vaults designed to flush the 6-foot (1.8-meter) diameter conduit along this street (Photo 3).

PRIVATE PROPERTY INFLOW CONTROL IN HURON A/B AND CONCORD AVENUE AREAS

Initial field engineering in the CAM 004 upper residential areas in the early 2000s determined locations of illicit connections into conveyance conduits that were to remain as storm drains after sewer separation. The work uncovered that the number of household roofs and basement sump pumps directly connected to sanitary sewers was much larger than initially anticipated.

Preliminary hydraulic modeling of the final, separated sewer system indicated that the proposed network would not achieve the desired hydraulic level of service of 4 to 5 feet (1.2 to 1.5 meters) below ground necessary to protect many residential, finished basements from sewer backups during peak flow periods for moderate storms. Level of service was affected mostly by limited downstream hydraulic capacity of regional interceptors backing up into the municipal sewer system as well as by significant upstream inflow contributions from private property, which reduced the design capacity of local sewers. Since addressing the regional downstream conditions was not cost-effective, the hydraulic and financial impact of removing private inflow sources was evaluated. Detailed building inspections were then performed for 994 buildings from 2005 to 2010, revealing that at least 25 percent of all buildings contributed private property inflow into sanitary sewers.

Detailed hydraulic modeling of the proposed separated sanitary system, integrating results from the field campaign, revealed numerous potential SSOs during the 10-year design storms, which amounted to a total flood volume of 800,000 gallons (3,000 cubic meters). The city decided that this level of SSO volume due to extreme sanitary sewer surcharge in the public right of way, aside from dozens of potentially flooded finished basements, could not be tolerated.

The city had been separating combined and over/under pipe systems since the 1950s primarily for local street and building flooding mitigation and since the 1990s for regional CSO control. To facilitate private inflow removal the city had been providing separate, storm drain laterals terminating at the property line for each home or business in an area of separation. Responsibility for private property inflow removal was the owner's decision, and the owner would also be responsible for the associated costs of internal building separation. Several thousand storm laterals had been constructed, but few were being used.

In late 2010 this approach changed as sanitary level of service after sewer separation could not be achieved without removing sufficient private property inflow. The city adopted the approach that private property inflow correction could be funded cost-effectively when no other mitigation solution was available. Private property inflow mitigation in the CAM 004 area became the first large-scale effort. The city conducted community informational meetings, and the idea gained acceptance. As a result, the interior plumbing of 175 buildings within the CAM 004 area is being modified as part of the ongoing sewer separation construction to direct private property inflow into dry wells and/or into new storm laterals. Private property inflow removal would minimize CSO volumes in the downstream Alewife regional MWRA conveyance system and save the city more than $2 million over a 20-year period due to reduced inflow and infiltration treatment fees (Bedoya et al. 2013).

Sewer separation, combined with an extensive private property inflow control program, is expected to provide sanitary (i.e., no sanitary sewer overflows) and storm flood (i.e., flood within the public right of way only) protection for the 10-year storm and achieve satisfactory level of service in 98.5, 90, and 76 percent of the sanitary manholes in the Huron A/B and Concord Avenue areas during the 2-, 5-, and 10-year design events, respectively. The city considers satisfactory sanitary level of service is attained if the peak hydraulic grade line reached within a manhole remains at least 4 feet (1.2 meters) below ground, which would prevent sewer backups into building basements in most instances. Figure 2 depicts expected level of service brackets in sanitary manholes in the Huron A/B and Concord Avenue areas after sewer separation and completion of the private property inflow control program. See photos (to right) of the ongoing private property inflow removal construction program.

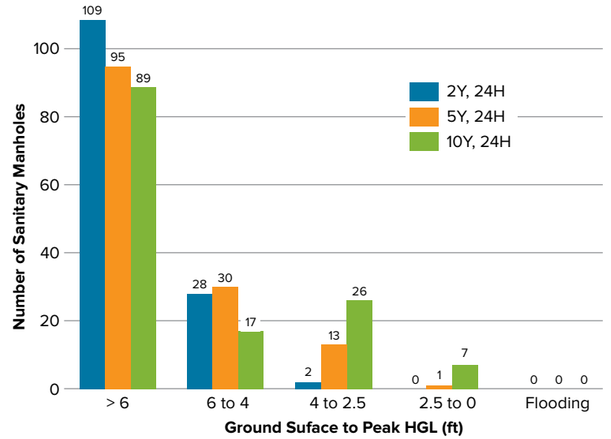


Figure 2. Expected sanitary level of service in Huron A/B and Concord Avenue at completion of CAM 004 sewer separation

Example of private property inflow removal work being performed in the Huron A, Huron B, and Concord Avenue areas

The wetland will be fed with flows from the entire separated stormwater system until its maximum capacity is reached. Then clean excess stormwater flows will be directed to the brook outlet

The Outcome

The official Grand Opening of the Alewife Stormwater Wetland took place in October 2013, with local, state, and regional authorities, and the public attending. It was generally agreed that this milestone was "an extraordinary example of what can be accomplished when new methods of stormwater management are undertaken with creative design and effective funding" (Mystic River Watershed Association) and that this project "brings the wonders and beauty of what my engineers are providing for the community" (City of Cambridge).

Full completion of the sewer separation and private property inflow control programs in the Huron B and Concord Avenue areas is expected by December 2015. The wetland will be fed with flows from the entire CAM 004 separated stormwater system until its maximum capacity is reached. When full capacity is reached, clean, excess stormwater flows will be directed to the CAM 004 outlet via a bending weir in Wheeler Street. Completion of these projects will mark an inflection point in the water quality of the Alewife Brook, as it is expected to be a major milestone in the regional CSO control program, reducing annual CSO volumes significantly and improving water quality of the stormwater entering the brook.

CONCLUSION

Many challenges were overcome during the improvement of the CAM 004 area. Key takeaways for other areas facing similar issues are as follows:

- Combined sewer infrastructure projects such as this one are best initiated by embracing the concept of a multi-benefit project during planning. Municipalities that proactively gain stakeholder support will discover that perceived limitations can be opportunities in disguise.
- Detailed hydraulic modeling and creative engineering analysis that embraces passive and active control technologies, and uses available natural resources are critical to address complex existing and proposed collection systems.
- A realistic evaluation of private property inflow contributions and the cost-benefit of its separation can show the value of performing work on private property despite the difficulty of working with many stakeholders.
- Detailed field investigations should be initiated and completed before design work is started to verify historical/anecdotal records and identify unknown defects and indications of surcharge in the system.
- By adopting a more holistic approach to the design of infrastructure projects, sustainable engineering will be able to take place more naturally and allow projects to reach their full potential in improving communities. This has been the mantra for Cambridge's efforts over the last 20 years. The Alewife Stormwater Wetland project is the culmination of these efforts and has quickly become the "gem," as it encompasses all aspects of this mantra.

The Alewife Stormwater Wetland is "an extraordinary example of what can be accomplished when new methods of stormwater management are undertaken with creative design and effective funding"

– MYSTIC RIVER WATERSHED ASSOCIATION

ABOUT THE AUTHORS

- Catherine Woodbury is a project manager for the Department of Public Works in Cambridge, Mass.
- David Bedoya is a project technical lead and supervising engineer for MWH Global based in the Boston office.
- Emerson Olander is a project technical lead and supervising engineer for MWH Global based in the Boston office.
- William Pisano is a senior advisor for MWH Global based in the Boston office.
- Dennis Carr is a senior project engineer for MWH Global based in the Boston office.
- Owen O'Riordan is the commissioner of Public Works for Cambridge, Mass.
- Kathy Watkins is the assistant commissioner of engineering and city engineer for Cambridge, Mass.

ACKNOWLEDGEMENTS

The design and construction administration of the Alewife Stormwater Wetland was performed by the engineering team of MWH Global, Kleinfelder, and Chester Engineers (formerly BioEngineering Group).

REFERENCES

1. Bedoya, D., Pisano, W.C., Hill, C.J., Gray, S., O'Riordan, O. (2013) "Private Property Inflow Control Makes Hydraulic and Financial Sense. A Case Study in Cambridge, MA," Proceedings of the ASCE Pipeline Conference 2013, Fort Worth, TX.
2. Bedoya, D., O'Riordan, O., Pisano, W.C., Olander, C.E., Kovacina, S., Struzzieri, J.J., and Bitsko, D. (2015) "Completion of the Alewife Stormwater Wetlands Brings Many Benefits to Residents and Stakeholders in Cambridge, MA," Proceedings of the Water Environment Federation Technical Exhibition and Conference (WEFTEC) 2015, New Orleans, LA.
3. Olander, C.E. and Pisano W.C., (2014) "Great Swamp Controls CSOs," Government Engineering, January/February 2014 Issue, pp: 28-32.
4. Pisano, W.C., O'Riordan, O., Olander, C.E, Bedoya, D., and Carr, D.H. (2014) "Tertiary Level Sewer Separation Benefits Great Swamp," American Water Works Association (AWWA) Journal, Volume 106(9), pp: 103-110.

FEATURE

Provincetown stormwater program revitalizes downtown and improves water quality

SANDRA TRIPP, P.E., BCEE; JESSICA JANNEY; RUSSELL KLEEKAMP, GHD Inc., Hyannis, MA
RICHARD WALDO, P.E. Town of Provincetown Department of Public Works, Provincetown, MA
ROBERT ROSEEN, Ph.D., P.E., D.WRE., Horsley Witten Group, Newburyport, MA

ABSTRACT | Provincetown, Mass., has significantly reduced beach closures along Provincetown Harbor through a comprehensive multi-year stormwater management program. The most recent improvements addressed organic (bacterial) and non-organic loadings from untreated stormwater runoff from Commercial Street, which serves as the town's "Main Street" and provides primary access to the harbor and hundreds of businesses. The challenge of treating stormwater from this narrow and highly traveled corridor was solved by reconstructing the road using porous pavement laid over a stone reservoir bed. Two of the three phases of this project have been constructed (the third phase is in design). The project provides the dual benefit of improving harbor water quality and revitalizing the downtown through road reconstruction. Two summers have passed since completion of the first phase of the project, and the reduction in the number of beach closures is significant. Based on the water quality testing program there were no beach closures during the summer of 2013 and three beach closures in 2014 (all at the outer edges of the project improvements), reduced from nine closures in 2012 and seven in 2011. On average, more than 10 closures per season were experienced prior to 2011.

KEYWORDS | Stormwater treatment, porous pavement, economics, project acceptance, Provincetown, Category 4a, pathogens, beach closures

INTRODUCTION

Provincetown is at the tip of Cape Cod. Like many Cape Cod communities, the town developed in the 19th century as a fishing town. Life revolved around the waterfront, and the main "road" was the hard-packed beach, which evolved into "Town Road," a footpath that ran behind the beach houses fronting Provincetown Harbor. As the 20th century dawned, the town began attracting artists and writers as well as summer tourists. Today, Provincetown boasts a diverse culture built on its early roots. Life still revolves around the waterfront. Town Road, which still serves as "Main Street," has become Commercial Street.

Commercial Street is one of the most charming, yet chaotic, main streets on Cape Cod. Spanning about 2.5 miles (4 kilometers) from the West End rotary to its intersection with Bradford Street near the Truro town line, Commercial Street boasts a charming architectural and cultural environment combining residential, commercial, and government establishments. History, culture, diversity, and commercial stores unique to Provincetown are all found on Commercial Street, which draws hundreds of thousands of tourists during summer. In fact, Provincetown's year-round population of approximately 3,400 increases 10-fold for the summer and to more than 100,000 tourists for Carnival Week in August. During the peak tourist season, vehicle traffic on Commercial Street takes a "back seat" to the thousands of bikers and pedestrians who travel the road.

As a waterfront community, Provincetown understands the importance of the harbor's water quality. In previous years as storms affected the town, infrastructure in the form of beach outfalls would carry runoff and the organic (bacterial) and non-organic matter it contains directly into the harbor. The resulting elevated fecal coliform and *enterococci* bacteria levels caused the town to close the beaches. Regulatory agencies along with state and local officials have worked for decades to alleviate this situation. The Commercial Street stormwater improvement and roadway reconstruction project is the latest step toward eliminating beach closures along Provincetown Harbor.

Commercial Street serves as the town's "Main Street" and provides primary access to the harbor and hundreds of businesses

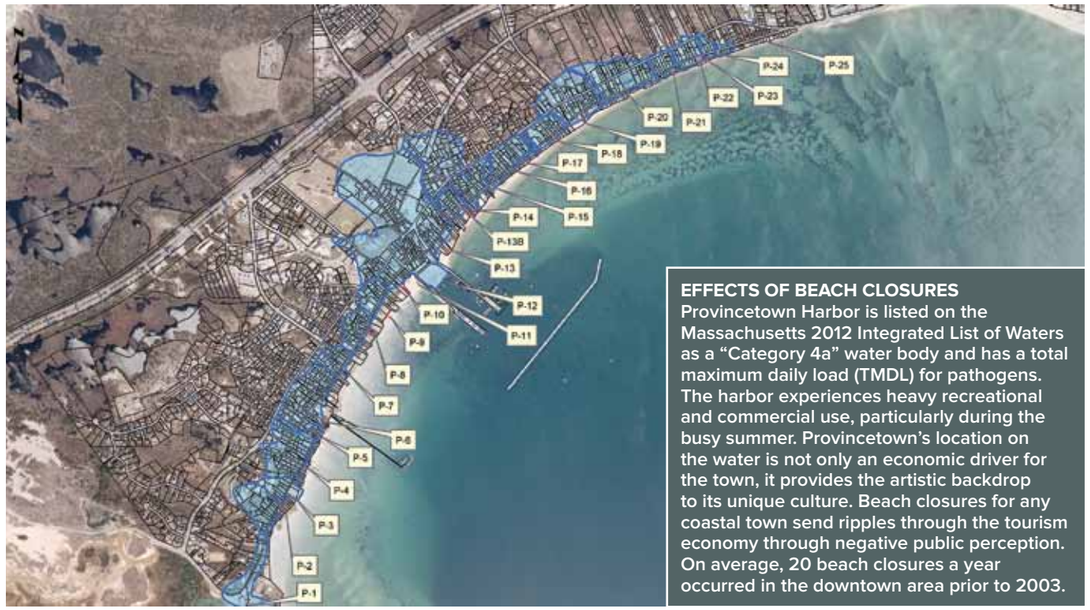
BACKGROUND

The first step the town took was to address impacts from hundreds of antiquated septic systems and an aging sewer system. This effort led to the replacement of septic systems and construction of a new wastewater treatment plant (completed in 2003). This, combined with public education about picking up pet waste, increased the safety for swimmers at harbor beaches[1]. Concurrently, the town began planning to address impacts from stormwater.

In 2003, the town completed the Provincetown Harbor Stormwater Mitigation Assessment project, funded through the Coastal Pollution Remediation program administered by the Massachusetts Office of Coastal Zone Management. This assessment identified the various discharges to Provincetown Harbor, assessed the water quality impacts from these discharges, and recommended mitigation measures. Watershed areas were delineated for the 25 identified outfalls, and water quality was measured for each discharge. The assessment resulted in a prioritized listing of recommended improvements (see Figure 1).

The town has systematically approached improvements at each outfall over the last 12 years,

[1] Pollution Reduction Efforts Paying Off for New England's Beaches, Robert W. Varney, U.S. EPA, July 2004.



EFFECTS OF BEACH CLOSURES
Provincetown Harbor is listed on the Massachusetts 2012 Integrated List of Waters as a "Category 4a" water body and has a total maximum daily load (TMDL) for pathogens. The harbor experiences heavy recreational and commercial use, particularly during the busy summer. Provincetown's location on the water is not only an economic driver for the town, it provides the artistic backdrop to its unique culture. Beach closures for any coastal town send ripples through the tourism economy through negative public perception. On average, 20 beach closures a year occurred in the downtown area prior to 2003.

Figure 1. Prioritized listing of recommended improvements

beginning with the installation of treatment units prior to discharge for the five highest-priority discharges. Each project improved the overall quality of the harbor, yet beach closures still occurred near the center of Commercial Street and along Ryder Street Beach.

CHALLENGE OF COMMERCIAL STREET

As of 2009, the town had not been able to implement improvements to address stormwater from the six outfalls discharging to the harbor near the center of

Commercial Street—July 4th

Commercial Street. These outfalls handle roughly 60 acres (24 hectares) of impervious surface area, including runoff from Commercial Street, and are along approximately 1.5 miles (2.4 kilometers) of beachfront. The physical constraints associated with this stretch of road provided challenges both for the design and implementation of traditional best management practices (BMPs) at these outfalls.

The evolution of Commercial Street from a footpath in the early 19th century has resulted in a narrow corridor identified on both sides by commercial and residential buildings. The pavement varies from 16 to 22 feet (4.9 to 6.7 meters), with its 4-foot (1.2-meter) sidewalks (when present) often set against the physical sides of buildings. Narrow as it is, this road remains vital to the town's economic well-being as it provides access to:

- MacMillan Pier—the primary seaport destination for the town
- MacMillan Pier Walkway and Gazebo—ferry access and accessibility to tour boats
- Intermodal Center/Ryder Street Terminal—bus station and park area
- The highest concentration of restaurants, lodging, retails stores, beaches, and nightlife venues in town
- Town Hall and the town post office

As noted, the town sees an influx of tens of thousands of tourists in the summer, most if not all of whom will walk, bike, or drive on Commercial Street.

Commercial Street has seen many utility installations. The storm drain system evolved over time and was not always well documented. Water distribution, wastewater collection, electric, and other utilities crowded the narrow street. This left little to no room to place traditional water quality BMPs to treat stormwater. In addition to normal wear, the recent

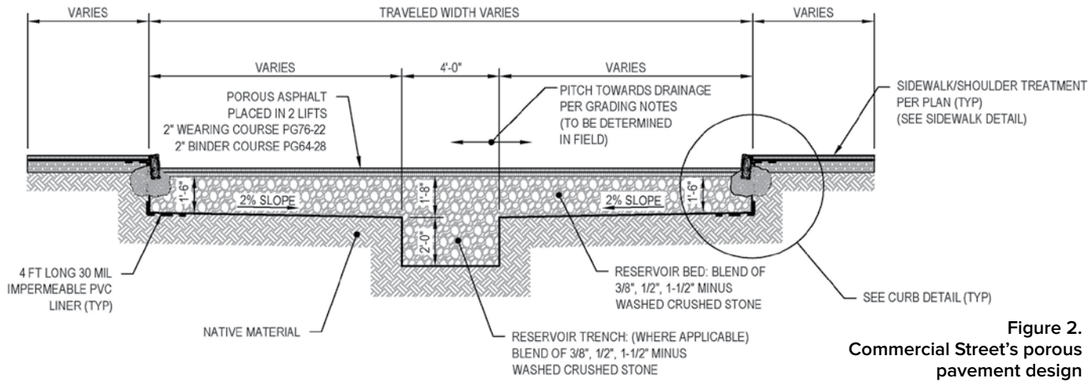


Figure 2. Commercial Street's porous pavement design

installation of a vacuum sewer system and routine utility repairs left the roadway in poor condition. For this reason, it was decided to address the water quality issues associated with this stretch of Commercial Street at its roots—Commercial Street's impervious surfaces, which directly cause stormwater to flow into the harbor. By reconstructing the roadway with porous paving material, the town receives the benefit of both treated stormwater and minimal direct stormwater discharge to the harbor, and a new roadway for this vital corridor.

