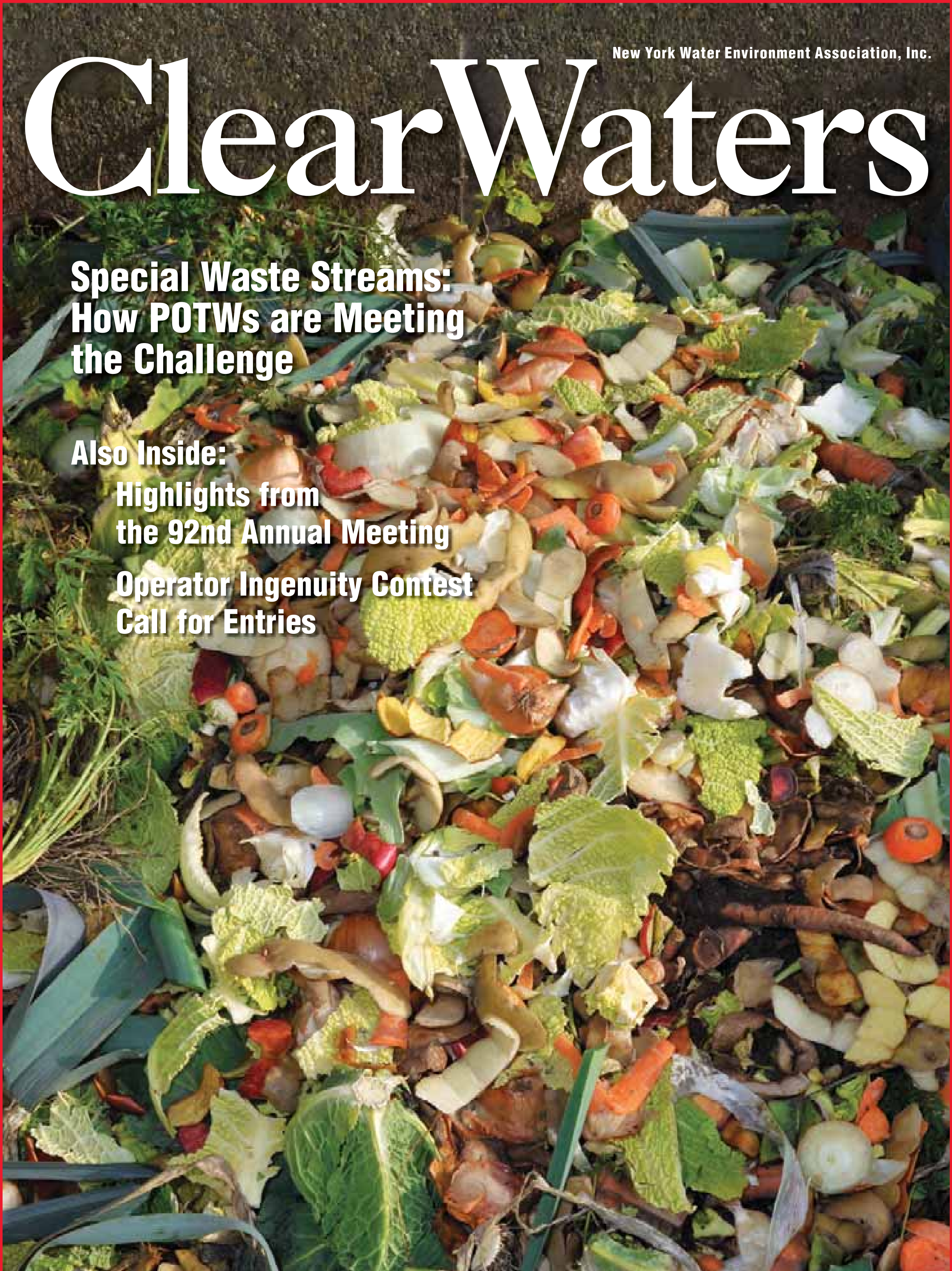
Spring 2020, Vol. 50, No. 1

New York Water Environment Association, Inc.

ClearWaters



Special Waste Streams: How POTWs are Meeting the Challenge

Also Inside:

- Highlights from the 92nd Annual Meeting
- Operator Ingenuity Contest Call for Entries

Members can search "NYWEA" in the App Store to view the digital edition of this magazine.

nywea.org

Spring 2020, Vol. 50, No. 1

ClearWaters

New York Water Environment Association, Inc.

