JOURNAL

OF THE NEW ENGLAND WATER ENVIRONMENT ASSOCIATION

VOLUME 53 NUMBER 2 / ISSN 1077-3002 **SUMMER 2019**

WASTEWATER

Phosphorus removal at a sequencing batch reactor plant

Flow distribution improvements at the Stamford Water Pollution Control Facility

Installation of screw press for solids dewatering at the Westerly Wastewater Treatment Plant

Beginning anew—a wastewater treatment system design for Orleans

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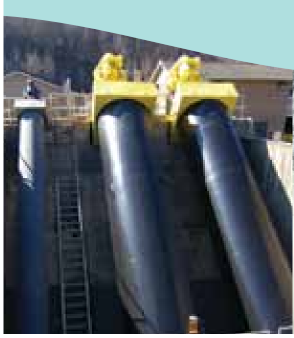

Screw Pumps

Open Screw Pumps
Enclosed Screw Pumps

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The concepts, ideas, procedures and opinions contained in the articles in this publication are those expressed by the various authors who submit the material for publication. The New England Water Environment Association, its executive committee, the editors, the executive director, and administrative staff hereby assume no responsibility for any errors or omissions in the articles as presented in this publication, nor are the concepts, ideas, procedures and opinions in these articles necessarily recommended or endorsed as valid by NEWEA, its executive committee, the editors, the executive director or staff. References to specific products or services do not constitute endorsement of those offerings by NEWEA. The Journal's committee reserves the right to make any editorial changes deemed necessary for publication of submitted papers.

NEWEA Journal ISSN #1077-3002
Published four times annually by New England Water Environment Association, Inc.
This is Volume 53 Number 2
Periodical postage paid at Woburn, MA 01801, and at additional mailing offices

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Woburn, MA 01801-2155

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NEWEA
WORKING FOR WATER QUALITY

MEMBERSHIP

OUR ASSOCIATION WAS ORGANIZED NINETY 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.

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2019 RATES ($)

Professional	185
Executive	355
Corporate	420
Regulatory	50
Academic	185
Young Professional	70
PWO	110
Dual	45
Student	15

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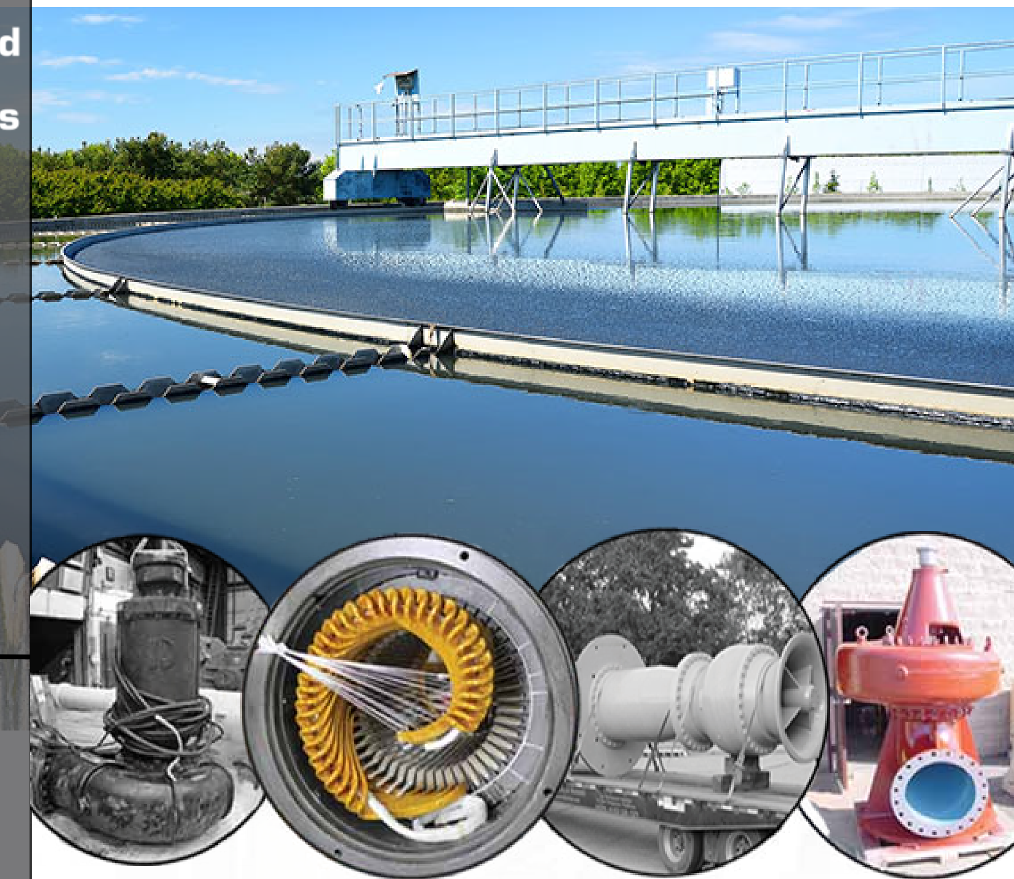
New England Water Environment Association | Statement of Ownership, Management and Circulation

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

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

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



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President's Message

WOW! The months of my term are flying by. Since the Annual Conference in January, things have been very busy. One focus of mine has been with the NEWEA/New England Water Innovation Network (NEWIN) collaboration. In February, we met with NEWIN Executive Director Marcus Gay (you may remember him if you attended the Innovation Pavilion at the conference) to discuss possible next steps in moving this relationship forward. Innovation Task Force Chair Howard Carter and Executive Director Mary Barry have been working out details, and an initial presentation was made at the April Executive Committee meeting. The discussions of a potential partnership are continuing, so stay tuned.

Another major focus for me was planning for the Spring Meeting at the historic Wentworth by the Sea resort in beautiful New Castle, New Hampshire. The Meeting Management Council and NEWEA office staff produced an outstanding program this year, and my request for nice weather was kindly answered throughout the conference. It was exciting to have New Hampshire Senator Jeanne Shaheen as our keynote speaker. There was also a facility tour of Portsmouth, New Hampshire's upgraded Peirce Island facility. This 6.1 mgd (23.1 ML/day) facility, now under construction, will use biological aerated filter (BAF) technology for nutrient removal as well as feature many other upgrades; the total estimated cost is more than $80 million. On the Saturday before the Spring Meeting, our Young Professionals Committee engaged in another service project. This year's project was in Dover, New Hampshire, rehabilitating a bioretention basin that has successfully removed pollutants in the Barry Brook watershed.

In March, NEWEA held a one-and-a-half-day planning session at the historic Hawthorne Hotel in Salem, Massachusetts. Two programs critical to NEWEA's future were presented for discussion: public awareness and government affairs. Attendees broke into two focus groups, each tasked with identifying goals, strategies, and action plans for implementing the assigned program. We had two great facilitators—Past President Linda Carroll for public awareness and WEF Delegate-at-large Susan Sullivan for government affairs. At the April Executive Committee meeting, President-elect Jenn Lachmayr presented a planning session update with preliminary action plans.

On Saturday, June 1, 2019, Young Professionals Committee members rehabilitated a bioretention basin in the Barry Brook watershed, Dover, New Hampshire

On March 21, the Plant Operations Committee held a specialty conference in Billerica, Massachusetts, where more than 70 attendees learned more about phosphorous removal in the Sudbury–Assabet–Concord River watershed. The conference highlighted phosphorus removal upgrades to the water resource recovery facilities within the watershed, and a presentation was made about the history, operation and maintenance, and ongoing impacts followed by an interactive roundtable discussion by facility leaders. Plant Operations Chair Tom Hazlett and the committee did a great job organizing an informative conference.

The senior management team has been busy attending state legislative events throughout New England. New England Water Works Association (NEWWA) President Dave Miller and I were fortunate to deliver the opening remarks in our home state at the New Hampshire Water Pollution Control Association's event, which was once again well attended. NEWEA's WEF Delegate Fred McNeil deftly orchestrated an informative "Waters Worth It" agenda for New Hampshire legislators.

On the national government level, this year I attended my first D.C. Fly-in, and what a fast-paced event it was. The action started with our NEWEA kickoff lunch, sponsored by Massachusetts Congressman James McGovern, who offered us optimistic remarks regarding upcoming water funding. The NEWEA Government Affairs Committee and our state liaisons put together the congressional briefing and organized the all-important appointments with Senators, Representatives, and legislative staffs. NEWEA and NEWWA emphasized two key issues, one to provide adequate funding for water quality and a second to use sound science and research before imposing additional regulatory requirements on utilities. With respect to sound science, we might have slipped in one more issue, perfluoroalkyl and polyfluoroalkyl substances (PFAS), which have rapidly become a priority in our water profession; we desperately need our congressional leaders to help us cope with this emerging concern.

On a chilly April 12, the Operations Challenge and Plant Operations committees jointly hosted an Operations Challenge training day at the West Warwick, Rhode Island treatment facility. This year 40 participants attended, and most participants also took advantage of the facility tour. With this training under their belts, this year five teams (the most in a long time) competed tightly at the NEWEA Spring Meeting. Congratulations to all five teams on a hard-fought contest! The winning teams, from Rhode Island, Connecticut, and Maine, will represent New England at the national Operations Challenge event in Chicago in late September.

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Finally, in case some of you are not yet aware, Linda Austin, our longstanding NEWEA administrator, will be retiring after the Spring Meeting. Ms. Austin recently said to me, "Ray, I don't know if I can do this anymore after dealing with you!" So I guess I may be remembered as the president who drove her into retirement; I was hoping to accomplish something better that that. All kidding aside, while we will miss Ms. Austin sorely, we wish her many years of enjoyment in her retirement. In the meantime, Ms. Barry and the NEWEA staff have completed interviews, and a newly-hired office administrator, Ms. Cindy Avagianos has begun taking over essential duties formerly performed by the irreplaceable Ms. Austin

As always, thank you to all our members and volunteers for your hard work and enthusiasm; you are the essence of NEWEA, and it is a privilege to represent you all. I hope to see you at the Spring Meeting.

From the Editor

Environmental stewardship seems to be increasingly relevant in today's news and pop culture. Leonardo DiCaprio becoming the face of clean water? A satirical rapper alongside an impressive list of Hollywood's most famous celebrities creating a Billboard Top 100 song about protecting the Earth? A Silicon Valley company, Impossible™ Foods, seeking to make environmentally friendly meat options more widely available and scoring an absolute success of its recent debut of the completely meatless Impossible™ Burger at Burger King? It's been nearly 60 years since Rachel Carson's *Silent Spring* was published, and nearly 50 since EPA was created. Why has it taken so long for environmentalism to become more prevalent in American pop culture?

Alexandra Bowen, PE
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I've always loved Joni Mitchell, and one of her staple songs holds true today. "Big Yellow Taxi," released on the 1970s' album *Ladies of the Canyon* paints a blunt picture: "Don't it always seem to go / That you don't know what you've got 'til it's gone / They paved paradise and put up a parking lot." Of course, the parking lot of 2019 would (hopefully) be made of porous pavements with various stormwater best management practices (BMPs), but you get the idea. The recently issued Intergovernmental Panel on Climate Change report described a mass die-off of coral reefs as soon as 2040. Yes, 2040! In 2040 Gen-Xers will be of age to take a solo vacation to visit the Great Barrier Reef, and we'd be remiss to deny them the opportunity to capture the perfect Instagram, #blessed.

We certainly did not choose the most glamourous of professions when we entered this field. My father (also a wastewater professional) visited my first-grade class to talk about his profession. I will never forget the look on my classmates' faces as he passed around a sealed jar of mixed liquor. They then proceeded to kindly refer to me as the "the poop doctor's daughter" for the rest of the week. I believe that jar of mixed liquor would be better received today, amid the recent poop emoji fad. Teaching children about wastewater treatment from a young age is going to help shift the immediate guttural yucks! to more positive responses. Perhaps this is a stretch, but maybe the widespread availability of poop emoji keychains, pillows, and iPhone cases are inspiring the "poop doctors" of the future!

I may be partial, but what could possibly be cooler than curating the perfect home to over a million species of microorganisms and manipulating them to undergo targeted respiration processes to not only "remove" various pollutants from the liquid phase but then to also recover invaluable resources like nutrients and carbon. We strive to give (and cruelly take away) everything that these microorganisms need, and we make them work. With ever-lowering effluent requirements, we are pushing the capabilities of these organisms, some of which have been in existence since not long after the days of primordial soup. This *Journal* issue focuses on just this: wastewater treatment. The articles feature various aspects of planning, design, and construction of wastewater treatment projects around New England.

Because this is a summer edition of the *Journal*, I close my message with a few eloquent words from a fellow climate change enthusiast and early 2000s' rap royalty, Nelly: "It's getting hot in here." Although we're not on stage rapping these lyrics in front of a sold-out arena, we as an organization are actually doing something about this! Whether you are a pipe designer lining old, leaky sewers, a sales representative selling advanced airflow control valves that deliver air to biological systems most efficiently, a process engineer installing that perfect FRP baffle wall to best manipulate bugs, or an operator prepping for another wet weather day at your facility, we're all working collectively toward the same goal. Let's make sure the next generation of meatless cheeseburger eaters and poop emoji lovers understand just how important our work is to the future of this industry and planet.

EPA announced the development of a Water Reuse Action Plan at a San Francisco water reuse workshop

EPA Announces Development of Water Reuse Action Plan

On February 27, 2019, at a water reuse workshop in San Francisco EPA announced the development of a Water Reuse Action Plan that will leverage the expertise of both industry and government to ensure the effective use of the nation's water resources.

"The nation's water resources are the lifeblood of our communities, and the federal government has the responsibility to ensure all Americans have access to reliable sources of clean and safe water," said David Ross, EPA's assistant administrator for water. "There is innovative work happening across the water sector to advance water reuse, and EPA wants to accelerate that work through coordinated federal leadership."

The Water Reuse Action Plan will seek to foster water reuse as important in integrated water resource management. EPA will facilitate discussions among federal, state, and water sector stakeholders and form new partnerships to develop and deploy the plan. A draft of the plan is scheduled for release and public review in September at the Annual WateReuse Symposium in San Diego.

EPA's actions are part of a larger effort to better coordinate and focus taxpayer resources on some of the nation's most challenging water resource concerns, including ensuring water availability and mitigating the risks posed by droughts. This includes working closely with the U.S. Department of the Interior (DOI), the U.S. Department of Agriculture (USDA), and other federal partners to collaboratively address western water supply, resiliency, and other resource management challenges.

"The Department of the Interior is excited about forging this partnership with EPA so that we can leverage each other's success and move forward on one path," said Tim Petty, assistant secretary for water and science at DOI. "Communities across the country are facing water shortages, and it is the role of the federal government to ensure that all have reliable access to the water needed to protect human health and maintain our robust economy."

EPA has previously supported water reuse efforts, including development of the *2017 Potable Reuse Compendium and Guidelines for Water Reuse*, but the Water Reuse Action Plan is the first initiative of this magnitude that is coordinated across the water sector. Ongoing efforts by other federal agencies, such as the U.S. Department of Energy's *Grand Water Security Challenge*, and by various non-governmental organizations dedicated to water resources management, will be coordinated and leveraged as part of the overarching strategy to advance water reuse.

EPA will work across the water sector to develop an integrated management approach for our nation's water resources

Background

Water reuse—sometimes referred to as water recycling—may be viable for various applications, depending on site-specific conditions. Examples include agriculture and irrigation, potable water supplies, groundwater replenishment, industrial processes, and environmental restoration.

In developing the Water Reuse Action Plan, EPA and its partners will evaluate these and other opportunities for reuse to identify the opportunities and challenges in the following areas:

- Technological improvements, including development, piloting, validation, and data considerations
- Regulatory/policy analysis at all levels of government, including considering public health and addressing barriers to progress
- Financial initiatives, including expansion and clarity in available funding mechanisms
- Performance requirements, including efforts to ensure the quality of reused water is appropriate for the intended purpose
- Access to water use and availability data, including the encouragement of watershed-based information sharing
- Outreach opportunities, including efforts to ensure public understanding of reused water as part of integrated water management

Note: All EPA industry news provided by EPA Press Office

River Flow Champion, Dr. Jackie King, Wins 2019 Stockholm Water Prize

– Stockholm International Water Institute

Dr. Jackie King has been named the 2019 Stockholm Water Prize Laureate for her game-changing contributions to global river management. She has advanced the scientific understanding of water flows, giving decision-makers methods and tools to assess the full range of costs and benefits when managing or developing river systems.

Dr. King led the early development of the methods as a researcher at the University of Cape Town, funded by South Africa's Water Research Commission. Later, she and colleagues Dr. Cate Brown and Dr. Alison Joubert created ecosystem models to demonstrate the ecological and social implications of damming and de-watering rivers. This has enabled objective assessment of the costs of water-resource developments that could emerge linked to benefits such as hydropower and irrigated crops.

Said Dr. King of the award, "I find it humbling, energizing and very rewarding. I have never sought high-profile jobs but was happy to be a working scientist, free to say what I felt needed to be said. I am delighted that the silent voices of river systems and their dependent people are increasingly being acknowledged. We all lose if rivers become severely degraded due to poorly informed development and management. It does not have to be like that."

Her commitment to raising awareness of the value of rivers and their importance for millions of people has made Dr. King highly regarded by academics and water managers globally. In its citation, the Stockholm Water Prize Nominating Committee notes that "Dr. Jacqueline King has, through scientific rigor, selfless dedication, and effective advocacy, transformed the way we think, talk, and work with water as a flow of and for life."

Dr. King was co-founder of, and principal researcher at, the Freshwater Research Unit, University of Cape Town, for almost four decades. She is now extraordinary professor at the Institute for Water Studies, University of the Western Cape and an independent consultant. As an aquatic ecologist she became influential in the recently established field of environmental flows. Her early research focused on South African rivers, but since the 1990s she has moved into advisory work on river systems across Africa and Asia.

Dr. King's work has been recognized with both the gold and silver medals from the Southern African Society of Aquatic Scientists and with South Africa's "Women in Water" Award in the research category. She was also the 2016 recipient of the "Living Planet Award" from the World Wildlife Fund–South Africa.." Her academic work includes more than 100 refereed items in books, international journals, and conference proceedings.

Dr. King's early work influenced South Africa's 1998 National Water Act and is increasingly guiding governments and institutions across the globe. First as a researcher and later as a consultant, she has worked in more than 20 countries and with governments of the Mekong, Zambezi, Indus, and Okavango river basins, among others.

Dr. Jackie King's early research focused on South African rivers, but since the 1990s she has moved into advisory work on river systems across Africa and Asia

"Governments developing their water resources understand the potential benefits but not necessarily the costs in terms of degrading rivers. We can now show these ecological and social costs at a similar level of detail to the benefits shown by planners. This is a new kind of information, not available until the last few years, that helps governments better understand the trade-offs involved in development as they decide on their preferred future," reflected Dr. King.

"Governments developing their water resources understand the potential benefits but not necessarily the costs in terms of degrading rivers."

Dr. King is clear that governments have the right to decide their own path to development. She strives to support them by providing transparent and accessible information so they can effectively assess their different options.

"Dr. King has helped decision-makers understand that healthy river ecosystems are not a luxury, but the basis for sustainable development," said Stockholm International Water Institute's Executive Director Torgny Holmgren.

The prize will be presented to Dr. King by H.M. King Carl XVI Gustaf of Sweden, patron of Stockholm Water Prize, at a Royal Award Ceremony on August 28, during World Water Week in Stockholm.

The Stockholm Water Prize, presented annually since 1991, is the world's most prestigious water award and honors women, men, and organizations who have made extraordinary water-related achievements. All nominations are carefully reviewed by the world-leading water experts of the Stockholm Water Prize Nominating Committee. After the committee has selected a candidate, the Royal Swedish Academy of Sciences makes the final decision, which is confirmed by the Stockholm International Water Institute board of directors.

EPA Administrator Wheeler Announces New WIFIA Loan Funding for Water Infrastructure Projects

Funding could leverage $6 billion in public and private investment for construction-ready projects to protect drinking water from lead and emerging contaminants, upgrade aging infrastructure, and promote water recycling and reuse.

On March 29, 2019, EPA Administrator Andrew Wheeler announced the availability of funding to provide an estimated $6 billion in Water Infrastructure Finance and Innovation Act (WIFIA) loans in 2019.

"For this round, we are prioritizing construction-ready projects in three areas: reusing and recycling water, reducing exposure to lead and addressing emerging contaminants, and updating aging infrastructure," Mr. Wheeler said.

WIFIA loans are available to public and private borrowers for a wide range of drinking water, wastewater, drought mitigation, and alternative water supply projects. This year's Notice of Funding Availability (NOFA) highlights the agency's priority to finance projects that are ready for construction in the three key areas noted above.

The WIFIA program received $68 million in funding in the Consolidated Appropriations Act of 2019, which was signed into law on February 15, 2019. EPA will accept letters of interest (LOI) from prospective borrowers for 90 days after publication in the Federal Register.

To date, EPA has issued eight loans of around $2 billion in WIFIA credit assistance to help finance $4 billion for water infrastructure projects and create over 6,000 jobs. EPA has invited an additional 42 projects in 17 states and D.C. to apply for a WIFIA loan. These 38 borrowers will receive WIFIA loans totaling approximately $5.5 billion to help finance nearly $11 billion in water infrastructure investments and create 172,000 jobs.

Background

Established in 2014, the WIFIA program is a federal loan and guarantee program at EPA that aims to accelerate investment in the nation's water infrastructure by providing long-term, low-cost supplemental loans for regionally and nationally significant projects.

WIFIA credit assistance can be used for a wide range of projects, including:

- Drinking water treatment and distribution projects
- Wastewater conveyance and treatment projects
- Enhanced energy efficiency projects at drinking water and wastewater facilities
- Desalination, aquifer recharge, alternative water supply, and water recycling projects
- Drought prevention, reduction, or mitigation projects

EPA will evaluate proposed projects described in the LOIs using WIFIA's statutory and regulatory criteria as described in the NOFA. Through this competitive process, EPA will select projects that it intends to fund and invite them to continue the application process.

Brown University Students Awarded $15,000 EPA Grant for Innovative Technology Project

On March 18, 2019, EPA announced $15,000 in funding for a team of Brown University students through its People, Prosperity, and the Planet (P3) grants program. The team is receiving funding to develop a sustainable technology to help address problems related to basic sanitation and drinking water for homes in tribal and disadvantaged communities.

"EPA's P3 grants program supports the next generation of scientists and engineers," Mr. Wheeler said. "These students are able to take what they learn in the classroom and apply it to real-world environmental problems that require innovative solutions."

EPA acting Regional Administrator Deb Szaro added: "This grant will enable Brown University students to further their critical research to find innovative ways to deliver clean water to Tribal and underserved communities. This funding demonstrates EPA's commitment to support research at New England colleges and universities that seeks to address some of our most pressing environmental problems."

The P3 competition challenges students to research, develop, and design innovative projects that address a myriad of environmental protection and public health issues. The Phase I teams will receive grants of up to $15,000 each to fund the proof of concept for their projects.

The Phase I recipients will attend the TechConnect World Innovation Conference and Expo in Boston on June 17–18, 2019, to showcase their research. They can then apply for a Phase II grant that provides funding up to $100,000 to further the project design.

These students, who represent the future workforce in diverse scientific and engineering fields, are following in the footsteps of other P3 teams. Some of these teams have started businesses based on ideas and products developed through their P3 project. In 2018, a previous P3 Phase I awardee from Oklahoma State University (OSU) leveraged P3 funding to initiate their research to develop a cost-effective approach to enhance energy efficiency in wastewater treatment. In furthering their P3 project, OSU transformed the research into a business plan and won the Queen's Entrepreneurs' Competition with its startup business plan for Contraire, a predictive analysis control system designed to provide near real-time wastewater test measurements. Among 15 other teams, OSU pitched its business plan to a panel of Canadian business leaders and received multiple inquiries from investors.