POROUS PAVEMENT

The water quality benefits of porous asphalt pavements are well documented. They greatly lessen pollutant concentration through filtration and pollutant load by reducing runoff volume through infiltration. Numerous studies have recognized a substantial volume reduction on sites with poor soil and nearly 100-percent recharge for sites with soil that has even modest infiltration capacity.

Porous pavement is typically used on roadways where sheeting water is a significant safety hazard and as such these open-graded surface treatments are widely used to wick water away from highway surfaces. Despite this, full-depth porous asphalt pavements are less commonly selected for roadways, in part due to concerns about cost and maintenance. Provincetown felt, however, that modern materials and mix designs would provide a porous pavement well suited to the demands of Commercial Street.

Commercial Street's porous pavement design included 4 inches (10 centimeters) of porous asphalt underlain by an 18-inch (46-centimeter) minimum thickness reservoir bed, atop proof-rolled native sands. Although many porous pavement projects are constructed on soil, the coarse nature of the sand locks well when rolled while still allowing for infiltration.

To focus the water permeating the pavement away from abutting sidewalks and basement walls, the roadbed included a 4-foot-wide by 2-foot-deep (1.2-meter-wide by 0.6-meter-deep) infiltration trench below the centerline of the road. The roadbed also incorporated an impermeable liner along the vertical walls of the pavement sub-base to prevent potential lateral migration under sidewalks and into buildings (see Figure 2).

Geotechnical investigations were performed at 12 locations along Commercial Street, assessing depth to water and soil characteristics. The soils generally consisted of fine sands with a trace of silt. The depth to groundwater ranged between 4 and 15 feet (1.2 and 4.6 meters), and was greater than the depth of the proposed pavement section along the design corridor. Hydraulic loading, groundwater table, and hydraulic mounding were evaluated for both the common 1-inch (2.5-centimeter) storm and the extreme 100-year storm. Potential hydraulic routing within pipe bedding was also considered to ensure that the bedding would not act as an avenue for water to infiltrate basements.

The porous asphalt mix design was chosen in collaboration with the University of New Hampshire's Stormwater Center. The design mix was based on its design specification for porous asphalt pavement and infiltration beds, and in accordance with the National Asphalt Pavement Association's Porous Asphalt Pavements for Stormwater Management: Design, Construction and Maintenance Guide. A PG 76-22 asphalt binder modified with a styrene-butadiene-styrene (SBS) polymer was used and the pavement was placed in two, 2-inch (5-centimeter) lifts. This durable pavement is well-suited for high-traffic

MAINTENANCE OF POROUS PAVEMENTS
Maintenance of porous pavement is critical to the pavement's performance. High traffic areas during rain events should be inspected monthly to confirm infiltration. In addition, vacuum sweeping should be done twice a year at a minimum, with an increased frequency in busier areas. Because of Commercial Street's close proximity to the beach, Provincetown employs nightly street vacuuming during summer to contribute to the long-term hydrologic functionality of the porous pavement. If, in the future, the pavement is found to be damaged, small areas can be patched with traditional asphalt as it will bind with the porous asphalt.

environments. A locally available reservoir bed was specified as a blend of ⅜, ½, and 1.5 inch (1, 1.3, and 3.8 centimeter) minus crushed stone, which locks better than a single size of aggregate and allows for more void space (up to 20 percent or more voids).

DESIGN AND IMPLEMENTATION

This project relied not only on the technical aspects of the porous pavement and the design of the roadway but on the town's ability to accept its implementation. From the beginning, the town understood that reconstruction of Commercial Street would most likely be the most disruptive project it had undertaken in years. Unlike a repaving or mill and overlay project, the roadway would be totally removed to a depth of 4 feet (1.2 meters). Vehicles would not be able to access the road for weeks at a time. Construction would occur sometimes up to the doors of businesses and at times storefronts were limited to pedestrian access only. Construction had to dodge both the summer's heavy tourist season and the New England winters.

To establish a collaborative environment, the town engaged in public meetings early on. Not only was the project discussed at special town meetings, the design engineer was available weekly to discuss the project with any interested party. Concerns were recorded and addressed. Together, the town and its citizens developed a plan for the project.

The scope was enhanced not only to accomplish the primary project goals of minimizing beach closures and restoring the road but to further enhance corridor functionality. The curbing, which was severely compromised along most of the corridor due to heavy truck traffic and several repaving projects, was replaced. This resulted in a full curb reveal throughout the corridor and improved public safety.

Throughout the years, the sidewalks have been reconstructed with brick, asphalt, concrete, and other materials. Most of the sidewalks in the project corridor were brick walks, which also needed replacing. Over time the bricks had cracked, heaved, swelled, and/or deteriorated, causing tripping hazards and making for uncomfortable walking or riding along the sidewalks. While understanding the need for diligent maintenance, the town replaced the brick sidewalks along the corridor while bringing them up to current Americans with Disabilities Act (ADA) standards. This allowed the town to maintain the historic look of the commercial corridor while improving pedestrian safety.

Also, the storm drain system was aging and under capacity in some areas. This project replaced failed, aging, or undersized storm drain features. Although the implementation of porous pavement greatly reduces the hydraulic loads on the storm drain system, it was decided to incorporate a system sized to handle the loads without the porous pavement (assuming impermeable pavement). The storm drain acts as an emergency bypass for the porous paving and will be present if any section of the porous pavement becomes clogged.

To minimize disruption for tourists and businesses alike, construction of the stormwater and roadway improvements was segmented into three manageable phases. Construction phasing can be challenging for permeable pavements and requires special considerations. This was especially true for Provincetown, where it was necessary to schedule all work outside the busy tourist season. To accomplish this, construction was limited to the period between mid-October to mid-May. Phasing the project allowed for work to be completed within the construction season and supported implementation in affordable steps.

As the project would benefit the town in many ways, it was attractive to various funding agencies. Provincetown obtained funding for the various phases as noted in the sidebar.

COLLABORATIVE EFFORT

Phase I, running approximately 2,700 feet (822 meters) from Johnson Street to Winthrop Street, was ready to be constructed in the fall of 2012. This is the busiest downtown area in Provincetown, and the businesses along this stretch were anxious about construction impacts. Although the fall, or "shoulder season," is not the busiest tourist season, the towns on Cape Cod see a lot of autumn activity and businesses count on this revenue to complete a successful year. As noted, the town held numerous public meetings and listened to the concerns of its citizens. It dedicated a full-time representative, or clerk of the works, to coordinate with the contractor and the citizens to mitigate impacts to businesses as much as possible. In addition, the town's Department of Public Works director was visible and available to citizens throughout construction.

The major road base reconstruction work including the storm drain system, stone reservoir,

VARIOUS BENEFITS PROVIDE FUNDING OPPORTUNITIES

The benefits from the Commercial Street stormwater and roadway improvements project resulted in a variety of funding agencies supporting the project. The Massachusetts Office of Coastal Zone Management (CZM) provided initial support by funding the 2003 stormwater assessment through the Coastal Pollution Remediation Program. The positive impact to the economy of the town was recognized by the MassWorks Infrastructure Grant Program, which provided a public works economic development grant for the design and construction of Phase I. The primary goal of cleaning up the waterways of Massachusetts (in this case Provincetown Harbor) is supported by the Massachusetts Department of Environmental Protection, which has provided 604(b) Water Quality Management Planning Program grants for Phases II and III. Additionally, the final design and construction for Phase II was assisted with funding from the U.S. EPA Clean Water Act Section 319 Nonpoint Source Program grant. To date, Provincetown has received $2.8 million in grant funding toward the planning, design, and construction of this project.

Excavation of existing roadway

Excavation and stone bed


Stone reservoir bed installation


Binder course installation – Phase I


Surface course pavement installation – Phase II


Binder course pavement installation – Phase II

TIPS FOR POROUS PAVEMENT SUCCESS

Porous asphalt pavements are an important stormwater management tool; however, their use requires careful planning. Successful installations generally require four critical elements:

1. Proper design including appropriate specification of pavement mix and sub-base construction
2. Strict quality control during pavement production
3. Proper engineering oversight during construction and pavement placement
4. Long-term operations and maintenance plans

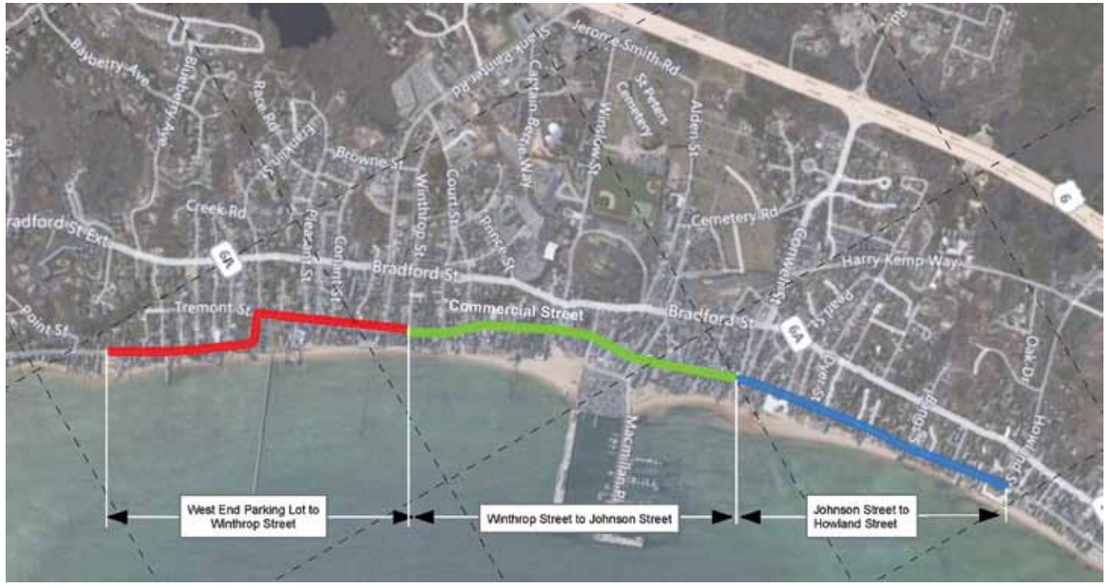


Figure 3. Commercial Street project phasing

and porous asphalt binder course was completed by December 2012, before the winter temperatures in January and February limited construction. Pre-existing conditions including the narrow road width required close coordination and attention to detail. Tying in the new road, curbing, and sidewalks to existing sidewalks, landings, stoops, and store entrances was a challenge. In addition, the local asphalt plants needed to be a part of the coordination to meet the technical requirements of the asphalt and the timing requirements.

Communications with the businesses was critical and primarily handled through weekly "e-blasts" which notified all interested businesses, citizens, and other parties of planned activities for the coming week. This, together with the ability to approach the town, allowed the businesses and residents in and around the project site to work around the construction and provide service to their own customers.

In the spring of 2013, the top layer, or porous asphalt wearing course, was placed along the Phase I site.

Phase II is to the west of Phase I and runs from Winthrop Street to the West End Parking Lot. The design was completed by the fall of 2013. Phase II progressed as did Phase I, with final paving being performed in the spring of 2014.

RESULTS

The Commercial Street stormwater improvement and roadway reconstruction project had an overwhelmingly positive response by the town's citizens. The most obvious benefit noticed by residents and business owners was the major facelift to the town's main economic hub. Despite the disruption during a critical business time, people along the corridor continue to express their satisfaction with the final product.

Additional benefits are seen during the intense rainstorms that often occur on Cape Cod. Residents and business owners alike took notice of the special properties of this new asphalt. Merchants noticed that tourists no longer had to jump over standing water to reach their establishments. Similarly, residents commented that they no longer found themselves leaping away from passing vehicles to avoid being splashed as tires went through puddles.

When the final layer of the porous pavement for Phase I was placed, many pedestrians were confused as to whether or not the road was finished. The larger open pores of the porous pavement were not what they were used to seeing. They questioned whether or not the rough appearance would affect the overall durability. With average daily summer foot traffic reaching 40,000 tourists and several larger delivery trucks frequenting the roadway, residents were concerned. However, after repeated exposure to sharp turning trucks and numerous parades, the durability concerns were answered. The pavement has proven to be durable and has not shown unusual signs of wear.

As for the primary project goal of improving the water quality and health of Provincetown Harbor, early indications are promising. Table 1 shows the number of beach closures for each sampling point within the Phase I and II areas. The orange highlighted numbers reflect the closures after the porous asphalt was installed as part of the two-phased project. This porous pavement installation appears to have helped reduce the number of beach closures.[2]

[2] Roseen, R., Waldo, R., Janney, J. and Tripp, S., 2014, Provincetown Porous Asphalt Keeps Beaches Open. Asphalt Pavement, September/October 2014, vol. 19, no. 5

Table 1. Bathing beach closures associated with Phases I and II sampling points

Phase	Beach Sampling Point	2007	2008	2009	2010	2011	2012	2013	2014
I	Johnson St	1	0	1	3	1	1	0	1
I	333 Commercial St	2	1	3	2	1	1	0	0
I	Ryder Beach (Middle)	0	1	1	2	2	3	0	0
I	Court St	1	3	0	3	1	1	0	0
II	Atlantic Ave	1	3	5	2	0	1	1	0
II	Town Landing (West of Coast Guard Station)	3	2	1	1	0	1	1	0
II	West End Lot	2	3	1	3	2	1	1	2

Following Phase I, there were no beach closures in 2013 and only one in 2014 associated with the four water quality sampling locations representative of the Phase I-impacted beach. There were three beach closings associated with the water quality sampling locations representative of the Phase II-impacted beach areas in 2012 and 2013 and two closings in 2014 at the furthest sampling point and end of the porous pavement installation.

Beach sampling is conducted by the Barnstable County Department of Health and Environment and the town of Provincetown's Health and Environmental Affairs Department during the summer. The indicator organism for bacteria is *enterococcus* and the limit for closure is 104 CFU/100ml.

SUMMARY

The 18-month installation was complex, involving narrow roadways, old building foundations, dense placement of utilities, and a tight construction schedule. Application of the porous pavement focused on quality control and a plan for long-term operations and maintenance.

Pavement durability has shown no visible distress, as identified by raveling or rutting, despite regular heavy truck traffic supplying the businesses and routine bus traffic accessing the public pier. Provincetown employs nightly street vacuuming during summer for trash and debris, which will contribute to the long-term hydrologic functionality of the porous pavement.

The town is moving forward with Phase III, which is east of Phase I, as it continues to improve Provincetown Harbor's water quality (see Figure 3).

ABOUT THE AUTHORS:

- Sandra Tripp is a senior project manager with GHD, in Hyannis, Mass. Ms. Tripp has more than 30 years of experience in the planning, design, and construction of municipal water, stormwater, reclaimed water, and wastewater systems.
- Jessica Janney is a project engineer with GHD, in Hyannis, Mass. Ms. Janney has 15 years of experience in engineering with a focus on planning, stormwater and remediation.
- Russell Kleekamp has worked successfully on some of the largest porous asphalt applications on the East Coast.
- Richard Waldo worked locally in Provincetown for an engineering firm before leaving to start his own practice. In March 2012, Mr. Waldo joined Provincetown's Department of Public Works as deputy director before taking on the role of director in November 2014.
- Robert Roseen, Ph.D., a practice leader at the Horsley Witten Group, is a recognized industry leader in green infrastructure and watershed management, and consults nationally and locally on stormwater management and planning. He is leading one of the first-in-the-nation integrated planning efforts in coastal New Hampshire.

ACKNOWLEDGEMENTS

- Derek Ritchie, Provincetown Clerk of the Works
- Sherry Prada, DPW Operations Manager
- Past and present Provincetown Board of Selectmen, Town Manager, and Town Staff
- Nathan C. Weeks, P.E., BCEE, GHD Inc.
- Robert B. Our Co., Inc.
- Aggregate Industries
- Every business owner and residence located along the Commercial Street corridor

REFERENCE LIST

- Pollution Reduction Efforts Paying Off for New England's Beaches, Robert W. Varney, U.S. EPA, July 2004.
- Roseen, R., Waldo, R., Janney, J. and Tripp, S., 2014, Provincetown Porous Asphalt Keeps Beaches Open. Asphalt Pavement, September/October 2014, vol. 19, no. 5.

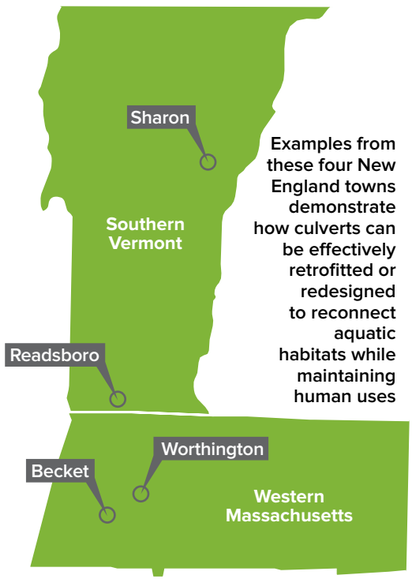
Rethinking stream crossings for humans and animals— four examples from New England

ROBERT SOWBY, Hansen, Allen & Luce, Inc., Midvale, UT

ABSTRACT | Culverts have been installed at countless stream crossings in the U.S. as the country's transportation networks have expanded. Unfortunately, many crossings have become barriers to aquatic organism mobility, a function essential to healthy ecosystems. Excessive velocity, outlet drops, and insufficient water depths impede mobility and constrict or sever habitats. Opportunities to reverse this trend continue to arise as aged culverts need to be replaced. Cooperation of public and private partners has led to successful local projects, many of which overlapped with planned infrastructure improvements and community priorities. Four examples from New England demonstrate how culverts can be effectively retrofitted or redesigned to reconnect aquatic habitats while maintaining human uses at each crossing.

KEYWORDS | Aquatic organism passage, culverts, ecology, fish, flood, rivers, streams, stream crossings, stream restoration, transportation

This open-bottom arch culvert replaced a double-box culvert on Bronson Brook (see page 41)



Examples from these four New England towns demonstrate how culverts can be effectively retrofitted or redesigned to reconnect aquatic habitats while maintaining human uses

INTRODUCTION

As transportation networks have crisscrossed the American landscape, hundreds of thousands of culverts have been installed at stream crossings. On one level, culverts perform well: They pass water downstream while allowing vehicles and people to cross above. Historically, however, little consideration was given to their impacts on fisheries and ecosystems. High flow velocities, outlet drops, and insufficient water depths impede the mobility of aquatic species and constrict or sever their habitats.

Amy Singler, associate director of American Rivers' River Restoration Program, emphasizes the importance of such crossings. "Fish and aquatic species need to move upstream and downstream to connect habitat for food, spawning, and shelter," she says. "While most people ignore the tiny stream under the bridge they're driving across, river scientists and road managers think a lot about these structures."