Cover: Food waste is but one of the many special waste streams that managers of publicly owned treatment works face. These special waste streams have chemical and physical characteristics that can disrupt wastewater treatment processes, which can lead to permit violations and increased treatment costs. Managers and operators are actively engaged in understanding the special waste streams unique to their facilities. From food waste codigestion in New York City to high-strength yogurt processing waste in Rome to untreated airplane deicing fluid in Onondaga County, managers across the state are finding creative ways to treat these wastes and, in the process, recover some benefit for the communities they serve

Photo credit, istockphoto.com/Grahamphoto23

Clear Waters (USPS 004-595) (ISSN 01642030) is published quarterly with a directory every four years in the fall by the New York Water Environment Association, Inc., 525 Plum Street, Suite 102, Syracuse, NY 13204. Subscription is through membership; public subscription is $25.00/year. PERIODICALS postage paid at Syracuse, NY. POSTMASTER: Send address changes to the New York Water Environment Association, Inc., 525 Plum Street, Suite 102, Syracuse, NY 13204. Ph: 315-422-7811, Fax: 315-422-3851.

♻ **Clear Waters** ***is printed on recycled paper, using soy-based ink.***

President's Message | Spring 2020

It was an honor for me to receive the NYWEA "gavel" from President Robert Wither during the 92nd Annual Meeting Awards Luncheon at the New York City Marriott Marquis. It is also a privilege for me to be the first Young Professional to hold this position. At NYWEA's annual meeting I thanked President Wither for all his contributions over the past year as he focused on the theme of "Creating a Sustainable Operator Workforce." This issue is tremendously critical as water professionals go mostly unnoticed in society unless there is an issue. Bob's work to promote certifications at multiple grade levels, as well as raising awareness of the challenges related to workplace sustainability, are essential to keeping water resource recovery facilities operating effectively.

2020 Theme – Making Connections with Our Members

As I mentioned in my remarks at the annual meeting, during my tenure as President I will focus on the theme of the connections we make through our involvement in NYWEA. For me, the value of NYWEA is based in the connections we make throughout our careers and by volunteering in this great organization. Through my chapter and committee work, as well as my service on the Board, I got to see and understand better the teamwork that is involved to move this organization forward. It meant so much to me to see the hundreds of members volunteering their own time to make this organization work. I suspect that I am not the only one who feels this way and encourage you all to reflect on how you became involved and who welcomed (or dragged!) you in. Please have that in mind when you encourage others to join and remember the impression you make on them could be one that lasts with them for the rest of their careers.

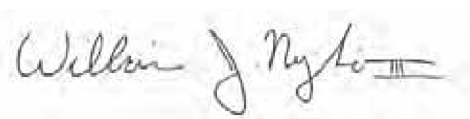
For me, being a part of this organization is deeply personal. I enjoy making the personal connections and seeing the same people year after year. It is also so great to see the organization growing and the influx of Young Professionals (YPs). I am especially proud of our well-known YP reception in New York City during the annual meeting, which attracts literally hundreds of YPs in a fun and exciting atmosphere.