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The Future of Phosphorus

by Patrick Dube

In January, the Water Environment Federation convened the James Barnard Research Forum on Emerging Themes in Biological Phosphorus Removal and Recovery. This three-day forum paid tribute to Dr. James Barnard by celebrating his significant contributions to wastewater processing, specifically focusing on biological phosphorus removal.

Three themes emerged from the forum. First, participants set out to discuss the science behind phosphorus removal and recovery to find out how much we know and don't know about the process. Second, the forum turned an eye toward future markets and drivers. This discussion also focused on the value proposition of phosphorus recovery, including products (phosphorus, biosolids, valuable metals), services (eutrophication prevention, meeting discharge limits), and global drivers (food products, energy to mine mineral phosphorus). Third, the forum provided an opportunity to look at a broad overview of the environmental effects of phosphorus recovery.

PHOSPHORUS 101

Phosphorus is an essential mineral for growth. However, phosphorus runoff and deposition in water bodies can cause aquatic dead zones that choke off oxygen to plants and wildlife. This leads to a unique conundrum where there can be no life without phosphorus, yet too much has disastrous effects.

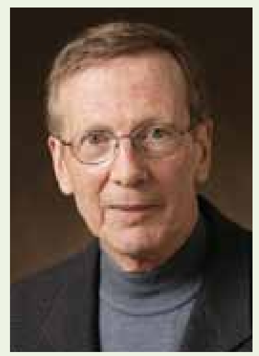
Furthermore, global supplies are dwindling, and we are facing a potential crisis if renewable sources are not developed. A balance must be struck between efficiently using phosphorus while simultaneously developing recovery techniques. Recovering biological phosphorus via "water resource recovery facilities" (WRRFs) can help fill this gap, but continued research is necessary to make it more efficient, reliable and accessible to utilities of all sizes.

BACTERIAL POPULATIONS AND MODELING

Current knowledge and existing gaps emerged as the first theme at the forum. Presentations dived into the microbial ecology of enhanced biological phosphorus removal (EBPR), starting with understanding two of the most important polyphosphate accumulating organisms (PAOs) in wastewater treatment, tetrasphaera and accumulibacter. These two organisms are studied widely, but there remains a knowledge gap about them as researchers continue to try to better utilize them by fully unlocking their mechanisms.

Patrick Dube is a technical program manager in the Water Science & Engineering Center at the Water Environment Federation (Alexandria, VA). He manages the Residuals and Biosolids Committee and the Air Quality & Odor Control Committee. He can be contacted at PDube@wef.org.

ABOUT JAMES BARNARD AND THE FORUM



As the developer of the Bardenpho, Modified Ludzack–Ettinger, and Phoredox processes for biological nitrogen and phosphorus removal, Mr. Barnard has been instrumental in bringing these innovative technologies to water resource recovery facilities (WRRFs) around the globe. The forum, held in Austin, Texas, featured leaders in biological phosphorus (bioP) removal for invited presentations and facilitated discussions. With short presentations and panel discussions, the forum encouraged free-flowing dialogue to examine the past, present, and future of biological phosphorus removal topics and set the agenda for years to come.

The Microbial Database for Activated Sludge (MiDAS), a program started at Aalborg University in Denmark, aims to learn more about these and other organisms by mapping the microbial diversity present in wastewater treatment systems worldwide. Getting people talking the same language by learning more about what options are present at WRRFs can help select for the most efficient and effective microorganisms.

Likewise, models frequently are used to help optimize WRRFs, plan for upgrades, and design new facilities. However, the limitations of these models came to the forefront of the modeling discussions as presentations addressed different approaches to unlocking the process dynamics of a WRRF. Each WRRF is a unique system with specific parameters and influent; as such, there exists no one-size-fits-all approach to modeling or treatment.

Two approaches highlighted during the forum were suggested for overcoming modeling challenges. One recommends modeling individual units within a system, while the other seeks to develop a predictive system relying on process metabolics. Both models are viable options and the presentations set up a further discussion on how to use information gleaned from a model and put it into practice.

The discussions highlighted one universal truth: the key to all good models is more data to better understand process dynamics. As we get to know more about the intricacies of these systems, models will become more accurate.

VALUE PROPOSITIONS

Forum participants also examined the value proposition of phosphorus recovery. One of the current pain points in widespread phosphorus recovery is that turning these value propositions into reality requires overcoming current technology bottlenecks and improving industry business models.

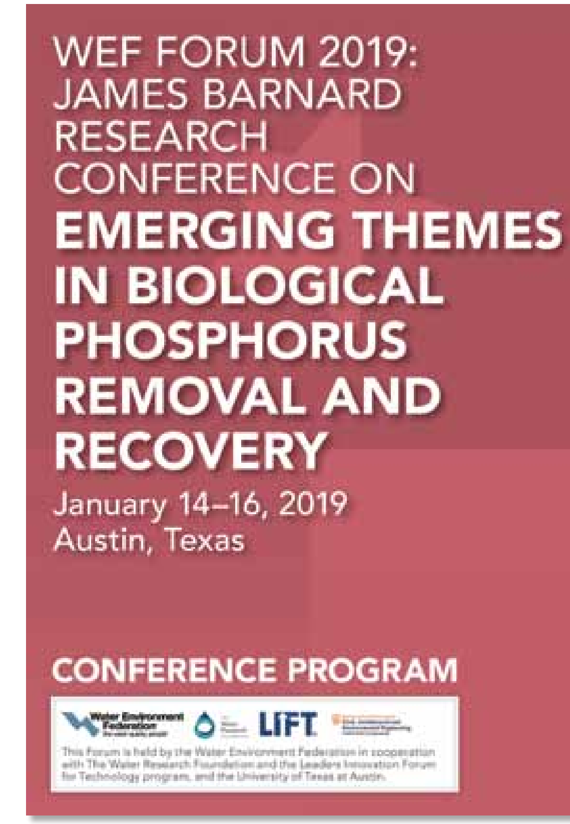
The key to success is broadening the current value potential of bioP from only recovered products to the entire ecosphere. When discussing the barriers for real-world application, several ideas were put forth. These included implementing real-time population sensing, developing cheaper and simpler instruments that can be used by utilities of any size, and incorporating phosphorus recovery in all industries such as food reduction and waste recycling. Additionally, work must be done to develop regulations and incentives that help promote resource recovery while continuing to educate the public and increase awareness about the potential value.

Overall, the tone of the session was optimistic, and attendees agreed that the research and ideas currently being developed were building a much-needed knowledge base which will soon be translated to implementation at WRRFs.

ADDRESSING ENVIRONMENTAL EFFECTS

The forum also provided an opportunity to look broadly at the environmental effects of phosphorus recovery. Representatives from utilities and government entities who have successfully addressed phosphorus concerns in their regions provided insight on replicating their successes. All panelists agreed that clearly defining regional problems is the first step in beginning to address them; science alone can't fix all problems. The buy-in of local communities and positive public perception often drives success as much as sound science. Without seeing a direct effect—perhaps the project isn't entirely local or the effects aren't readily visible—achieving buy-in can be difficult.

One example shared the experience of EPA's Chesapeake Bay Program. When first starting, this program, which aims to clean up the formerly polluted bay, required getting signatures on more than 400 best management practice documents from around the entire region. These 400 individual agreements combined to increase the health of the bay, but individually, they only had a small effect and local communities had to be convinced to buy in to help the overall region.



The forum's complete, 42-page technical program can be accessed online at www.wef.org/forum

Forum speakers recommended making the effort to translate national or regional challenges into the effects the problem has on your specific locality. By making it a personal issue, citizens are more likely to connect. Also, involving key, trusted members of a community can further help promote public acceptance. Overall, a clear message tackling a well-defined problem that community members can engage with is the best way to quickly and efficiently get projects completed locally.

MORE TO COME

All participants reconvened at the end of the forum to summarize and discuss the best ways to approach phosphorus removal and recovery now and in the future. Throughout the next few months, the forum's steering committee members plan to summarize the event thoroughly and release outcome reports. They aim to capture the entirety of the forum, the current state of the phosphorus removal and recovery science, what recovery needs to look like in the next 50 years, and what research needs to be tackled to meet these needs. In the meantime, the forum's complete, 42-page technical program can be accessed online at wef.org/forum.

Phosphorus removal at an SBR plant

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ABSTRACT | In 2015, the town of Plainville, Connecticut, received a National Pollutant Discharge Elimination System permit requirement to reduce effluent phosphorus to an average seasonal load of 3.49 lb/d (1.58 kg/d), which is equivalent to 0.16 mg/l at the design flow of 2.6 mgd (9.8 ML/d). Five years earlier, Plainville's water pollution control facility was upgraded for nitrogen removal with sequencing batch reactors (SBRs). A phosphorus removal planning study and design was completed. This paper focuses on four challenges presented by the SBRs and how each challenge was addressed, including the following: 1) dosing chemical in batches; 2) equalizing the flow for stable post-secondary treatment; 3) addressing the potential for double decants; and 4) conducting validation testing to verify equipment selection. The design has been completed, and bids were opened in May 2018. Construction is anticipated to be completed in 2020.

KEYWORDS | Sequencing batch reactor (SBR), phosphorus removal, disc filter, chemical addition

INTRODUCTION

The town of Plainville, Connecticut, owns and operates a water pollution control facility (WPCF) that treats the town's wastewater prior to discharge to the Pequabuck River. The WPCF is designed for a daily average flow rate of 2.6 mgd (9.8 ML/d) and a peak hour flow rate of 7.5 mgd (28 ML/d). The WPCF liquid treatment train includes preliminary treatment, primary treatment, secondary biological treatment using sequencing batch reactors (SBRs), ultraviolet disinfection, and post-aeration.

The WPCF was overhauled from 2006 to 2010. Before then, the WPCF used rotating biological contactors, secondary clarifiers, and mixed media filters. During that overhaul, these older processes were demolished and replaced with SBRs designed for biochemical oxygen demand (BOD), total suspended solids (TSS), and nitrogen removal. Since the town's National Pollutant Discharge Elimination System (NPDES) permit at the time did not include a phosphorus limit, the WPCF upgrade did not include phosphorus removal.

In 2011, the Connecticut Department of Energy and Environmental Protection (CT DEEP) published its "Phosphorus Interim Strategy." This included a proposed average seasonal phosphorus limit for the Plainville WPCF of 3.49 lb/day (1.58 kg/d), equivalent to 0.16 mg/l at the design flow of 2.6 mgd (9.8 ML/d), or 0.11 mg/l at the permitted flow rate of 3.8 mgd (14 ML/d). For comparison, the historical seasonal average phosphorus load was approximately 29 lb/day (13 kg/d), meaning an 88 percent reduction was required. Based on correspondence with CT DEEP, the town selected a design phosphorus target of 0.10 mg/l to be conservative in case future limits were lowered. In 2015, the town's NPDES permit was renewed, implementing the 3.49 lb/day (1.58 kg/d) phosphorus limit that had been proposed in 2011.

SBR Basics

SBRs provide combined aeration and clarification in one tank. In Plainville, four SBRs are used, with one SBR always being filled. The SBRs were sized and designed for BOD, TSS, and nitrogen removal. Each SBR can treat up to 300,000 gal (1.1 ML) of wastewater in each batch, holding an additional 760,000 gal (2.9 ML) of mixed liquor suspended solids (MLSS) below the low water level. Each SBR comprises fine bubble diffusers, a mixer, a decanter, an analog level sensor, a backup high level switch, and a dissolved oxygen (DO) sensor.

Since the influent flow is continuous and no flow equalization or storage is upstream, at least one SBR must receive flow at any given time. Under normal operation, the four SBRs are staggered such that one SBR is always filling and, ideally, one SBR is always decanting. Since a single SBR can receive up to only 300,000 gal (1.1 ML) in a batch, the maximum flow that can be received is limited by the number of cycles per day. The SBRs were designed for a 72-minute fill phase, resulting in a total cycle time of 288 minutes. This results in a maximum flow rate of 6.0 mgd (23 ML/d) among all four SBRs (less than the 7.5 mgd [28 ML/d] peak hour flow rate). The operators can adjust the phase times under various flow conditions to optimize treatment or for peak flow capacity.

Each cycle contains the following phases:

- **Mix Fill**: Untreated water enters the tank while the tank is mixed with no aeration provided. Denitrification occurs as microorganisms in the activated sludge metabolize carbon in the incoming wastewater.
- **React Fill**: Untreated water continues to enter the tank while the tank is mixed and aerated cyclically. Oxidation of BOD and nitrification take place. Denitrification can also occur if the oxygen is depleted when the aerators are off and sufficient carbon is available.
- **React**: The tank is mixed and aerated cyclically. BOD oxidation and nitrification continues while no wastewater enters the tank. Denitrification can also occur if the oxygen is depleted when the aerators are off and sufficient carbon is available.
- **Settle**: The mixers and aerators are turned off, and the activated sludge is allowed to settle to separate the treated water from the microbiology responsible for treatment.
- **Decant**: The mixers and aerators are left off, and the decanter is lowered, allowing water from the top of the SBR to decant. During the last few minutes of this phase, some activated sludge is wasted from the bottom of the tank.

One of Plainville's SBRs in the react phase, showing the mixer on the left and the decanter on the right

PHOSPHORUS REMOVAL APPROACH

In response to the new phosphorus limit, the town prepared a phosphorus removal plan that included a desktop screening of phosphorus removal approaches, an analysis of technology alternatives, and jar testing of chemical coagulants.

Phosphorus removal generally consists of two broad steps. First, dissolved phosphorus must be converted into a solid, and then the solid must be removed. Conversion to a solid can be accomplished either chemically by reacting with a chemical coagulant or biologically by incorporating the phosphorus into biomass. A chemical coagulant reacts with the dissolved phosphorus and forms a precipitate. Biological phosphorus removal happens to some extent in every activated sludge process due to microorganisms using phosphorus as an essential nutrient, and this can be greatly accelerated using enhanced biological phosphorus removal (EBPR) to facilitate the preferential growth of phosphorus accumulating organisms (PAOs). Once in solid form, phosphorus can be removed by primary clarification, secondary clarification, or a post-secondary solids removal process. The specific phosphorus removal approach will depend on the effluent total phosphorus concentration required.

Effluent total phosphorus as low as 0.5 mg/l can be reliably achieved using either chemical addition or EBPR, using primary and secondary settling to remove the solids. However, to reduce the effluent total phosphorus concentration to the level required by Plainville's NPDES permit, all dissolved phosphorus must be converted to solids and the effluent solids concentration must be extremely low. To reach a target of 0.1 mg/l, post-secondary chemical addition and solids removal are required; this is generally coupled with upstream treatment to reduce the secondary effluent total phosphorus concentration down to 1.0 mg/l.

In Plainville, chemical addition was selected for the upstream treatment, with provisions for chemical injection in the primary clarifiers, in the SBRs, and in the sludge dewatering recycle stream. EBPR to lower total phosphorus to 1.0 mg/l was evaluated but was not considered sufficiently reliable in Plainville due to the limited size and cycle time of the existing SBRs. EBPR may be possible; however, it would compete with nitrogen removal—also a priority for the WPCF—for cycle time.

SBR fill pipe

Several alternatives were considered for downstream treatment, including ballasted flocculation, deep-bed sand filtration, and cloth media filters, which are also referred to as disc filters. The analysis considered the advantages and disadvantages of each type of system, capital costs, and operation and maintenance costs, specifically considering the performance requirements and system sizes needed in Plainville. The phosphorus removal plan recommended disc filters with a dedicated coagulation and flocculation system for post-secondary phosphorus removal.

Disc filter designs vary significantly from manufacturer to manufacturer. Some manufacturers use an in-to-out flow pattern, which requires a separate bypass system to protect the filters but allows for a lower system profile. Other manufacturers use an out-to-in flow pattern, which allows bypassing to occur over the top of the filters without a separate bypass system but requires a taller building. In addition, both styles can be provided with stainless steel tanks, or they can be inserted into a cast-in-place concrete tank.

Rather than designing both systems for contractors to bid, a competitive pre-selection process was used early during design to select a disc filter manufacturer and tank material. This enabled the manufacturer and tank material to be selected based on both non-monetary factors and total life-cycle costs such as equipment capital cost, building and incidental costs, and operation and maintenance costs based on guaranteed chemical dosages. After selecting the disc filter manufacturer, the town required the manufacturer to perform a validation test using a pilot trailer to verify that its system would meet the performance requirements at the guaranteed chemical dosages.

THE CHALLENGE: SBRs

While SBRs have several advantages, the presence of SBRs in Plainville introduced several design challenges to the phosphorus removal project, including batching chemical, equalizing flow, double decants, and validation testing.

Batching Chemical

In a conventional activated sludge system, coagulant is added constantly to the MLSS while it is flowing from the final aeration tank to the secondary clarifiers. Coagulant is simply flow-paced, which provides a constant and easily controlled coagulant dose. Mixing occurs naturally while the MLSS is conveyed from one process to another.

The presence of the SBRs complicates this conventional approach. Since each SBR serves as both an aeration tank and a secondary clarifier in a single tank, MLSS does not flow from one process to the other. In addition, rather than a steady stream of MLSS that passes from aeration to settling, an entire batch is instantaneously switched from aeration to settling.

One solution to this challenge would be to dose chemical upstream of the SBRs before flow is split to the individual SBRs. Doing so provides one dosing location with a steady stream that is easily flow-paced. However, this would mean that coagulant is dosed before the aeration process, thus making the coagulant less effective and less efficient for several reasons:

- The coagulant would react with constituents other than phosphorus in the untreated influent prior to aeration.
- Since non-reactive phosphorus is converted to reactive phosphorus during aeration, the reactive phosphorus concentration at the SBR influent would be lower, requiring a higher concentration of coagulant to remove the same amount of phosphorus.
- Non-reactive phosphorus that is converted to reactive phosphorus during aeration would not be available for coagulation, which would have already occurred. Any newly converted reactive phosphorus not taken up by biomass growth would be passed on to post-secondary treatment.

To better mirror the optimal conventional approach at an SBR plant, the Plainville phosphorus removal design included a coagulant dosing system that doses directly to the SBRs at the end of the react phase. This avoids the disadvantages described above. Instead of dosing a steady stream of coagulant, the coagulant system will dose the required amount of chemical for the entire SBR batch within just a few minutes. This increases the size of the chemical metering pumps significantly. A system of valves is used to select which SBR is dosed. The dose is timed to finish dosing a few minutes before the mixer turns off to allow for mixing, coagulation, and flocculation just prior to the settle phase. Operator-adjustable setpoints are included in the control logic to allow the operator to tune and optimize the dosing system based on experience.

Equalizing Flow

Each SBR decanter currently overflows into the decant collection "box" or well, a small structure open to the atmosphere. From here, flow is directed to the UV channel via a common pipe without any equalization. Each SBR has an effluent throttling valve to control the decant discharge rate such that the flow would be relatively constant over the planned decant phase time. In theory, there would always be one SBR decanting, resulting in a constant flow to the UV system and post-aeration tank—all without the need for an equalization tank.

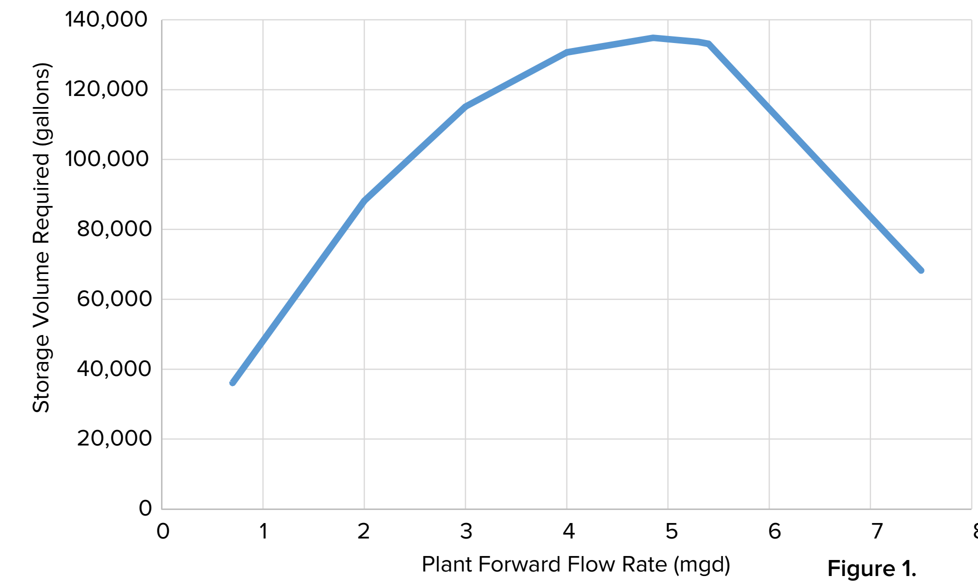

Figure 1. Minimum flow equalization tank volume required

This control sequence was never able to be successfully tuned, however, and the operators have instead selected a constant effluent valve position. The decant now typically occurs in about half of the decant phase time depending on the valve setpoint and the batch volume. Once the SBR batch has been fully decanted, the downstream processes receive no flow until the next SBR decants.

While this operating mode works satisfactorily for the UV system and post-aeration tank, cycling batches of flow through the proposed disc filtration process for phosphorus removal would be significantly more problematic. Post-secondary phosphorus removal down to the low level of 0.1 mg/L requires a finely tuned coagulation and flocculation pre-treatment step. It is easily possible for the coagulant and/or polymer doses to be either too high or too low, so the chemicals must be reliably flow-paced. This requires a relatively steady flow through the rapid mix and flocculation tanks and any changes to occur gradually so that the chemical metering systems can also be adjusted gradually.

To overcome this challenge, the phosphorus removal system includes a flow equalization tank to collect the SBR decant in batches, and it is then pumped to the rapid mix tanks at a steady pace. A flow meter on the pump discharge provides the flow signal used for flow-pacing the chemical metering systems.

To equalize flows under normal conditions, the minimum flow equalization tank volume was set to level out the flow curve through a single decant at all plant influent flow rates, from the minimum hour design flow rate (0.7 mgd or 2.6 ML/d) to the peak hour design flow rate (7.5 mgd or 28 ML/d). For each scenario, the flow equalization tank begins to empty when the decant occurs. As the decant occurs filling the equalization tank, the filter influent pumps withdraw water at a rate that is set to equal the plant influent flow rate, thereby maintaining a steady flow rate throughout the decant. Since the decant happens faster than the filter influent pumps are withdrawing water, the flow equalization tank fills up. The maximum volume required for each scenario occurs when the decant ends and the net volume in the tank stops increasing and starts decreasing. This analysis is based on a maximum decant rate of 9.7 mgd (37 ML/d), which in turn is based on the capacity of Plainville's SBR equipment and a review of the WPCF hydraulics.

Figure 1 graphs the minimum required flow equalization volume at various influent flow rates using the above analysis. The required flow equalization volume is low when the forward flow rate is low, and it is also low when the forward flow rate approaches the decant flow rate. The storage volume reaches a peak when the influent flow rate is exactly half of the decant flow rate: 4.85 mgd (18 ML/d). The minimum required working storage volume at this flow rate is 135,000 gal (500,000 L).