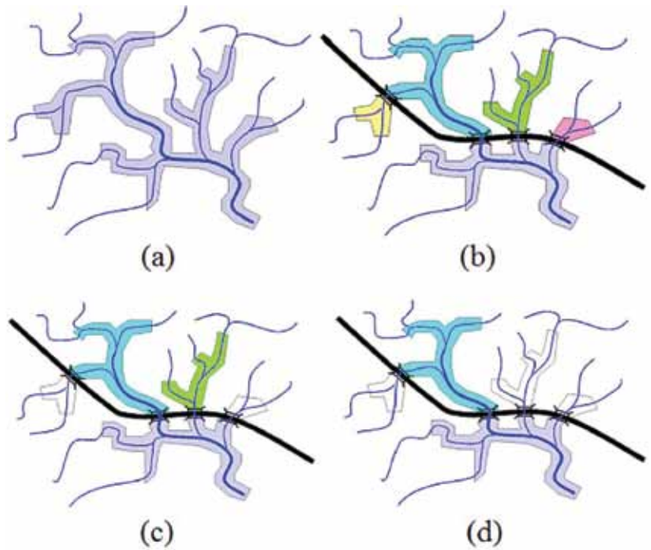
Although not all culverts need to accommodate fish passage, many that should fail to do so. In Washington and Oregon, more than half of an estimated 10,000 culverts are considered to be barriers to juvenile salmon passage (Kilgore et al. 2010). In Washington alone, 1,987 crossings in fish-bearing streams were identified as barriers (WSDOT 2013). In Vermont, only six percent of some 1,500 culverts inventoried were fully passable (VFWD 2010). In Massachusetts there are an estimated 28,500 road or railroad crossings that affect streams (VC&PB 2004). Not all of the Massachusetts crossings involve passage issues, but the number represents the extent and impact of such in-stream structures.

TOWARD SOLUTIONS

In recent years the design of culverts has expanded to include considerations for aquatic life. Some states, particularly in New England, have established new design criteria for crossings. Qualitative stream crossing handbooks and more detailed technical guides are available for Connecticut, Massachusetts, Vermont, New Hampshire, and Maine.

Several best practices contribute to a fish-friendly crossing (Baker and Votapka 1990; Behlke et al. 1991; Kilgore et al. 2010; Metsker 1970; Tillinger and Stein 1996; Watts 1974; Singler et al. 2012):

- Locate the culvert in a straight segment of the channel
- Use bank-full width; avoid constricting the channel
- Minimize the total culvert length
- Match the culvert slope to the natural stream slope
- Size the culvert appropriately to accommodate high flows and avoid high velocities
- Use corrugated pipe to reduce velocity
- Use open-bottomed culverts where possible, or fill the culvert bottom with natural sand and gravel to provide surfaces for insects and a familiar environment for fish
- Avoid perched outlets; embed the culvert when possible



Changes in fish habitat due to stream crossings: (a) undisturbed habitat (shaded), (b) disconnected habitats (colored) caused by ineffective culverts, (c) fragmented system and loss of first habitat, and (d) extirpated habits (hollow) (Kilgore et al. 2010)

- Provide an outlet pool of sufficient depth
- Provide downstream conditions such that adequate depth in the culvert is maintained

With the country's transportation network already well established, new stream crossings will be rare. Rather, replacements and retrofits provide the best opportunities to address the problem. Since most of the culvert infrastructure in the U.S. was installed more than 40 years ago, the design lives of many culverts are expiring, bringing opportunities for solutions and practices that are more compatible with aquatic ecosystems.

Various states and organizations have succeeded in raising funds, replacing impassible culverts, and restoring aquatic habitats while still preserving road and rail networks. Here are four examples that demonstrate the ability to satisfy the human and animal needs of stream crossings.

CASE STUDIES

Broad Brook—Sharon, VT

A culvert on Broad Brook is above its confluence with the White River near Sharon, Vt. Despite the original inclusion of wooden fish baffles, the culvert was undersized and ultimately developed a 1-foot (0.3-meter) perch, hindering the passage of brook trout, rainbow trout, and a variety of nongame fish.

Culvert with perched outlet on Broad Brook

Rock sill constructed to raise outlet pool on Broad Brook

Several groups—White River Partnership, U.S. Fish & Wildlife Service, U.S. Forest Service, Trout Unlimited, Vermont Fish & Wildlife Department, Vermont Department of Environmental Conservation, and the town of Sharon—cooperated to retrofit the culvert by building a rock sill downstream to submerge the outlet. Constructed like a natural stream feature, the culvert now permits fish to pass at a variety of flows.

Heartwellville Brook—Readsboro, VT

At a crossing of Heartwellville Brook near Readsboro, Vt., an original corrugated metal pipe culvert was undersized, constricting the flow and producing high barrel velocities that prevented passage.

The Vermont Agency of Transportation replaced the crossing with a larger concrete box culvert. The new culvert accommodates higher flows and features a natural streambed. Subsequent monitoring revealed that brown trout and brook trout of various sizes could successfully navigate the culvert, and some had even made a home in it.

Original pipe culvert on Heartwellville Brook

Replacement concrete box culvert with natural substrate

The two Vermont projects have been effective since their completion in 2007, as have several others. "Both structures continue to function," said Rich Kirn, a fisheries biologist with the Vermont Fish & Wildlife Department. "We have many examples of these throughout the state."

Shaker Mill Brook—Becket, MA

When a routine inspection in 2007 revealed that a culvert on Shaker Mill Brook at McNerney Road near Becket, Mass., was structurally unsafe, the road was closed immediately.

"The culvert was in bad shape," said Carrie Banks of the Massachusetts Division of Ecological Restoration, "with cracked headwalls and evidence of piping around the structure."

The Massachusetts Department of Transportation selected a prefabricated concrete culvert to accelerate reconstruction of the critical highway. David G. Roach & Sons, TEC, National Park Service, and U.S. Army Corps of Engineers also contributed.

The new structure, completed ahead of schedule in 2009, allows bank-full width and a natural stream bottom, partial rock dams, and plunge pools. Trout, turtles, wood ducks, and otter can now pass freely.

In a test of flood resilience less than two years after its installation, the new crossing withstood tropical storm Irene in 2011, a flow that likely exceeded the 100-year event.

"The stream was able to move water, sediment, and debris, including several large trees, through the crossing during the flood," Banks reported. "Post-flood, the crossing was stable and maintained fish and vehicular passage."

In 2013, Banks' agency sponsored six statewide workshops to educate 400 highway staff, municipal officials, transportation planners, engineers, and others on how to design "fish-friendly and flood-resilient" crossings. They are also working with other groups to "replace undersized culverts with structures that will improve habitat, river connectivity, and flood resilience," Banks says.

| RETHINKING STREAM CROSSINGS FOR HUMANS AND ANIMALS |

Original culvert at Shaker Mill Brook and McNerney Road

Replacement culvert installed on Shaker Mill Brook

Bronson Brook—Worthington, MA

A double-box culvert at Dingle Road on Bronson Brook near Worthington, Mass., was destroyed in 2003 when a flood eroded the banks and gouged a 3-meter (9.8-foot) rift between the culvert and the road.

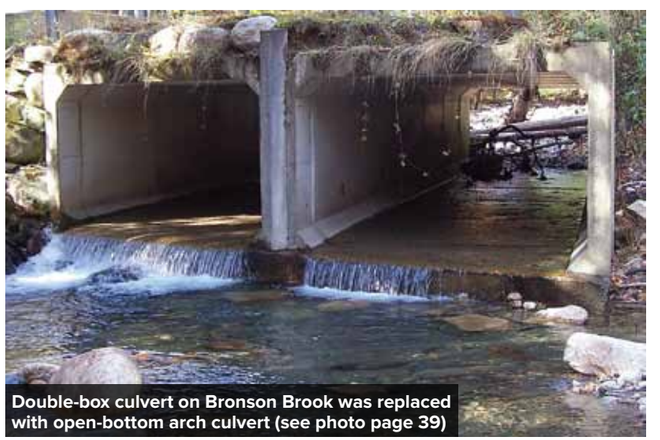
Brian Graber, senior director of American Rivers' River Restoration Program, explained the problem in a news release. "Even before the road failure, the previous culvert was harmful to fish and wildlife. It was suspended above the brook on the downstream end, and the inside of the culvert had less than 1 inch (2.5 centimeters) of water depth."

After the collection of $380,000 from government grants and local donations, the crossing was reconstructed with a 39-foot (12-meter) wide open-bottom arch culvert.

"The project team installed a new fish-friendly culvert that is wider than the brook and is bottomless, allowing fish and wildlife to move through the site as if the road were not even there," Graber said in the news release.

"The Bronson Brook project has performed really well since it was installed," Singler said. The new crossing, more robust than the original, held up in tropical storm Irene in 2011. "It was a great example of the infrastructure and safety benefits of these types of crossings," he added.

Partners included Massachusetts Division of Ecological Restoration, Massachusetts Division of Fisheries and Wildlife, the town of Worthington, Wild & Scenic Westfield River Committee, Westfield River Watershed Association, Connecticut River Watershed Council, The Nature Conservancy, American Rivers, Inter-Fluve Inc., and federal agencies.



Double-box culvert on Bronson Brook was replaced with open-bottom arch culvert (see photo page 39)

CONCLUSIONS

Mobility of aquatic organisms is essential to healthy ecosystems. These four examples demonstrate how culverts can be retrofitted or redesigned to allow this mobility. Successful projects involved public, private, and community partners with a desire to reconnect aquatic habitats while maintaining human uses at each crossing.

Banks is pleased with how stream crossings are earning more attention. "In regards to progress on stream crossings, in the last 10 years, there has been a substantial increase in awareness of how our road and stream networks intersect," says Banks.

While culverts represent a problem for many fisheries, opportunities to reverse this trend continue to arise as aged culverts need to be replaced. This can be accomplished through targeted local projects or with planned infrastructure improvements for transportation or flood control. Each crossing is unique and requires the cooperation of both technical experts and community stakeholders for the best solution.

ACKNOWLEDGEMENTS

- Rollin H. Hotchkiss, Brigham Young University
- Betsy Colburn, Harvard University
- Rich Kirn, Vermont Fish & Wildlife Department
- Brian Graber and Amy Singler, American Rivers
- Carrie Banks, Massachusetts Division of Ecological Restoration

REFERENCES

- Baker, C. O.; Votapka, F. E. (1990) Fish Passage through Culverts. Technology and Development Center, U.S. Department of Agriculture, U.S. Forest Service
- Banks, C. (2015) Personal communication, Jan. 5.
- Behlke, C. E.; Douglas, K. L.; McLean R. F.; Travis, M.D. (1991) "Fundamentals of Culvert Design for Passage of Weak-Swimming Fish." Final report to Alaska Department of Transportation and Public Facilities
- Connecticut Department of Environmental Protection (2008) "Stream Crossing Guidelines." Inland Fisheries Division, Habitat Conservation and Enhancement Program
- Forman, R. T. T. (2000) "Estimate of the Area Affected Ecologically by the Road System in the United States." Conservation Biology 14 (1): 31–35
- Forman, R. T. T.; Deblinger, R. D. (2000) "The Ecological Road-Effect Zone of a Massachusetts (U.S.A.) Suburban Highway." Conservation Biology 14 (1): 36–46
- Foster, H. R; Keller, T. A. (2011) "Flow in Culverts as a Potential Mechanism of Stream Fragmentation for Native and Nonindigenous Crayfish Species." Journal of the North American Benthological Society 30 (4): 1129–1137
- Graber, B. (2008) "State and Non-Profit Partners Complete Restoration of Bronson Brook in Worthington, MA." American Rivers. Press release, Dec. 29
- Graber, B. (2014) Personal communication, Dec. 18
- Jessen, K. (2011) "Conservation Award for MassDOT Bridge Project." MassDOT Blog, Nov 17. blog.mass.gov/transportation/massdot-highway/massdot-highway-district-honored
- Kilgore, R. T.; Bergendahl, B. S.; Hotchkiss, R. H. (2010) "Culvert Design for Aquatic Organism Passage." Hydraulic Engineering Circular No. 26, first edition. U.S. Department of Transportation, Federal Highway Administration
- Kirn, R. (2014) Personal communication, Dec. 10.
- Maine Department of Transportation (2004) "Fish Passage Policy and Design Guide: Design Guide for Fish Passage through Culverts"
- Metsker, H. E. (1970) "Fish versus Culverts: Some Considerations for Resource Managers" Engineering Technical Report 7700-5. U.S. Department of Agriculture, U.S. Forest Service
- Singler, A. (2014a) "Why Did the Fish Cross the Road?" American Rivers. The River Blog, Oct. 15. americanrivers.org/blog/why-did-the-fish-cross-the-road
- Singler, A. (2014b) Personal communication, Dec. 18
- Singler, A.; Graber, B.; Banks, C. (eds.) (2012) "Massachusetts Stream Crossings Handbook." 2nd ed. Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Fish and Game, Division of Ecological Restoration
- Tillinger, T. N.; Stein, O. R. (1996) "Fish Passage Through Culverts in Montana: A Preliminary Investigation." Final report to the Montana Department of Transportation and U.S. Department of Transportation, Federal Highway Administration
- Trombulak, S. C.; Frissell, C. A. (2000) "Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities." Conservation Biology 14 (1): 18–30
- University of New Hampshire (2009) "New Hampshire Stream Crossing Guidelines"
- VC&PB (Venner Consulting and Parsons Brinkerhoff) (2004) Section 3.5, "Culverts and Fish Passage," in Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance. Final Report for National Cooperative Highways Research Program Project 25-25, Task 4, Transportation Research Board
- VFWD (Vermont Fish & Wildlife Department) (2010) "Vermont Stream Crossing Handbook."
- Watts, F. J. (1974) "Design of Culvert Fishways." Water Resources Research Institute, University of Idaho
- WSDOT (Washington State Department of Transportation). 2013. Fish Passage Barrier Inventory: Progress Performance Report, July 2013

ABOUT THE AUTHOR

- Robert Sowby is a project engineer at Hansen, Allen & Luce, Inc., in Salt Lake City, Utah, and a former researcher at Massachusetts Institute of Technology in Cambridge, Mass.

Tools to assist Cape Cod communities reach sustainable nitrogen reduction goals—technologies matrix and adaptive management practices

THOMAS PARECE, P.E.; MARK OWEN, PG; and BETSY SHREVE-GIBB, AICP, AECOM
PAUL NIEDZWIECKI; KRISTY SENATORI; and ERIN PERRY, Cape Cod Commission
SCOTT HORSLEY, Consultant

ABSTRACT | As the population of Cape Cod has increased, so has the volume of nutrients entering coastal waters and freshwater ponds. The population has increased by about 60 percent since the completion of the Area Wide Water Quality Management Plan, developed in 1978 under Section 208 of the Federal Clean Water Act by the Cape Cod Planning and Economic Development Commission (CCPEDC), the predecessor to the Cape Cod Commission. This population increase led to an increase in wastewater flows, applications of fertilizers, and stormwater runoff with corresponding increases in nitrogen and phosphorus entering coastal and fresh waters in the region. About 85 percent of the wastewater generated on Cape Cod is treated by on-site Title 5 septic systems that do not adequately remove nutrients, discharging them directly to the groundwater that feeds estuaries, lakes, and ponds.

In 2013, the Massachusetts Departmental of Environmental Protection (MassDEP) tasked the Cape Cod Commission with updating Section 208 of the Clean Water Act that requires "…areas with substantial water problems develop a water management plan to control pollution on a regional or 'area-wide' basis." To help communities address water quality impairment cost-effectively, and in an environmentally sound and sustainable way, a water quality Technologies Matrix was developed, consisting of a range of 45 technologies that can reduce nitrogen.

KEYWORDS | Regional planning, nutrient removal, traditional and non-traditional wastewater management technologies, adaptive management, and technology resource guide

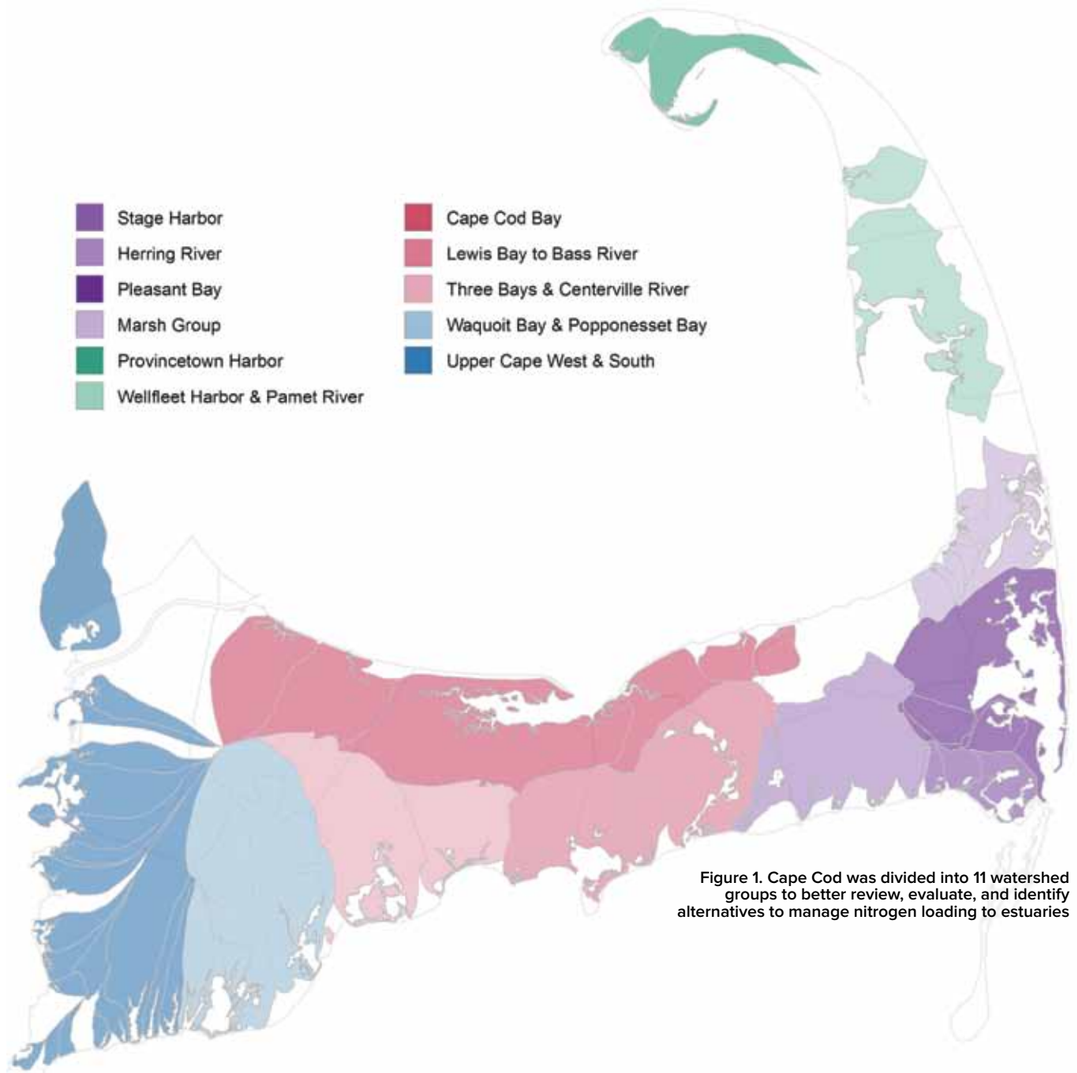


Figure 1. Cape Cod was divided into 11 watershed groups to better review, evaluate, and identify alternatives to manage nitrogen loading to estuaries

BACKGROUND

The Area Wide Water Quality Management Plan developed in 1978 identified increasing residential densities and a threefold summer population influx as the cause of isolated water quality and wastewater management problems. It anticipated that future growth, primarily in more inland areas where most public water supply wells are located and along the shores of the Cape's many inland ponds, threatened to cause more serious groundwater contamination and increased eutrophication in surface waters. As part of the update to the plan, Cape Cod was divided into 11 watershed groups to better review, evaluate, and identify alternatives to manage nitrogen loading to estuaries (see Figure 1).