Upcoming Events and COVID-19

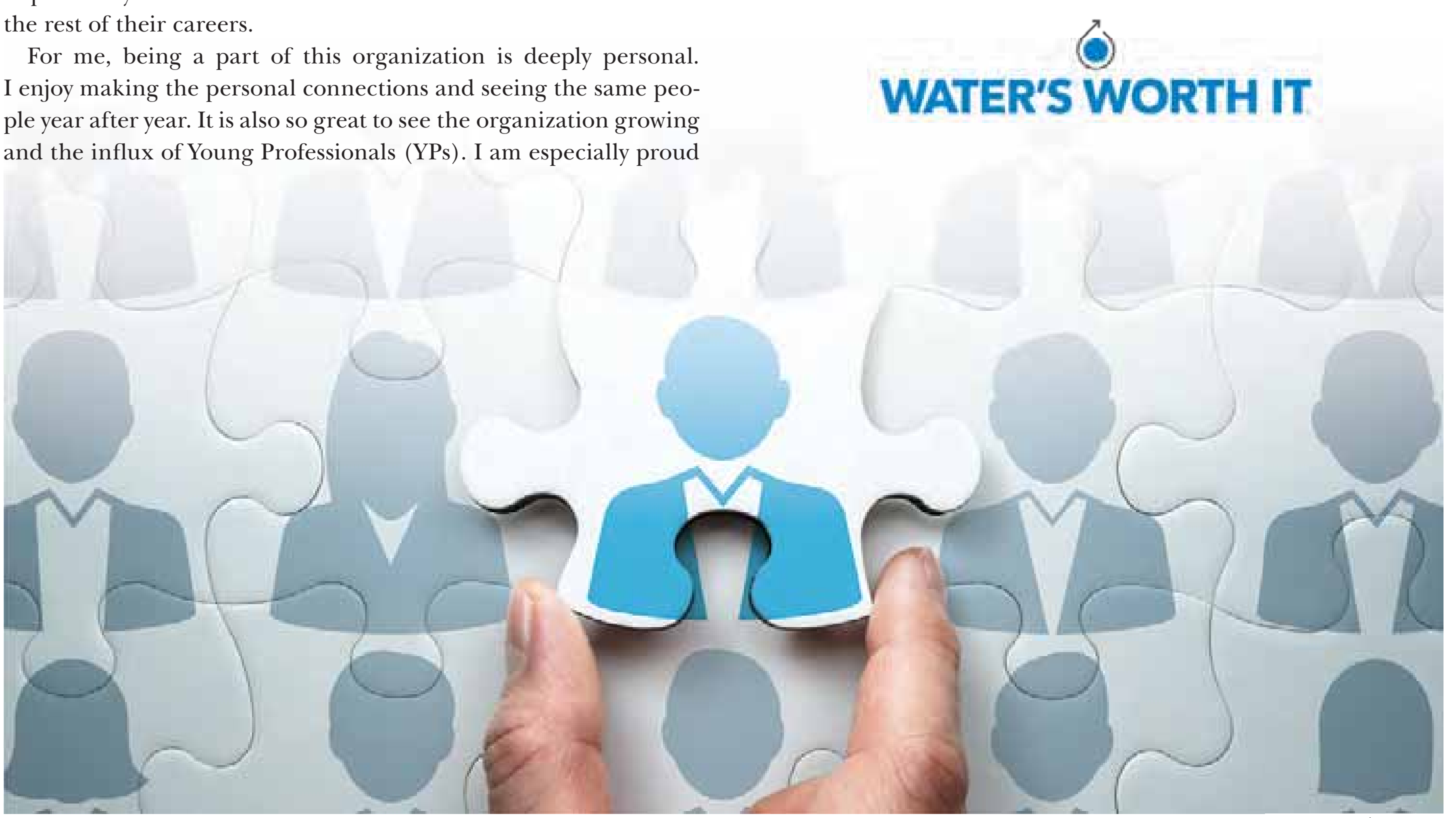
As we go to print on this issue, we are just starting to see the effects of the novel coronavirus disease, COVID-19, and its impact on New York, the United States and globally. Of utmost importance is the health and safety of our members. While there are many upcoming events we are all looking forward to, unfortunately several of these events will be canceled or postponed due to the measures we as a society are taking to curb the pandemic.

NYWEA and WEF are taking actions to ensure that our decisions are in the best interests of the health and well-being of our members. With the cancellation of the Young Professionals Summit and WEFMAX, we are navigating in unchartered waters. At the executive level, we are evaluating each event on a case-by-case basis, offering guidance and making the most educated decision possible. We appreciate your patience in this process and wish you and your family a safe and healthy spring season!

Looking past the immediate pandemic situation, one of the many events I'm anticipating is the Spring Technical Conference and Exhibition taking place in Hauppauge, New York. The meeting will be held June 8 through June 10 and is guaranteed to give you a taste of Long Island. I encourage you all to attend this event and connect with fellow NYWEA members. I'm sure you won't be disappointed!



William J. Nylic III, PE, NYWEA President



Credit, istockphoto.com/tadamichi

Fifty Years of *Clear Waters*

It is a pleasure for me to write this message that celebrates NYWEA's 50th volume of *Clear Waters* magazine. Why is the volume number important? It represents the number of years that this educational publication has been circulated. For 50 years our magazine has informed our members on technical topics that run the gamut, covering both geographic regional issues and specific environmental topics. From stormwater and wet weather to specific technologies like aeration and co-digestion, and everything in-between, *Clear Waters* is a valued resource for our members to learn from one another. In NYWEA's 2019 survey, we heard from our members that the printed magazine is still a preferred method of delivery. We thank you for your input!