Handling Double Decants

If the 300,000 gal (1.1 ML) batch volume of a single SBR is filled in less than the fill phase time (72 minutes by design), the full SBR can no longer accept additional flow. Further complicating this is that the operators can lengthen the SBR cycle to optimize treatment but possibly reduce the maximum treatment flow rate even further. Plainville's operators typically use an 80-minute fill phase, reducing the maximum treatment capacity to 5.4 mgd (20 ML/d), which is well below the peak hour flow rate of 7.5 mgd (28 ML/d).

To avoid surcharging the primary clarifiers, the SBR control panel includes a "storm mode," which automatically shortens SBR phases to make room

Disc filter pilot trailer during validation testing

Equalization tank apparatus used during the validation test

for the additional flow. In this mode, one SBR begins to decant early, while another SBR is still decanting. If the storm mode occurs for an extended period, two SBRs could begin decanting simultaneously. This would result in an SBR effluent flow rate of 12 mgd (45 ML/d) for up to 72 minutes even though the WPCF influent flow rate is between 6.0 mgd (23 ML/d) (design max day flow rate) and 7.5 mgd (28 ML/d) (design peak hour flow rate).

If a flow equalization tank were designed with 135,000 gal (500,000 L) to equalize the flow as described above, it would fill after only 43 minutes of 12 mgd (45 ML/d) entering and 7.5 mgd (28 ML/d) exiting. As a result, to handle a double decant, either the post-secondary treatment process must be sized for much larger than the WPCF's peak hour flow rate, or the equalization tank needs to be upsized to equalize a double decant. Plainville selected the latter.

To accommodate a double decant, the equalization tank size is determined by adding two batch volumes (600,000 gal or 2.3 ML total), and subtracting the post-secondary treatment process peak flow rate multiplied by the decant time (7.5 mgd x 72 minutes = 375,000 gal, or 28 ML/d x 72 minutes = 1.4 ML). The total required storage volume is therefore 225,000 gal (850,000 L).

Validation Testing

After pre-selecting the disc filter manufacturer, the selected manufacturer was required to perform a 15-day validation test using a pilot trailer to verify the equipment's ability to meet the performance requirements. The presence of the SBRs complicated the validation testing procedure in two different ways.

First, intermittent effluent flow from the SBRs added to the test apparatus requirements. At a conventional activated sludge plant, a steady stream of secondary effluent can be pulled from the WPCF for testing. At Plainville, the SBRs decant in batches, resulting in intermittent effluent flow so there is no steady stream to pull from. In this case, a pilot scale flow equalization tank was set up. A pump was set up on a timer to fill the equalization tank while the SBRs were decanting. To simplify the controls, an overflow pipe was routed back to the withdrawal point, allowing the tank to be filled up quickly with no need to turn the pump off once the tank is full.

Second, the SBRs added significant complexity to the pre-treatment requirements. Since the disc filter design was based on an influent total phosphorus concentration of 1.0 mg/l, but the upstream chemical addition system needed to achieve this concentration was not yet in place, the validation test protocol required a pre-treatment step. Setting up a control sequence to batch chemical to each SBR at the end of the mix phase would be impractical for a short-term test, so the disc filter manufacturer provided a chemical addition skid and flow-paced the coagulant upstream of the SBR influent pump station, before splitting to the SBRs.

The chemical addition skid failed to achieve the intended pre-treatment. Several factors likely explain this. First, as described in the section discussing the batching chemical challenge above, dosing prior to aeration results in the non-reactive portion of the phosphorus being unavailable for coagulation, and it ends up passing through the

| PHOSPHORUS REMOVAL AT AN SBR PLANT |

Plainville's new filter building in construction as of February 2019. Equipment pads for the disc filters are in the foreground. The background shows the flow equalization tank, which will be located underneath the chemical storage room.

SBRs rather than being removed. Second, since each batch is only a fraction of the tank contents, it takes many batches for a chemical injection upstream of the SBR to reach steady state. Based on a full batch, which is nearly 30 percent of the tank volume, each SBR would need nine batches, or about two days, to reach 95 percent of steady state. However, depending on the flow conditions, a batch may be as low as 5 percent of the tank volume. If a typical 10 percent batch is used, the number of batches required to reach 95 percent of steady state jumps to 28, or about six days. This challenge is compounded by changing influent conditions (a high flow event diluted the phosphorus concentration near the beginning of the validation test.)

This challenge was overcome by demonstrating that the disc filters could perform better than guaranteed, meeting the guaranteed treatment requirements even at significantly higher influent total phosphorus concentrations than intended. This required several additional days of testing and was more difficult than anticipated but was successful.

CONCLUSION

The Plainville WPCF design was completed in early 2018, addressing all the challenges presented by the SBRs. Bids were opened in May 2018 and came in under budget, enabling the town to award all bid alternates. The project was awarded for just under $11.2 million. The project is scheduled to be completed in 2020.

ACKNOWLEDGMENTS

The author thanks Joseph Alosso and the town of Plainville staff for the opportunity to work on this project and for explaining the everyday challenges they face, as well as the Tighe & Bond team, especially Stephen Seigal and Frederick Mueller, for guidance and support throughout the design.

ABOUT THE AUTHOR

Paul Moran is a senior engineer at Tighe & Bond focusing on wastewater and drinking water treatment. He was both project manager and process design engineer for the Plainville WPCF phosphorus removal upgrade project from preliminary design (after the phosphorus removal plan was completed) through construction. He has a Master of Science in Environmental Engineering and a Bachelor of Science in Civil and Environmental Engineering, both from Worcester Polytechnic Institute.

Flow distribution improvements at the Stamford Water Pollution Control Facility

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ABSTRACT | The Stamford Water Pollution Control Authority owns and operates the Stamford Water Pollution Control Facility (WPCF), an advanced wastewater treatment facility that uses a four-stage Bardenpho process to achieve biological nitrogen removal. The Stamford WPCF is a 24 mgd (91 ML/d) facility with a peak design capacity of 68 mgd (257 ML/d) and an annual average flow of 18 mgd (68 ML/d). Biological treatment facilities at the plant consist of two aeration basins and four secondary clarifiers. Effluent from the plant is discharged to Stamford Harbor, which is a tidally influenced body of water off Long Island Sound. Under conditions of high tide and/or plant flow, plant effluent must be pumped to Stamford Harbor.

KEYWORDS | Flow distribution, hydraulic model, pumping, return activated sludge (RAS), mixed liquor

INTRODUCTION

The Stamford Water Pollution Control Facility (WPCF) had experienced issues related to the distribution of primary effluent to the plant's two aeration basins and distribution of mixed liquor to the four secondary clarifiers. Legacy flow-split mechanisms were difficult to adjust, and the flow to individual secondary clarifiers varied significantly, especially when one of the other clarifiers was out of service. The Stamford Water Pollution Control Authority (SWPCA) evaluated flow distribution problems at the plant to determine improvements to address the ongoing hydraulic issues.

Another issue at the plant was that while the return activated sludge (RAS) pumps provided adequate RAS pumping capacity, the configuration of the RAS piping caused operational problems. These problems included the lack of flow monitoring for RAS withdrawal from three of the plant's four secondary clarifiers, not allowing for uniform withdrawal from each clarifier, and the lack of a reliable way to evenly return RAS to the two aeration basins. Although flow meters existed in the RAS discharge piping to each aeration basin, flows were manually balanced by plant operators by manipulating RAS pump speeds and discharge valve positions.

The plant also discharges its effluent into Stamford Harbor, a tidally influenced body of water off Long Island Sound. Under conditions of low tide in Stamford Harbor and average plant flow, effluent can be conveyed by gravity from the plant to the harbor. However, during high tide and/or higher plant flows, the effluent must be pumped to prevent submergence of the plant's UV disinfection effluent weir gates that regulate water levels through the process. Although the plant's three effluent pumps were designed to deliver 34 mgd (129 ML/d) each, for a firm capacity equivalent to the plant's peak design capacity of 68 mgd (257 ML/d), operation of all three pumps was required under peak-flow conditions.

APPROACH

Hydraulic evaluations of the facilities were performed using the flow conditions summarized in Table 1. The RAS flow is the rate at which settled solids are pumped (i.e., returned) from the secondary clarifiers to the head of the two aeration basins. RAS pumping facilities are typically designed to return approximately 100 percent of the design plant influent flow, which equates to 24 mgd (91 ML/d) for the Stamford WPCF. During normal plant operations, the RAS rate is often less than 100 percent of plant influent flow. Historical flow data provided by the SWPCA showed that the plant often operates the RAS rate at 60 percent to 75 percent of the plant's influent flow.

Under the plant's four-stage Bardenpho configuration, nitrified recycle (NRCY) is pumped from the third oxic zone of each of the two aeration basins to the anoxic zone at the head of each basin. As shown in Table 1, hydraulic capacities at the plant were calculated using RAS rates of 18 and 24 mgd (68 and 91 ML/d), and a NRCY flow rate of 80 mgd (303 ML/d).

Hydraulic profile calculations were performed using an Excel-based hydraulic model developed specifically for the analysis of treatment plant hydraulic profiles. Information about the existing facilities was acquired from record drawings from past construction projects and equipment operation and maintenance manuals and, where possible, was verified in the field. Critical elevations, such as invert and weir elevations, were verified with a field survey performed by a surveyor licensed in Connecticut.

Hydraulic profiles through a treatment plant are calculated beginning at the downstream end of the plant and working upstream, with the downstream control point being the water surface elevation in Stamford Harbor at the plant outfall. The hydraulic profile calculations consist of a series of head loss calculations in each hydraulic element (pipe, channel, gate, weir, etc.) of the plant, with the head loss in each element influencing the element immediately upstream. The model consists of Excel spreadsheet modules for each type of hydraulic element that are linked to create a continuous hydraulic profile of the plant. The theoretical bases for the model's hydraulic profile calculations are as follows:

- **Head loss in piping** consists of friction and minor losses. Friction losses are calculated using the Hazen–Williams equation. Hazen–Williams C-values are selected based on those typically found in pipes that have been in service for years. Minor loss k-values are selected using published values.
- **Head loss in channels** consists of friction losses and minor losses. Friction losses are calculated using the Manning equation and depend on the roughness of the channel as measured by the Manning n-value. The calculation for friction loss in a channel is an iterative solution, since the depth and velocity of flow vary along the length of the channel. Minor losses in channels are calculated similarly to those in a pipe.
- **Gates and ports** can be submerged (typical for sluice gates) or have free-surface flow (typical for a slide gate). Losses through gates and ports are calculated using the orifice equation, with orifice coefficients determined based on the geometry of the port.
- **Weirs** are often used to maintain a constant level in a process unit and can have different forms (sharp-crested, v-notch, etc.). Weir equations used in the hydraulic profile calculations vary based on the type of weir.

Table 1. Stamford WPCF design flow conditions

Plant Flow Condition	Flow mgd (ML/d)		
	Influent	RAS	NRCY
Annual Average	24 (91)	18, 24 (68, 91)	80 (303)
Peak Wet-Weather	68 (257)	18, 24 (68, 91)	80 (303)

Table 2. Stamford WPCF hydraulic control points

Hydraulic Control Point Location	Elevation ft (m)
Primary Clarifier Effluent Weirs	21.80 (6.64)
Aeration Basin Influent Weirs	17.92 (5.46)
Mixed Liquor Distribution Weir Gates	15.60 (4.75)
Secondary Clarifier Effluent Weirs	13.50 (4.11)
UV Channel Effluent Weir Gates [1]	9.42 (2.87)
Mean Higher-High Tide [2]	8.49 (2.59)
100-Year Flood [3]	10.74 (3.27)

[1] UV channel effluent weir gates are modulated to maintain noted water surface elevation

[2] Referenced from the two nearest NOAA Stations (8468448 South Norwalk, CT; 8518091 Rye Beach Amusement Park, NY)

[3] Referenced from FEMA FIRM No. 09001C0517G

The equations used in the hydraulic profile calculations are widely accepted and have been in use for many years. However, the accuracy of the equations is affected by the selection of values for the coefficients used in the model. Some of these coefficients, such as the Hazen–Williams C-value, change over time. A 20-year-old pipe will not have the same C-value as a new pipe of the same material due to deterioration of the pipe wall or biological growth on the pipe walls. Conservative values were selected for the model that would predict the performance of older pipes.

The hydraulic evaluation aimed to identify hydraulic constraints (i.e., "bottlenecks") in the plant that may affect plant performance by submerging critical hydraulic control points. Critical hydraulic control points are defined as those hydraulic elements where the water level is somehow fixed or those points that, if submerged, could lead to significant process upsets. For the Stamford WPCF, Table 2 summarizes the locations and elevations of critical hydraulic control points.

RESULTS

The segment of the plant between each pair of hydraulic control points was modeled to predict performance under the plant's design flow conditions, to determine the maximum hydraulic capacity of each segment, and to identify bottlenecks in

Table 3. Maximum hydraulic capacities of plant segments

Segment Description	Maximum Hydraulic Capacity mgd (ML/d) RAS = 18 (68)	RAS = 24 (91)
Primary Clarifier Effluent Weirs to Aeration Basin Influent Weirs	56 (212)	
Aeration Basin Influent Weirs to Mixed Liquor Distribution Weir Gates	63 (238)	63 (238)
Mixed Liquor Distribution Weir Gates to Secondary Clarifier Effluent Weirs	57 (216)	51 (193)
Secondary Clarifier Effluent Weirs to UV Disinfection Effluent Weir Gates	52 (197)	
UV Disinfection Effluent Weir Gates to Stamford Harbor by Gravity[1]	15 (57)	

[1] Based on mean higher-high tide elevation in Stamford Harbor

1. Former mixed liquor distribution channel (in foreground) serving secondary clarifier No. 3

the unit processes and yard piping. Modeling was performed with all process units in service.

Plant segments that were modeled, and their estimated maximum hydraulic capacities, are summarized in Table 3. Individual segments were modeled assuming no impacts from downstream hydraulic constraints.

Primary Effluent Flow Distribution

Primary effluent is distributed to the plant's two aeration basins from a common distribution channel adjacent to the aeration basins by two, 50 ft long (15 m long) influent flow splitting weirs. The depth of head above these weirs is small (less than 3 in. [7.6 cm] under average-flow conditions) compared to potential flow disturbances in the influent channel and was considered inadequate to ensure good flow distribution. A small error in the adjustment of one of these weirs could introduce significant flow distribution problems.

Mixed Liquor Flow Distribution

Mixed liquor from the two aeration basins is distributed to the plant's four secondary clarifiers through four parallel flow paths, one to each clarifier. Each flow path consists of a mixed liquor distribution weir gate, clarifier influent center column with distribution ports, and an effluent v-notch weir around the perimeter of the clarifier. A primary distinction between the four flow paths is that influent to secondary clarifier Nos. 1 and 4 is conveyed through buried pipes, while influent to secondary clarifier Nos. 2 and 3 is conveyed by both open channels and buried pipes. The maximum hydraulic capacities of this segment presented in Table 3 are expressed as 4 times the most-constrained flow path. A 4 ft wide, 44 ft long (1.2 m wide, 13 m long) open channel to secondary clarifier No. 3, pictured in the foreground of photo 1, was identified as the principal contributor to hydraulic limitations of this plant segment.

RECOMMENDATIONS

Primary Effluent Flow Distribution

During field verification of critical elevations to support the hydraulic model development, measurements of the aeration basin influent weirs revealed a variation in weir elevations of as much as 1.3 in. (3.3 cm). Under the plant's average-flow conditions, the depth of head above the aeration basin influent weirs was determined to be relatively small compared to the 50 ft (15 m) length of the weirs. Variations in weir elevations, such as the variation measured by the field survey, can significantly affect flow distribution. As such, it was recommended that all aeration basin influent weirs be adjusted based on the final hydraulic profile calculations with the assistance of a professional surveyor licensed in Connecticut.

Mixed Liquor Flow Distribution

For the plant's mixed liquor distribution weir gates to provide adequate flow distribution to the four secondary clarifiers, staff considered an alternative to install new isolation gates in the common mixed liquor effluent channel (located immediately downstream of the weir gates). Under this alternative, an additional gate was also recommended in a new opening between the two aeration basin mixed liquor distribution channels (located immediately upstream of the weir gates) to hydraulically connect the two aeration basins.

A second alternative to improving mixed liquor flow distribution from the two aeration basins to the four secondary clarifiers was also considered, consisting of a new mixed liquor distribution box. Under this alternative the mixed liquor effluent from each of the two aeration basins would be conveyed through a common channel to the new distribution box. The distribution box was recommended to consist of four isolation slide gates and distribution weirs to provide for equal distribution of mixed liquor to the four secondary clarifiers.

Figure 1 shows a plan drawing of the proposed distribution box, including the installation of a vertical mixer so that solids would be maintained in suspension and evenly distributed to the secondary clarifiers. Following the hydraulic evaluations of the plant, the SWPCA selected this second alternative for improving mixed liquor flow distribution. The SWPCA also favored this approach because it combines the mixed liquor effluent from both aeration trains and avoids running two separate activated sludge processes side by side with separate mixed liquor streams.

RAS Withdrawal and Distribution

Regardless of other improvements considered, flow meters were recommended in the RAS withdrawal piping from each secondary clarifier. Under existing conditions, only the RAS withdrawal from secondary clarifier No. 4 was monitored. The added instruments allow better control of individual clarifier RAS withdrawal rates and consistency of withdrawal from each secondary clarifier. Plant SCADA modifications were also recommended for automatic control of RAS withdrawal rates by modulating pump speeds to maintain a specific RAS flow setpoint from each clarifier. Additional modifications were also recommended, including proportional RAS control, where the plant's cumulative RAS flow setpoint is calculated as a percentage of the plant's influent flow.

To improve RAS distribution to the two aeration basins, two alternatives were considered. One alternative consisted of a new RAS distribution box at the influent end of the two aeration basins that would intercept both RAS discharge lines and distribute the RAS to the two aeration basins using fixed weirs. The second alternative was to install new motorized discharge plug valves in each of the two RAS discharge lines to automatically balance flow by modulating one of the two valves. Plant SCADA modifications were recommended to employ the most-open-valve logic. Using this approach, one of the two modulating discharge plug valves would be set to a fixed position, while the other is modulated to evenly split the RAS return to the two aeration basins. The two RAS discharge flow meters were acceptable for reuse under this second alternative, and SCADA would be relied upon to modulate the position of one of the two discharge plug valves using the new control logic.

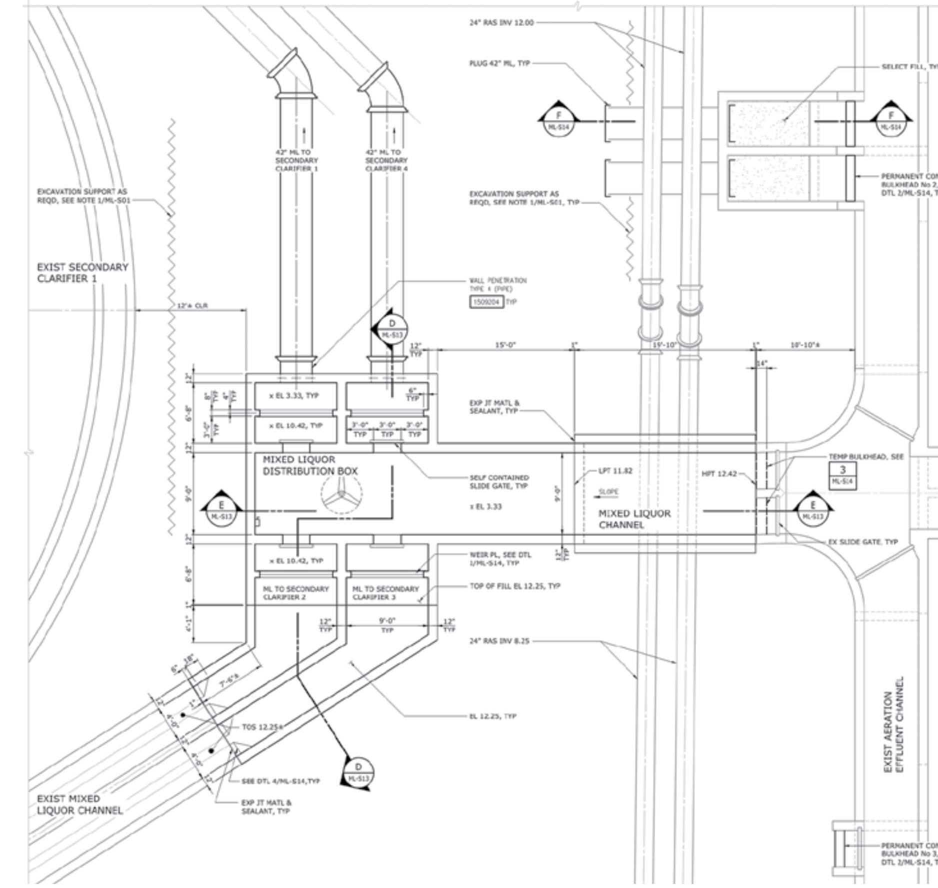

Figure 1. New mixed liquor channel and distribution box

The SWPCA elected to design and construct the recommended RAS withdrawal improvements, as well as the second alternative for improving RAS distribution to the two aeration basins. Figure 2 presents a schematic of the recommended RAS withdrawal and distribution configurations.

Final Effluent Pumping

Several potential modifications were considered to improve the firm capacity of the plant's final effluent pumping system. One solution considered addressing the possibility that trapped air in the discharge piping was restricting the maximum discharge capacity of each effluent pump. Under this solution, venting each pump's discharge line was considered by designing and installing new air-release valves to improve discharge conditions for each pump. Since it was thought to be unlikely that this solution alone would achieve the desired effluent pumping capacity, other improvements were considered.

Raising the operating levels of the effluent pump wet well would reduce the static head that the effluent pumps must overcome and increase pump capacity. However, the allowable wet well level at this plant is limited by the need to avoid submerging the channel effluent weir gates that maintain proper water surface elevations through the UV disinfection process. Although it was important to start the effluent pumps while significant freeboard is

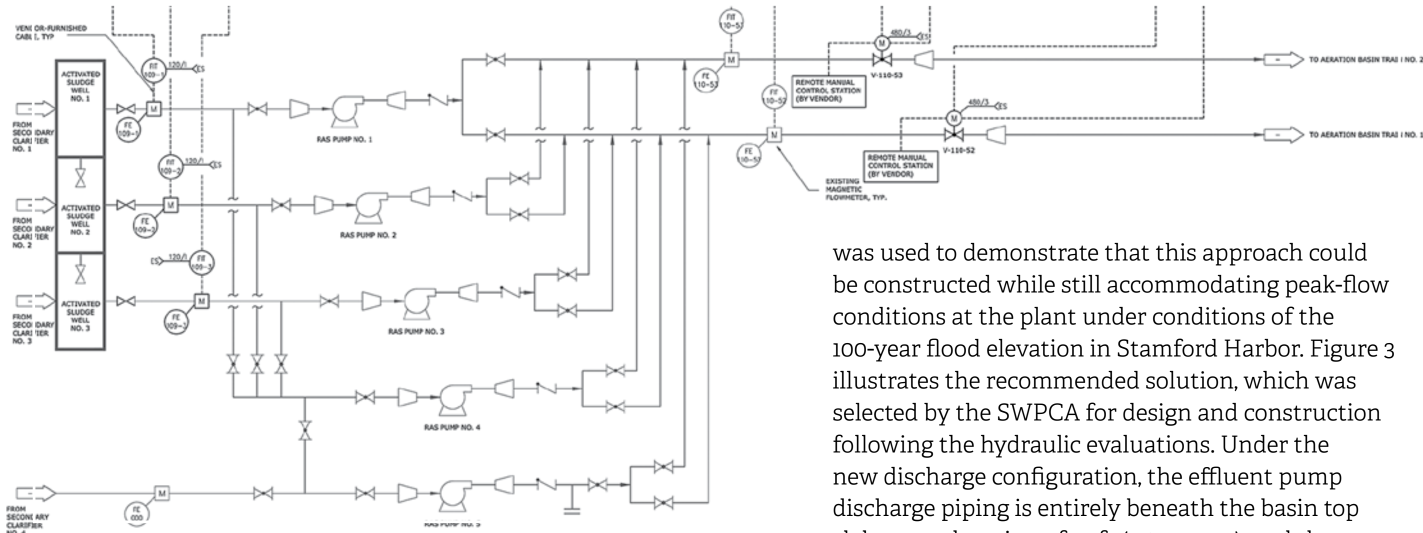

Figure 2. Proposed RAS withdrawal and distribution improvements

downstream of the UV channel effluent weir gates, it was reasonable to assume that the operating level could be raised above its existing setpoint. The SWPCA was wary of this approach, since detailed evaluation and optimization of SCADA programming would be required in order not to jeopardize effective UV disinfection.