A decade of discussions about water quality problems in the estuarine systems produced divergent perspectives on potential solutions. The background of Cape Cod and the specific problems are illustrated to the right. In addition, Cape Cod communities would like to explore the use of non-traditional technologies and approaches for water quality restoration due primarily to cost considerations. To update the 1978 plan an effort was made to identify all available technologies that communities could consider. As a result, the Technologies Matrix was developed.

Cape Cod background and problem summary

BACKGROUND
- 105 Watersheds
- 57 Embayment Watersheds
- 994 Ponds
- Sole Source Aquifer
- Development over Time
- Increased Nutrient Loads
- MEP Studies and TMDLs
- Section 208 Update

PROBLEM
- Estuaries Nitrogen Sensitive
- Ponds Phosphorus Sensitive
- Eutrophication
- Economic Impacts (Tourism)
- Cost of Nutrient Removal

To provide an unbiased starting point, the broadest range of traditional and non-traditional technologies and policies are considered for Cape Cod watersheds. Not every technology is suitable for every watershed. The Technologies Matrix of options represents the best information available for each potential nutrient intervention, including existing cost, performance, sustainability criteria, and permitting analysis.

ADAPTIVE MANAGEMENT

The proposed adaptive management framework enables a thorough vetting of new technologies while maintaining a secure foundation of proven traditional technologies. The plan provides a thoughtful process for integrating emerging and non-traditional technologies with traditional practices. Applying this approach, each watershed will develop a targeted adaptive management plan that encompasses carefully planned practices that meet the specific nutrient management targets for the watershed as cost-effectively and beneficially as possible.

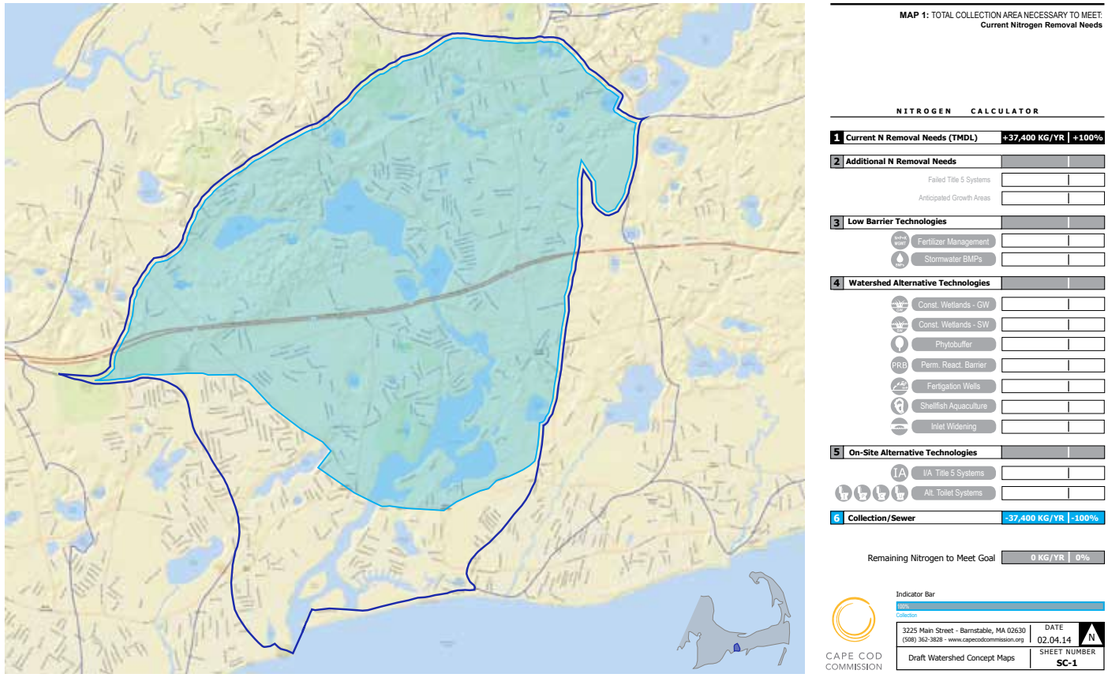
Each watershed plan will include a set of traditional and non-traditional practices to meet identified nutrient reduction targets, or total maximum daily loads (TMDLs), and desired water quality goals. Ultimately, a combination of these practices may be the optimal situation.

The adaptive management process optimizes this combination of technologies. In some watersheds a traditional sewering plan may be identified for construction during the first phase of implementation to address significant Title 5 compliance issues and/or identified growth zones. Future expansion of this core collection system will be planned and will serve as the backup plan for future phases of the watershed plan if the non-traditional practices do not perform as anticipated. See Figures 2, 3, and 4 for an example of the adaptive management approach.

This adaptive management framework is in 5-year increments. This period allows 2 years for the design, permitting, and construction of technologies and a minimum 3-year testing period. After each 5-year period, the performance of deployed technologies is evaluated. This evaluation will include the nutrient removal achieved, cost-effectiveness of the technology, and any associated benefits identified.

Technologies that meet the identified objectives can continue to be used and additional installations may be implemented in the watershed. In instances of partial success, potential adjustments and improvements may be evaluated and, if appropriate, that technology may continue to be applied. When poor performance is realized, further application of that technology will be discontinued or modified.

Figures 2. Sample Cape Cod subwatershed



TOWN OF YARMOUTH MASSACHUSETTS

MAP 1: TOTAL COLLECTION AREA NECESSARY TO MEET:
Current Nitrogen Removal Needs

NITROGEN CALCULATOR

1	Current N Removal Needs (TMDL)	+37,400 KG/YR	+100%
2	Additional N Removal Needs		
	Failed Title 5 Systems		
	Anticipated Growth Areas		
3	Low Barrier Technologies		
	Fertilizer Management		
	Stormwater BMPs		
4	Watershed Alternative Technologies		
	Const. Wetlands - GW		
	Const. Wetlands - SW		
	Phytobuffer		
	Perm. React. Barrier		
	Fertigation Wells		
	Shellfish Aquaculture		
	Inlet Widening		
5	On-Site Alternative Technologies		
	I/A Title 5 Systems		
	Alt. Toilet Systems		
6	Collection/Sewer	-37,400 KG/YR	-100%
	Remaining Nitrogen to Meet Goal	0 KG/YR	0%

Indicator Bar
100%
Collection

CAPE COD COMMISSION

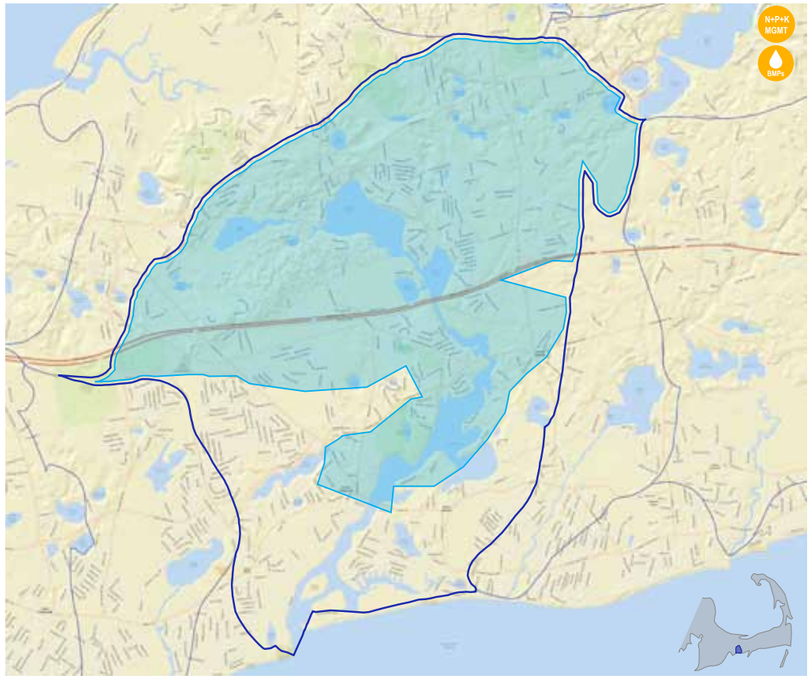
3225 Main Street - Barnstable, MA 02630
(508) 362-3828 - www.capecodcommission.org

DATE 02.04.14

Draft Watershed Concept Maps

SHEET NUMBER SC-1

Figure 3. Sample Cape Cod subwatershed



TOWN OF YARMOUTH MASSACHUSETTS

MAP 3: TOTAL COLLECTION AREA NECESSARY TO MEET:
Current Nitrogen Removal Needs
+ Additional Future Nitrogen Removal Needs
- Low Barrier Technologies

NITROGEN CALCULATOR

1	Current N Removal Needs (TMDL)	+37,400 KG/YR	+93.5%
2	Additional N Removal Needs	+2,600 KG/YR	+6.5%
	Failed Title 5 Systems	+600 KG/YR	+1.5%
	Anticipated Growth Areas	+2000 KG/YR	+5%
3	Low Barrier Technologies	-10,000 KG/YR	-25%
	Fertilizer Management	-5,000 KG/YR	-12.5%
	Stormwater BMPs	-5,000 KG/YR	-12.5%
4	Watershed Alternative Technologies		
	Const. Wetlands - GW		
	Const. Wetlands - SW		
	Phytobuffer		
	Perm. React. Barrier		
	Fertigation Wells		
	Shellfish Aquaculture		
	Inlet Widening		
5	On-Site Alternative Technologies		
	I/A Title 5 Systems		
	Alt. Toilet Systems		
6	Collection/Sewer	-30,000 KG/YR	-75%
	Remaining Nitrogen to Meet Goal	0 KG/YR	0%

Indicator Bar
75% 50%
Collection Low Barrier

CAPE COD COMMISSION

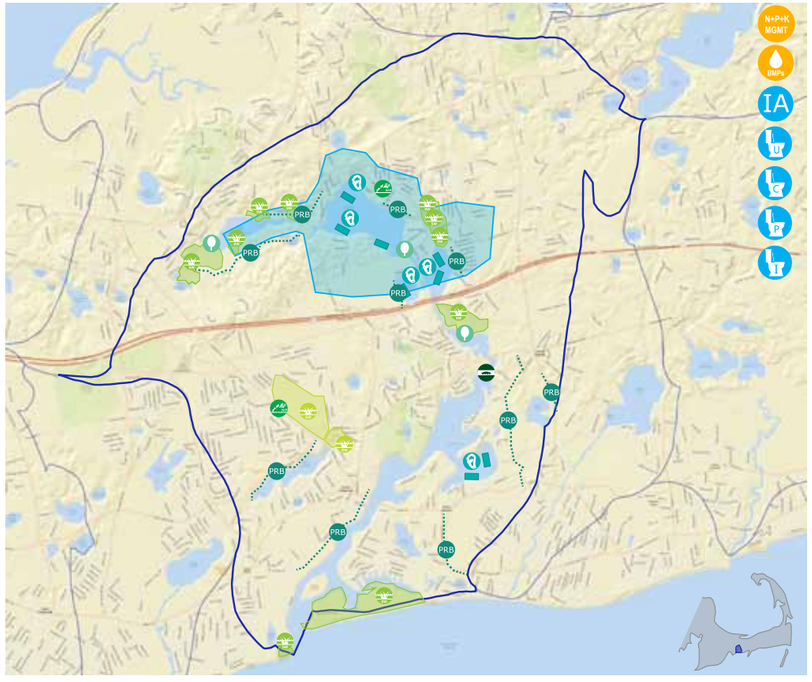
3225 Main Street - Barnstable, MA 02630
(508) 362-3828 - www.capecodcommission.org

DATE 02.04.14

Draft Watershed Concept Maps

SHEET NUMBER SC-3

Figure 4. Sample Cape Cod subwatershed



TOWN OF YARMOUTH MASSACHUSETTS

MAP 5: TOTAL COLLECTION AREA NECESSARY TO MEET:
Current Nitrogen Removal Needs
+ Additional Future Nitrogen Removal Needs
- Low Barrier Technologies
- Watershed Alternative Technologies
-On-Site Alternative Technologies

NITROGEN CALCULATOR

1	Current N Removal Needs (TMDL)	+37,400 KG/YR	+93.5%
2	Additional N Removal Needs	+2,600 KG/YR	+6.5%
	Failed Title 5 Systems	+600 KG/YR	+1.5%
	Anticipated Growth Areas	+2000 KG/YR	+5%
3	Low Barrier Technologies	-10,000 KG/YR	-25%
	Fertilizer Management	-5,000 KG/YR	-12.5%
	Stormwater BMPs	-5,000 KG/YR	-12.5%
4	Watershed Alternative Technologies	-22,100 KG/YR	-55.25%
	Const. Wetlands - GW	-3,000 KG/YR	-7.5%
	Const. Wetlands - SW	-4,000 KG/YR	-10%
	Phytobuffer	-100 KG/YR	-.25%
	Fertigation Wells	-600 KG/YR	-1.5%
	Shellfish Aquaculture	-10,000 KG/YR	-25%
	Perm. React. Barrier	-3,900 KG/YR	-9.75%
	Inlet Widening	-500 KG/YR	-1.25%
5	On-Site Alternative Technologies	-2,800 KG/YR	-7%
	I/A Title 5 Systems	-0 KG/YR	-0%
	Alt. Toilet Systems	-2,800 KG/YR	-7%
6	Collection/Sewer	-5,100 KG/YR	-12.75%
	Remaining Nitrogen to Meet Goal	0 KG/YR	0%

Indicator Bar
12.75% 25% 55.25% 7%
Collection Low Barrier Watershed Alternative On-site

CAPE COD COMMISSION

3225 Main Street - Barnstable, MA 02630
(508) 362-3828 - www.capecodcommission.org

DATE 02.04.14

Draft Watershed Concept Maps

SHEET NUMBER SC-5

Overall water quality improvements at the established sentinel monitoring stations are also evaluated. This information will be integrated with the technology performance to determine next steps in the implementation of the watershed plan.

To recognize the complexity of implementing a monitoring and adaptive management plan, the following is recommended for locally developed adaptive management plans and should be incorporated into regulatory approvals and permits:

- A technical review panel to meet regularly and comprising local, regional, and state representatives
- Pilot project design, development, and monitoring
- Targeted watershed project funding, design, construction, and permit compliance
- Compliance monitoring including baseline water quality and habitat monitoring for estuaries

DECISION SUPPORT TOOLS

Several decision support tools to facilitate the creation of watershed scenarios were developed. These tools make complex data sets easier to understand and increase informed deliberation locally and regionally. This will expedite the selection and implementation of watershed solutions. See Figure 5 for a tools overview.

TECHNOLOGIES MATRIX

The technologies and approaches included in the Technologies Matrix address nutrients by means of reduction, remediation, and restoration, and are implementable in scales ranging from on-site, neighborhood, watershed, and Cape-wide. An overview of the technologies by scale and their means of addressing nutrients are presented in Figure 6.

The Technologies Matrix has been developed using input from the Cape Cod Commission's Panel on Technologies, the Cape Cod Water Protection Collaborative's Technical Advisory Committee, various federal, Massachusetts, and local regulatory agencies, special interest groups, and the public.

The Technologies Matrix summarizes in one place information that can serve as a starting point to help Cape Cod communities evaluate various nutrient mitigation alternatives through adaptive management to address their water quality issues. It should be used as an educational tool to understand the benefits, design requirements, and regulatory considerations of the nutrient mitigation technologies, along with their order-of-magnitude costs, which must be adjusted based on local/site-specific conditions.

The matrix is used to estimate the net nitrogen load addressed by technology presented while the Watershed Calculator estimates the net nitrogen load addressed from the watershed and compares it to the required nitrogen removal target.

Table 1 summarizes the technologies in the Technologies Matrix while Table 2 summarizes the components in the matrix.

USER INFORMATION FOR THE TECHNOLOGIES MATRIX

The Technologies Matrix is a primary source of information that should be updated based on continued research and development of water technologies and

FIGURE 5. DECISION SUPPORT TOOLS

WatershedMVP (Multi-Variant Planner)
A dynamic web-based, geospatial scenario planning tool developed by the Cape Cod Commission that allows technical experts and the public to compare various traditional and non-traditional options across neighborhood, watershed, and subregional levels.

Financial Model
Estimates the total cost to build, finance, and operate a proposed set of wastewater solutions and determine if it is affordable to households and within the financial capacity of towns affected, and evaluates potential revenue sources to pay for the scenario proposed.

Watershed Tracker
A companion tool to WatershedMVP, the Watershed Tracker tracks parcel-specific nutrient loads to subembayments within a watershed.

Watershed Calculator
A tool used in the adaptive management framework to track cumulative nitrogen reductions through the layered application of technologies in specific watersheds to meet reduction targets.

Technologies Matrix
A flexible, dynamic, and continually updated source of information on available technologies for collection, treatment, disposal, and solids processing, and their applicability to Cape Cod.

Site Screening GIS Viewer for Non-Traditional Technologies
A GIS-based analysis of non-traditional technologies and approaches to weigh potential nitrogen attenuation enhancements, improvements to green infrastructure networks, and conditions necessary to maximize effectiveness.

Barnstable County Cost Report Update (BCCR)
An update to the 2010 Barnstable County Wastewater Cost Task Force report on Cape-wide collection, treatment, and disposal costs to aid with financial decisions in the update to the §208 WQM Plan.

Figure 6. An overview of the technologies by scale and their means of addressing nutrients

Table 1. Summary of technologies

NON-TRADITIONAL TECHNOLOGIES
- Aquaculture
- Chemical Treatment of Ponds
- Coastal Habitat Restoration
- Compact and Open Space Development
- Constructed Wetlands
- Turf and/or Bog Fertigation
- Fertilizer Management
- Floating Constructed Wetlands
- Hydroponic Treatment
- Inlet/Culvert Widening
- Permeable Reactive Barriers (PRBs)
- Phytoirrigation
- Phytoremediation
- Pond and Estuary Circulators
- Pond and Estuary Dredging
- Remediation of Existing Development
- Select Stormwater BMPs
- Surface Water Remediation Wetlands
- Transfer of Development Rights
- Waste Reduction Toilets

COLLECTION SYSTEMS
- Gravity Sewers
- Low Pressure Sewers
- Septic Tank Effluent Gravity (STEG)
- Septic Tank Effluent Pumping (STEP)
- Vacuum Sewers

TREATMENT
- Advanced Treatment
- Cluster Treatment System—Single-stage
- Cluster Treatment System—Two-stage
- Conventional Treatment
- Innovative/Alternative (I/A) Systems
- Innovative/Alternative (I/A) Enhanced Systems
- Satellite Treatment
- Satellite Treatment - Enhanced
- Title 5

EFFLUENT DISPOSAL
- Drip Irrigation
- Infiltration Basin
- Injection Well
- Ocean Outfall
- Soil Absorption System (SAS)
- Wick Well

BIOSOLIDS
- Commercial Disposal
- Composting
- Dewater and Haul to Landfill
- Digestion
- Drying and Gasification
- Incineration
- Lime Stabilization
- Septage Disposal
- Thermal Drying

Table 2. Summary of technologies matrix components
- Technology/Strategy
- Description
- Influent Source and Concentration
- Pollutant Treated/Reason for Use
- Potential Permitting Agencies
- Siting Requirements
- Flow and Nutrient Influent Load
- Nutrient Reduction
- Impact on Surface Water Quality
- Nutrient Removed per Year
- Unit Metric
- Reduction per Planning Period
- Construction, Project and O&M Costs
- System Considerations
- Average Life Cycle Cost
- Cost per Kg of Nutrient Reduction
- Advantages/Disadvantages
- Eco Services: Habitat, Green Space, Energy Savings
- Monitoring
- References

modeling. Adaptive nutrient management planning therefore depends on a regional monitoring program that provides performance monitoring, policies and compliance monitoring, and measurement of the collective effectiveness of permitted watershed nutrient mitigation strategies.