What's on the horizon for *Clear Waters*? Our appreciation goes out to the members of the Publications Committee who help to set the themes for the upcoming issues:

- Summer 2020: Student Chapters
- Fall 2020: A Focus on Safety
- Winter 2020: Diversity & Inclusion
- Spring 2021: Women in Water
- Summer 2021: Upgrades & Technology Trends
- Fall 2021: Chesapeake Bay
- Winter 2021: Odor Control

If you would like to author an article on any of these topics, please do not hesitate to reach out to me at *pcr@nywea.org*. We would welcome your input!

Also, 50 Years of NYSDEC

It is serendipitous that as we celebrate 50 years of publishing *Clear Waters* magazine, the New York State Department of Environmental Conservation (NYSDEC) also celebrates its golden anniversary. On April 22, 1970, Governor Nelson A. Rockefeller signed legislation to create NYSDEC. Just a few months later, NYSDEC opened its doors for business.

Commissioner Basil Seggos and his predecessors have made remarkable progress in a variety of environmental accomplishments. While New York's air and waters are cleaner today, there are still several unmet environmental challenges that must be addressed including climate change, emerging contaminants and workforce issues, to name a few.

In Other News …

During NYWEA's 92nd Annual Meeting, the board of directors unanimously approved support of the United Nations Sustainable Development Goals (SDG). Like the Water Environment Federation's mission, NYWEA's mission, programs and activities support the objectives of the SDG, aligning in particular SDG 6 – Clean Water and Sanitation. However, if you look at each one of the goals, water has a connection. NYWEA will seek opportunities to build upon the work currently being done to advance progress toward achievement of these goals where we can.

As we move toward Earth Day and Water Week, there is cause for celebration in everyday events! As the days grow refreshingly longer and the temperature warms, trees bud out and flowers bloom – now is the time to recharge and share our passion on water issues with younger generations. To that end, NYWEA and NYSDEC have made their selection of the winning posters that will be featured on the 2021 calendars. This poster/calendar contest has been taking place for over 15 years. It is a wonderful opportunity to reach students and introduce them to water quality issues. I hope you can engage in public outreach activities wherever you live. It's a wonderful opportunity to give exposure and celebrate the good work that takes place at water resource recovery utilities.

Patricia Cerro-Reehil, pcr@nywea.org

CLEARWATERS

NEW YORK WATER POLLUTION CONTROL ASSOCIATION

Hennigan Testifies Before House Public Works Committee

CLEARWATERS

NEW YORK WATER POLLUTION CONTROL ASSOCIATION

SENATOR SMITH DISCUSSES ENVIRONMENTAL BOND ACT

Blast from the past: front pages of *Clear Waters* from 1971 and 1972.

NYWEA President Robert Wither introduces the Opening Session panelists, and sets the stage for an Operator Workforce discussion.

92nd Annual Meeting: Creating a Sustainable Operator Workforce

Over 1,500 environmental professionals gathered to attend NYWEA's 92nd Annual Meeting held at the NYC Marriott Marquis, February 3-5, 2020. A record number of technical sessions brought the latest information to our members. Our heartfelt appreciation goes out to all of the Exhibitors, Sponsors and Advertisers for their generous support that makes up the backbone of the meeting's success. Our sincere appreciation goes out to the volunteers who are generous with their time, especially the members of the Program Committee. Many thanks to the Conference Management Committee and all of the speakers and moderators for their help in putting together New York state's largest water quality technical conference and exhibition. Of course, we extend our appreciation to all conference attendees.

NYSDEC Commissioner Basil Seggos gives the keynote address.

NYCDEP Commissioner Vincent Sapienza addresses NYWEA members.

Brig. Gen. (Retired) Marianne Watson from Center for America.

Joseph Kane of the Brookings Institute.

Andy Kricun from Camden County, New Jersey, addresses workforce development.

Victoria Johnson from Jacobs speaks about her experiences around the country on workforce issues.

Stephen Sanders, Director of the Environmental Training Center, Morrisville State College, talks about inclusivity and diversity.

It was SRO for Monday's Opening Session!

Michelle Virts enjoys a light moment; she is from Monroe County and is NYWEA's Stormwater Committee Chair.