To achieve additional discharge capacity using the plant's existing effluent pumps, the pumping head had to be reduced significantly. Since achieving this outcome by increasing wet well operating levels was not favored, it was recommended to lower the elevation of each pump's discharge piping below the existing elevation. As shown in photo 2, the effluent pump discharge piping was previously above the top slab of the basin structure that houses the effluent pumps. Under the proposed recommendations, the effluent pump discharge piping centerline elevation was lowered by approximately 5.8 ft (1.8 m). The hydraulic profile developed in support of this work was used to demonstrate that this approach could be constructed while still accommodating peak-flow conditions at the plant under conditions of the 100-year flood elevation in Stamford Harbor. Figure 3 illustrates the recommended solution, which was selected by the SWPCA for design and construction following the hydraulic evaluations. Under the new discharge configuration, the effluent pump discharge piping is entirely beneath the basin top slab at an elevation of 19 ft (5.8 meters), and the top flange of the effluent pump discharge column is flush with the basin top slab. New air-release valves were installed in the top flange of each effluent pump's discharge column and in the horizontal run of discharge piping from each effluent pump.

Another alternative that would have replaced the effluent pumps with new units was considered but was cost-prohibitive.

2. Former effluent pump discharge configuration

CONSTRUCTION AND CONCLUSIONS

Following design of the recommended and SWPCA-selected flow distribution improvements for the Stamford WPCF, construction commenced in February 2017 and was completed by the end of December 2017 at a cost of approximately $4.3 million.

Since that time, the plant has seen wet-weather flows as high as 58 mgd (220 ML/d). The SWPCA has been satisfied with the performance of the new mixed liquor distribution box shown in photo 3. Isolation of individual secondary clarifiers for routine maintenance and other activities has also been simplified, since plant operators must close only the associated slide gate in the mixed liquor distribution box. No other adjustments are necessary to maintain equal flow distribution when a secondary clarifier needs to be removed from service. Similarly, individual aeration basins can be taken offline without any other adjustments to maintain mixed liquor flow distribution to the secondary clarifiers.

3. Completed mixed liquor channel and distribution box

4. Completed effluent pump discharge modifications

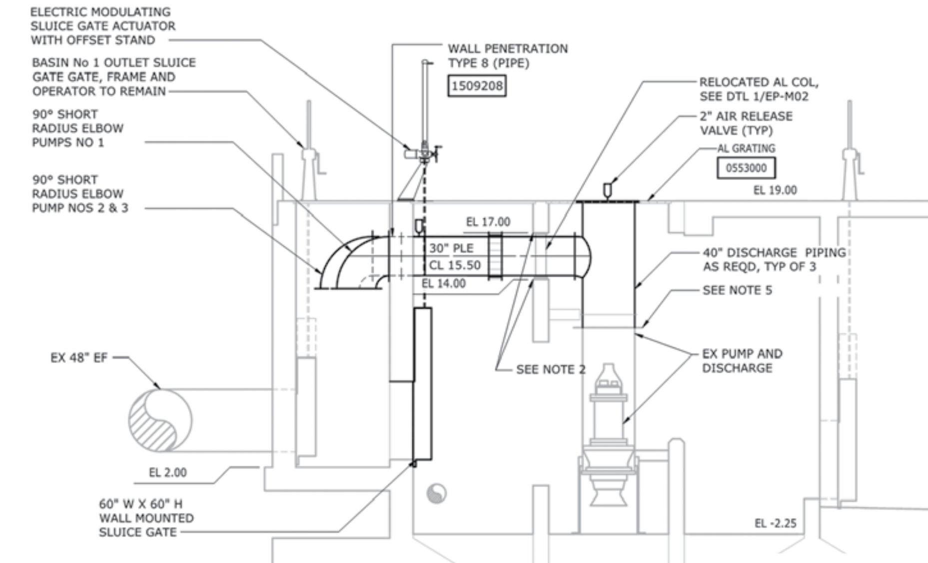

Figure 3. Proposed effluent pump discharge modifications

The RAS withdrawal and distribution improvements have allowed the SWPCA to better automate the operation of its RAS pumps. Following the related plant SCADA modifications, the SWPCA can now rely on flow pacing of the RAS pumps as a function of influent flow. These improvements have reduced the plant operator attention required to maintain appropriate RAS distribution to the plant's two aeration basins. In addition, the SWPCA secured partial funding for the improvements from the plant's electricity supplier, through available energy-efficiency funding, by demonstrating a reduction in energy consumption associated with improved RAS pumping operations.

Plant operators report effluent pumping operations have also improved since the effluent pump discharge piping modifications. Photo 4 shows the modified effluent discharge piping after the improvements shown in Figure 3. In addition to increasing the discharge capacity of each effluent pump, related efforts during construction and startup optimized the SCADA and variable frequency drive (VFD) programming for the pumps. Previously, effluent pump operation during nighttime minimum flows coincident with high-tide elevations in Stamford Harbor required plant operators to partially open a sluice gate between the effluent pump wet well and the common effluent channel to which the pumps discharge. This operating procedure was employed because the effluent pump VFDs previously could not be turned down low enough to match nighttime minimum flows without excessive pump cycling. However, VFD speed caps were discovered during startup and programming that have since been modified to increase the usable speed range of the effluent pumps and VFDs. As a result, the effluent pump speeds can now be turned down low enough to meet nighttime minimum flows without requiring plant operators to partially open the sluice gate. As with the RAS withdrawal and distribution improvements, the SWPCA was also able to obtain partial funding for the final effluent pumping improvements from the electricity supplier through available energy-efficiency funding.

ACKNOWLEDGMENTS

The author acknowledges the following members of the Stamford Water Pollution Control Authority: William P. Brink, PE, executive director; Prakash Chakravarti, PE, supervising engineer; and Robert Pudelka, acting plant supervisor.

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Installation of screw press for solids dewatering at the Westerly Wastewater Treatment Plant

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ABSTRACT | Before 2018, the town of Westerly, Rhode Island, disposed of sludge generated at the wastewater treatment plant (WWTP) and septage received there as liquid sludge. The process required three to four trucks per day, something time-consuming for the plant operators, expensive, and disruptive to the surrounding roads and community. The town evaluated several alternatives for installation of a dewatering process to alleviate the issues with the disposal process. A screw press was selected as the preferred technology. Pilot- and bench-scale testing provided the necessary information to size the equipment and design the process. Construction began in May 2018, and the WWTP was processing sludge by October 2018. The project reduced disposal costs and truck traffic, and allowed operators to spend more time on other parts of the WWTP.

KEYWORDS | Screw press, copper, pilot test, sludge disposal


Westerly Wastewater Treatment Plant

INTRODUCTION

The town of Westerly, Rhode Island, is an oceanfront community on the Pawcatuck River at the border of Rhode Island and Connecticut. The town owns the Westerly Wastewater Treatment Plant (WWTP) located at 87 Margin Street. The treatment plant has an average monthly flow rate of 3.3 mgd (12.5 ML/d) and serves approximately 16,500 customers. In addition to flow from the collection system, which includes nine pumping stations, the WWTP receives an average of 7,650 gpd (29,000 L/d) of septage collected from sections of the town and surrounding communities that are not sewered.

The WWTP flow train starts at the headworks, which includes screening and grit removal. Flow from the headworks enters primary treatment consisting of two 50 ft (15 m) diameter primary clarifiers. Ferrous chloride is added for control of copper and for odor control. Solids from the primary clarifiers are drawn from the center of the tanks and pumped to gravity thickeners. Secondary treatment includes an integrated fixed film activated sludge (IFAS) process followed by three 60 ft (18 m) diameter final clarifiers. The bioreactors are separated into anoxic and aerobic zones and include mixed liquor recycle. Waste activated sludge (WAS) is pumped from the final clarifiers to co-settle with primary sludge in the gravity thickeners. Flow from secondary treatment is disinfected using hypochlorite and dechlorinated using bisulfite. Figure 1 presents a simplified liquid stream process flow diagram.

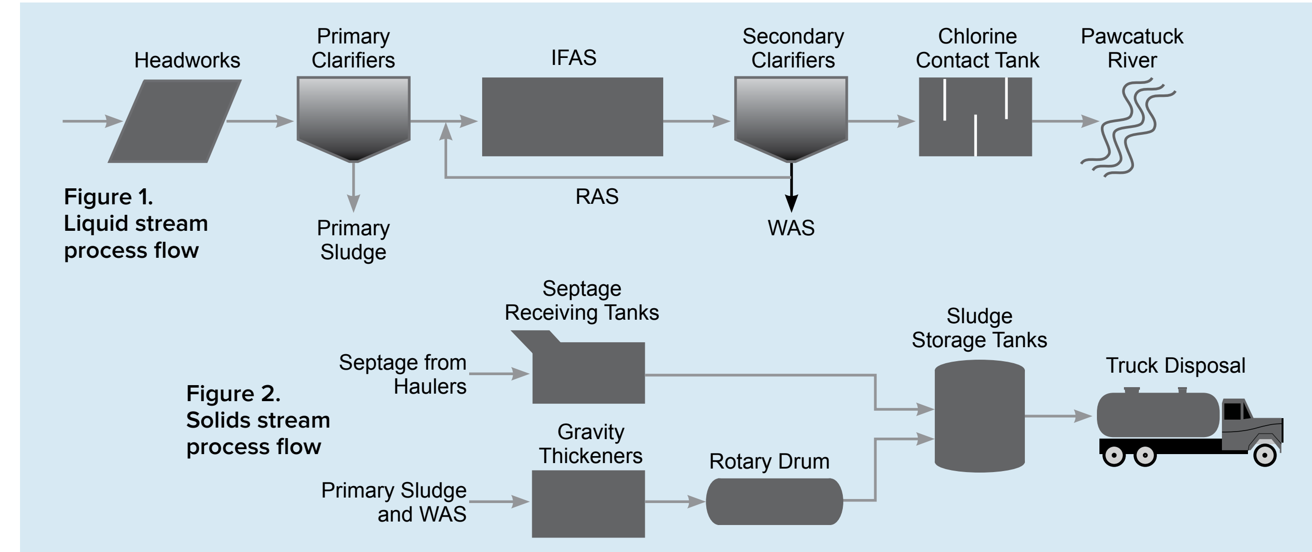

Figure 1. Liquid stream process flow
Figure 2. Solids stream process flow

To reduce trucking volume, the blended, gravity thickened sludge was further thickened using a rotary drum thickener that discharged into thickened sludge storage tanks. Septage received at the plant was screened during discharge into two septage receiving tanks, and then pumped into the sludge storage tanks to mix with the blended sludge produced onsite. The contents of the storage tanks were pumped to tanker trucks for disposal offsite. The sludge handling and disposal process posed problems of expense and public relations concern that prompted a plan to upgrade the sludge handling facilities. Figure 2 shows a simplified solids process flow diagram for the system prior to the upgrade.

The sludge disposal operation required filling three to four tankers per day with liquid sludge. This was time-consuming and expensive, and caused annoying heavy truck traffic in the neighborhood around the plant. The approximate volumetric and mass concentration mix of primary to WAS to septage was 53:35:12 and 58:38:5, respectively. Table 1 summarizes the production of biosolids at the plant prior to the upgrade.

To begin with its planned upgrade, the town first conducted an alternatives analysis to determine the appropriate technology for the WWTP. The analysis showed that a screw press would provide the greatest benefit: It would allow a rather dilute sludge to be fed to the press while still producing a high-solids cake. Screw presses can be fully automated, thus requiring minimal operator attention, which is valuable for a small facility with minimal staff. Screw presses also rotate slowly, reducing wear, and have relatively small power demands compared to other dewatering equipment. A WWTP in West Liberty, Iowa, that has experienced successful operation with a screw press for dewatering, provided the design and operation teams with a helpful reference for selection and design of the press as well as a level of comfort with the new technology.

Table 1. Biosolids production prior to upgrade

Parameter	Units	Average	Max Month	Peak
Septage	lbs/d	319	565	
Septage (0.5% solids)	gpd	7,647	13,540	
Blended Sludge (WAS + Primary)	lbs/d	4,073		10,721
Blended Sludge (1.5% solids)	gpd	29,412		76,571
Net Biosolids Production	lbs/d	4,392		11,040
Net Biosolids Production (1.3% solids)	gpd	37,059		87,238

TECHNOLOGY

Screw presses are a relatively new biosolids technology, and the screw press selected for the process had been used only in a few locations in the United States, warranting extra discussion regarding its application at the Westerly WWTP.

Technology emergence, growth, and development follow a life cycle. Figure 3 depicts one model of the technology life cycle, showing how the phases change with knowledge, experience with the technology, and successful application.

The technology life cycle consists of four phases, each with a unique focus:

1. **Acclimation**—novel, dependent on perception of value added, marketability and strategic importance; risk focused

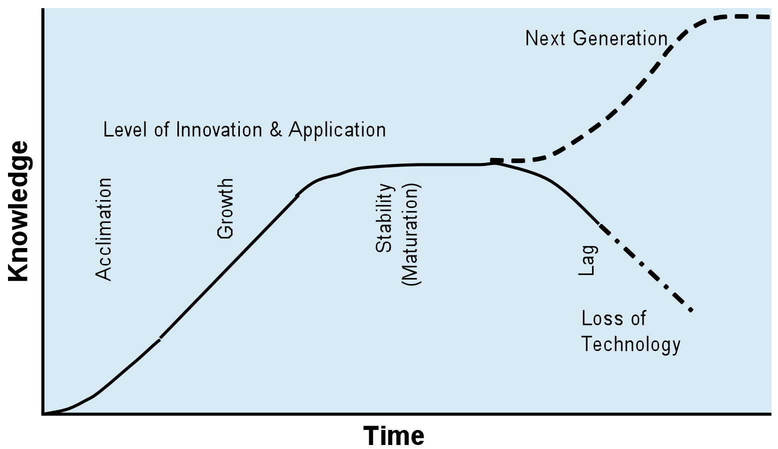

Figure 3. Technology life-cycle model

Table 2. Technology life cycle

Technology	Life Phase			
	Acclimation	Growth	Stability	Lag
Gravity Belt Thickening			■	
Screw Press	■			
Rotary Press		■		
Belt Filter Press			■	
Vacuum Filter				■
Centrifuge Dewatering			■	
Recuperative Thickening		■		
Acid-Gas Digestion				■
Temperature Phased Anaerobic Digestion		■		
Co-digestion	■			
Dual Digestion		■		
Auto-thermal Aerobic Digestion	■			
Thermal Hydrolysis	■			
Thermal Drying			■	
Class A Heat Treat System	■			
Sludge Disintegration	■			
Microsludge	■			
Open Cel	■			
Lyso	■			
Ultrasonics	■			
Ostara	■			
Co-generation			■	
Fuel Cell	■			
Solar Photovoltaics		■		
Gasification	■			
Biosolids Composting			■	

2. **Growth**—understood, well documented applications and signs of transfer success; experience focused
3. **Stability and maturation**—growth rechecked at the value-added plateau; new generation emerging due to feedback and activity from innovation; cost focused
4. **Lag phase**—demise of technology support and life span or emergence of next generation

Table 2 summarizes the life stage of various solids management technologies as considered by the design team. The table depicts innovative and acclimating technologies that will either emerge with promise or die based on application experience. In many respects the growth of a technology is fueled by engineers taking appropriate risk and obtaining experience from new applications to achieve a critical mass that allows the technology to stabilize and mature.

PILOT TEST

A pilot test in July 2017 demonstrated polymer dosage, hydraulic loading, screw speed, and cake solids. Photo 1 shows the pilot test setup. Based on the pilot testing and a mass balance analysis, two presses were identified that would meet the facility's needs. One unit was smaller with less throughput, requiring a longer run time to process the facility's daily sludge production. The larger unit with higher throughput allowed for a shorter run time. Table 3 presents the press alternatives.

The town decided to proceed with the larger unit. Limited plant staff made it more advantageous to select a machine that could process the facility's sludge in a single shift. The smaller unit would require 11 hours of run time to process the sludge while the larger unit could process it in eight hours. The solids balance showed that with effective dewatering the number of truck trips needed to dispose of the plant's solids could be reduced from three to four trucks per day to fewer than three trucks per week.

The WWTP's National Pollutant Discharge Elimination System (NPDES) permit includes an effluent total copper limit of 23 ug/L. Most of the copper is believed to enter the sewer system from copper drinking water pipes and local industries. The plant has successfully demonstrated that the stringent copper limit can be achieved with the existing liquids treatment processes. The plant averaged 52.4 ug/l total copper in the influent and 9.7 ug/l total copper in the effluent prior to the upgrade. The existing process removed 82 percent of the influent copper. In planning for the dewatering upgrade, the town turned its attention to septage received at the plant. Prior to the upgrade, septage did not enter the liquid stream; it was mixed with the blended sludge

Table 3. Screw press alternatives

Parameter	Units	Small Unit Value	Large Unit Value
No. of Units		1	1
Production	kg DS/hr	253	344
Production	lpm	300	390
Run Time (assume five-day week)	Hr/day	11	8
Feed Solids	% Solids	1.5	1.5
Cake Solids	% Solids	25	25
Capture Efficiency	%	93	93
Screw Drive	kW	3.7	4.1
Screw Speed	rpm	0.1-0.7	0.1-0.7
Wash Water	lpm	186	186
Wash Water	kPa	345-552	345-552
Air Requirements	m^3/hr	6.6	6.6
Air Requirements	kPa	552	552

and hauled offsite. The facility did not test copper concentrations in the septage before the planning period for the project. During the pilot test, septage received at the plant was tested and had an average copper concentration of 5.8 mg/l, a matter of concern, since the septage would be mixed with the blended sludge for dewatering, and the filtrate from the process would then enter the plant's liquid stream via the headworks.

A copper mass balance showed that if all the copper in the septage remained in the filtrate and was introduced into the plant's liquid stream, assuming the current removal rate, effluent concentrations would be expected to reach 34.9 ug/l—far exceeding the plant's effluent limit. Some portion of the copper would likely remain bound up in the solids but how much was not known.

Bench-scale testing was performed to determine which polymer would best bind the copper to the sludge to prevent it from entering the plant's liquid stream through the filtrate. Polymers formulated for removing heavy metals were evaluated. Bench-scale testing with one polymer showed an average of 80 percent of the copper bound to the sludge. The mass balance showed that in using this polymer, the effluent copper concentration would increase from only 9.7 ug/l to 12.8 ug/l and keep the facility to within the permit limit; however, the polymer required a two-part feed system, and the screw press is designed for a single-polymer feed.

1. Setup during pilot test

2. Cake production during pilot test

During the pilot test for the screw press, a different polymer was used based on jar testing to produce the best floc. Copper samples were collected in the feed sludge and filtrate to determine the copper concentration that would be in the filtrate. Testing showed that this optimal floc-producing polymer also effectively bound the copper, resulting in a 97 percent removal rate in the screw press. The mass balance showed that removing 97 percent of the copper in the sludge would cause the plant's effluent concentration to increase to only 10.3 ug/l. This would allow the facility to remain below the effluent limit while using a single-part polymer feed system as required by the screw press design.

The pilot system was fed a blend of septage, primary sludge, and WAS at 1.5 percent solids content. The polymer dose, screw press speed, and hydraulic loading were varied during the test. The press produced an average of 24.6 percent solids content with ranges of up 27.9 percent (photo 2). The average polymer dose was 34 lbs active/dry ton (17 kg active/dry tonne). Solids capture averaged 93.2 percent with ranges of up to 96.8 percent. Based on these results, the town proceeded with the polymer used during the pilot testing.

DESIGN AND CONSTRUCTION

Once the technology was selected and the press was sized, a location for the new screw press at the plant needed to be identified. Although constructing a new facility to house a new treatment process is desirable because it does not restrict layout or space for maintenance, the cost of new construction was prohibitive and available spaces at the site were far away from the existing solids processing infrastructure. Reusing existing infrastructure is generally preferable, because it minimizes cost and thus allows a shorter return on the initial investment.

Several options were explored that used existing space no longer in active use.

- The rotary drum thickener was in the main operating building next to other abandoned thickening

3 and 4. Facility prior to start of construction

and dewatering equipment. The space was adequate for the new press, but there was no room for storing cake indoors. Using this space would also require demolition of the operating rotary drum thickener, leaving no ability to thicken the blended sludge during construction. This would increase sludge disposal costs during construction and eliminate future use of the rotary drum thickener as a backup to the screw press.

- A garage space that was previously used to store gaseous chlorine tanks was large enough to fit the screw press and cake storage and had an overhead door that could be used to bring cake bins in and out of the building. The garage foundation was a slab on grade, however, which presented challenges in disposal of filtrate. Either the press would need to be installed at a high enough level to drain the filtrate by gravity out of the space before running it below grade or the slab would need to be cut to install the filtrate line below grade. In addition, the space was being used for storage by plant operators.
- The sludge storage tanks were part of an abandoned septage facility. The space was not in use, was large enough to fit the screw press and ancillary equipment, included a garage bay with an overhead door suitable for cake storage, was on top of the storage tanks minimizing pumping distance, and had access to the plant drain for disposal of filtrate.

After several layouts were developed and discussed with plant personnel, it was decided to locate the press in the abandoned septage facility. The rotary drum thickener location was preserved mainly to keep the system in place as a backup in case the screw press could not be used for a period, an important consideration since only one press was being installed. The garage previously housing the gaseous chlorine tanks was not selected because the cost of installing the filtrate line exceeded that of demolition and minor modifications needed for the abandoned septage facility.

While the facility had been used for septage, flow had entered a channel with a bar screen and discharged into one of the tanks. The first tank had a center channel with a screw for grit removal; the screw pulled the grit to one side. A chamber was next to the tank with grit pumps and the screw drive. Flow from the first tank overflowed into the second tank. A grit washer was above the tanks along with a scrubber for odor control. The building included a garage bay for storage of grit.

The septage receiving facility had been abandoned, but most of the equipment was still in place (photos 3 and 4). The first step was to remove equipment to make space for the proposed press and ancillary equipment. Plant operators volunteered to demolish the existing equipment to save money and time. They rented a dumpster and worked during slow periods and overtime to clear the space to allow the contractors to start installing equipment immediately.

The project included installation of the screw press and ancillary equipment required for operation of the press. Only one of the two sludge storage tanks was in use at the outset of construction. The tank had a submersible mixer installed to prevent stratification and deposition of solids. An identical mixer was installed in the tank not currently in use, and a hatch was cut in the ceiling to allow the mixer to be removed for maintenance. With the second storage tank online, the facility had a combined hydraulic retention time of 32.4 hours at annual average solids production and 13.7 hours at peak production. The volume was crucial for the plant to provide storage over weekends, because the WWTP operates at full staff only five days a week.