When selecting technologies watershed site-specific conditions must be considered and evaluated. As an example, the unit costs for decentralized options that involve on-site or local disposal must be combined with an estimate of the additional nitrogen removal required by in-watershed disposal. Although cost and performance are important, the ability to permit and implement that option is important and site specific. In addition, selection of a watershed solution depends on the type, amount, and accuracy of the information available.

Redundancy and reliability standards are typically incorporated into traditional technology reviews by regulators. Redundancy and reliability of non-traditional technologies will be based on technology-specific considerations and, therefore, must be reviewed with the regulatory agencies to fully understand the technology requirements, and associated project and operation and maintenance (O&M) costs.

Although the Technologies Matrix has a contingency incorporated into the project costs, the user should consider adjusting the contingency when developing options, incorporating site-specific information, and identifying the risks for the options. Some of the technologies in the Technologies Matrix may not work as a single solution but are required to be coupled with other technologies and, therefore, may or may not be able to be compared directly to other technologies that are self-standing.

For example, the user must assemble various costs (collection, treatment, and disposal, for example) to make a fair comparison between approaches that require collection and off-site disposal versus those that involve on-site treatment and disposal. The Technologies Matrix summarizes the infrastructure to consider when designing and pricing various technologies and approaches.

In general, the Technologies Matrix does not express cost savings realized through economies of scale. However, economy of scale is factored in with some technologies, as a cost curve is used for construction costs. These include both traditional technologies and non-traditional technologies, such as centralized treatment, satellite treatment, permeable reactive barriers, and constructed wetlands.

TECHNOLOGY DESCRIPTIONS

A brief description of each technology is included in the Technologies Matrix, based on the information available at the time of this §208 Plan Update submission. These descriptions are intended as a narrative overview for the reader of a few elemental characteristics of each technology. Each section discusses how the technology works; how the technology performs, expressed as a range of nitrogen removal percentages; potential performance challenges, including siting constraints; examples of applications of the technology, including where they may have been implemented on Cape Cod; and the costs of implementation, operations, and maintenance. When a technology provides meaningful co-benefits not otherwise quantified, these are discussed briefly. Additional information, including more specific siting characteristics, regulatory considerations, and references, can be found in the matrix as well. Over time the Technologies Matrix (or the tool or reference document that succeeds it) will be the best source of current data, removal rates, and references.

GENERAL NOTES AND ASSUMPTIONS

The following summarizes information and assumptions in the Technologies Matrix:

- The Technologies Matrix and other nitrogen reduction tools should be applied by a professional with an understanding of the technologies, permitting, and goals of the town(s)/watershed group(s).
- Various references, notes, and assumptions used to develop the information for each technology.
- Pollutant removal ranges for nitrogen and phosphorous based upon actual case studies.
- The general requirements that need to be considered when siting the technology. The user must understand that the siting requirements will be site-specific, requiring additional engineering to determine if a technology is applicable to a specific location.
- The annual average household wastewater flow on Cape Cod of 160 gallons (600 liters)/household/day, which is based on water use records. This flow was used throughout the matrix.
- Assumptions about various nitrogen input concentrations, based on influent source flow. The nitrogen input concentration will vary based on the wastewater generation location versus wastewater effluent that has been released into the environment. The effluent nitrogen from the technology depends on the technology applied. The total nitrogen reduction for the technology is: specified input concentration minus the effluent nitrogen concentration.
- Nutrient (nitrogen and phosphorous) percent removal is the estimated low to high range considering actual operating facilities/technologies, and pilot testing and research for the technology. Important—the closer the range of percent removals, the higher the predictability of the technology to reduce nutrients. These ranges are expected to be reduced through additional pilot project testing.
- The nitrogen reduction percent is used to estimate the cost per pound or kilogram of nitrogen reduced. In other words, the cost per pound or kilogram of nitrogen removed is: the present value of estimated project cost and annual operation and maintenance costs divided by the influent load specified minus the effluent nitrogen load. The net reduction from a specific technology would be the specified influent nitrogen load minus the effluent nitrogen load resulting from installing and properly operating a selected technology.
- The Technologies Matrix assumes a baseline input of 26.25 milligrams per liter (mg/L) from Title 5 septic systems. This input is based on the Massachusetts Estuaries Project (MEP) assumptions. This 26.25 mg/L of nitrogen assumes nitrogen reduction of approximately 30 percent from both the Title 5 septic system and treatment in the subsurface soils between the septic system discharge and the water table.
- The net nitrogen reduction from a specific technology is the decrease in nitrogen from the Title 5 septic system baseline of 26.25 mg/L and the additional reduction achieved by installing and operating the technology.
- Quantities/unit costs are based on the following: (a) Pricing as of March 2014 (no escalation was included); (b) Construction costs include contractor's overhead, profit, general condition costs, etc. (estimated at 20 percent); (c) Project cost equals the construction cost plus 40 percent for engineering (design and construction engineering), municipal administrative, legal costs and contingency; (d) Pricing does not include considerations for site-specific conditions or items such as hazardous materials; (e) Accuracy is assumed to be plus or minus 15 percent; and (f) In providing these estimated costs, it is understood that the developers of the Technologies Matrix have no control over costs of labor, materials, equipment, or services furnished by others or over market conditions or contractors' methods of determining prices, and that any evaluation of alternatives to be constructed or work to be performed is speculative. Accordingly, there is no guarantee that proposals, bids, or actual costs will not vary from cost information provided herein.
- The land cost is based on the Barnstable County Cost Report (BCCR) Update (2014) estimate of $250,000 per acre ($617,500 per hectare).
- The construction and O&M costs for cluster treatment systems—single-stage, conventional treatment, and satellite treatment facilities are based on the cost curve in the BCCR Update (2014). The construction and O&M costs for cluster treatment system—two-stage, advanced treatment, and satellite treatment—enhanced facilities are based on the same cost curve plus a 20-percent factor for the higher level of treatment.
- The construction and O&M costs for constructed wetlands (surface flow and horizontal subsurface flow) are based on the cost curve in Appendix E of the BCCR Update (2014).
- The construction and O&M costs for permeable reactive barriers (PRBs) (both trench and injection well methods) are based on the cost curve in Appendix F of the BCCR Update (2014). Specific inputs include: (a) length of the PRB; and (b) influent nitrogen concentration.
- Adjustment factors are included for some technologies to anticipate pilot testing that may be necessary for refinement of the performance and cost data presented. Each adjustment factor increases or decreases the project and O&M costs by 10 percent to account for the relative complexity of the technology, local oversight, extensive permitting, pilot testing to satisfy regulatory compliance, and compliance (long-term) monitoring, etc.
- There are many potential impacts of climate change. The primary impacts examined in this plan, characterized as "system resilience," consist of the impact on the technology during sea level rise and flooding conditions (i.e. nitrogen release, pathogen release, timely ability to replace/begin operation). Other potential impacts considered include increased air and ocean temperatures, but these will have little effect on system resiliency of the technologies considered. It is possible that over time increased air and ocean temperatures will improve performance of biological communities through lengthened growing seasons. Higher water table conditions may also enhance the performance of constructed wetlands (that are built in water table conditions) and permeable reactive barriers (by increasing the effective saturated thickness that is captured).
- Eco-services are considered ecological and social co-benefits of a technology and are referenced in the matrix. A cost offset of a benefit is not included in the technology cost analysis, but the environmental and social eco-services that a technology provides should be considered when selecting a technology. Elements of eco-services include total nitrogen and phosphorus, carbon sequestration, sediment accretion, water filtration, habitat restoration, bioturbation, bioremediation, and biodiversity.
- Monitoring of a technology will generally occur over the life of the system. Monitoring of most of the traditional and non-traditional technologies will be required to confirm nitrogen removal

capacities of each technology. The length of this monitoring period is estimated. Annual monitoring costs are included in the annual O&M cost estimates.

- The O&M costs for non-traditional technologies include both pilot test (short-term) monitoring and compliance (long-term) monitoring. Pilot test monitoring generally represents 2 to 3 years of site-specific monitoring. This may involve frequent monitoring and/or monitoring in multiple locations, depending on the technology. Pilot test monitoring helps establish nitrogen load reduction as well as the efficiency with which the non-traditional technology works. Compliance monitoring is generally used to establish progress in meeting water quality goals in the receiving water body. Compliance monitoring, with respect to specific technologies, is used to monitor the long-term effects of the technology. Based on compliance monitoring results (if technology performance drops or increases over time), adjustments can be made to the technology or reliance on a new technology can be established if necessary.

CONCLUSIONS

To help communities address water quality impairment cost-effectively and in an environmentally sound and sustainable manner, a Technologies Matrix was developed. The Technologies Matrix provides information on nitrogen mitigation technologies that include traditional and non-traditional technologies.

The Technologies Matrix is a single source of information that can be used by town officials, stakeholders, and citizens within the watersheds affected. The Technologies Matrix will be updated annually as additional information becomes available through national research, international research, and direct application of these technologies as pilot projects on Cape Cod.

A proposed use of the Technologies Matrix is to assist in adaptive management, a strategy that encourages the pilot testing of non-traditional technologies, monitoring the efficiency of the new technologies, and over time modifying the nitrogen reduction plan through application of both non-traditional and proven traditional technologies. Applying this approach, communities in each Cape Cod watershed can develop an adaptive management plan that meets the specific nutrient management targets for the watershed.

ACKNOWLEDGEMENTS

- Beacon Strategies Group
- Cape Cod Water Protection Collaborative
- Consensus Building Institute
- Creative Strategies & Communications
- Mark Fahey Website Design
- New England Waste Systems
- Offshoots, Inc.
- Regina Villa Associates, Inc.
- The Abrahams Group
- Water Resources Associates
- Watershed Working Groups

ABOUT THE AUTHORS

- Thomas Parece, P.E., is an associate vice president at AECOM and is responsible for the planning, design and construction of wastewater collection and treatment systems in addition to being an active member of NEWEA's Water Reuse Committee and member of various MassDEP technical advisory committees.
- Mark Owen, PG, is a project hydrogeologist and project manager at AECOM and is responsible for groundwater resource investigations, groundwater discharge (effluent disposal of treated wastewater) evaluations, and groundwater contamination studies throughout New England.
- Betsy Shreve-Gibb, AICP, is a vice president at AECOM and manages and directs environmental quality and water resources programs for communities in the northeastern U.S., including managing regulatory compliance for controversial water and wastewater infrastructure projects.
- Paul Niedzwiecki, is the executive director of the Cape Cod Commission (Barnstable, Mass.) and leads the agency in fulfilling its mission, "Keeping a special place special" by protecting the natural environment, enabling economic growth, increasing transparency, and encouraging community engagement.
- Kristy Senatori is a deputy director at the Cape Cod Commission (Barnstable, Mass.) and leads the commission's Strategic Information Office and the information, innovation and geo-design departments as well as leading regionalization efforts and smarter government initiatives.
- Erin Perry is a special projects coordinator in the Water Resources Department of the Cape Cod Commission (Barnstable, Mass.) and leads the commission's development of the §208 WQM Plan Update to Section 208 of the Federal Clean Water Act.
- Scott Horsley is a consulting hydrologist and serves as a consultant to the Cape Cod Commission through AECOM. He is also a partner in the consulting firm Horsley Witten Group, Inc., and serves as adjunct faculty at Tufts University and Harvard Extension School.

GOVERNMENT AFFAIRS

NEWEA Goes to Washington

by Peter Grose, Chair, NEWEA Government Affairs Committee

NEWEA members traveled to Washington, D.C., during National Water Week to make a pitch to our senators and congressmen for support of clean water in New England and our nation. We had three objectives on this trip:

- Explain to our federal legislators what is important to us as water quality professionals
- Learn more about the status of clean water legislation
- Build relationships

The signature event was our 2015 Congressional Clean Water Briefing, held in the Rayburn House Office Building on April 15. Our speakers included legislators, regulators, utilities, and water organizations. Massachusetts 6th District Representative Seth Moulton spoke as a new congressman about his hopes for bipartisan support for infrastructure investments, while Representative James McGovern (Massachusetts 3rd District, and our event sponsor) provided a more experienced and cautious view of the political landscape at the Capitol. Senator Sheldon Whitehouse (Rhode Island) attended the breakfast and spoke briefly in support of clean water, but with concern for the challenges in congress. Sid Holbrook, executive director of the Greater New Haven Water Pollution Control Authority, provided his perspectives as a former Connecticut state representative and Department of Environmental Protection commissioner, and now regional utility leader, including the importance of personal respect and communications with others. Curt Spalding, Environmental Protection Agency (EPA) Region I administrator, told us about the significance of iconic waterways in New England and the importance of revitalization of our communities. We heard from Susan Sullivan, deputy director of the New England Interstate Water Pollution Control Commission (NEIWPCC), about the differing roles of NEIWPCC and NEWEA, and some important water issues facing us today. NEWEA President Matt Formica summarized NEWEA's state legislative events and other NEWEA initiatives, and Rick Warner, vice president of the Water Environment Federation (WEF), provided insights from WEF and his water utility in drought-stricken Nevada, as well as his appreciation for NEWEA's activities as one of the premier WEF member associations.

Representative James McGovern
Mass. 3rd District, and our event sponsor

A specific "ask" was that Congress fully fund the Clean Water State Revolving Fund (CWSRF) at $1.45 billion

Our other major activity for getting our message out and strengthening relationships with our legislators were the meetings we had on Capitol Hill. Our NEWEA contingent was busy April 14 and 15, meeting with 25 senators, representatives, and their aides. We had a set of NEWEA talking points so that we were relaying consistent messages to Congress. Our major point was the importance of investing in water and wastewater infrastructure to protect water quality, support economic vitality, and create jobs. A specific "ask" was that Congress fully fund the Clean Water State Revolving Fund (CWSRF) at $1.45 billion, which has been the budget amount for several years now (despite growing needs), rather than the significantly reduced CWSRF request from EPA of $1.12 billion.

NEWEA's annual trip to Washington during National Water Week provides an important link between the work that we do to protect and preserve our water resources and the national level policy makers

Other funding-related requests include $25 million for the Water Infrastructure Finance and Innovation Act (WIFIA) and $13 million for integrated planning. (NEWEA recently signed on with WEF, the National Association of Clean Water Agencies (NACWA), and many other state and regional organizations in a letter to congressional leaders urging support for these three budget items.)

While at these meetings we offered, as NEWEA members, to serve as "boots on the ground" for providing information and insights to our federal elected officials and their aides.

The NEWEA Congressional Briefing was coordinated with the National Water Policy Fly-in again this year. This event was sponsored by WEF, NACWA, the Water Environment Research Foundation (WERF), and WateReuse, which brought in visitors from across the country to engage Congress with activities similar to our own. Four of us from NEWEA attended an informative legislative issues briefing conducted by WEF and NACWA on April 13, which helped expand our knowledge and reinforce the talking points we had developed in advance. We also heard from author and American Enterprise Institute scholar Norm Ornstein at this briefing, whose often-humorous observations about the current state of Congress were notably critical.

NEWEA members also attended the NACWA/WEF Congressional Reception on April 14, which included three representatives from key congressional committees as speakers. We also discussed water quality and government affairs issues with our counterparts from other states and regions at this reception.

Mass. 6th District
Representative Seth Moulton

NEWEA's annual trip to Washington during National Water Week provides an important link between the work that we do to protect and preserve our water resources and the national level policy makers who set the overall course and budgets for the water environment. This national level interaction dovetails with events each spring in all six New England states with the NEWEA-affiliated state associations and our state legislators. These events focus on the particular water issues faced by each state. By working together we can make our opinions known, learn from the wider legislative, regulatory, and advocacy communities, and build stronger relationships between these segments and within NEWEA itself.

AWARDS

New England Stormwater Collaborative presents inaugural STORMY awards

New England Stormwater Collaborative Co-Chairs: Zach Henderson, Rob Robinson, and Ginny Roach

On April 1, 2015, the New England Stormwater Collaborative presented its inaugural STORMY awards, which recognize communities and utilities for their best stormwater ideas that increase efficiency, funding, or political support. Of 14 submissions, the collaborative recognized five organizations. The judges looked at the simplicity and resourcefulness of programs as well as their relevance and transferability to other communities.

WHY THE STORMY AWARDS

In 2013, members of NEWEA, the New England Water Works Association, and the New England chapter of the American Public Works Association formed the New England Stormwater Collaborative. A year later, this newly formed collaborative surveyed municipal managers, consultants, and staff to understand their stormwater management needs and issues. Of the 408 respondents from across New England, 56 percent noted that stormwater runoff and drainage management was of "very high concern." The most important issue to respondents was source water protection (20 percent), followed by Municipal Separate Storm Sewer System (MS4) permit requirements (17 percent).

Given the concern for stormwater issues and lack of political support, attention, and dedicated funding, members of the collaborative recognized the need to increase awareness of successful stormwater ideas. Through the STORMY awards, the collaborative is drawing attention to case studies that highlight effective and affordable steps communities can take to address stormwater management challenges.

The awards also advance the collaborative's threefold objective of: increasing the understanding of stormwater issues by providing a forum for information and exchange; educating the sector about ongoing efforts adopted by other communities to address stormwater issues; and advocating for action on sound stormwater management practices.

"The group's goal is to highlight the importance of collaboration and advocate for solutions that reach beyond city and state boundaries while promoting local ideas," says Mary Barry, NEWEA executive director. "The STORMY awards put a spotlight on New England stormwater success stories with best ideas for improving program management that can be duplicated here and throughout the country."

FUTURE ENGAGEMENT

The New England Stormwater Collaborative's 2014 survey also indicated that additional work is needed to increase political support and funding for stormwater management programs. Among respondents, 63 percent said funding was their primary obstacle—44 percent had no specific budget to address stormwater management, and 37 percent had annual budgets of less than $100,000. These responses indicate that New England may be far behind its Mid-Atlantic peers in which funding studies show average non-capital stormwater spending is $35 per capita. Additionally, 61 percent of respondents had not considered implementation of a dedicated fund and entity for delivery of stormwater management services. The survey ranked general awareness of stormwater issues second as a barrier to executing an effective stormwater management program.

The collaborative aims to become a platform for the dissemination of great, simple ideas that improve a community's stormwater management level of service with the ultimate goal of increasing municipal leadership's understanding of the need for sound stormwater management and a willingness to invest in successful practices.

The STORMY awards are one way to increase stormwater awareness by public and elected officials. Despite limited political support and funding, STORMY Award winners created resourceful solutions that increased their efficiency and effectiveness at meeting permit requirements. These communities show that investing in stormwater services can produce smart and sustainable programs that increase public engagement and improve water quality. With additional resources, these and other stormwater programs could create an even bigger positive impact.

Two award-winning municipal programs

LEXINGTON, MASSACHUSETTS

Volunteers expand monitoring of illicit discharges

The town of Lexington, Mass. Department of Public Works—Engineering Division won a STORMY Award for increasing efficiency by using university student volunteers to improve illicit discharge detection and elimination (IDDE).

In the fall of 2011, Lexington's Engineering and Conservation divisions piloted a volunteer water quality program to assist the town with identifying illicit discharges and improving the area's stream health. Building on the success of the volunteer program, the Engineering Division developed a municipal partnership with the University of Massachusetts (UMass) Lowell. Lexington engineering staff worked directly with UMass professor Edward Hajduk, who helped connect the town with student volunteers and ensured that program content met the needs of the student intern curriculum. Town staff met with the student interns to discuss what their objective would be, why it was important, and how they could accomplish tasks safely.