Right: Lorraine Janis, Administrative Director of Labs in Bureau of Water Supply.

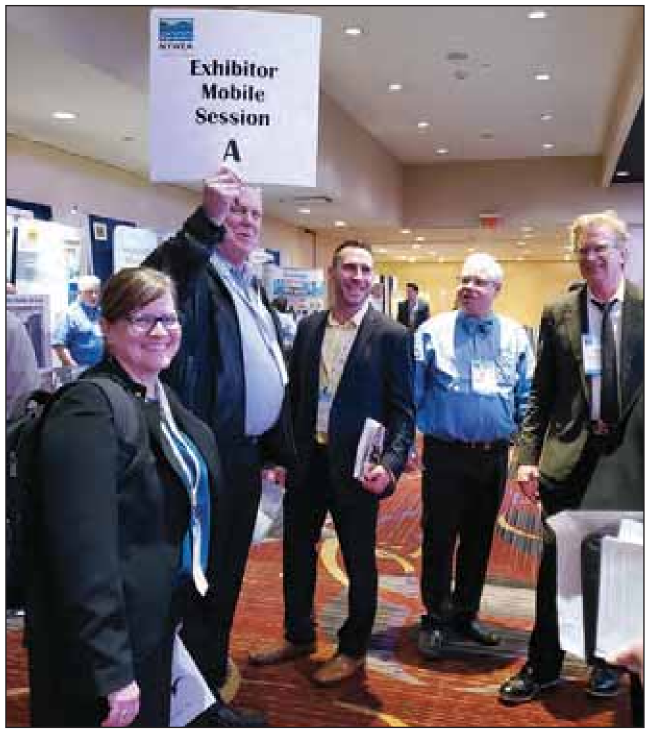
Right: WEF President-Elect and NYWEA President-Elect, Jaimie Eichenberger (left) and Lauren Livermore.

Vanessa Brabant scans in Demian Sadeghi of NYCDEP.

Tucker Cox, right, scans in Matt Osit of NYCDEP.

L-r: Donna Bee, Angel French and Tanya May Jennings strike a pose in the Exhibit Hall.

Milagros Soriano, left, catches up with Diane Hammerman of NYCDEP.



Attendees for Monday's Exhibitor Mobile Session A meet at Booth 178 for an in-depth session on "Infrastructure Maintenance with Remotely Operated Vehicles".

Joyette Tyler shakes hand of William Richardson, Raritan Group, upon his receiving the Exhibitor Award, "Best Single-Booth Exhibit". Congratulations, William!

Robert Ortiz performs Pipe Cutting at Monday's Operations Challenge Collections Event demonstration.

Fun at Metro Fab's exhibit.

Enjoying a humorous moment are (l-r) Corky Kelsey, Monroe County; Vatche Minassian, HDR and Metropolitan Chapter Rep; and NYCDEP Commissioner Vincent Sapienza.

Maggie Hoose, left, and Maureen Kozol staff the check-in desk.

More photos on page 58.
And for even more pictures, visit https://www.facebook.com/nywea

Photography courtesy of Trent Wellot

Water Views | Spring 2020

Industrial Pretreatment Programs and POTWs

Industries help fuel New York state's local economies, but the wastewater that they generate can be a challenge for publicly owned treatment works (POTWs). While some industrial facilities have their own State Pollutant Discharge Elimination System (SPDES) permits, many send their wastewater to local POTWs. Industrial wastes can include pollutants or toxics that may interfere with treatment, or pass through untreated, as POTWs are typically designed to treat human waste.

The undesirable outcome of such discharges can be prevented using treatment techniques or management practices to reduce or eliminate the discharge of these contaminants. The act of treating wastewater prior to discharge to a POTW is commonly referred to as "pretreatment."

While DEC regulates the discharge from a POTW, it is the municipality's obligation to regulate what enters the plant through its sewer use ordinance and associated pretreatment programs.

Pretreatment program requirements were established to ensure that industries that discharge wastewater to POTWs do so in a manner that controls the pollutant levels such that four goals are achieved: prevent the pass-through of toxics to the receiving water; prevent pollutant interference with the wastewater treatment process; prevent contamination of sludge generated from the treatment system; and protect the workers and treatment works.