Sludge feed pumps and suction lines were installed to draw from the storage tanks and feed the screw press. Sludge lines were also provided to transfer from one tank to the other or pump directly from the tanks to a truck bypassing the screw press. The intent was to provide the operators with maximum flexibility. The sludge lines were installed on top of the existing storage tanks to limit

5. Installed grinder and plunger pumps
6. Screw press with cover panels removed showing the basket and washwater spray bar
7. Container (30 yd^3) (23 m^3) with leveling cover and conveyors and screw press in background

the time the tanks were offline during construction. Continuous tank availability is important for two reasons. First, if necessary, the plant can pump directly from the gravity thickeners to a truck for disposal, although that process is slow and causes sludge to back up. More importantly, the facility cannot dispose of septage without using the sludge storage tanks. Septage receiving is an important revenue source for the facility and restricting access to it is also difficult on the haulers.

The screw press requires a consistent flow rate to optimize performance, necessitating a positive displacement style pump. A grinder was provided to protect the pumps from clogging with rags. Plunger pumps were selected because plant operators had extensive experience with that style of pump, and suction lift capability was needed because the pumps were installed at grade and the tanks are below grade. The plunger style pumps selected offer a 25 ft (7.6 m) suction lift, which is more than adequate, and plunger pumps can also pass moderately large solids if the grinder fails. A bypass is provided in case the grinder has to be offline for maintenance (photo 5).

The plunger pumps discharge to the conditioning tank where blended sludge is mixed with polymer to form floc. The conditioning tank feeds the screw press. The press comprises a screw inside a perforated basket. Sludge entering at one end is conveyed toward the discharge chute at the opposite end by the screw. A pneumatic pressure cone provides backpressure at the outlet. A small air compressor near the press supplies compressed air to the cone. The screw pushes the sludge against the cone, squeezing water out of the sludge. The water passes through the perforations in the basket and leaves through the filtrate line. A spray bar cleans the basket while the press is in daily operation. The spray bar encircles the basket and moves across the length of the basket (refer to photo 6).

Dewatered cake discharges from the press into a shaftless screw conveyor. A series of screw conveyors transports the dewatered cake to a roll-off container equipped with a leveling cover. The leveling cover is adjustable. A hand crank raises and lowers the cover to fit either a 20 yd^3 or 30 yd^3 (15 m^3 or 23 m^3) container. The leveling cover distributes dewatered cake across the bin while containing odors. The container and level loader are connected to an existing biofilter for treatment of odors (photo 7).

To reduce cost and improve the schedule, the major equipment was purchased before hiring a contractor. The sludge feed pumps, grinder, mixer, screw press, and leveling cover were all purchased before the final design was completed. The procurement process began in November 2017 to allow the contractor to install the equipment immediately instead of needing a long procurement phase in the construction schedule. The critical piece of equipment was the screw press, which had a lead time of six months. Construction documents were finalized in April 2018, and the project was bid in May 2018.

Construction started in May 2018 with the goal of producing cake by August; however, equipment delays and field issues caused the schedule to slip. Screw press components produced outside the United States were delayed, causing the press delivery to be delayed. Delivery was further delayed when the truck used for delivery broke down and a backup could not be found. The press is large and heavy, requiring a crane to take it off the truck. When the first truck broke down a crane needed to be rescheduled. Once the press was installed, the support configuration was determined to be outside the tolerance required by the manufacturer and had to be modified. The concrete supports had been poured, and the grout pads had been set, so the change required chipping the grout out and raising the leveling nuts to meet the manufacturer's specifications.

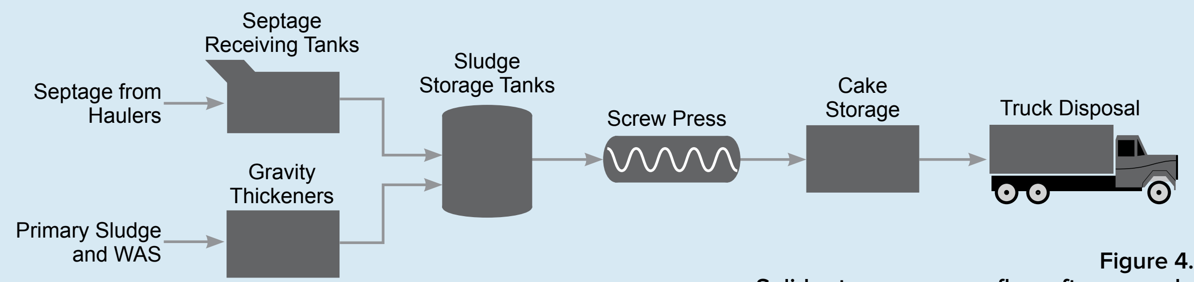

Figure 4.
Solids stream process flow after upgrade

The facility was producing cake by the first week of October 2018. Manufacturer representatives for the pumps, grinder, polymer system, leveling cover, conveyors, and air compressor arrived first to field check their components. Once each component was commissioned, the completed system was commissioned with the screw press. The screw press manufacturer came to the site for a week of commissioning to optimize the system and train operators. The plant operators then took ownership and have been operating the facility ever since.

Results

The press has been in operation for about six months at the time of this article, and preliminary results are positive. Figure 4 presents the final solids process flow diagram.

The facility has continued to meet the strict effluent copper limit since installation of the press. Table 4 presents the average influent and effluent copper concentrations prior to, during, and after commissioning the press.

Table 4.
Copper concentrations pre- and post-commissioning

Parameter	Influent Copper Concentration (µg/L)	Effluent Copper Concentration (µg/L)
Pre-commissioning	52.4	9.7
During Commissioning	66.0	10.2
Post-commissioning	57.2	10.3

The average cake solids concentration since commissioning is 25 percent. The plant is using 16 to 24 lbs active/dry ton (8 to 12 kg active/dry tonne) of polymer and consuming 100 to 150 gallons (380 to 570 liters) of polymer per week.

The facility can still dispose of liquid sludge as a backup in case the receiving facility cannot take the material or if the press is offline for maintenance, but the liquid sludge disposed of at the facility has dropped from 537,000 gallons (2 ML) per month prior to commissioning to 54,000 gal (204,000 L) per month after commissioning.

The cost of disposal has also dropped from an average of $40,849 per month prior to commissioning to $21,801 per month after commissioning.

Plant staff now have more time to address other projects. They no longer must attend to three to four liquid trucks per day or operate the labor-intensive rotary drum thickener.

LESSONS LEARNED

Lessons learned from this project are as follows:

- Engage plant operators early and throughout design. This should be a common practice for all design projects, but several design changes were implemented on this project that further reinforced this.
- Plant operators requested a platform outside a new roll-up door for delivery of polymer totes. The platform is the same elevation as the floor inside, so the polymer totes can be set at the platform and can be easily transported inside without navigating a step or a slope. It is a simple request but greatly simplifies a weekly activity that could have become a troublesome chore (photo 8).
- The initial drain location was modified after discussion with plant operators. They requested a longer trench drain that would be the full length of the press (see photo 9).
- The operators requested the previously discussed flexibility in the suction piping. They also wanted it hard-piped so that a single operator could transfer sludge from one tank to the other or load a truck from the tanks without multiple operators assembling temporary piping and temporary pumps. Having maximum flexibility for a minimally staffed plant was important.
- Engage haulers in discussion with installing and removing bins. The space was tight, and designers were unsure if a 30 yd^3 (23 m^3) container could be installed and removed from the garage bay. A hauler came to the site with a bin and demonstrated that the bin could be installed and removed in the space available. The one limiting factor was that the weight of the full bin needed to be within the limits of the truck used. Mobility in the tight space was critical. This caused the operators to be more careful in filling the bin to ensure they were not overfilling and preventing the truck from being able to lift the container. After optimization of the level indicator the operators can now determine when the bin is full without being overweight.
- Use of a flow meter with a plunger pump was problematic during startup. The pulsation from the pump caused the flow meter to vary wildly. This was an issue since the polymer feed was flow paced. The pumps were run for a few days with the intent of purging the air from the line, but the problem persisted. The flow issue was finally remedied by taking flow averages in SCADA and using average sludge feed flow for pacing the polymer feed rather than the instantaneous readout from the meter.

8. Platform outside the rollup door for polymer deliveries

9. Trench drain running the length of the press

ACKNOWLEDGMENTS

The authors acknowledge Ishigaki USA LTD for its assistance during design, pilot testing, and commissioning of the screw press. We also thank the Westerly WWTP staff and the town of Westerly for helping with the project.

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- Kevin Dahl is a regional manager for the Jacobs operations and maintenance business in the North region. Mr. Dahl, based in Connecticut, is an engineer and a licensed operator with 20 years of experience in the wastewater industry operating, maintaining, and overseeing various plant operations and improvement projects.

Beginning anew—a wastewater treatment system design for Orleans

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ABSTRACT | Excess nitrogen in the groundwater is impairing the water quality in coastal waters and estuaries in the town of Orleans, Massachusetts. Because of this, the town's Comprehensive Wastewater Management Plan (CWMP), prepared and approved in 2011, recommended to sewer approximately 60 percent of Orleans over 20 years. However, funding for the recommended plan failed to be appropriated twice at two different Town Meetings, leading to the development of a "hybrid" approach that incorporates both traditional and non-traditional technologies to remove the same amount of nitrogen as identified in the CWMP. Implementation of a "hybrid" approach under the Cape Cod 208 Water Quality Plan was approved by both EPA and the Massachusetts Department of Environmental Protection. Various non-traditional technologies were studied and piloted, and permeable reactive barriers (PRBs) were identified as one potentially cost-effective and reliable alternative. Thus, the current design includes a collection system, wastewater treatment facility, effluent disposal site, and demonstration project placements for PRBs.

KEYWORDS | Nitrogen removal, permeable reactive barriers (PRBs), equipment preselection, sequencing batch reactors (SBRs), collection system, wick wells, comprehensive wastewater management plan (CWMP)

PRIOR PLANNING WORK

The Comprehensive Wastewater Management Plan (CWMP)/Single Environmental Impact Report (SEIR) for the town of Orleans, Massachusetts, included a 20-year, phased construction of a wastewater collection system and wastewater treatment facility (WWTF) to reduce nitrogen loadings to coastal embayments. Since the approval of the CWMP in 2011, the town has allocated funds each year through the town meeting process to advance the planning and implementation of the agreed-upon solutions and projects. Subsequent to CWMP approval in 2011, the Cape Cod Commission updated the 1978 water quality management plan for the region in accordance with Section 208 of the Federal Clean Water Act due to the impairment of water quality in coastal waters resulting from excess nitrogen. The Section 208 update identified several recommendations to improve water quality in coastal waters surrounding Cape Cod and potential alternative technologies to achieve improvements, such as aquaculture, floating constructed wetlands, permeable reactive barriers (PRBs), nitrogen reducing barriers (NRBs), and others. The Section 208 update was approved by the Massachusetts Department of Environmental Protection (MassDEP) and EPA in 2015, and included a matrix of potential alternative approaches to reduce nitrogen in coastal waters. The alternative approaches were identified as non-traditional (NT) technologies.

In 2014, the Orleans Water Quality Advisory Panel (OWQAP, comprising Orleans selectmen and citizen constituencies with liaisons from key town boards and commissions, organizations, neighboring towns, and regional, state, and federal partners) convened to build widespread community support for a customized, affordable water quality management plan for the town. Following the Section 208 update, the OWQAP investigated both traditional and NT approaches, and in 2017 developed consensus agreement on a written plan that identified a hybrid approach to nutrient management technologies as an alternative, more cost-effective strategy for managing wastewater and reducing nitrogen in the Rock Harbor, Nauset Marsh, Pleasant Bay, Namskaket, and Little Namskaket watersheds.

For each NT technology selected, the town has either compiled, is compiling, or is planning to compile three years of nitrogen removal data at several strategically chosen demonstration project sites for MassDEP review and determination of whether the NT technology could be assigned a nitrogen removal credit. In addition, a MassDEP-sponsored modeling program is under development that will help inform these discussions. If a nitrogen removal credit is agreed upon, the town may propose replacing part of the originally envisioned sewer area in the CWMP with a combination of NT technologies. However, it is still premature for the town to propose any change to the CWMP's recommended sewering plan.

The 2017 plan included a conceptual and preliminary design to update the CWMP and to reflect the consensus plan. The goal was to minimize the proposed sewer system footprint, while maximizing the use of NT technologies (coastal habitat restoration, aquaculture, floating constructed wetlands, PRBs, and NRBs). The proposed new sewer system could consist of two construction phases that each covers a different area of Orleans: Phase 1 includes the Downtown Area, and Phase 2 includes the Meetinghouse Pond Area. This reduces the CWMP-proposed collection system area from approximately 60 percent of the town and average daily flow (ADF) of 650,000 gpd (2.46 ML/d) to about 24 percent and ADF of 350,000 gpd (1.32 ML/d). In the reduced consensus plan, the Downtown Area consists of about 330 parcels, and the Meetinghouse Pond Area consists of about 360 parcels.

REDUCED CONSENSUS PLAN INITIAL PHASE SCOPE

Phase 1 consists of the following: construction of a combination of gravity sewers and low-pressure sewers to service the Downtown Area; construction of a WWTF; and installation of the effluent disposal system. The WWTF is proposed to be constructed at the former Tri-Town Septage Treatment Facility on Overland Way; this facility has been demolished as of April 2019. Phase 2 is the construction of a combination of gravity sewers and low-pressure sewers to service the Meetinghouse Pond Area. The proposed wastewater system schematic is shown in Figure 1.

The Phase 1 project will be bid under two contracts: one for the WWTF and effluent disposal, and a second for the Downtown Area collection system and pumping stations.

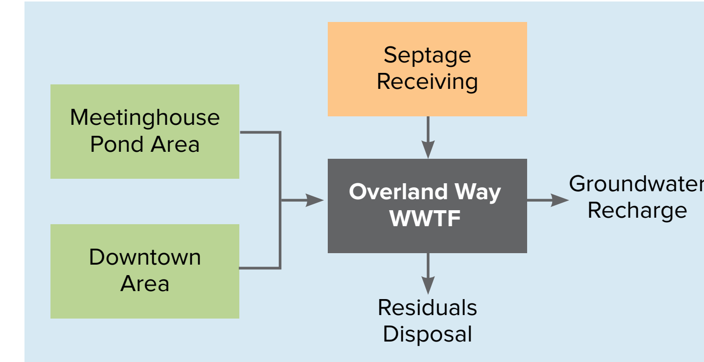

Figure 1. Proposed wastewater system schematic

Wastewater Flows

The WWTF is also to be constructed in two phases: a first phase to accommodate the Downtown Area flows including associated infiltration/inflow (I/I) and septage receiving; and a second phase to accommodate the capacity requirements for the Meetinghouse Pond Area including associated I/I. The second phase would be scheduled for construction approximately one to five years after the first phase, subject to funding approval for the design and construction of the Meetinghouse Pond Area collection system. Where the construction cost makes sense, the design concept incorporates many features, such as installed equipment capacity, building space, and tank volumes for expansion to accommodate both phases. Since it is assumed that wastewater flows will not be available until 6 to 12 months following substantial completion of the WWTF, equipment manufacturers will be required to provide a mothballing procedure to maintain the operability of the systems during the idle time.

Wastewater flow estimates assumed that 95 percent of water consumed enters the wastewater system. Two years of water records were used for this calculation; under consideration were various Downtown Area development scenarios as well as zoning for the Downtown and Meetinghouse Pond Area. Average daily flow (ADF) estimates, with allowances for I/I, include: the Downtown Area estimate of 140,000 gpd (530,000 L/d) and future ADF estimated at 234,000 gpd (886,000 L/d); and the Meetinghouse Pond Area estimated at 65,000 gpd (246,000 L/d) and future ADF estimated at 104,600 gpd (396,000 L/d). Table 1 (next page) presents the WWTF annual average flow for Phase 1 and Phase 2.

Septage Acceptance

The former Tri-Town Septage Treatment Facility treated approximately 8 to 9 MG (30 to 34 ML) of septage per year. The necessary septage volume is expected to decrease because of a proposed wastewater system that would sewer various areas of the lower Cape, including Orleans, Chatham, and Harwich, and because the local Yarmouth–Dennis

Table 1. WWTF annual average flow for Phases 1 and 2

Description	Future Wastewater Flow (with build-out) Annual Avg gpd (L/d)
WWTF–Phase 1	245,400 (930,000)
Downtown Area Downtown Area I/I Septage	212,100 (803,000) 16,800 (62,600) 16,500 (62,460)
WWTF–Phase 2	104,600 (396,000)
Meetinghouse Pond Area Meetinghouse Pond Area I/I	96,600 (366,000) 8,000 (30,283)
WWTF Total (Phase 1 + 2)	**350,000** (1.325 ML/d)

Septage Treatment Facility has been aggressively seeking to increase its annual throughput. Therefore, to restore septage receiving service to Orleans residents, as well as to the lower and outer Cape towns, a future design septage volume is based on the recovery of about 67 percent of former septage receiving business at the Tri-Town facility, about 6 MG per year (23 ML per year), or 6,500 gpd (24,600 L/d) on a seven-day average. That is thought to be a conservatively reasonable estimate for the restart of wastewater and septage treatment operations once the new WWTF comes online. Figure 2 shows a schematic of planned septage receiving and wastewater solids processing.

Table 2. Anticipated effluent permit limits

Constituent	Anticipated Effluent Limit
BOD	30 mg/L
TSS	30 mg/L
TN	10 mg/L
Fecal Coliform	200 cfu/ 100 mL

Anticipated Effluent Permit Limits

A groundwater discharge permit (GWDP) application will be submitted to MassDEP for review and approval. The anticipated effluent limits, based on the hydrogeologic evaluation and discussions with MassDEP, are shown in Table 2.

Environmental Evaluation and Impacts

The environmental evaluation and impacts are discussed below.

- **WWTF Site Decreased Footprint.** The proposed work at Overland Way will occur in previously disturbed areas of the site (both for the WWTF and the pipeline). It reduces the area of disturbance from the Tri-Town Septage Treatment Facility and the proposed WWTF from approximately 35,000 ft^2 (3,200 m^2) to about 17,000 ft^2 (1,600 m^2), significantly lessening the impact on priority habitat and allowing other usage of the remaining area.
- **Groundwater Mounding/Wetland Impacts**. Groundwater mounding does not indicate an impact to any structures or nearby properties, as

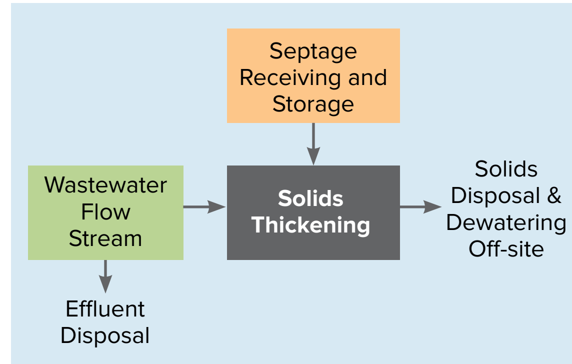

Figure 2. Septage receiving and processing flow

the average or high-water-level elevations from groundwater mounding are insignificant and well below surrounding surface levels.

While simulations show that increased groundwater elevations near Namskaket and Little Namskaket creeks could cause a shift from salt marsh to freshwater plant species (e.g., a potential increase in existing Phragmites), any vegetation shift is difficult to predict. Post-start-up monitoring of the plant species distribution within Namskaket Marsh may be necessary to document any such shifts in plant species.

Over time, these changes may be dwarfed by the impacts of sea level rise. Compared to the minimal likely effect of groundwater mounding, as a result of sea level rise groundwater levels on Cape Cod will rise as high as 2.11 ft (64.3 cm), with a more nominal rise of 0.1 ft (3 cm) near inland streams (based on a recent U.S. Geological Survey study).

No portion of the pipeline route from the WWTF to the effluent discharge site at the Lots Hollow Road parcels is in wetlands or buffer zones.

- **Watershed Nitrate Loads**. The elimination of septic systems will result in long-term improvements in groundwater quality. No significant short-term impacts on surface water quality are expected, though surface water quality should improve as groundwater moves from inland areas to coastal discharge areas, or toward ponds from tributary areas. The emergence of effluent groundwater and its blended concentration to well-mixed off-shore coastal waters would not occur until many years after the initiation of treatment and disposal activities.

The modeling results indicate that the anticipated blended concentration of freshwater flow and nitrate load from the discharged WWTF effluent will eventually reach Cape Cod Bay, Little Namskaket Creek, Namskaket Creek, Town Cove, Rock Harbor, and Boat Meadow River, but the discharge plume will not reach these receiving water bodies for approximately 100 years.

While Cape Cod Bay and Boat Meadow River have not been evaluated by the Massachusetts Estuaries Project (MEP), the MEP modeling analysis of both the Namskaket Marsh and Little Namskaket Marsh systems indicates that they can still assimilate additional nitrogen without adverse water quality and benthic habitat impacts. The residual nitrogen remaining in treated effluent discharge at the Lot Hollow sites will increase the nitrogen loading to both Namskaket Marsh and Little Namskaket Marsh, but the loading would still be below the respective MEP nitrogen load target. The MEP analysis indicates that Rock Harbor and Town Cove already receive nitrogen loads exceeding the target watershed loads for a healthy aquatic ecosystem, but the proposed discharge location will reduce nitrogen loading to these sub-watersheds, benefiting the previously impaired receiving waters.

- **Increased Freshwater Flow to Watersheds**. Either the previously proposed discharge or the proposed new discharge location would add freshwater flow to receiving estuaries. Most of the relatively low percentage increased flow would likely enter the marshes through the stream channels where the greatest stream flow occurs due to tidal flux. Those estuaries with the greatest flow would discharge most of the additional freshwater with each tidal cycle, with minimal effect on the estuaries.
- **Potential Impacts to Coastal Resources**. The groundwater mound and effluent discharge would occur within the inner Cape Cod Bay Area of Critical Environmental Concern (ACEC), but because of the depth of effluent disposal (beneath coastal resources such as beaching and associated swimming areas, commercial and recreational shell fishing areas, and marine/estuarine habitat), and its mixing with waters sufficiently offshore to ensure tidal flushing, the discharge is not expected to adversely affect the ACEC functions. Sewage treatment and disposal through the proposed groundwater discharge, rather than the current on-site septic systems, is expected to improve water quality and thus benefit all coastal resources.
- **Potential Impacts to Rare and Endangered Species**. No adverse water quality impacts are anticipated in any of the receiving waters, and, therefore, no water quality impacts are expected to any protected species in local Priority Habitats.
- **Public Water Supplies**. Proposed groundwater discharge is not expected to have an impact on the groundwater supplies of Orleans or Harwich. Under a modeling scenario with a 500,000 gpd (1.9 ML/d) discharge and the water supply wells pumping at either 2002 average rates or 2020 projected rates, neither particle traces representing the landfill plume nor the groundwater discharge move toward the pumping water supply well.
- **Private Wells**. According to town records, no known sensitive receptors are directly downgradient of the discharge except for potential private water supply wells; if any such wells exist and are used for drinking water or irrigation, the town may need to connect these to the public water supply.

1. (top) Main Street sanitary manhole installation
2. Main Street gravity sewer installation

DOWNTOWN AREA COLLECTION SYSTEM

MassDOT Project

Part of the Downtown Area collection system design (Figure 3 next page) overlapped a Massachusetts Department of Transportation (MassDOT) road intersection upgrade project. MassDOT has a moratorium that prohibits the road from being excavated for five years after it has been rebuilt, so this area of the collection system had to be installed prior to MassDOT's road repair project to align with the anticipated collection system construction schedule. Thus, a project was created to install this portion of the collection system, including gravity sewers, force mains, and service connections to provide wastewater service to the Downtown Area. This area was completed in the fall of 2018. See photos 1 and 2, and orange gravity lines in detail of Figure 3. This infrastructure is considered the spine or foundation for the rest of the Downtown Area collection system.