The outfall-monitoring program consisted of four trainings and 20 days of fieldwork. The town provided student volunteers with field kits, and they inventoried and monitored 80 outfalls over a 2-year period, which included 141 samples collected for laboratory analysis and 47 samples screened for ammonia concentration using field test kits.

This program added 244 person-hours to Lexington's IDDE program with little cost to the town. The students gained valuable field experience as well as mentoring from engineering professionals. The program's success resulted from solid training and written health and safety protocols, and it has led to an ongoing internship program with the university. The program provides valuable data used by the town of Lexington for IDDE and permit compliance. The program also is providing a research opportunity to compare the results of ammonia test strips and ammonia lab testing.

BRISTOL, CONNECTICUT

City trust ensures long-term maintenance of stormwater controls

The city of Bristol, Conn., received a STORMY Award for its proactive strategy to ensure and fund long-term maintenance of stormwater controls.

With significant development increases in the 1980s, the city needed to increase maintenance of its stormwater control structures. It created a fiscal entity called the Storm Water Control Trust, which requires organizations that propose stormwater control structures to specify a long-term ownership and maintenance plan. The proposers have three options: turn the structure over to the city with a monetary deposit for long-term maintenance; create a homeowner's association that would coordinate maintenance; or relinquish ownership and maintenance responsibility to another entity.

Since its inception, homeowner associations have assumed responsibility for the long-term maintenance of five storm

(continued on next page)

Award Winners (from left): Mark Austin, City of Bristol; Danielle Mucciarone, Northern Middlesex Stormwater Collaborative; Dan Albrecht, Chittenden County Regional Planning Comission; Benn Sherman, Central Massachusetts Regional Stormwater Coalition; and John Livsey and David Pavlik, Town of Lexington

Three award-winning regional collaborative efforts

Three entities received STORMY awards for their regional collaborative efforts to improve stormwater program efficiency. In New England, a town is the basic unit of local government and there is a well-established home rule form of governance, which provides municipalities with maximum authority to govern themselves. Municipalities are often small—between 2 and 10 mi² (5 to 52 km²)—but are still the primary regulated entity under the MS4 general permit program. In New England, around 440 individual municipalities are regulated under the MS4 permit program. This creates obvious redundancies and unique challenges for effective regional initiatives.

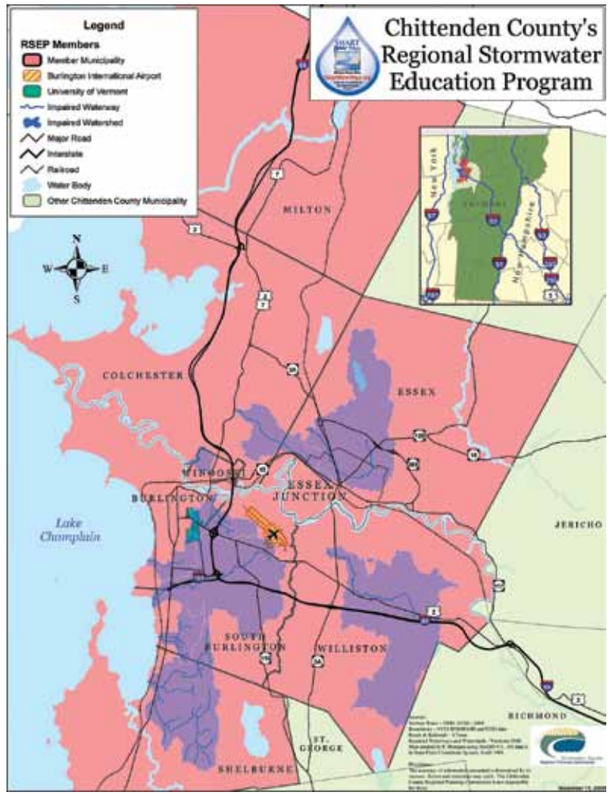
NORTHERN MIDDLESEX STORMWATER COLLABORATIVE

Joining forces improves program efficiency

The Northern Middlesex Council of Governments established the Northern Middlesex Stormwater Collaborative in 2013. The collaborative comprises 13 regional communities (Billerica, Chelmsford, Dracut, Dunstable, Lowell, Pepperell, Tewksbury, Tyngsborough, Westford, Burlington, Carlisle, Littleton and Wilmington). Its regional approach to meeting MS4 requirements is a more effective, watershed-based model. Additionally, it enables the collaborative to enhance the quality of service provided to residents while minimizing costs through resource sharing among local governments.

By establishing common programs, each community has reduced its responsibility for creating, implementing, maintaining, and managing separate but similar programs. In the past 2 years, the collaborative implemented a common public outreach and education program, regionalized stormwater-mapping activities, developed workshops and training sessions for municipal staff, boards, and officials, and is coordinating regional procurement for contracted stormwater services.

It was established using funds from two Community Innovative Challenge grants, administered by the Massachusetts Executive Office for Administration and Finance.



The Chittenden County Regional Stormwater Education Program and Chittenden County Stream Team have established regional public awareness of the need for individual action on stormwater problems

(*Bristol, Conn. continued*)
water control systems, and three remain in private ownership. The trust has accepted 22 systems, and at the time of the award, three systems were pending deposit or construction.

After construction and once the municipal trust takes ownership of a stormwater control, the developer is no longer liable for that system, and the city monitors it. The trust keeps a detailed inventory of properties and inspects the systems three times a year. The trust also is the fiscal entity that receives funds, controls expenditures for the sole purpose of maintaining or repairing the systems, and oversees the investment portfolio to grow its endowment.

With an annual inspection and maintenance program, the stormwater control systems remain viable, and the program controls post-construction runoff effectively, one of the minimum control measures of the city's MS4 permit.

CHITTENDEN COUNTY REGIONAL PLANNING COMMISSION

Creating public awareness through one message

In the northwestern part of Vermont—with the support of the Chittenden County Regional Planning Commission—12 MS4s (Bolton, Buells Gore, Burlington, Charlotte, Colchester, Essex, Essex Junction, Hinesburg, Huntington, Jericho, Milton, Richmond, St. George, Shelburne, South Burlington, Underhill, Westford, Williston, and Winooski) have pooled resources since 2003 to engage the public in a one message, one outreach effort. They first conducted a public opinion survey to benchmark current public understanding to create measurable public outreach improvement goals. They then hired a social marketing firm to implement a combination of television, radio, and online advertisements to encourage residents to visit the program's website. Online, visitors can engage with messages linked to specific stormwater problems, such as pet waste, car washing, and excessive runoff. More recently, the MS4s also have contracted with a regional Natural Resources Conservation District to engage the public in hands-on projects, including rain barrel workshops and rain garden planting.

These cooperative efforts, known as the Chittenden County Regional Stormwater Education Program and Chittenden County Stream Team, fulfill the MS4's public education and outreach, and public participation and involvement permit responsibilities affordably and efficiently. More important, these programs have established regional public awareness of the need for individual action on stormwater problems.

CENTRAL MASSACHUSETTS REGIONAL STORMWATER COALITION

Cooperation increases staff training and resources

Formed in November 2011, the Central Massachusetts Regional Stormwater Coalition is a group of 28 communities (Auburn, Boylston, Charlton, Dudley, Grafton, Hardwick, Holden, Hopkinton, Leicester, Millbury, Northbridge, Northborough, Oxford, Palmer, Paxton, Rutland, Shrewsbury, Southbridge, Spencer, Sterling, Sturbridge, Upton, Uxbridge, Ware, Webster, West Boylston, Westborough, and Wilbraham). The coalition addresses common priorities related to municipal stormwater management and shares solutions with other groups and organizations.

Also using funding from the state's competitive Community Innovation Challenge grant program, the coalition has created many products and purchased tools that enable its members to meet MS4 requirements.

Coalition programs and educational materials include staff training on inspection practices for stormwater infrastructure, development of a Stormwater Pollution Prevention Plan template and training modules, and training on the use of salt calibration tools and water-quality field test kits and meters. The coalition also has developed educational materials focusing on several target audiences, and an online mapping and inspection platform enabling members to see infrastructure in adjacent communities.

NEBRA Highlights

"We support the education of both farmers and the public on the benefits of using biosolids as a source of fertilizer..."
– New York State Farm Bureau

Biosolids Legislation and Regulation 2015

Little significant legislation has occurred in New England recently related to biosolids. This year, however, there was more. And several state regulatory changes that have been pending for some time are advancing in 2015.

Local control was the theme of several bills under consideration by state legislatures around the country. Some local governments want to impose restrictions on biosolids use. Such local control requirements have been in place in New Hampshire for some time. But many states pre-empt local control.

This year, opposition has hardened in New York regarding land application of biosolids from renewable energy facilities (anaerobic digesters) in some western towns. A few have placed local moratoria or bans on biosolids use. Such local laws contradict state pre-emption, and quasar energy group is challenging the Wheatfield, N.Y., ban in court (initial arguments scheduled for June 25). (The town of Marilla sued quasar, a local farmer, and the New York Department of Environmental Conservation (NY DEC) last year; the ruling is due soon.)

Recycled organics—tools for sustainability
nebiosolids.org
Twitter: @nebiosolids

Town officials and area members of the New York Assembly were pushing legislation, AO6250, giving the town of Marilla local control, and some other bills negative to biosolids recycling. Although passage does not appear likely, NEBRA members and the NEBRA Reg/Leg Committee are concerned, as are state agencies that have encouraged resource recovery from biosolids (e.g. NY DEC and NYSERDA). The New York State Farm Bureau is helping fight any anti-biosolids legislation; it included the following statement in its 2015 policy priorities:

"We support the education of both farmers and the public on the benefits of using biosolids as a source of fertilizer, and using information provided [by] the Departments of Agriculture and Markets and Environmental Conservation. These agencies are the appropriate regulators for the use of this product and municipal prohibitions restricting the use of biosolids should not be allowed."

Bills seeking local control of biosolids management also popped up in North Carolina (HB 61) and Tennessee (SB 1096 & HB 1131). As in New York, they are not expected to pass.

Meanwhile, in Washington, state pre-emption of biosolids regulation was strongly upheld by a court decision that was backed by the state Supreme Court.

Maine legislating odors

NEBRA also watched a bill in the Maine Legislature, LD 394 (HP 260), which would arbitrarily reduce the odor thresholds in the new solid waste odor regulations by 50 percent. There could be repercussions for biosolids management facilities, which are the focus of the odor regulation. At press time, the bill had a committee hearing but was not moving forward.

Banning microbeads

Another Maine bill, LD 85, was passed by the legislature and became law without the governor's signature. It states, "A person may not, after December 31, 2017, manufacture for sale a personal care product, except for an over-the-counter drug, that contains synthetic plastic microbeads." Accepting such products for sale is banned as of December 31, 2018. Over-the-counter drugs containing microbeads will be phased out by the end of 2019. Vermont's house approved a similar ban on microbeads, and, at press time, it was under consideration in the senate.

Molybdenum standards

NEBRA collaborated with a variety of stakeholders to create a workshop in June in the Boston area regarding molybdenum (Mo) in biosolids. This "MA Mo Workshop" reviewed the science and risk assessment for Mo in biosolids compared to current regulatory standards and to encourage adoption of a more current, science-based standard in Massachusetts.

New Hampshire's biosolids regulations

This spring, the New Hampshire Department of Environmental Services (NH DES) announced formal rulemaking. State law requires completion of a review and update of the "sludge" regulations (Env-Wq 800) this year. NH DES has worked with stakeholders and has proposed significant changes.

Vermont's biosolids program

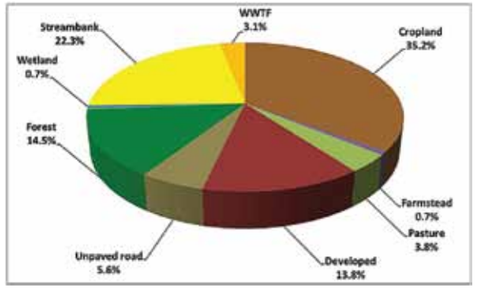
Vermont Department of Environmental Conservation (DEC) remains skeptical about biosolids use on soils, despite the following: information from a November 2013 workshop it convened; a comprehensive evaluation of the scientific research it conducted last year; that most states support biosolids use on soils and have active biosolids recycling programs; and that its own policies encourage recycling to soils with a stated goal of 75-percent recycling. At the 2013 workshop, Vermont DEC called for regulation updates, but nothing further has been announced.

Meanwhile, most of the Burlington area wastewater solids (which were being landfilled) have started going to the Casella Organics Grasslands facility in Chateaugay, N.Y., where they are lime-stabilized to Class A standards and land applied on area farms. Thus, although most are recycled outside of the state, Vermont's biosolids recycling rate has climbed back up to about 70 percent.

Major water quality legislation

Vermont DEC's languishing attention to biosolids is understandable. Concerning water quality, the state has been overwhelmed for several years with Environmental Protection Agency (EPA) negotiations on the Lake Champlain Total Maximum Daily Load (TMDL). The wastewater treatment profession has been active in these negotiations and is being heard. EPA has been threatening severely low phosphorus limits (0.2 mg/l or even 0.1 mg/l) for wastewater treatment facility permits in the watershed, all of which are up for renewal. The wastewater treatment profession has emphasized that because the treatment facilities contribute only 3 percent of the phosphorus entering the lake, further reductions will cost a lot of money per pound of phosphorus removed. But, for the state to avoid expensive wastewater treatment upgrades, it must demonstrate to EPA the ability to force reduction of phosphorus inputs from non-point sources (see chart).

This is the backdrop of the current water quality legislation, house bill 35 (H. 35)—a high priority. The house overwhelmingly passed a version on April 2, by 133 to 11. By early May, it had passed through the senate Natural Resources and Finance committees. The lengthy bill would require certification and fees for small farms and establish strict new management practices for manures and other sources of nutrients under the state agriculture department's Acceptable Agricultural Practices (AAP). "Custom applicators" of nutrients (including biosolids) will be required to be certified. The bill would also establish:



Sources of phosphorus in the Vermont portion of the Lake Champlain basin (EPA-Tetra Tech, 2013)

- Best management practices (BMPs) to avoid agricultural runoff and reduce nutrient losses from tile drainage
- Procedures for enforcement and penalties
- Requirements and BMPs for developed lands and stormwater management
- Requirements and BMPs for silviculture
- A process to determine a system for assessing fees on parcels of property or impervious surface
- Increased fees (and new fees) for various kinds of discharges and permits (e.g., stormwater discharges; land application site permit fees to increase from $950 to $1,000)
- New staff positions for implementation of the state water quality initiative, including implementation of the TMDL for Lake Champlain
- Water quality data collection

The senate version creates a dedicated water quality fund to be managed by a special board. A major source of the $8 million funding for these new water quality measures may be a new real estate transfer tax surcharge of 0.2 percent.

Even though H. 35 imposes new fees and requirements, area farmers appear to be supportive. And the water quality profession—including wastewater treatment operators—are pleased to see a strong, comprehensive program to address the major sources of phosphorus runoff to surface waters.

What's Happening with Biosolids at EPA

Update from Rick Stevens, EPA, forwarded by Greg Kester, CASA

Biosolids Program

EPA has reduced its biosolids program staffing considerably in recent years. Biosolids reporting has been consolidated to the Region 7 office; limited research on biosolids occurs at the labs in Cincinnati; and staff at headquarters in Washington have thinned to just a few, mostly part-time, on biosolids. Rick Stevens, who continues the Part 503 review and risk assessment program, recently outlined the work for 2015:

1. Risk assessment (RA) for Targeted National Sewage Sludge Survey (TNSSS) pollutants:

- Full probabilistic risk assessment for the Phase I TNSSS pollutants (i.e., barium, beryllium, manganese, molybdenum, silver, pyrene, 4-Chloroaniline, fluoranthene, nitrate and nitrite)
- Screen Phase II pollutants (up to 135 pollutants with sufficient data) using the Biosolids Core Risk Assessment Model (BCRAM) screening tool and input from the 10 TNSSS pollutants RA (4QFY2015)

2. Biennial review of biosolids and pollutants potentially warranting regulation (required by the Clean Water Act):

- The final report has been released for the 2011 biennial review of "information to evaluate potential harm to human health or the environment from use or disposal of sewage sludge, also called biosolids." A new fact sheet on this review is also available. These ongoing reviews are intended to determine if any new information indicates toxic levels of any contaminant in biosolids. "At this time, EPA has not identified additional toxic pollutants in biosolids for regulation under Clean Water Act section 405(d)(2)(C)."
- Summarize progress of Biennial Review 2013 and submit for management review.

3. Re-evaluate dioxin and dioxin-like congeners using a non-cancer Institutional Repository for Information Sharing (IRIS) human health benchmark Reference Dose (RfD). A draft document has been prepared; peer review is next.

4. Develop and refine scientific tools available for evaluating risks for pollutants found in biosolids:

- An updated version of the BCRAM screening tool and User's Guide are being prepared for external peer review starting in the second quarter of 2015
- For the full-scale probabilistic model, efforts continue to integrate LandApp into Framework for Risk Analysis in Multimedia Environmental Systems software (FRAMES) reading data from the system database used in the 10-pollutant risk assessment. The latest effort includes setting up and running the model with EPA's Supercomputer for Model Uncertainty and Sensitivity Evaluation (SuperMUSE), a key framework for enhancing quality assurance in environmental models

5. Other:

- Identify a path forward for products derived from sewage sludge (e.g., struvite)
- Make the biosolids webpage Drupal WebCMS and One EPA Web compliant (fourth quarter of 2015)

Dr. Stevens reports that, of the 14 projects to which EPA committed in response to the National Academy of Sciences 2002 review of the Part 503 rule, all but one are completed or ongoing (e.g. the biennial reviews are ongoing). The one remaining project is the continuing review of molybdenum in land-applied biosolids.

Sewage Sludge Incineration Rules

On April 27, 2015, EPA issued the Federal Plan Requirements for Sewage Sludge Incineration Units (SSI) emissions standards for the new and existing SSIs proposed rule. (See: gpo.gov/fdsys/pkg/FR-2015-04-27/html/2015-08777.htm.)

The published notice states: "On March 21, 2011, EPA issued emissions standards for new and existing SSI units. This action proposes that existing SSI units implement the emission guidelines (EG) adopted on March 21, 2011, in states that do not have an approved state plan implementing the EG in place by March 21, 2012. This federal plan will result in emissions reductions of certain pollutants from all units affected." Comments are due June 11, 2015.

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

WEF delegate report

As we near the half-way point of our WEF Delegate year we have all been hard at work on our WEF House of Delegates (HOD) focus work groups and standing committees. Howard Carter and the member association (MA) leadership development work group continue to work on the webinar series based on the Membership Recruitment & Retention Guidebook, January 2014 (4th edition) created by a previous HOD work group. We have modified and expanded this guidebook into a series of PowerPoint presentations. The beginning of April marked our last broadcast of the year, and the broadcasts have been a great success. A link to view the past webinars is: wef.org/Members/page_ma_detail.aspx?id=6442451557.

Mr. Carter has also been busy with the HOD Steering Committee. The committee reviews and prioritizes information received from committees and work groups, develops and summarizes the information, and provides advice and direction to the Speaker of the House and HOD. It also advises the board of trustees on strategic direction and public policy development.