Remainder of Collection System Design

The Downtown Area collection system consists of approximately 25,800 lf (7,900 m) of gravity sewers, 2,100 lf (640 m) of low-pressure sewers, and 8,300 lf (2,500 m) of force mains. An estimated 1,090 users will be connected into the system with about 57 privately owned and maintained grinder pumps used to pump to the gravity system. The system has been designed to accept the future flows from the Meetinghouse Pond Area.

The wastewater collection system and associated force mains will be installed by open trench cut and cover methods (within existing roadways), not including the 275 ft (84 m) segment crossing Route 6, which will be installed by jacking. The crossing

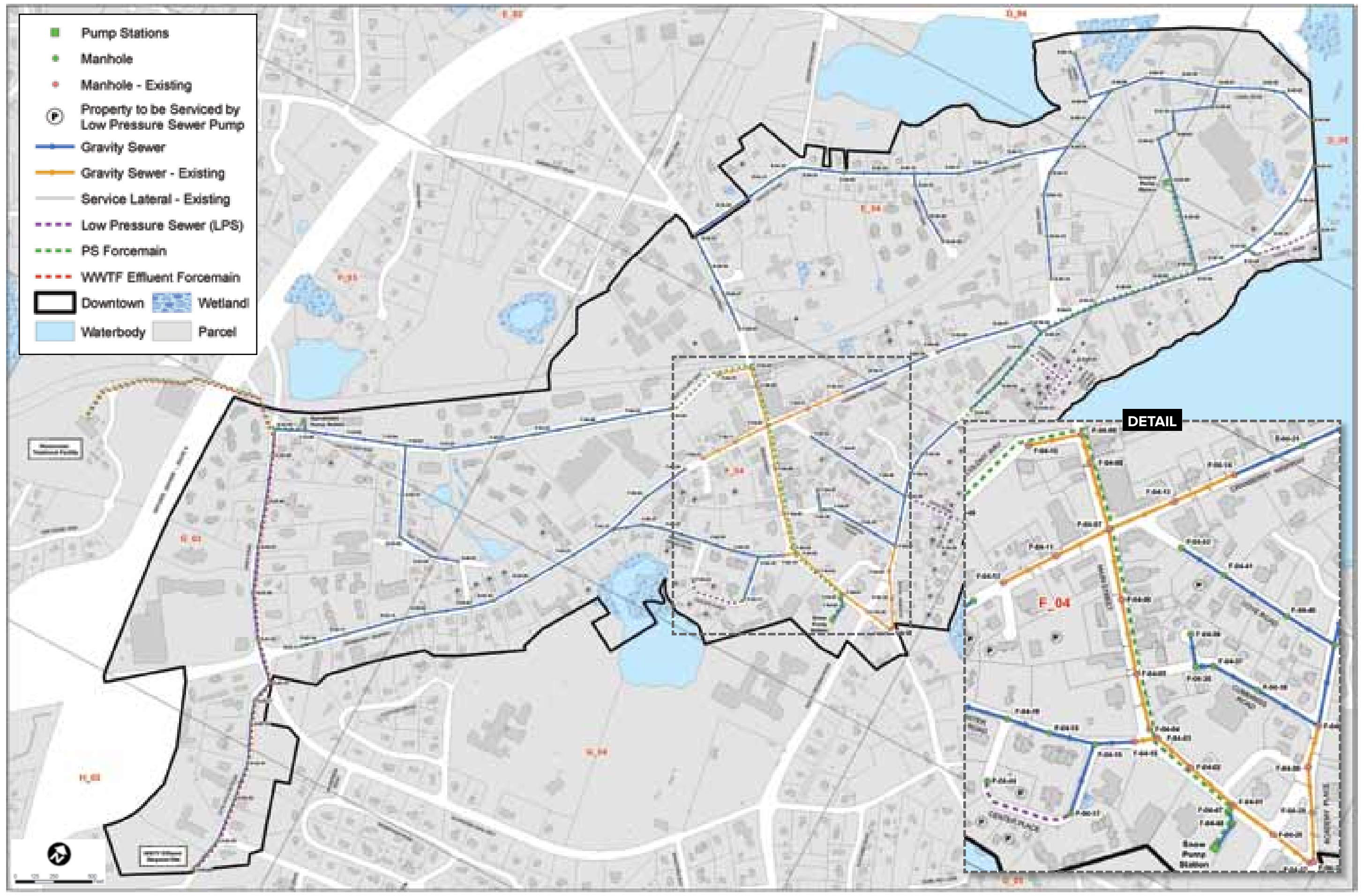

Figure 3. Downtown Area wastewater collection service area

will include a 48 in. (122 cm) casing, an 8 in. (20 cm) force main from Pump Station 1 to the WWTF, an 8 in. (20 cm) effluent force main from the WWTF to the effluent disposal site, two 4 in. (10 cm) electrical conduits, and an additional 8 in. (20 cm) force main for future buildout conditions. The force mains and effluent force mains are inside the 48 in. (122 cm) casing. The size of the casing allows for the future installation of other pipes/conduits if necessary.

Pumping Stations

Three pump stations are included in the Downtown Area collection system design: (a) Pump Station 1 located at 84 Old Colony Way; (b) Pump Station 2 located at Snow Library, 67 Main Street; and (c) Pump Station 3 located at the local Stop & Shop, 10 Route 6A.

Each pump station design includes a wetwell with submersible pumps and a valve vault. The wetwells are concrete structures with a protective coating (entire interior of the structure) that will be set below grade with access hatches flush with grade. Each station will have submersible pumps with slide rails, one of which will feature a base elbow flushing connection. There will be level controls (transducer and floats), and concrete will be used in the structure as fill to enhance self-cleaning and an interior drop inlet. The valve vaults are concrete structures set below grade with two hatches flush with grade and a wall-mounted aluminum ladder. Each valve vault will have a magnetic flow meter, a bypass pumping connection, an activated carbon barrel for odor control, lights, electrical components, sloped floors, and hatch drains that flow to a sump that drains to the wetwell. Each pump station will have a pig launcher with the force main draining back to the wetwell.

Each station will include a pump control panel, variable frequency drives, SCADA interface panel, automatic transfer switch, an exterior red strobe light, and an emergency generator with diesel belly tanks and a weathertight and soundproof enclosure.

WASTEWATER TREATMENT FACILITY

As shown in Figure 3, the WWTF will be located at 29 Overland Way, where the previous Tri-Town Septage Treatment Facility was located. The facility includes a multi-story building with administrative spaces, laboratory, control room, chemical storage rooms, mechanical and electrical rooms on the main floor, pumps and other equipment in the basement, and an equipment storage facility (ESF). See Figure 4 for a process flow diagram.

The WWTF comprises the following: influent screening, a septage receiving station, two

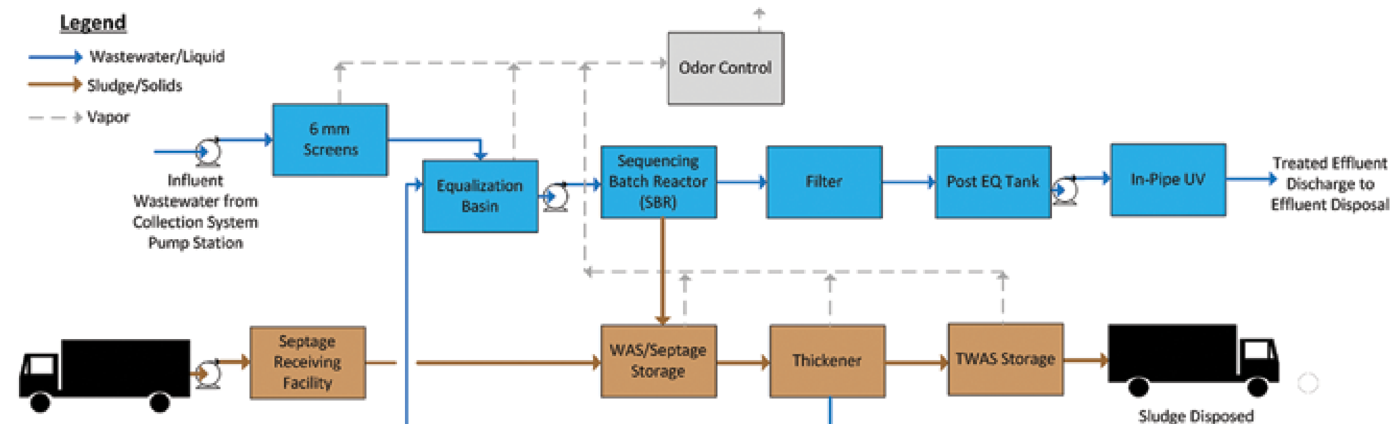

Figure 4. WWTF process flow

pre-equalization tanks with three sequencing batch reactor (SBR) transfer pumps, two SBRs, two effluent disk filters, one post-equalization tank with submersible mixers and three effluent pumps, two ultraviolet reactors, seven mixing and aeration blowers, two waste sludge storage tanks with two sludge transfer pumps, two rotary drum thickeners, one thickened sludge storage tank with tank-to-truck sludge transfer pumps, and chemical storage and feed systems.

Because no sewage collection or treatment system exists, no data is available to project sewage pollutant concentrations for mass loadings, so the normal textbook ranges for the key parameters as shown in Table 3 were used. As this will be a new collection system with low I/I, medium-to-high end concentrations were assumed and applied to the annual average flow to determine annual average mass loadings. Table 4 (next page) summarizes the WWTF design sewage flow and loads, which were based on New England Interstate Water Pollution Control Commission *Guides for the Design of Wastewater Treatment Works* (TR-16) recommendations. A seasonal peaking factor of 2.6 was used based on TR-16 and other Cape Cod WWTFs.

Table 3. Concentrations

Constituent	Influent	Effluent
BOD, mg/L	270	30
TSS, mg/L	310	30
TKN, mg/L	55	10
Fecal Coliform, cfu/100 mL	TNTC	200

Secondary Influent Design Flows and Loads

Table 5 (next page) presents the secondary influent flows/loads for Phase 1 and for Phases 1 and 2 combined. The secondary influent includes internal recycle flows and loadings from the various processes including effluent filter backwash and sludge processing filtrate.

Thickened Waste Activated Sludge Design Flows and Loads

Waste activated sludge (WAS) will be stored with received septage in holding tanks, pumped through rotary drum thickeners and discharged into thickened waste activated sludge (TWAS) holding tanks. The TWAS/septage will be pumped into a haul truck for offsite processing.

Architectural Design

The building lies within the Old King's Highway (OKH) district, which requires specific architectural features. The design abides by these OKH district requirements and preferences, and the approval process with the OKH District Committee has commenced.

The WWTF is oriented parallel to Overland Way in the same general location as the previous Tri-Town Septage Treatment Facility. The WWTF layout allows for the future expansion (up to double in size) to allow for the proposed flows in the CWMP. The exterior architectural design of the WWTF and the ESF (with its vehicle bays and maintenance facilities) is intended to convey a state-of-the-art treatment facility using attractive, appropriately-colored, and highly durable materials that require minimal maintenance. The overall attention to materials, details, building setbacks, historic requirements, and scale create an architectural solution fitting for the small-scale Cape Cod/OKH residential context of this area. Figure 5 (page 47) depicts the preliminary overview of the WWTF and the ESF at the site.

Process Equipment Pre-selection

The town has elected to pre-select septage receiving equipment, SBRs, effluent disk filters, and rotary drum thickeners in accordance with MGL Ch. 30b Section, 39M. The pre-selection process will include advertising, receiving of manufacturer's proposal submittals, conducting interviews, and evaluating each piece of equipment based on performance and a life-cycle cost analysis.

Table 4. WWTF design sewage flows and loads

Phase 1 Only	Min Month	Annual Avg	Max Month	Max Day	Peak Hour
Flow, gpd	194,600	228,900	320,500	595,100	1,098,720
BOD, lbs/d		515	649	825	
TSS, lbs/d		592	769	1,124	
TKN, lbs/d		105	130	147	
Phase 1 + 2	**Min Month**	**Annual Avg**	**Max Month**	**Max Day**	**Peak Hour**
Flow, gpd	283,500	333,500	466,900	833,800	1,500,750
BOD, lbs/d		751	946	1,202	
TSS, lbs/d		862	1,121	1,638	
TKN, lbs/d		153	190	214	

Table 5. Secondary influent flows and loads

Phase 1	Min Month	Annual Avg	Max Month	Max Day	Peak Hour
Flow, gpd	224,713	264,368	374,649	689,120	792,500
BOD, lbs/d		626	800	1,022	
TSS, lbs/d		725	948	1,359	
TKN, lbs/d		136	172	199	
Design Temp	10°C				
Phases 1 + 2	**Min Month**	**Annual Avg**	**Max Month**	**Max Day**	**Peak Hour**
Flow, gpd	321,163	377,839	565,928	957,417	1,101,000
BOD, lbs/d		884	1,127	1,446	
TSS, lbs/d		1,030	1,346	1,940	
TKN, lbs/d		188	238	276	

Effluent Disposal Site

While the CWMP identified that effluent be discharged at the former Tri-Town Septage Treatment Facility and location of the proposed WWTF on Overland Way, a nearby, less archaeologically sensitive location was proposed and approved at 32 Lots Hollow Road, approximately 4,840 ft (1.48 km) from the WWTF. Nearby reserve or back-up sites are located at 43 Lots Hollow Road, the Route 6 Exit 12 Lobe, and 223 Beach Road.

In addition, a wick discharge is now proposed instead of discharge via open bed infiltration. The wick discharge requires much less area and therefore will disturb less acreage than previously proposed. In addition, the site avoids impacts to sensitive Estimated and Priority Habitat mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) compared to the CWMP.

Based on site conditions, subsurface soils encountered, a wick loading test, and groundwater modeling results, a minimum of 500,000 gpd (1.9 ML) can be discharged at each site (32 Lots Hollow Road, 43 Lots Hollow Road, Route 6 Exit 12 Lobe, or 223 Beach Road).

Since the proposed discharge method is a series of wicks, five wicks are proposed to be installed at 32 Lots Hollow Road. The number of wicks installed includes redundancy in the WWTF discharge capacity as well as the proper operation and maintenance of the wicks.

A pre-cast concrete distribution chamber housing motorized valves and magnetic flow meters is proposed at the site. The operator inputs the order of the operation of the wicks into the SCADA system and the duration of discharge (a number of days) into a single wick. As an alternative, the duration of discharge into a single wick could be changed based on the volume of effluent discharged (e.g., in excess of 500,000 gpd) into the wick.

In addition, if the wick's water level reaches a high-water-level (HWL) SCADA system set point, an alarm will be activated, opening the next wick valve and closing the wick valve with the HWL reading. The operator will remove the wick with the HWL reading from service until the issue is addressed.

The location of the wicks, distribution chamber, roadway, and associated piping allows for the construction of a future water tank on the site.

PROGRAM COSTS, SCHEDULE, AND FUNDING

Cost estimates were developed to perform a life-cycle cost analysis on various collection system types and WWTF processes. This analysis was used to recommend the basis of the design for the Downtown Area collection system, pumping stations, WWTF, and effluent disposal project.

The program costs for the Downtown Area wastewater collection system include capital, annual operations and maintenance, replacement, and monitoring. These costs vary with the design considerations and layout configuration selected for each collection system technology. The life-cycle cost analysis was used to determine the most cost-effective technology or combination of technologies.

Figure 5. Preliminary overview of the WWTF and the equipment storage facility at the site

STATE REVOLVING LOAN PROGRAM

As part of the town's water quality and wastewater planning project, a final project evaluation form was submitted in August 2018 for the 2019 round of financing regarding the Downtown Area sewer collection system, pumping stations, WWTF, and effluent disposal site through the MassDEP Clean Water State Revolving Fund (CWSRF) loan program.

On March 7, 2019, MassDEP issued the Final 2019 Intended Use Plan (IUP), which details the projects, borrowers, and amounts that will be financed through the CWSRF loan program.

The Orleans Downtown Area sewer collection system, pumping stations, WWTF, and effluent disposal site project met the minimum scoring criterion and therefore was included on the Final IUP.

In addition, the Final 2019 IUP stated that "All projects on the Intended Use Plan are eligible for 2 percent interest rate loans. Certain projects that are primarily for nutrient removal are eligible for zero percent interest rate loans. These nutrient removal projects will be evaluated in accordance with 310 CMR 44.04(2) and a determination will be made as to the eligibility for zero percent interest loans before the loan is permanently financed."

PUBLIC MANAGEMENT SYSTEM DOCUMENTS

In addition to the implementation of the wastewater infrastructure, various public management system documents will be required to be developed to enable practical and effective operation, maintenance, and administration of the new system. These documents include GIS wastewater mapping, sewer use rules and regulations, pretreatment rules and regulations, private property rules and regulations, a septage management plan, and operation and maintenance manuals for the wastewater treatment facility, pumping stations, and collection system.

CONCLUSION

Among the many choices that are presented by the challenge that the town of Orleans faces in complying with its wastewater collection and treatment responsibilities under federal and state statutes, NT technology alternatives may enable a practical plan and design that is far less onerous and more palatable to the citizenry than that proposed in its original CWMP. As further decisions are still to be made (e.g., regarding PRB and NRB technology), beginning anew and composing a hybrid system including the best of both traditional and NT techniques appear to be the most effective and acceptable approach for all concerned.

ACKNOWLEDGMENTS

- Town of Orleans: Board of Selectmen/Town Administrator's Office, Department of Public Works and Natural Resources, Board of Water and Sewer Commission, Planning Department, Board of Health/Health Department, Finance Committee/Town Accountant, Orleans Water Quality Advisory Panel, Shellfish and Waterways Improvement Advisory Committee, Marine and Fresh Water Quality Committee
- Tighe & Bond

continued on next page

ABOUT THE AUTHORS

- Tess Laffer is a water/wastewater engineer at AECOM in Chelmsford, Massachusetts. Ms. Laffer graduated from Worcester Polytechnic Institute (WPI) with a Bachelor of Science in Environmental Engineering in May 2018. She has been involved with the Orleans project since the beginning of her employment.
- Thomas Parece, P.E., is an associate vice president and senior project manager at AECOM in Chelmsford, Massachusetts, with 38 years of experience. He was the project manager for the development of the 208 Plan for the Cape Cod Commission and is the project manager for the work associated with the town of Orleans.

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2019 National Water Policy Fly-in

by Bob Fischer, NEWEA Government Affairs Committee Chair, Green Mountain Water Environment Association Government Affairs Committee Chair, City of South Burlington, Vermont Water Quality Superintendent

Continuing a more than 20-year tradition, NEWEA members attended the National Water Policy Fly-in, which took place in Washington D.C., April 3–4, during Water Week 2019. For the second year, the Government Affairs Committee collaborated with the New England Water Works Association (NEWWA) to produce joint talking points. By collaborating, we bring the knowledge of 8,000 New England water professionals to the event. We started with an informational lunch for the attendees in the Rayburn Building (where many U.S. House of Representatives offices and committee rooms are located). Instructions and pointers about meeting with the legislators were given out, and Steve Dye from WEF distributed the national "Asks," which were compiled by a consortium of water groups including WEF, the National Association of Clean Water Agencies (NACWA), and the American Water Works Association (AWWA). Representative Jim McGovern, who has sponsored the NEWEA event for many years, attended the lunch and gave an excellent speech emphasizing that we need to stress to the legislators we meet with that water quality needs to be included in any bipartisan funding package.

As this was the third event I have helped organize as chair of the Government Affairs Committee, and as my term will end in January, I thoroughly thank all the members of the Government Affairs Committee, especially the Fly-in attendees and the two vice-chairs, Scott Firmin and Ray Willis. None of this would be possible without a total "team" effort. I am especially excited that we have partnered with NEWWA these last two years and that the collaboration will continue as we continue to conduct joint meetings.

The NEWEA/NEWWA "Talking Points" emphasized multiple issues, including the following:

1. Funding—Our top priority: provide robust federal funding for water quality

- America's economic future depends on clean and safe water, yet our water, wastewater, and stormwater systems are old and in critical need of repairs, upgrades, and replacements. The American Society of Civil Engineers gives these systems only a "D" grade. Many utilities are financially challenged, and simply keeping up with standard maintenance and repairs can be an issue even with State Revolving Fund loans and funds available via the Water Infrastructure Finance and Innovation Act – WIFIA. The WIFIA loans must be repaid, while O&M costs continue to rise faster nationwide than the funding for these capital investments. Federal government spending on these systems has continually decreased: Federal water industry funding decreased from $17 billion in 1977 (2014-dollar equivalent; 63 percent of total investment) to $4.4 billion in 2014 (9 percent of total investment), and that trend persists. As a greater share of the cost burden for future investment is shifted down to the local level, affordability becomes increasingly more difficult for low-income and fixed-income customers. This is especially difficult for NEWEA members, as many of the oldest collection and treatment systems are in the Northeast.
- Federal funding is needed to separate combined sewers with reduction and containment of combined sewer overflows, which are an increasing public/political issue locally. Continued federal support of integrated planning to address these issues will allow for local communities to have a larger voice in prioritizing water quality projects.
- Federal funding is increasingly needed by utilities to treat the ever-increasing numbers of emerging contaminants, such as perfluoroalkyl and polyfluoroalkyl substances (PFAS). Many emerging contaminants are best managed by eliminating them from the source, an effort in which Congress can play a key role. Treatment in advanced wastewater treatment facilities, where technologies are always improving, may reduce contaminants somewhat but at significantly higher costs. Onsite septic tank systems are not as robust and may be costlier to adapt; besides, many private systems do not function adequately.
- Additional federal funding would strengthen water and wastewater resiliency (e.g., additional water sources, drought preparedness planning, flooding, cybersecurity).
- We support continued funding for U.S. Department of Agriculture Rural Development programs, a key resource for small rural systems.
- Federal funding is needed for regional interconnection projects, which combat water scarcity, emerging contaminant remediation, or brackish water infiltration.

2. Regulations

- Use sound science and research before imposing additional, overly onerous or impractical requirements on water and wastewater utilities—as exemplified by stringent aluminum standards in National Pollutant Discharge Elimination System (NPDES) permits when natural background levels of aluminum in the Northeast exceed the imposed standards. These requirements strain already limited resources and often divert funding away from infrastructure improvements that would better protect public health. Cost/benefit analyses must be considered for any federal or state regulatory mandate.
- Carefully monitor bills regarding limiting groundwater extraction or water rights. Although mainly aimed at private entities, by limiting supply and capacity capabilities these bills can negatively affect public water suppliers that are providing full services to consumers.

- Increase funding for the EPA National Priorities Water Research grant program to $20 million and fully fund the Innovative Water Technologies grant program at $10 million as authorized, for fiscal year 2020.

When we returned from Washington, D.C., we drafted thank-you letters to the region's legislators with links to the information we had discussed with them. Having attended this event for the last six years, I cannot stress enough what an amazing experience it is and how you all should try to attend next year. Very few Americans ever go to Washington to interact with their legislators. After visiting our capital, I am always left with the feeling that fewer people than we think run this great country of ours. The legislators and their staffs have limited knowledge on water industry topics; they need and appreciate the expert information and insight that we as NEWEA members can offer, and they are impressed by how much impact we have on their constituencies. We encourage you to share your expertise with your legislators freely. The D.C. Fly-in is just one way that the Government Affairs Committee helps us to carry our message forward to our governmental leaders. Join us and help us make your voice heard.

NEBRA Highlights

Phosphorus Sustainability Challenge

How can your operations use phosphorus more efficiently and release less to water? At its annual forum on April 5 in Washington, D.C., the Phosphorus Sustainability Alliance

announced the phosphorus sustainability challenge, a call to action for organizations of any size and type to publicly commit to lowering their phosphorus footprints. Wastewater treatment and biosolids management are opportunities for phosphorus recycling.

Through this challenge, the alliance and its many stakeholders (including NEBRA) are raising awareness about the role of phosphorus in global food security and water quality. This is the conundrum: Phosphorus is a key ingredient in fertilizer and animal feed, so a sustainable phosphorus supply is essential to meeting the growing global demand for food. Meanwhile, phosphorus is a devastating pollutant that degrades water quality in rivers, streams, lakes, and coastal oceans.

Many organizations work hard to make phosphorus use more sustainable. The phosphorus sustainability challenge provides a platform where they will receive public recognition for their leadership and see how their efforts contribute to larger-scale sustainability impacts. Businesses in particular use the challenge as a metric for measuring advances in sustainable operations. Commitments can be submitted online on the challenge website: psustainabilitychallenge.org.

Matt Scholz, program manager at the alliance, explained at the forum that phosphorus does not appear in any corporate social responsibility (CSR) reports. Such reports are used by shareholders, the media, consumers, and the public to assess the sustainable practices of corporations. Goals are created by societal pressures on companies concerning sustainability metrics. Nearly 4,000 corporate sustainability goals are currently defined, including, for example, 1,246 related to climate change, 133 on deforestation and paper, and 28 for volatile organic compound (VOC) emissions. But there are no goals yet related to phosphorus. Yet, according to Scholz, "phosphorus is the most important pollutant of our most important natural resource and commodity (fresh water)."

For the challenge, efforts should concentrate on several key phosphorus sustainability goals, including using phosphorus more carefully in crop production and animal operations, sustainably recycling phosphorus, reducing food system waste, recovering phosphorus pollution from surface waters, removing phosphorus from human and animal waste streams, and improving the efficiency of phosphorus mining. In wastewater and biosolids management, actions are underway and can be further advanced to reduce phosphorus discharges, recover concentrated phosphorus from wastewater and biosolids, and carefully manage phosphorus applied to land in biosolids and reclaimed water.

We urge all organizations to join the phosphorus sustainability challenge and lead the charge toward improving phosphorus sustainability. Follow the conversation on social media using the hashtag #PhosphorusChallenge.

NEBRA Welcomes New Executive Director

Janine Burke-Wells, new executive director of NEBRA

Janine Burke-Wells is the new executive director of NEBRA. The announcement was made at the beginning of May by NEBRA President Tom Schwartz (Woodard & Curran) after a five-month search process and interviews with several outstanding, experienced finalists for the position.

Ms. Burke-Wells has been executive director of the Warwick Sewer Authority in Rhode Island since 2008, responsible for daily management of the wastewater system for the second largest city in the state, including a 7.7 mgd (29 ML/d) treatment facility and associated collection system. She had worked for the town of West Warwick as director of administration/assistant superintendent beginning in 1998, and, prior to that, worked for EPA Region 1 in Boston for a decade. Her experience in the environmental field, with a focus on wastewater management, is underpinned by a degree in chemical engineering from the University of Rhode Island and a Master of Public Administration from Northeastern University.

In addition to experience at the federal and local level, Ms. Burke-Wells has served in non-profit leadership. She is well-known to NEWEA members; in January, she completed a year as president of the association. She is also active in the NEWEA Government Affairs Committee and initiated and organizes the annual Narragansett Water Pollution Control Association annual clean water legislative event, now in its eighth year.

About biosolids, Ms. Burke-Wells says "it is the second largest expense, after salaries, for the treatment facility where I worked. I have come to see that managing our biosolids in a sustainable way is a fiscal and moral imperative." She managed the Warwick facility's response and $14 million restoration after the floods of 2010. As she looks forward to NEBRA's next five years, Ms. Burke-Wells notes the importance of "bringing common sense" to the perfluoroalkyl and polyfluoroalkyl substances (PFAS) issues. And, beyond that, she says "I see NEBRA being a leader with respect to alternative or innovative uses of biosolids."

> ***Ms. Burke-Wells brings a great combination of industry knowledge, the public/non-profit experience, and an overall attitude and commitment for NEBRA***
>
> – NEBRA President Tom Schwartz

Mr. Schwartz led the search committee and relied on diverse input from all board members. "We were pleased with the very high caliber of the final candidates, and the board of directors worked hard on its decision," Mr. Schwartz said. "Ms. Burke-Wells brings a great combination of industry knowledge, the public/non-profit experience, and an overall attitude and commitment for NEBRA."

Ms. Burke-Wells can be reached at janine@nebiosolids.org. Ned Beecher, former executive director and the full-time, long-term employee of NEBRA since the organization's inception in 1997, is now Projects Lead and will continue his work on PFAS. Other projects in the works include data collection on the use, disposal, and regulation of biosolids across the nation that will update data compiled in a NEBRA-led report published in 2007.

The FOG Clears at York, Maine

Travis Jones of York Sewer District uses Lego® constructions as metaphors for building a program to address FOG—fats, oils, and grease. As in other communities, the southern Maine coastal resort town of York has been plagued by sewer overflows caused by FOG blockages. Over the last two years Mr. Jones has been updating the town's sewer ordinance (that was last updated in 1976) and developing robust, enforceable FOG capture requirements for local restaurants. In an entertaining presentation at the Joint Environmental Training Coordinating Committee's (JETCC's) North Country Convention in late April, he showed many Lego constructions of various complexities, stressing that a FOG program can be simple or complex, and both are effective. The marketing materials, forms, and enforcement tools he developed for York are models that he gladly shares with anyone.

Travis Jones presenting to the JETCC North Country Convention, April 25, Presque Isle, Maine

PFAS Update

NEBRA has been advancing understanding of PFAS related to wastewater and biosolids for the past two years. "But, this spring, the issue of regulating PFAS in biosolids and other residuals has reached a crisis level in northern New England," said Mr. Beecher, NEBRA's lead for the project.

The challenge is this: PFAS are the only commonly used chemicals regulated in drinking water in parts per trillion. (A part per trillion is one second in 31,700 years.) Such small traces of PFAS can get into groundwater and drinking water in many ways, including through conveyance in wastewater, biosolids, and residuals, where their inevitable presence is due to PFAS used in many consumer products and in our daily living environments. If society wants to ensure no waters are impacted at levels above identified screening values—i.e., EPA's 70 parts per trillion (ppt) for PFOA + PFOS (perfluorooctanoic acid and perfluorooctanesulfonic acid) in drinking water—the management of wastewater and residuals may be challenged. If society chooses to regulate PFAS at even lower levels, as several states do (e.g., Vermont's 20 ppt limit in groundwater for five PFAS combined), current wastewater and biosolids/residuals management practices might not be acceptable. What that means and the solutions are challenging questions front and center for regulators and municipalities. Either the regulatory trends in these few states are too severe, or wastewater and biosolids management will have to be widely disrupted, at a cost to utilities.

Getting traces of PFAS out of drinking water is possible with moderately priced granulated activated carbon systems. But keeping them out of wastewater, or removing them from wastewater and biosolids, is not economically feasible—nor will it be for the foreseeable future. The only solution is to remove the most concerning PFAS from commerce. That has worked dramatically for PFOA and PFOS, which have been reduced through voluntary phase-outs. But, because they are persistent and do not degrade in the environment, their continued presence will confound efforts to address them.

With the limitations on data and understanding of fate and transport in soils related to PFAS, state regulators—especially those focused on groundwater protection—have begun to target biosolids and septage. Two regulatory actions this spring have shown how biosolids and residuals recycling can be disrupted.

In Maine, on March 22, Jerry Reid, new commissioner of the Department of Environmental Protection (MEDEP), imposed a moratorium on biosolids distribution and use, pending testing of all biosolids for PFAS. Wastewater utilities and companies managing biosolids scrambled to complete required sampling plans and tests. These Maine tests are finding PFAS in typical low levels, similar to other data in the literature and other state investigations. But MEDEP is applying very low screening levels, which NEBRA has argued are scientifically indefensible for use related to biosolids, and all but one Maine biosolids product exceeds the screening levels (some tests are still pending).

Exceeding the screening values does not preclude possible use of biosolids. MEDEP regulations allow for demonstration, through loading rate calculations, that biosolids applied to soil for several decades will not raise soil levels above the screening values. Those calculations have now been applied to several Class A products, such as the compost from the Casella Organics' Hawk Ridge compost facility in Unity, New England's largest compost facility. Maine DEP has determined that compost is safe for use and permitted resumed sales and distribution in mid-April, lessening the impacts of the moratorium. But programs that land-apply Class B biosolids are still unable to proceed, even as spring planting season begins. The Lewiston Auburn Water Pollution Control Authority, a leader in progressive biosolids recycling, has had two-thirds of its permitted land-application fields shut down. And farmers are nervous, meaning that the market perception of biosolids has been affected.

Municipalities have met with the commissioner, and there is discussion of collaboration on advancing the science through robust modeling of fate and transport of PFAS applied to soils in biosolids. NEBRA has been pointing to field data that indicate that PFAS in soils at even much higher levels than MEDEP's screening values do not affect groundwater at levels approaching the state's 70 ppt groundwater screening value.

Meanwhile, in New Hampshire, a facility that has been managing septage for 30 years has been shut down by the New Hampshire Department of Environmental Services (NHDES) because of PFAS found in neighbors' wells. The PFAS is thought to have migrated from the septage lagoon and wetlands treatment system. The highest level of PFAS measured in well water was somewhat more than twice the state's groundwater standard of 70 ppt. Within a week of acting, on May 2, NHDES and the local town selectmen held a public informational meeting attended by more than 100 residents. The septage facility owner is cooperating with NHDES on providing bottled water to neighbors and further investigation. But the business, which has been permitted by NHDES for decades and has not had any enforcement action before this, is shut down, ordered to stop receiving and processing any septage. Unanticipated costs are mounting.

"These situations are warnings to the wastewater and biosolids/residuals management profession," said Mr. Beecher. "While the sites targeted by regulators in Maine and New Hampshire have seen much more biosolids and residuals activity than average, there are likely similar sites in every state. The question is whether or not the very strict regulatory standards—anything being proposed that is less than EPA's health advisory of 70 ppt—are necessary to protect public health. Regulators need to carefully assess the costs and benefits of setting drinking water and groundwater standards, recognizing the potential impacts on important, beneficial environmental programs like wastewater treatment and biosolids recycling."

How are Biosolids and Manures Regulated?

Coming soon: biosolids and manure regulations database

States and provinces across the United States and Canada regulate biosolids and manures differently and in various ways. No two jurisdictions are the same. The complexity and diversity of regulations make managing biosolids and manures more challenging. According to the Sustainable Phosphorus Alliance, this results in barriers to efficient, protective, sustainable recycling of phosphorus and the other nutrients and organic matter in these materials.

The alliance has created an online database of state and provincial manure and biosolids regulations, including summaries of each jurisdiction's regulations and links to key documents. The information is under final review by state regulators.

According to Rebecca Muenich, who provided an overview of the project at the alliance's annual forum on March 5 in Washington, D.C., "the project is useful for understanding the regulatory landscape and the impacts on how manure and biosolids are managed, which influences phosphorus losses. We hope this will help move toward more consistent regulations." The alliance expects to make the database available online later this year.

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

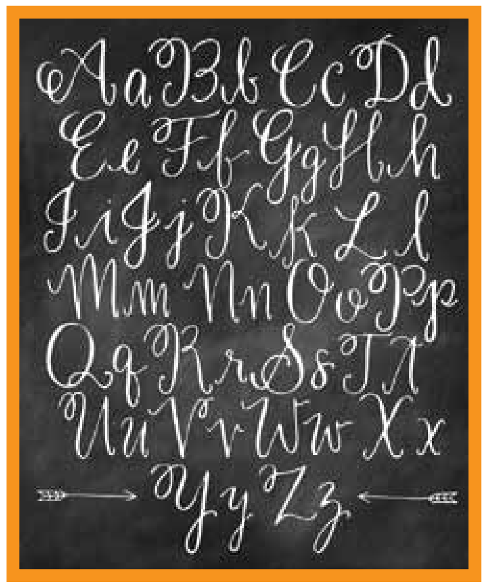
nebra
North East Biosolids & Residuals Association

WEF Delegate Report

The ABCs of NEWEA, MAs, and WEF

Who is WEF?

WEF is a not-for-profit technical and educational organization of 35,000 members from 76 affiliated member associations (MAs) representing water quality professionals around the world. Since 1928 WEF has promoted its vision of a community of empowered professionals creating a healthy global water environment. As a global water leader WEF's mission is to connect water professionals, enrich the expertise of water professionals, increase the awareness of the impact and value of water, and provide a platform for water sector innovation. A board of trustees governs WEF and holds legal authority and fiduciary responsibilities on behalf of the federation and its membership. WEF employs a staff of nearly 100, with headquarters in Alexandria, Virginia, just outside Washington, D.C.



How is NEWEA associated with WEF?

NEWEA is one of WEF's 76 MAs. Forty-one MAs are in the United States, five are in Canada, and 30 others are around the world from South Africa to Singapore. NEWEA has been an MA of WEF since 1929 (when the New England Sewage Works Association—later NEWEA—was formed as an affiliate of the infant National Federation of Sewage Works Associations, which later became WEF). In today's WEF, based on the size of our MA, NEWEA is assigned a delegation of three persons to represent NEWEA, one of the largest delegations in the country, and one of the most highly respected. This is a testament to NEWEA's long-term contributions to WEF and our shared success.

What Does WEF do for NEWEA?

WEF offers NEWEA similar benefits to those which NEWEA provides for each New England state. WEF connects water professionals nationally and internationally and enriches the expertise of water professionals through WEFTEC (the annual international technical conference), numerous specialty conferences, and technical publications. WEF also increases awareness of the impact and value of water nationally. Finally, WEF provides a platform for water sector innovations—all common goals promoted by NEWEA—but WEF does so nationally with an international audience.

WEF designates a liaison to each MA. NEWEA is fortunate to have Kelsey Hurst working with us. Ms. Hurst is a second-generation water professional from Pennsylvania and fits right in with the NEWEA delegation. She has proved a valuable member of the NEWEA team nationally.

What does a NEWEA WEF delegate do?

Acting on behalf of NEWEA, delegates are a primary conduit of information exchange with WEF. Delegates also advise the board of trustees on strategic direction and public policy development. NEWEA's delegates are members of WEF's house of delegates (HOD), the organization's deliberative and representational body. The HOD advises WEF on strategic direction and public policy development. The HOD consists of 82 delegates representing MAs and 12 at-large positions, from various broad interest groups. NEWEA's three-person delegation is currently joined by one at-large delegate from NEWEA.

Delegates must attend their MA's annual conferences, WEFTEC, and at least one WEF MA meeting (WEFMAX) annually. They must also participate in one or more HOD workgroups and/or committees. The workgroups are each given, at WEFTEC, a task for the coming year, and they typically report their progress at the next year's WEFTEC. Monthly conference calls and individual/small group deliverables are the norm for these workgroups.

UPDATES FROM OUR DELEGATES

Fred McNeill, City of Manchester, New Hampshire – Senior Delegate (Term ends at WEFTEC in September 2019). I am energized by participating as a WEF delegate for NEWEA. Interacting and exchanging ideas with like-minded water professionals from around the world is both professionally and personally fulfilling. It makes me proud of our industry and the contributions we make to the world's health and well-being.

In March, I participated in a WEFMAX in Scottsdale, Arizona, where more than 50 water professionals from around the country exchanged ideas, practices, and lessons learned. Industry-critical subjects such as membership engagement, future work force, and diversity were discussed. On behalf of NEWEA, I presented on our efforts at membership retention and growth. I was proud to share with this national audience that NEWEA membership is at an all-time high.

I am in my third and final year of my tenure as a delegate. Since my first HOD meeting, I have worked as a member of the Operations workgroup. As manager of a wastewater utility, I see first-hand the critical need for qualified operators. Our workgroup has focused on operator workforce development, review of existing operator training materials, and long-term initiatives to strengthen the recognition of the importance of our industry.

Matt Formica, AECOM – Junior Delegate. After holding several leadership positions with NEWEA, I am pleased to serve as a delegate to share NEWEA's highly respected programs and forward-thinking initiatives with the other MAs and with the WEF leadership. In May, I attended a WEFMAX in Orange Beach, Alabama, with leaders from other MAs and WEF. These leaders from across the country all truly see NEWEA as a MA leader, and we have an obligation as a leader to share our successes. As part of a federation of professionals, we are committed to improving the impact of all the MAs and WEF on public awareness, government affairs, and the advancement of education and innovation in our industry. NEWEA also benefits from this relationship by sharing ideas on ways to modify and improve our programs and initiatives and by learning from the successes and challenges that other MAs and WEF face.

The Membership workgroup focuses on increasing the diversity of the WEF membership to support our workforce of the future

I am fortunate this year to be involved in positions that give NEWEA a voice in the selection of future leaders for WEF. I am serving for the second year on the WEF Sub-Nominating Committee with the WEF president and past president, one trustee, and one other delegate. This five-person committee's charge is to review the applications for two annual positions on the WEF board of trustees and for the next WEF vice president. Ultimately, we will provide a recommended slate of officers to the board of trustees for these positions of significant importance. I also serve as the Nominating Committee chairman for the HOD. This group reviews applications and recommends committee assignments for six HOD committees, the delegate-at-large positions, and the HOD speaker-elect. Having NEWEA at the table for input to the selection of these positions allows us to make sure NEWEA's initiatives and position in WEF will be secured and maintained.

Susan Guswa, Woodard & Curran – First-year Delegate. I am enjoying my first year as WEF delegate for NEWEA. I participated in my first HOD meeting at WEFTEC in September 2018 and quickly realized how respected NEWEA is, a testament to our organization's contributions to the water quality profession and the professionalism and vision provided by our current and past NEWEA leaders. This year, I am participating on the Membership Diversity and Structure workgroup and am a member of the WEFMAX Committee.

The Membership workgroup focuses on increasing the diversity of the WEF membership to support our workforce of the future. Our current WEF president, Tom Kunetz, is passionate about this topic and spoke about this as one of this year's priorities on the October 8, 2018 *Words on Water* podcast titled #58: *Tom Kunetz on Priorities as WEF President*. The workgroup is surveying MAs for best practices and facilitating conversations at this year's WEFMAX meetings on diversity and inclusion.

Participation on the WEFMAX Committee allows me to bring my experience from chairing NEWEA's Program Committee to WEF. I was tasked with moderating a session at my first WEFMAX in Orange Beach, Alabama, in May. It was informative and rewarding to engage with leaders from WEF and other MAs on topics such as operator outreach, engagement, and workforce development. NEWEA will be hosting a WEFMAX in 2022, and this will also be great experience to draw from as we begin planning for that event.

James Barsanti, City of Framingham, Massachusetts – Incoming Delegate (Term begins at WEFTEC in September 2019.) I am looking forward to participating in our WEF endeavors with my fellow delegates. Since finishing my role as NEWEA past president, I have been working with WEF's Collection Systems Committee (CSC) and Public Communications and Outreach Committee (PCOC). Beginning in October, I will be the CSC's project manager for the Operation and Maintenance Technical Practice workgroup. My activities with the PCOC include reviewing nominations for this year's WEF Public Communication and Outreach awards.

Susan Sullivan, New England Interstate Water Pollution Control Commission – Delegate-at-large. After completing my three-year NEWEA delegate role, I was selected by WEF to continue in a delegate-at-large role for a three-year term, during which I will represent the state and interstate member constituencies to WEF. In this new role, I joined the WEF Budget Committee, which reviews the budget development process with the WEF treasurer and finance staff to confirm consistency of the annual budget with WEF's Strategic Plan and other initiatives. The committee also provides advice and direction to the HOD and the speaker of the house. This year we have also been working on the MA grants pilot program; this initiative invites MAs to submit applications for funding resources from WEF to support specialty MA projects. We are in our second round of selecting projects for funding for 2019.

I am also privileged to have been selected as the Leadership Development and Recognition Community of Practice (CoP) director for the WEF Committee Leadership Council (CLC). The CLC was established in 2003 by the board of trustees to serve as the communication link between the WEF committees, Councils, CoPs, HOD, and the board. As the CoP director, I work with WEF's Awards, Manufacturers, and Representatives (MARC), Program, and Students and Young Professionals committees. This is a rewarding opportunity that I have enjoyed since October 2018 when I started my term.

For more information regarding WEF and NEWEA interactions, programs, and involvement opportunities, please ask any current or past WEF delegate or contact the NEWEA office.

Spotlight: **Young Professionals**

We are excited to showcase two talented Young Professionals (YPs) who do not take the business of clean water "for granite." You guessed it, in this issue the *Journal* spoke with New Hampshire-based YPs to offer their perspectives on the water environment profession and share their reflections on their career development. Kate Biedron is a project manager and environmental engineer with CDM Smith in Manchester and serves as NEWEA's meeting management council director. Mike Curry is a lead project engineer with Wright-Pierce in Portsmouth.

Journal How did you come to enter the clean water profession?

Kate: It was not until I got my internship in college that I realized there was this whole underground city thing going on, and I thought it was so cool.

I mean growing up we watched the Ninja Turtles (I always thought I was April), but I never realized how many utilities were actually down there. I am fascinated with tunnels and old conduits. So cool!

Mike: More or less by accident. The first half of my college career I wanted to focus on structural engineering. The Zakim and Chesapeake Bay bridges always interested me. As my college career progressed, a few memorable and persistent professors led me to the dark side—water. A couple of treatment plant tours later, I officially caught the "clean water" bug and I have not turned back since.

I should also mention that I learned I am terrible at matrix structural analysis…but who isn't?

■ *You have both been working in the industry for some time. What has surprised you most about this industry that you might not have been aware of when you were fresh out of school?*

Kate: How old the infrastructure is!

Mike: How tight of a community the industry has developed. From Maine to Connecticut, more times than not you can find a common industry connection with a stranger.

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

Kate: I started at CDM Smith right out of college, and it will be 14 years in July. After about two years of work I realized that I was doing something "good" and that there would always be need for water and wastewater. I love helping people, and I knew this was going to be a rewarding career. I then decided I was all in and it was time to get my master's degree.

Mike: I have been in the water field for seven years. I started in the remediation field for a couple of years before realizing that it was not a good long-term fit for my strengths and goals, so I made a change. I have been with Wright-Pierce for the past five years, and after three years working in the water/wastewater field on both the design and construction side, everything seemed to click for me. The diversity of work I was exposed to was always challenging and constantly changing. Seeing designs that I sweated over being constructed sealed the deal for me—I was hooked for the long-term.

■ *Do you talk with people outside the profession about what you do for work? What kind of reactions do you typically get from those outside the profession?*

Kate: I constantly get from all my friends, "You do such cool things! All I do are people's taxes!" My friends are all having great careers and are doing fabulous, but I could not sit inside all day doing taxes (Sorry, CPA friends)! I like how we can see things get built and feel good about making improvements to the environment.

Mike: I love to learn and I love to teach—so I often find myself talking about my profession outside work to folks who are interested. So much of what we do is hidden from the public so generally people are amazed to learn about the critical infrastructure right below their feet and the work that is required to maintain it. However, you do get the occasional, "You stepped in WHAT?!"