We recently completed work with the Constitution and Bylaws Committee during which we offered edits and suggestions on an upcoming revision. We have also been evaluating the possibility of making the MA leadership work group a standing committee.

Mike Wilson has participated in the MA Financial Sustainability Committee to develop new policies that may be easily implemented by MAs to promote better financial health and long-term financial sustainability. Mr. Wilson summarized travel and expense policies for the work group to use. Additionally he helped create a PowerPoint presentation on financial sustainability that was presented at the four WEF MA Exchange meetings (WEFMAXs) held in 2015. Mr. Wilson is also serving as vice-chair of the Nominations Committee and attended the WEFMAX in Coeur d'Alene, Idaho, that was hosted by the Pacific Northwest MA.

We should all be proud that NEWEA volunteers have invested so much time in helping WEF with these WEFMAX leadership events. NEWEA was well represented at each of the WEFMAXs this year.

Mr. Wilson also participated in the sub-committee involved with planning for the recent Water Reuse and Industrial Wastewater Specialty Conference that was held in East Hartford, Conn. The specialty conference was a great success with robust and informative presentations on both industrial wastewater and reuse topics; the highlight of the seminar was the tour of the Hamilton Sundstrand wastewater reclamation facility.

Dan Bisson is chair of the HOD Nominations Committee. The charge of that committee is to recruit and receive HOD nominations and to convene as necessary to evaluate and prepare recommendations for each committee position and the speaker elect by September 1 of each year. The nominated functions on HOD include speaker-elect, WEF Nominating Committee, Steering Committee, Budget Committee, HOD Nominating Committee, and WEFMAX Committee. Recently proposed changes are also being considered to transfer the selection and recommendation of the delegate-at-large positions. The committee's recommendations will be presented to HOD prior to WEFTEC to allow all positions to be confirmed at WEFTEC. Representatives from the Nominations Committee attended all WEFMAX meetings to provide an overview of HOD, including each committee's charge and the nomination process, and to recruit future leaders. The WEFMAX meetings, during which MAs exchange ideas and collaborate with WEF staff, were held this year in Virginia Beach, Kansas City, Coeur D'Alene, and Quebec City.

Mr. Bisson is also serving on the on the Value of Water Coalition (VOW) task force. The Value of Water Coalition is a U.S. water industry collaboration among national associations, engineering and construction firms, and private water companies and technology and service providers. These groups aim to create a stronger, more united voice across the sector and to improve public awareness about the value of water. For details, visit thevalueofwater.org. The task force's mission is to serve as a sounding board to WEF leadership and to assist Linda Kelly (WEF's sr. director of development and strategic alliances) in providing feedback to and garnering support for VOW's Water Works! campaign. The committee provided critical feedback to Linda for her report to VOW on the slogan, "It's all over unless we fix what's under." The group also discussed and provided suggestions for communication tools, including:

- Newspaper, magazine, bill stuffers, radio, billboard, and television ads
- Bus, railway, metro, utility vehicle, and civic center placards/banners
- Coordination of standard VOW messages for MAs to deliver to the members at the annual conferences and WEFMAX events

Comments or questions may be directed to any of the three WEF delegates from NEWEA: Mr. Carter at hcarter@sacomaine.org, Mr. Bisson at bissondp@cdmsmith.com, or Mr. Wilson at mwilson@ch2m.com.

NEWEA
WORKING FOR WATER QUALITY

2015 student posters

The blizzard ruined all the plans for the student activities organized by the Student Activities Committee (SAC) during the Annual Conference, but the sun was shining on May 1 when NEWEA in collaboration with the American Society for Engineering Education (ASEE) Northeast division and Northeastern University gave the opportunity to students to present their posters during the ASEE conference.

Nick Tooker took home first place for best graduate poster for the overall conference, as well as the NEWEA-sponsored award for "best water-related poster."

Impact of Advanced Oxiation Processes on the Composition and Biodegradability of Soluble Organic Nutrients in Wastewater Effluents

Nicholas B. Tooker[1], Michael Drinkwater[2], Jack Horton[3], Karla Sangrey[4], and April Z. Gu[1]
[1]Department of Civil and Environmental Engineering, Northeastern University; [2]Truckee Meadows WRF, Nevada; [3]North Attleborough WWTF, MA; [4]Upper Blackstone WPAD, MA

Background

- Characteristics and bioavailability of wastewater derived organic nutrients and their susceptibility to removal has recently drawn significant attention, primarily due to decreases in effluent nutrient permit limits. The bioavailability of effluent organic nutrients to algae is varied and can be relatively high[1,2]. Therefore, greater removal of these compounds is needed to reduce eutrophication potential.
- Residual effluent SON and SOP are generally resistant to further removal by longer biological treatment detention times or by common tertiary chemical/physical treatment processes[3]. Therefore, investigation on alternative technologies and mechanisms involved in transformation and reduction of organic nutrients is of interest.
- The objective of this study was to investigate the impact of AOP treatments on the speciation and composition of soluble nutrients and the consequent biodegradability of SON in wastewater effluents.

Materials and Methods

- Secondary or tertiary effluents from three water resource recovery facilities (WRRFs) were collected for treatment with advanced oxidation processes (AOPs). Treatment at all of the WRRFs included both biological nitrogen and phosphorus removal processes.
- Each of the three effluents was treated with three AOPs at two doses, including low-pressure ultraviolet (UV) irradiation, hydrogen peroxide (H_2O_2), and a combination of UV and H_2O_2. Untreated and AOP-treated effluents were subjected to nitrogen fractions analysis, phosphorus fractions analysis, and SON biodegradability assays. All samples were also analyzed with fluorescence spectrometry to determine impacts of AOP treatment on dissolved organic matter.

Samples were treated with low-pressure UV irradiation at doses of 1,000 and 2,000 mJ/cm²

Samples were treated with H_2O_2 at doses of 5 and 10 mg/L and a contact time of 5 minutes

Results

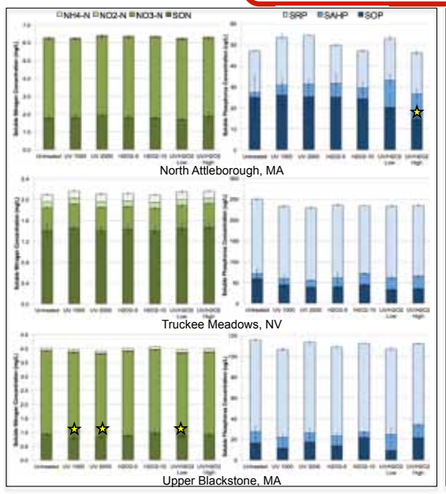


Figure 1: Concentrations of nitrogen and phosphorus species before and after AOP treatment for the North Attleborough, MA, Truckee Meadows, NV, and Upper Blackstone, MA WRRF effluents. Statistically significant changes in SOP or SON concentrations are indicated by a ★ symbol

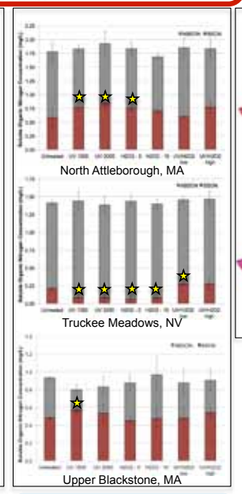


Figure 2: Biodegradable soluble organic nitrogen (BSON) concentration before and after AOP treatment. Statistically significant changes are indicated by a ★ symbol

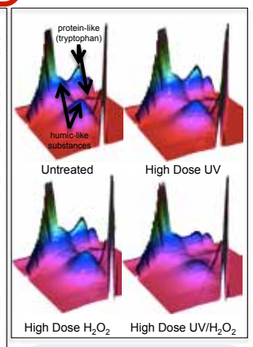


Figure 3: Fluorescence emission-excitation matrices for the Truckee Meadows WRRF before and after AOP treatment. Samples were irradiated with 220-450 nm light and fluorescence intensity was measured from 240-600 nm. Similar trends were observed for the other effluents.

Conclusions

- No significant mineralization of SON or SOP was observed in the wastewaters tested with UV doses up to 2000 mJ/cm² and/or H_2O_2 up to 10 mg/L.
- AOP treatment had a statistically significant, but variable, impact on the biodegradable soluble organic nitrogen concentrations in the three wastewaters.
- Dissolved organic matter composition was transformed during AOP treatment, particularly when samples were treated with a combination of UV and H_2O_2.

References

[1] Liu, HZ, Jeong, J, Gray, H, Smith, S, and Sedlak, DL, 2012. Environ. Sci. Technol. 46, 713-721.
[2] Gu, AZ, Liu, L, and Onnis-Hayden, A, 2014. WERF report NUTR1R06o.
[3] Bott, CB and Parker, DS, 2011. WERF report NUTR1R06k

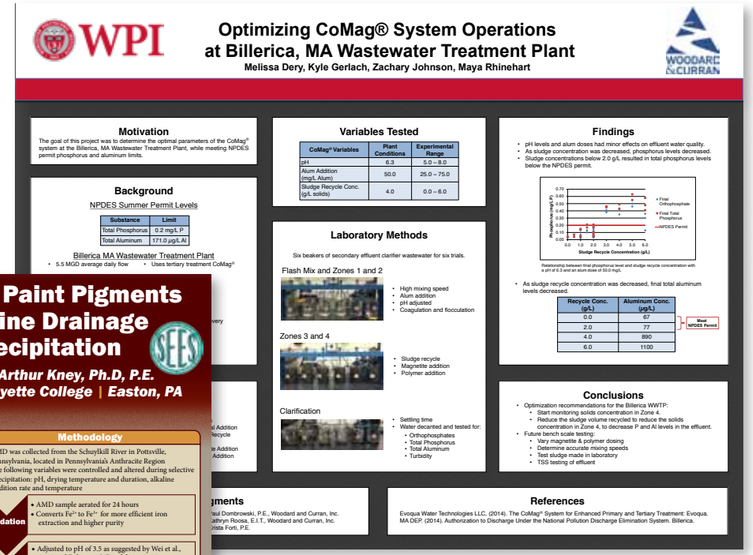
Acknowledgements

Funding for this research was provided by the Water Environment Research Foundation Nutrient Program. The authors thank Dr. David Stensel, Dr. JB Neethling, and Dr. Amit Pramanik from the WERF Nutrient Program for their support and feedback. We also thank NU Ph.D. student Ce Gao for assistance with the PARAFAC analyses, and undergraduate research assistants Lindsey Carver, Emily Derrig, Alex Silveri, and Andrea Zatorski for assistance with testing and analyses.

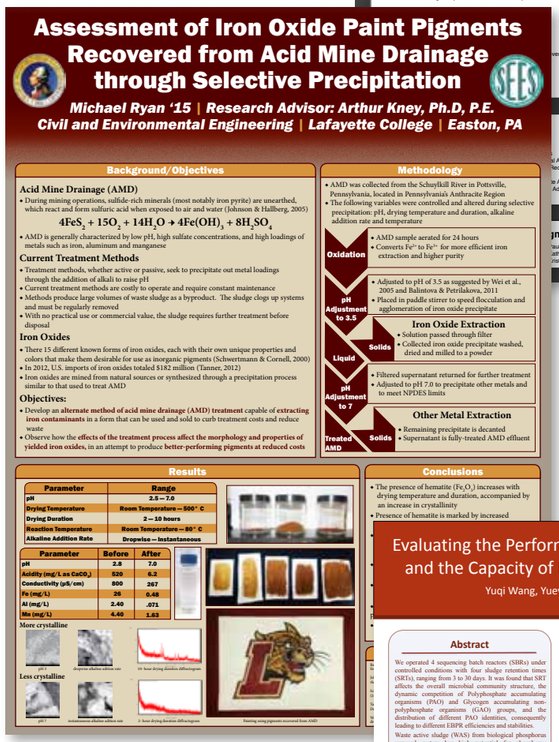
Environmental Biotechnology Laboratory

Northeastern University
Department of Civil & Environmental Engineering

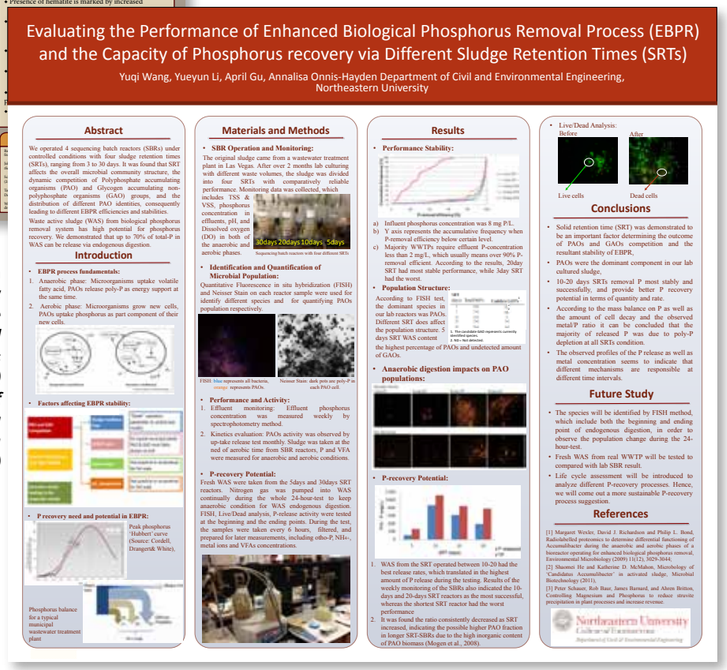
A group of students from WPI presented *Optimizing CoMag® System Operations at Billerica, Mass. Wastewater Treatment Plant*



The poster presented by Michael Ryan from Lafayette College is titled—*Assessment of Iron Oxide Paint Pigments Recovered from Acid Mine Drainage through Selective Precipitation*



Yuqi Wang, from Northeastern University presented *—Evaluating the Performance of Enhanced Biological Phosphorus Removal Process (EBPR) and the Capacity of Phosphorus recovery via Different Sludge Retention Times (SRTs)*



Specialty conference proceedings

Water reuse & industrial wastewater

The New England Water Environment Association's Water Reuse and Industrial Wastewater Committees held a Specialty Conference, Exhibit and Tour on April 28, 2015, at the University of Hartford in West Hartford, Connecticut. Meeting registrants included 69 attendees and four exhibit displays for a total of 73 registrants.

The technical presentations commenced on Tuesday, April 28, 2015, with NEWEA Water Reuse Committee Chair Ed Whately and NEWEA President Matt Formica providing the Welcome and Opening Remarks to meeting attendees. Jay Sheehan, Woodard & Curran, gave a brief overview to attendees.

In addition to the conference, an optional facility tour to the UTC Aerospace Wastewater Treatment Facility was offered in the afternoon.

TECHNICAL PRESENTATIONS

SESSION 1

Water Re-Use System for Industrial Discharger –
• Tim St. Germain, Fuss & O'Neill

CONCURRENT SESSION A

Moderators: David Young, CDM Smith & Nick Ellis, Hazen & Sawyer

Planning for Reuse – Part 1

The Customer is Key—How to Design A Reuse System to Maximize Satisfaction and Minimize Cost
• Lynne Putnam, Dewberry

Water Conserv II Sets the Standard for Reuse Projects in the Northeast
• Jay Sheehan, Woodard & Curran

Planning for Reuse – Part 2

Improving Competitiveness Through Financial Assessment of Water Reuse Technologies
• Marina Fernandes, CDM Smith
• Paul Sinisgalli, CDM Smith

Reuse of Secondary Treated Effluent for Potential Power Plant Cooling Supply
• Christine Kurtz, Wright-Pierce
• Brian Armet, Mattabassett District

CONCURRENT SESSION B

Moderators: Matt Dickson, MGD Process & Hardik Raval, Town of Concord

Commercial and Institutional Water Reuse

On-Campus Water Reuse: Reliability & Readiness
• Scott Nelles, Sustainable Water

Overcoming Water Scarcity in the "Water-Rich" Northeast at the University of Connecticut
• Rob Scott, Woodard & Curran

Water Conservation and Reuse Technologies

Water Conservation Technology for Recirculating Cooling Systems
• Karen Golmer, New England Water Innovation Network
• John Rowen, Capture H20, Inc.

Innovative Single Pass Process Intensified MBR Design Producing Excellent Effluent Quality
• Rahul Thukral, OVIVO USA

SESSION 3

Moderators: Sarah White, Unifirst Corp. & Debbie Hoyes, ARCADIS

Industrial Wastewater as an Alternative Carbon Source
• Matthew Gray, Keystone Engineers

Water Reuse for a Commercial Greenhouse
• Elizabeth Troop, Fuss & O'Neill

Cost-Effective Industrial Water Reuse
• Carl Wilcox, Woodard & Curran

EXHIBITORS

Aqua Solutions, Inc.
Retain-It LLC
Smith & Loveless, Inc.
Sustainable Water

SPONSORS

AECOM
ARCADIS
Black and Veatch
Blake Equipment
CDM Smith
Dewberry
Environmental Partners Group
EST Associates
Fuss & O'Neill
Green Mountain Pipeline Services
Hayes Pump
Hazen and Sawyer
Kleinfelder
The MAHER Corporation
Tighe & Bond
Weston & Sampson

Upcoming meetings & events

NEWEA COMMITTEE APPRECIATION EVENT
July 16, 2015
Kimball Farms, Westford, MA

OPERATIONS CHALLENGE GOLF TOURNAMENT
August 24, 2015
Brookmeadow Country Club, Canton, MA

EXECUTIVE COMMITTEE MEETING WITH ALL CHAIRS
September 15, 2015
Worcester Polytechnic Institute, Worcester, MA

WEFTEC ANNUAL CONFERENCE
September 26 – 30, 2015
McCormick Convention Center, Chicago, IL

NEWEA ANNUAL WEFTEC LUNCHEON MEETING
September 28, 2015
Chicago, IL

NORTH EAST RESIDUALS BIOSOLIDS SYMPOSIUM & BIOCYCLE'S REFOR15
October 19 – 22, 2015
DoubleTree Hotel, Danvers, MA

CSO/WET WEATHER ISSUES CONFERENCE & EXHIBIT
October 26 – 27, 2015
UMASS Lowell Conference Center, Lowell, MA

SMALL COMMUNITY SPECIALTY CONFERENCE
November 2015
Sturbridge, MA

CSO/WET WEATHER ISSUES CONFERENCE & EXHIBIT
October 26 – 27, 2015

This one-day specialty conference will benefit collection systems operators, managers, engineers, and members of the regulatory community

AFFILIATED STATE ASSOCIATIONS AND OTHER ASSOCIATIONS

MWPCA GOLF TOURNAMENT
June 22, 2015
Shaker Hills, Harvard, MA

NWPCA GOLF TOURNAMENT
June 29, 2015
Potowomut Golf Club, East Greenwich, RI

NHWPCA ANNUAL GOLF TOURNAMENT
August 6, 2015
Beaver Meadow Golf Course, Concord, NH

APWA CONGRESS
August 30 – September 2, 2015
Phoenix, Arizona

MWPCA FALL TRADE SHOW
September 23, 2015
Wachusett Mountain Resort and Conference Center, Princeton, MA

NARRAGANSETT WPCA CLAMBAKE AND EXHIBITION
September 11, 2015
Twelve Acres, Smithfield, RI

MeWEA FALL CONVENTION AND TRADE SHOW
September 16 – 18, 2015
Sunday River, ME

NEWWA ANNUAL CONFERENCE
September 20 – 23, 2015
Mt Washington Resort, Bretton Woods, NH