■ *What benefit can YPs gain from being involved in NEWEA?*

Kate: If you are in the water profession in New England you are silly not to be involved in NEWEA. The networking that takes place with this group is invaluable. I have been so grateful to meet such great and smart people in the industry. I have bounced many questions off so many folks and have gotten so many great ideas from others with their own lessons learned. NEWEA has become a second family to me, and I have made many lifelong friends and had lots of fun and many laughs!

Mike: Sharing of ideas. This industry is constantly evolving. Whether you're dealing with an innovative technology application or a new approach to an old problem, most likely someone in the NEWEA community can relate.. It is a great resource to learn from others and collaborate on innovative ideas to help improve the industry.

■ *What challenges do you see for the water environment profession? How do you see the industry changing in response to these challenges?*

Kate: Back to the aging infrastructure topic, I think that we have more aging infrastructure than we know what to do with. The municipalities cannot keep up with it and have a hard time allocating funds. Decisions get made to "fix the worst for now." People need to continue to be educated about how important maintaining and improving this infrastructure is to their health. People need to continue to vote to help allocate funds and make infrastructure a priority.

Mike: Public communication. Many major infrastructure projects in the future will require funding through a combination of tax revenues and user rates. The 2019 ratepayer demands information on 1) what they are paying for and 2) why they are paying for it, as they should. It is our job as engineers, operators, and administrators in the water industry to strive to better educate the public about aging infrastructure, capital planning, and the financial implications of proposed infrastructure upgrades.

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

Kate: The environmental field is awesome! It is very rewarding, and it is not going anywhere. Think about it: You need water and you need to flush. Job security, people.

Mike: Jump in with an open mind and passion for whatever you set your sights on. If you do not find yourself in a position that you enjoy or that challenges you, make a change! The water/wastewater field offers a diverse variety of professional paths—work hard to find the one that suits you best.

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

Kate: I am very lucky to have many mentors in my life, and I must say that many of them are from NEWEA.

Mike: I was fortunate enough to study under Dr. Nancy Kinner during my time at the University of New Hampshire. I still use her weekly adage, "There's no free lunch" from time to time. Her unwavering passion for this industry helped encourage me to be a part of it.

■ *What has been your most rewarding experience with the NEWEA YPs Committee?*

Kate: I had a blast moderating the YP summit at the 2019 NEWEA Annual Conference. The panel was so fun, and the room had great energy. I left feeling that we are in good hands with the next generation of folks that participated.

Mike: Poo and Brew Events! Any day at a wastewater treatment plant is a good day. Add a beverage to it, it is even better.

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

Kate: I think that NEWEA offers something for everyone. There are great technical committees and so much more to keep this volunteer organization going: meeting management, which involves event planning, to government affairs, which involves staying up with the latest legislation and regulations, and if you are good with numbers like my CPA friends mentioned above, you could be treasurer or get involved in the Finance Committee. There really is something for everyone. I would recommend getting involved and taking on the leadership positions. You learn so much, and there are so many folks willing to help you. I know what you are thinking, and no, you are not too young. We take all ages. Trust me: They took me!

Mike: Start young. The longer YPs wait, the less likely it is that they will be part of NEWEA and the corresponding state association. Get active!

■ *What is a fun fact about you that your professional network may be surprised to learn about you?*

Kate: I eat way too much sushi.

Mike: I can juggle torches (yes, when they are on fire).

Student Design Competition

by Nick Tooker, PE, Student Activity Committee chair

The NEWEA Student Design Competition (SDC), organized by the Student Activity Committee, was recently completed. This competition promotes "real world" design experience for students interested in pursuing an education and/or career in water engineering and sciences. The competition tasked teams of student members within NEWEA to design a project that they have worked on together as a team. Student teams submitted written reports and presented their findings in front of judges during the SDC reception and presentation, held on April 25 at Northeastern University (NU). A team from NU presented "Town of Amherst Water Reuse Initiative and Wastewater Treatment Plant Retrofit."

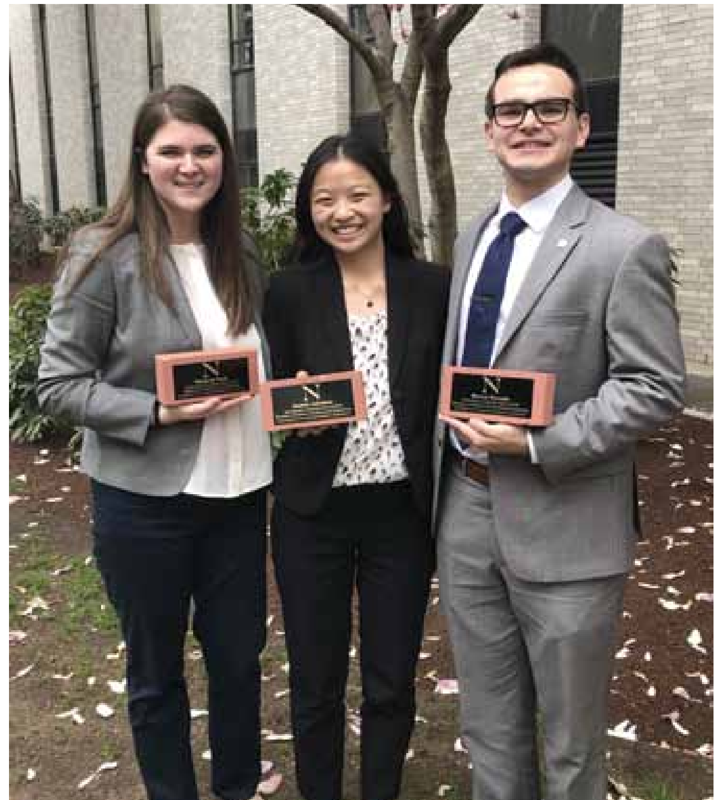
Judges evaluated the technical aspects, the appearance, and structure of the written submittal, and the content organization and effectiveness of the presentation.

The NU project included the design of an upgrade for nutrient removal and increased water reuse capacity at the Amherst Water Resource Recovery Facility in Amherst, Massachusetts. The preliminary design satisfies a potential total nitrogen regulation for secondary treatment and addresses various sustainability goals, including water reuse for the University of Massachusetts (UMass) Amherst. Nitrogen removal is accomplished through the design of a moving bed biofilm reactor (MBBR), and water reuse is accomplished though membrane ultrafiltration followed by reverse osmosis. The reuse water is intended for utility use at the central utilities plant, for irrigation of recreation fields, and for toilet flushing on the UMass Amherst campus.

The winning team will receive a travel allowance to WEFTEC 2019 in Chicago, where it will present its project at the WEF SDC.

Meet the winning team: Margaret Keefe (left in photo) managed the project and was available in all aspects for support whether it be design research or client communication. Ms. Keefe was extensively involved in the design for the ultrafiltration and reverse osmosis components of the tertiary treatment upgrade. She also completed the preliminary cost estimate and final report.

Marcus Brunelle (right in photo) was the site civil and distribution engineer. He used his experience in municipal water systems to design the water reuse building and distribution system. Mr. Brunelle also managed the public outreach portion of the project, creating the educational website and pamphlet.



Winners of the NEWEA Student Design Competition: (L to R) Margaret Keefe, Kestral Johnston, and Marcus Brunelle of Northeastern University presented their team project *Town of Amherst Water Reuse Initiative and Wastewater Treatment Plant Retrofit.*

Kestral Johnston (middle in photo) served as the wastewater engineer for the project. Ms. Johnston was the design lead for the MBBR and all other aspects of the secondary treatment retrofit. She also helped to construct a preliminary BioWin model and assembled the project poster.

Brendan Curran (not in photo) provided additional support through preliminary research and vendor communication for the ultrafiltration and reverse osmosis system. He also compiled specifications for the system and the chemical cost breakdown.

Judges for the competition were: Marissa Dreyer (Applied Materials), Helen Gordon (Environmental Partners Group), Tracy Chouinard (Brown and Caldwell), Carina Hart (JK Muir), Jonnas Jacques (Kleinfelder), Jerry Hopcroft (WIT), Ben Stoddard (Kleinfelder), Jim Barsanti (City of Framingham), Alex Silveri (Kleinfelder), Joanna Sullivan (Hazen & Sawyer), and Asher Keithley (Tighe & Bond).

Specialty Conference, Training, & Networking Proceedings

Participants gather at the Operations Challenge Facility Tour and Training Day at the West Warwick, Rhode Island Wastewater Treatment Facility

PLANT OPERATIONS SPECIALTY CONFERENCE

NEWEA's Plant Operations Committee hosted Perspectives on Phosphorus Removal in the Sudbury-Assabet-Concord River Watershed in Billerica, Massachusetts, on March 21, 2019. The technical conference and exhibit had 70 participants.

NEWEA President Ray Vermette, Plant Operations Committee Chair Tom Hazlett, and Billerica Town Manager John Curran provided the Opening Remarks to welcome attendees and commence the conference.

History of the SuAsCo Watershed Planning, 1972 – 2005
- Paul Hogan, Woodard & Curran

Introduction to Phosphorus Removal
- Maureen Neville, CDM Smith

Phosphorus Removal within the SuAsCo River Watershed
- Tom Parece, AECOM

Panel Discussion: Plant Operations on the SuAsCo WRRFs
- Staff from SuAsCo WRRF discuss benefits and challenges of their operation

Is it Making a Difference? What 20 Years of Water Quality Trends Tell Us
- Alison Field-Juma, OARS

Regulatory and Permitting Updates
- Suzy King, MassDEP

Future Directions in Phosphorus Removal and Recovery
- Nick Tooker, UMASS Amherst

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OPERATIONS CHALLENGE FACILITY TOUR & TRAINING DAY

NEWEA's Operations Challenge Committee held a Facility Tour and Training Day on April 12, 2019, at the West Warwick, Rhode Island Wastewater Treatment Facility (WWTF). Forty attendees participated.

Attendees learned about the Operations Challenge and its five competition events (Collection Systems, Process Control, Laboratory, Safety, and Maintenance). This event also included a facility tour of the West Warwick WWTF.

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YOUNG PROFESSIONALS NETWORKING EVENTS

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

Sponsored by: ADS Environmental Services; AECOM; Aqua Solutions; Arcadis; Brown and Caldwell; Carlsen Systems; CDM Smith; David F. Sullivan & Associates; Dewberry; Environmental Partners Group; EST Associates; Flow Assessment Services; Fuss & O'Neill; Green Mountain Pipeline Services; Hazen and Sawyer; Hoyle, Tanner & Associates; Jacobs; The MAHER Corporation; Mott MacDonald; NASSCO; Stantec; SUEZ; Tata & Howard; Tighe & Bond; Weston & Sampson; Woodard & Curran; Wright-Pierce

POO & BREW #19

This event featured a tour of the Amherst, Massachusetts Water Resource Recovery Facility, followed by a networking reception at Abandoned Building Brewery. Sixty students and professionals attended this event, held on April 24, 2019. The Massachusetts Water Pollution Control Association (MWPCA) co-hosted, and CDM Smith and ACV Enviro sponsored as Event Supporters.

New England Water Environment Association, Inc.

Statement of activities
For the years ended September 30, 2018 and 2017

Changes in unrestricted net assets:	**2018**	**2017**
Revenues and gains:		
Registration Fees	$ 514,447	$ 451,858
Exhibitor Fees	270,315	266,000
Membership Dues	52,852	51,030
Pass Through Dues	58,405	63,068
Advertising and Subscriptions	117,741	118,138
Sponsorships	75,584	73,782
Certification Fees	17,377	17,900
Investment Income	45,599	61,134
Other Income	29,648	30,842
Total unrestricted revenues and gains	**1,181,968**	**1,133,752**
Total unrestricted revenues, gains and other support	**1,181,968**	**1,133,752**
Expenses:		
Program services	844,935	739,129
Management and general	256,934	252,997
Pass Through Dues	44,751	35,343
Total expenses	**1,146,620**	**1,027,469**
(Decrease) Increase in unrestricted net assets	35,348	106,283
Net assets, beginning of year	**735,175**	**628,892**
Net assets, end of year	**$ 770,523**	**$ 735,175**

New Members February – March 2019

Robert Backman
Wayland, MA (PRO)

Brian Bernard
North Hampton, NH (PRO)

Ben Chadwick
Smith & Wilkinson
Scarborough, ME (PRO)

Taylor Cheverier
Town of Northborough
Northborough, MA (PWO)

Emily Church
Tighe & Bond
Worcester, MA (YP)

Jeremy Cigal
Westfield, MA (PRO)

Christina Conrad
Brown and Caldwell
Andover, MA (PRO)

Tricia Fabrizio
Narragansett Bay Commission
Providence, RI (PWO)

Ryan Flynn
Worcester, MA (YP)

Jody Frymire
Gorham, ME (STU)

Todd Gaignat
Loudon, NH (PRO)

Joe Griffin
SUEZ
Agawam, MA (YP)

Steve Jobes
Town of Northborough
Northborough, MA (PWO)

David Meier
Somerville, MA (YP)

Amy Mueller
Northeastern University
Boston, MA (ACAD

Shannon Ruggieri
Providence, RI (YP)

Tyler Schofield
SUEZ
Agawam, MA (YP)

Eric Schwab
RPS Environmental Remedial
Walterboro, SC (PRO)

Jeremy Weeks
Town of Northborough
Northborough, MA (PWO)

Larry Woznicki
SUEZ
Agawam, MA (PWO)

Ryan Angelico
Weston & Sampson
Peabody, MA (YP)

Tim Babkirk
Eliot, ME (PWO)

Alyssa M Beck
Grass Island WWTP
Greenwich, CT (PWO)

James Birkenberger
Wolcott, CT (PRO)

Michael Bobinsky
City of Somersworth
Somersworth, NH (PRO)

Frank Bottone
Westport, CT (PRO)

Douglas Brandt
Plymouth, MA (PWO)

Jason Cairelli
Lebanon WWTP
West Lebanon, NH (PWO)

Bernadette Callahan
Stantec
Philadelphia, PA (PRO)

Umang Chauhan
Boston, MA (STU)

Isaias Colombani
Westfield, MA (STU)

Chelsea Conlon
JK Muir LLC
Rocky Hill, CT (YP)

Crystal Cooper
Windham, ME (PRO)

Adrianna Copeland
Baton Rouge, LA (STU)

James Costa
City of New Bedford
New Bedford, MA (PRO)

Christopher Coyle
CDM Smith
Hartford, CT (PRO)

Jami Fitch
Lynn Water & Sewer Commission
Windham, ME (PRO)

Peter Fitzgerald
Lunenburg, MA (STU)

Doug Flanagin
Rock Hill, SC (PRO)

Stephen Frederick
Springfield Water & Sewer
Commission
Springfield, MA (PRO)

Elizabeth Fulton
Cranford, NJ (STU)

Susan Geelmuyden
Dewberry
Boston, MA (PRO)

Alan Gunnison
Beta Group, Inc.
Lincoln, RI (PRO)

Insley Haciski
Onset Computer
Bourne, MA (PRO)

Tyler Hebert
Baton Rouge, LA (STU)

Caitlin Hunt
Massachusetts Water
Resources Authority
Winthrop, MA (PRO)

Matthew Hutchins
Vestavia Hills, AL (STU)

Charles Johnson
Nantucket Sewer Department
Nantucket, MA (PWO)

Ronald Kelton
City of Portland
Portland

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)

Upcoming Meetings & Events

COMMITTEE MEMBER APPRECIATION EVENT & WATERSHED HOMEBREWING COMPETITION
July 18, 2019
Kimball Farms, Westford, MA

TEACHER TRAINING WORKSHOP
August 20, 2019
NBC, Providence RI

WEFTEC TECHNICAL EXHIBITION AND CONFERENCE
September 21–25, 2019
McCormick Place, Chicago, IL

NORTHEAST RESIDUALS & BIOSOLIDS CONFERENCE, EXHIBIT AND TOUR
October 16–18, 2019
Sheraton Springfield Monarch Place, Springfield, MA

NEWEA ANNUAL CONFERENCE & EXHIBIT
January 26–29, 2020
Boston Marriott Copley Place Hotel, Boston, MA

AFFILIATED STATE ASSOCIATIONS AND OTHER EVENTS

NHWPCA SUMMER MEETING
June 21, 2019
Ellacoya State Park, Gilford, NH

NHWPCA ANNUAL GOLF TOURNAMENT
August 1, 2019
Beaver Meadow Golf Course, Concord, NH

MEWEA FALL CONFERENCE & GOLF TOURNAMENT
September 11–13, 2019
Point Lookout, ME

MWPCA TRADE SHOW
September 11, 2019
Wachusett Mountain Resort

PRINCETON, MA NHWPCA FALL MEETING
September 13, 2019
Red Fox Bar and Grille, Jackson, NH

NEWWA ANNUAL CONFERENCE
September 22–25, 2019
Samoset Resort, Rockport, ME

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

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

U.S.	International System of Units (SI)
Liquid volume	
gallon (gal)	liter (L)
cubic feet (ft³)	cubic meters (m³)
cubic yards (yd³)	cubic meters (m³)
acre-feet (ac ft)	cubic meters (m³)
Flow	
million gallons per day (mgd)	million liters per day (ML/d)
for larger flows (over 264 mgd)	cubic meters per day (m³/d)
gallons per minute (gpm)	liters per minute L/m
Power	
horsepower (hp)	kilowatts (kW)
British Thermal Units (BTUs)	kilojoules (kJ) / watt-hours (Wh)
Velocity	
feet per second (fps)	meters per second (m/s)
miles per hour (mph)	kilometers per hour (km/h)
Gas	
cubic feet per minute (ft³/min)	cubic meters per minute (m³/min)

U.S.	International System of Units (SI)
Length	
inches (in.)	centimeters (cm)
feet (ft)	meters (m)
miles (mi)	kilometers (km)
Area	
square feet (ft²) or yards (yd²)	square meters (m²)
acre (ac)	hectare (ha)
square miles (mi²)	square kilometers (km²)
Weight	
pounds (lb)	kilograms (kg)
pounds per day (lb/d)	kilograms per day (kg/d)
ton – aka short ton (tn)	metric ton or tonne (MT)
Pressure	
pounds/square inch (psi)	kiloPascals (kPa)
Inches water column (in wc)	kiloPascals (kPa)
Head	
feet of head (ft of head)	meters of head (m of head)

Thank you

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

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

Sponsorship Benefits:

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

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

NEWEA
WORKING FOR WATER QUALITY

Advertiser Index

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The Fall issue advertising deadline is August 1, 2019

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Call: 781-939-0908

Upcoming *Journal* Themes

Fall 2019—**Collection Systems**

Winter 2019—**Safety**

NEWEA/WEF* Membership Application 2019

Water Environment Federation — the water quality people
NEWEA — WORKING FOR WATER QUALITY

Personal Information (please print clearly)

Last name | M.I. | First Name | (jr. sr. etc)

Business Name (if applicable)

Street or P.O. Box | (☐ Business Address ☐ Home Address)

City, State, Zip, Country

Home Phone Number | Mobile Phone Number | Business Phone number

Email Address

☐ Check here if renewing, please provide current member I.D.

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

Employment Information (see back page for codes)

1. ORG Code | Other (please specify) | 2. JOB Code: | Other (please specify)

3. Focus Area Codes | Other (please specify

Signature (required for all new memberships) | *Date*

Sponsorship Information

WEF Sponsor name (optional) | Sponsor I.D. Number | ACQ. Code for WEF use only I WEF 19

Membership Categories (select one only)

Membership Categories		Member Benefit Subscription	Dues
☐ **Professional Package**	Individuals involved in or interested in water quality	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$185
☐ **Young Professional Package**	New members or formerly student members with 5 or less years of experience in the industry and less than 35 years of age. This package is available for 3 years. Date of birth (mm/yy) ________	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online*	$70
☐ **Professional Wastewater Operations (PWO) Package**	Individuals in the day-to-day operation of wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of < 1 mgd or 40 L/sec. License # ________________	■ WE&T (including *Operations Forum*) ■ *WEF Highlights Online*	$110
☐ **Academic Package**	Instructors/Professors interested in subjects related to water quality.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$185
☐ **Student Package**	Students enrolled for a minimum of six credit hours in an accredited college or university. Must provide written documentation on school letterhead verifying status, signed by an advisor or faculty member.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *Water Environment Research* (Online)	$15
☐ **Executive Package**	Upper level managers interested in an expanded suite of WEF products/services.	■ *WE&T* (including *Operations Forum*) ■ *WEF Highlights Online* ■ *World Water* ■ *Water Environment Research* (Online) ■ *Water Environment Regulation Watch*	$355
☐ **Dual**	If you are already a member of WEF and wish to join NEWEA		$45
☐ **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*	$420
☐ **New England Regulatory Membership**	This membership category is a NEWEA only membership reserved for New England Environmental Regulatory Agencies, including: USEPA Region 1, CT Department of Energy and Environmental Protection, ME Department of Environmental Protection, MA Department of Environmental Protection, NH Department of Environmental Services, VT Department of Environmental Conservation, and RI Department of Environmental Management		$50

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

Payment

☐ **Check or money order enclosed** Made payable to NEWEA 10 Tower Office Park, Suite 601 Woburn, MA 01801 For more information: 781.939.0908 Fax 781.939.0907 NEWEA.org	**Charge** ☐ Visa ☐ American Express ☐ Master Card ☐ Discover	Card # | Security/CVC Signature | Exp. Date Name on Card (please print)	*Depending upon your membership level, $10 of your dues is allocated towards a subscription to the NEWEA Journal.*
Billing Address (☐ check here if same as above)	Street/PO Box	City, State, Zip	

NEWEA/WEF* Membership Application 2019

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

What is the nature of your ORGANIZATION?

(circle one only–required) (ORG)

1 Public/Private Wastewater Plants and/or Drinking Water and/or Stormwater
2 Public/Private Wastewater Only
3 Public/Private Drinking Water Only (e.g. municipality, utility, authority)
4 Industrial Systems/Plants
5 Consulting or Contracting Firm
6 State, Federal, Regional Government Agency
7 Research or Analytical Laboratories
8 Educational Institution
9 Manufacturer of Water/Wastewater/ Stormwater Equipment or Products
10 Water/Wastewater/Stormwater Product Distributor or Manufacturer's Rep.
11 Public/Private Stormwater (MS4) Program Only
12 Public Financing, Investment and Banking
13 Non-profits
99 Other ______________ (please specify)

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

1 Management: Upper or Senior
2 Management: Engineering, Laboratory, Operations, inspection, Maintenance
3 Engineering and Design Staff
4 Scientific and Research Staff
5 Operations/Inspection Maintenance
6 Purchasing/Marketing/Sales
7 Educator
8 Student
9 Elected or Appointed Public Official
10 Other ______________ (please specify)

What are your KEY FOCUS AREAS?

(circle all that apply) (FOC)

1 Collection Systems
2 Drinking Water
3 Industrial Water/Wastewater/ Process Water
4 Groundwater
5 Odor/Air Emissions
6 Land and Soil Systems
7 Legislation (Policy, Legislation, Regulation)
8 Public Education/Information
9 Residuals/Sludge/Biosolids/Solid Waste
10 Stormwater Management/ Floodplain Management/Wet Weather
11 Toxic and Hazardous Material
12 Utility Management and Environmental
13 Wastewater
14 Water Reuse and/or Recycle
15 Watershed/Surface Water Systems
16 Water/Wastewater Analysis and Health/ Safety Water Systems
17 Other ______________ (please specify)

Optional Items (OPT)

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

Gender? _______
1 Female 2 Male

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

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

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

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

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2017 Operational Data

Month	Influent TKN	Effluent TKN	Effluent TN
February	62	1.6	1.6
March	31	1.2	1.2
April	59	2.1	3.5
May	26	.92	.92
June	62	1.6	1.92
July	24	.84	.84

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