GMWEA Fall Trade Show
November 5, 2015
Sheraton Hotel & Conference Center, Burlington, VT

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

New members
December 2014 – April 2015

Christopher Findley
Greater New Haven WPCA
Naugatuck, CT (PRO)

Dan Wolff
Greater New Haven WPCA
New Haven, CT (PWO)

Gregory Allen
Greater New Haven WPCA
New Haven, CT (PWO)

James Brownell
Greater New Haven WPCA
New Haven, CT (PWO)

Jason Nenninger
Bristol, CT (PRO)

Kevin Maltese
Greater New Haven WPCA
New Haven, CT (PWO)

Natasha Krell
Bar Harbor, ME (STU)

Richard Nasse
Greater New Haven WPCA
New Haven, CT (PWO)

Ryan Harrold
Greater New Haven WPCA
New Haven, CT (PWO)

Visha Jensien
Greater New Haven WPCA
New Haven, CT (PRO)

Art Enderle
Town of East Windsor
East Windsor, CT (PRO)

Baxter Miatke
Burlington, VT (STU)

Brian F. Goetz
City of Portsmouth
Portsmouth, NH (PRO)

Rick Johnson
Clearas Water Recovery
Madison, OH (PRO)

Tom Joslin
Jericho, VT (PRO)

Trevon Noiva
Stowe, VT (STU)

Adison Charles Vanina
Western New England University
Schenectady, NY (PWO)

Andrea Zatorski
Cedar Grove, NJ (STU)

Arne Bomblies
Burlington, VT (PRO)

Blake D. Lukis
Town of Framingham
Framingham, MA (PRO)

Bradford Devins
North Easton, MA (STU)

Brion Kane
Town of Bar Harbor
Bar Harbor, ME (PWO)

Bryan Weiner
Wright-Pierce Engineers
Providence, RI (PRO)

Clair Meehan
Walpole, MA (PRO)

Cory C. Knick
Woodward and Curran Inc
Portland, ME (PRO)

Dan Scott VanSchalkwyk
Town of Ayer
Ayer, MA (PRO)

Dan Ranzoni
Town of Bar Harbor
Bar Harbor, ME (PWO)

Daniel Iannicelli
Fuss & O'Neill Energy
Alternatives LLC
Manchester, CT (YP)

Daniel Meany
Orleans, MA (PWO)

Dingnan Lu
Lowell, MA (STU)

Donald Dubiel
The MDC
Hartford, CT (PWO)

Eddie McFarland
Town of Bar Harbor
Bar Harbor, ME (PWO)

Emily C. Demusz
Weston & Sampson
Peabody, MA (YP)

Eric Lemont
AECOM
South Portland, ME (PRO)

Hannah O'Connell
Town of Brattleboro
Brattleboro, VT (PRO)

Jeff Van Trump
Town of Bar Harbor
Bar Harbor, ME (PRO)

Joanna M. Lewis
Durham, NH (STU)

John Raymond Livsey
Town of Lexington
Lexington, MA (PRO)

Kevin Rathbun
Boston, MA (YP)

Marcel H. Tremblay
MCI Concord
Concord, MA (PRO)

Megan Burke
Westborough, MA (STU)

Meghan M. Healy
CDM Smith
Manchester, NH (YP)

Nate Turner
Oakland, CA (PRO)

Nelson Durgin
City of Bangor WWTP
Bangor, ME (PRO)

Peter Jandrisevits
Andover, MA (PRO)

Philip J. Tucker
Sanford Sewerage District
North Berwick, ME (PWO)

Rachel Drew
Fuss & O'Neill Inc
Manchester, CT (YP)

Sahar Kunay
Hazen & Sawyer
Boston, MA (YP)

Sarah Bucci
Rocky Hill, CT (PRO)

Sarah Connors
Peabody, MA (YP)

Sean P. Mitchell
Arcadis
Wakefield, MA (YP)

Sharon Newman
Preti Flaherty Beliveau &
Pachios LLP
Portland, ME (EXEC)

Sidney Holbrook
Greater New Haven WPCA
New Haven, CT (PRO)

Tony Griffin
Town of Bar Harbor
Bar Harbor, ME (PWO)

Travis Jones
Town of Bar Harbor
Bar Harbor, ME (PWO)

Whitney Chamberlain
Dover, NH (STU)

Betsy C. Frederick
Kleinfelder Inc
Tucson, AZ (PRO)

Edward Gaffny
Statiflo Corporation
Pittsfield, MA (PRO)

Jeffrey Colby
Town of Chatham
Chatham, MA (PRO)

Scott Farrington
Ledyard, CT (STU)

Aaron Souza
Weston & Sampson Engineers Inc
Peabody, MA (PRO)

Alexander Sirocki
Tighe & Bond
Westborough, MA (PRO)

Alexandria Skinner
CDM Smith
Manchester, NH (PRO)

Andrew Osei
Weston & Sampson Engineers, Inc
Rocky Hill, CT (STU)

Ashley Warren
United Water
Easthampton, MA (PWO)

Brian Pena
City of Lawrence
Lawrence, MA (PRO)

Christopher Gallant
City of Saco
Saco, ME (PRO)

David Cedarholm
Westfield, MA (PRO)

David McKay
Griswold, CT (PRO)

Edwin McAuliffe
Rockland, MA (PWO)

Gail DaSilva
Coughlin Env Service LLC
Stoneham, MA (YP)

Gerald Hanson
Veolia Water
Bourne, MA (PRO)

Jason O'Brien
Ridgefield, CT (PRO)

Jeffrey Briggs
Marlborough, MA (PRO)

Joe Kietner
Chicopee DPW-WPC
Chicopee, MA (PWO)

John Loughlin Sr.
City of Rockland
Rockland, MA (PWO)

Kathryn Pratka
United Water
Boston, MA (YP)

Kevin McAndrews
Clean Soils Environmental
Ipswich, MA (YP)

Kevin Phillips
Wilmington, MA (PRO)

Laurie Goff
City of Chicopee
Chicopee, MA (PWO)

Lexi Dewey
Belchertown, MA (PRO)

Mark Lamontagne
Uxbridge, MA (PWO)

Martin Lee
Waterbury, VT (PRO)

Michael Dipalma
Weston & Sampson Services
Peabody, MA (YP)

Michael Bisienere
Mashpee, MA (PRO)

Patrick McKeown
CDM Smith
East Hartford, CT (YP)

Patrick Fox
City of Saco
Saco, ME (PRO)

Patrick Yeo
Weston & Sampson Engineers Inc
Peabody, MA (YP)

Peter Higley
Douglas Water & Sewer Dept.
Douglas, MA (PRO)

Richard Ruppert
United Water
Agawam, MA (PWO)

Robert Pudelka
New Milford Sewer Commission
New Milford, CT (PRO)

Robert Wells
Town of Middlebury
Middlebury, VT (PWO)

Roxanna Chomas
Epping, NH (PWO)

Ryan Graham
CDM Smith
East Hartford, CT (YP)

Ryan Henley
Weston & Sampson Engineers Inc
Peabody, MA (YP)

Ryan Cain
Marlborough, MA (PRO)

Whitney P. Woodcock
Westborough, MA (STU)

Chase Berkeley
Boston Water & Sewer Commission
Roxbury, MA (PRO)

Chris Nietupski
Wilbraham, MA (YP)

Darwin Cevallos
BETA Group Inc
Walpole, MA (PRO)

David Tischier
Springfield Water & Sewer Commission
Springfield, MA (PWO)

Ernst Etheart
Boston Water & Sewer Commission
Roxbury, MA (PRO)

Evan Moore
Springfield Water & Sewer Commission
Springfield, MA (PWO)

Harry Stewart
Londonderry, NH (PRO)

Jamie Ponte
City of New Bedford
New Bedford, MA (PWO)

Jamie Grome
Roxbury, MA (STU)

Kenneth Noyes
NHDES-WRBP
Franklin, NH (PWO)

Lawrence Sullivan
Norwich, CT (PRO)

Mollie Caliri
Quincy, MA (YP)

Nate White
Woodard & Curran
Dedham, MA (YP)

Nathaniel Maltais
Town of Seabrook
North Hampton, NH (PWO)

Nick Popolizio
JK Muir LLC
Rocky Hill, CT (PRO)

Nick Tranghese
Concord, MA (YP)

Peter Salvatore
Boston Water & Sewer Commission
Roxbury, MA (YP)

Rodrigo Pineros
MWRA
Chelsea, MA (PWO)

Samantha Lathrop
Milford, MA (STU)

Sarah Ray
Plymouth, NH (STU)

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)

NEWEA
WORKING FOR WATER QUALITY

NEWEA Executive Committee

PRESIDENT
Matthew Formica
AECOM, Wakefield, MA

PRESIDENT-ELECT
Raymond L. Willis III
Onsite Engineering,
Franklin, MA

VICE PRESIDENT
James R. Barsanti
Town of Framingham, MA

TREASURER
Frank E. Occhipinti
Weston & Sampson,
Peabody, MA

SECRETARY
Gerald C. Potamis
Town of Falmouth, MA

PAST PRESIDENT
Bradley L. Moore
City of Bangor, ME

COMMUNICATIONS DIRECTOR
Jennifer K. Lachmayr
ARCADIS, Wakefield, MA

MEETING MANAGEMENT DIRECTOR
Margaret C. Tabacsko
MWRA, Chelsea, MA

DIRECTORS
Priscilla J. Bloomfield
CH2M, Orleans, MA

Peter Goodwin
York, ME

Virgil J. Lloyd
Fuss & O'Neill, Manchester, CT

Jonathan E. Kunay
CDM Smith, Boston, MA

Nathan W. Lavallee
Town of Milton, VT

Frederick J. McNeill
City of Manchester, NH

Michael Moreau
Wastewater Treatment Services,
Raynham, MA

Jay G. Sheehan
Woodard & Curran,
Cheshire, CT

Michael Spring
Narragansett Bay Commission,
Providence, RI

EXECUTIVE DIRECTOR
Mary M. Barry

WEF DELEGATES
Howard F. Carter
City of Saco, ME

Michael J. Wilson
CH2M, Boston, MA

Daniel P. Bisson
CDM Smith
Manchester, NH

Susan J. Sullivan
NEIWPCC, Lowell, MA

Advertiser index

NEWEA/WEF** Membership Application 2015

Water Environment Federation
the water quality people

NEWEA
WORKING FOR WATER QUALITY

Personal Information

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 | Business Phone Number | Fax number

Email Address

☐ Please send me information on special offers, discounts, training, and educational events, and new product information to enhance my career ☐ by e-mail ☐ by fax

☐ 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 15

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*	$157
☐ **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.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$67
☐ **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.	■ WE&T (including *Operations Forum*) ■ *WEF Highlights Online*	$96
☐ **Academic Package**	Instructors/Professors interested in subjects related to water quality.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$157
☐ **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*	$10
☐ **Executive Package**	Upper level managers interested in an expanded suite of WEF products/services.	■ *WE&T* (including *Operations Forum*) ■ *World Water* ■ *Water Environment Research* (Online) ■ *Water Environment Regulation Watch*	$338
☐ **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*	$393

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 x7213).

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 # | Security/CVC | Exp. Date

Daytime Phone

Signature

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 Codes 2015

To help us serve you better, please complete the following:

(choose the one that most closely describes your organization and job function)

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

What is the nature of your ORGANIZATION?

(circle one only) (ORG)

1
Municipal/district Water and Wastewater Plants and/or Systems

2
Municipal/district Wastewater Only Systems and/or Plants

3
Municipal/district Water Only Systems and/or Plants

4
Industrial Systems/Plants (Manufacturing, Processing, Extraction)

5
Consulting or Contracting Firm (e.g., Engineering, Contracting Environmental, Landscape Architecture)

6
Government Agency (e.g., U.S. EPA, State Agency, etc.)

7
Research or Analytical Laboratories

8
Educational Institution (Colleges and Universities, libraries, and other related organizations)

9
Manufacturer of Water/Wastewater Equipment or Products

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

11
Stormwater (MS4) Program Only

12
Other _____
(please specify)

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

1
1. Upper or Senior Management (e.g., President, Vice President, Owner, Director, Executive Director, General Manager, etc.)

2
Engineering, Laboratory and Operations Management (e.g., Superintendent, Manager, Section Head, Department Head, Chief Engineer, Division Head, Landscape Architect etc.,)

3
Engineering and Design Staff (e.g., Consulting Engineer, Civil Engineer, Mechanical Engineer, Chemical Engineer, Planning Engineer, Landscape Architect, Environmental/ Wetland Scientist etc.)

4
Scientific and Research Staff (e.g., Chemist, Biologist, Analyst, Lab Technician, Environmental/Wetland Scientist etc.)

5
Operations/Inspection & Maintenance (e.g., Shift Supervisor, Foreman, Plant Operator, Service Representative, Collection Systems Operator, BMP Inspector, Maintenance, etc.)

6
Purchasing/Marketing/Sales (e.g., Purchasing, Sales Person, Market Representative, Market Analyst, etc.)

7
Educator (e.g., Professor, Teacher, etc.)

8
Student

9
Elected or Appointed Public Official (Mayor, Commissioner, Board or Council Member)

10
Other _____

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 _____

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)

Year of birth? _____

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.

Too Much to Swallow?

Retrofit Your Failing Gravity Sewer with the E/One Solution

If rain events are overloading your wastewater treatment plant, E/One Sewers can insure that real wastewater will be the only thing that your facility has to deal with in the event of storms or high groundwater.

Huge resulting savings on facility upkeep, treatment and electric costs make E/One the green way to go for your next central sewer replacement or rehabilitation project.

Environment One Corporation
www.eone.com/sewer
A Precision Castparts Company

e/one SEWER SYSTEMS

40 YEARS OF PRESSURE SEWER SOLUTIONS FOR THE NEW ENGLAND REGION

WIPE OUT!

Sanitary wipes are causing widespread ragging and downtime at plants and pump stations. Franklin Miller has a proven solution!

Our TASKMASTER® and DIMMINUTOR® grinders finely cut these problem solids down to size.

Call today to wipe out problem solids at your facility. 1-800-932-0599

www.franklinmiller.com

Franklin Miller Since 1918
Grinders & Screens

f.r. mahony & associates inc.
frma

Celebrating 50 years ~ 1964 - 2014
WATER SUPPLY AND POLLUTION CONTROL EQUIPMENT SINCE 1964

273 Weymouth Street
Rockland, MA 02370
Web: www.frmahony.com
Web: www.amphidrome.com

Phone: (781) 982-9300
Fax: (781) 982-1056
Email: info@frmahony.com

PROCESS APPLICATION ENGINEERS - WATER SUPPLY AND WASTEWATER TREATMENT
24 HOUR REPAIR SERVICE

AUTHORIZED SALES REPRESENTATIVES FOR

FRMA/Advanced Treatment Solutions:
Amphidrome®
Amphidrome® Plus™
ColdDisk™ Lagoon Nitrification
Custom Rotor Systems
RBC Package Plants
Sewage Lift Stations
Treatment System Upgrades/Retrofits

AQUIONICS
Low Headloss UV Pipe Reactors for WWTF or WTPs
Low Pressure Enclosed UV Disinfection Systems
Medium Pressure Enclosed UV Systems
Open Channel UV Systems

ASSMANN CORP OF AMERICA
Rotational Molded Polyethylene Storage Tanks

BAL-LAST
Interlocking Ballast Systems for E/One Grinder Pumps

E/ONE Sewer Systems
Low Pressure Sewer System Design, Supply & Service
Prefabricated Grinder Pump Stations
Direct Replacement Units for Failed Centrifugal Grinder Pumps

FIBERGLASS FABRICATORS, INC.
Compos-Cover™ / Compos-Truss™ Pultruded Flat Covers
Weir / Algae Covers
Baffle Walls
Troughs / Launders
Weirs & Baffles
Density Current Baffles
FRP Slide Gates / FRP Buildings & Shelters

FRANKLIN MILLER
Dimminutor® Comminutors
Spiral®™ Grinder/Fine Screen
Taskmaster™/Twin Shaft Grinders
Trio™ High Flow Channel Grinders

GARDNER DENVER
Hoffman and Lemon Series Multistage Centrifugal Blowers
Hoffman™ Revolution™ Turbo Blowers
TurboTron® Regenerative Blowers

HIGH TIDE TECHNOLOGIES
Satellite, Cellular or Ethernet Monitoring & Control
Grinder Pump Guardian
Lift Station Monitoring

KAESER COMPRESSORS
Rotary Blower Packages
Rotary Screw Compressors
Sound Attenuation Enclosures

KRUGER
ACTIFLOW
AnoxKaldnes IFAS
AnoxKaldnes MBBR
BioCos® Dryers
Biosolids Treatment Technologies
BIOSTYR® BAFs
Hydrotech Discfilter
NEREDA™ Membrane Bioreactor
Oxidation Ditch Technology

KWS ENVIRONMENTAL
Belt Conveyors
Bucket Elevators
Drag Conveyors
Shafted Screw Conveyors
Shaftless Screw Conveyors

LEGACY ENVIRONMENTAL PROCESS
Prefabricated Steel Packaged Wastewater Treatment Systems & Equipment

LIGHTNIN MIXERS
– A Unit of SPX Process Equipment
Portable Mixers
Rapid Mixers & Flocculators
Gearbox Exchange Program
Chem-Edge Ragless Impeller
Surface Aerators

MGD PROCESS TECHNOLOGY
Turbotron® Self Aspirating Aerator/Mixer

MOGERS PRODUCTS INC.
Fixed Diffusers and Coarse Bubble Aeration
SideCar RBC Aeration Systems

OR-TEC
Belt Press & Thickening
Rocker™ Disc Screw Press
Micro Bar Screen
Screening & Compacting
Flotation Systems

ORTHOS LIQUID SYSTEMS
Filter Nozzles/Strainers
Complete Filter Floor Solutions for New and Retrofit

PALL
Microfiltration and Ultrafiltration Membrane Systems
Nano & RO Systems

PINNACLE OZONE SOLUTIONS
Quadblock® ozone generators
Energy efficient
Trim linear turn down to 1%

PURAFIL
Odor Control Scrubbers
Carbon & Permanganate Media
Control Room Corrosion Control
Emergency CL2 Gas Dry Scrubbers

WALKER PROCESS EQUIP
Clarification for Water and Wastewater
Digestion Equipment
Grit and Grease Systems
RBC's
Rotary Distributors

REVISED 1/14/2015

Represented in New England by:

Please contact us to request a complete line card!

Celebrating 50 years°1964-2014

f.r. mahony & associates inc.
frma
273 Weymouth Street • Rockland MA 02370

Contact ED QUANN c.781.820.6268
edquann@frmahony.com
t.781.982.9300 f.781.982.1056
www.frmahony.com

Fay, Spofford & Thorndike

Watershed & Stormwater Management

Underdrained Soil Filter Stormwater Treatment System –
Long Creek Restoration Project, South Portland, ME

Automated Weir Gate Construction at
Combined Sewer Overflow Regulator –
Alewife Reservation, Cambridge, MA

Groundwater Flow Seepage Meters –
Farm Pond Watershed Study, Sherborn, MA

New Drain Manhole Construction –
Reserved Channel Sewer Separation Project, Boston, MA

5 Burlington Woods

Burlington, MA 01803

1.800.835.8666

www.fstinc.com

Twitter: @FSTinc

Additional offices in:

Boston, Quincy

and Hyannis, MA;

Bedford, NH;

South Portland, ME;

East Windsor, CT;

Melville and

New York, NY.

FST

100 YEARS