In New York state, POTWs may have one of two types of pretreatment program requirements in their SPDES permits: an EPA-approved Industrial Pretreatment Program or a Mini Industrial Pretreatment Program.

Under Title 40 Code of Federal Regulation Part 403, any POTW with a total design flow greater than 5 million gallons per day that receives industrial users' pollutants, which pass through or interfere with the operation of the POTW, is required to establish an Industrial Pretreatment Program. This program is one of the few areas of the Clean Water Act where the state has not been granted authority and the EPA maintains federal primacy. There are currently 57 EPA-approved Industrial Pretreatment Programs in New York state.

Mini Industrial Pretreatment Program requirements are included in SPDES permits when a POTW that serves significant industrial users is not required to have an EPA-approved Industrial Pretreatment Program. DEC oversees the Mini Industrial Pretreatment Program.

While the two types of programs have different reporting and implementation requirements, both hold the municipality responsible for regulating their industrial users and the wastewater that enters the POTW. The municipality is required to set limits for their industrial users such that the POTW will be able to handle the waste and meet SPDES permit limits. If the industrial user exceeds those limits, it is the responsibility of the municipality to pursue enforcement.

For more information about pretreatment programs, visit *https://www.dec.ny.gov/chemical/8456.html* and *https://www.epa.gov/npdes/national-pretreatment-program*.

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

Focus on Safety | Spring 2020

Making a Silk Purse from a Sow's Ear

Each manufacturer, farm or food processor has a waste stream. How each one thinks of their wastes may be quite different. Some will think of their waste as a necessary evil of their process. Others may think of their waste as opportunity borne out of difficulty. And with opportunity comes possibility.

In thinking about the subject of this issue of *Clear Waters,* I recalled the many industries I have been involved with. After over 40 working years, I have developed quite the list! Farming, paper, energy, manufacturing and all the variations thereof.

When I was young, waste was waste, and it simply went to the dump. We had fun scrambling over the mounds looking for treasure and had date nights shooting rats. Then dumps became citified and there were roll-offs, designated spots and hours of operation. Waste had become managed. In hindsight, these changes were for the better, even if at the time they stifled some youthful, adventurous souls.

But some waste did not go to the dump. When my father had a college job at Crowley Foods, he could take all the skim milk waste that he wanted back home to feed his pigs. At that time, skim milk was just a waste byproduct destined to be dumped. While my father didn't make a dent in the skim milk waste from Crowley's, he was a forerunner of the concept of waste diversion. He could take the waste product and find beneficial use for it so it didn't end up in the dump. However, when in later years skim milk became the healthier, low-fat alternative to whole milk, my father refused to allow any of that 'blue milk' in the house, because in his experience it was only fit for pigs!

Another former waste product that has found a better use? Chicken wings. They were waste pieces for years, and now they drive an industry. I don't know if chickens exist more for their breast meat or their wings, but I am glad that Buffalo sauce was invented. How about the paper punches created at paper binderies? Plenty of children enjoy the resulting confetti. Ash from coal plants? Fly ash might be mixed into your Portland cement concrete, while flue gas desulfurization byproduct material may be bound into gypsum wallboard.

So how does all this relate to safety? In my experience, safety just isn't limited by the current condition of what you see right now in front of you. Safety is looking down the road at all the possibilities that could exist and managing that larger potential. Examining the larger potential about the future use of new or special waste streams might be both useful in conservation and helpful on the safety side. Innovation and new thinking are reinventing the concepts of waste and byproduct future use. If the labor, capital and infrastructure costs align, why not make that silk purse out of your sow's ear?

– Eileen M. Reynolds, Certified Safety Professional
Owner, Coracle Safety Management

Managing Special Waste Streams at POTWs

by Jim Cunningham

Most of the time, publicly owned treatment works (POTWs) are designed for the treatment of conventional pollutants such as biological oxygen demand (BOD), total suspended solids (TSS), pH, fecal coliform, oil and grease, nitrogen and phosphorous. If a business is discharging pollutants that are not conventional pollutants, they may be considered a categorical discharger as listed within the U.S. Environmental Protection Agency's (EPA's) Code of Federal Regulations (40 CFR, parts 405 to 471). But often overlooked are noncategorical significant industrial users (SIUs), which are defined as:

> "Any other Industrial User that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewater); contributes a process waste stream which makes up 5% or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority on the basis that the Industrial User has a reasonable potential for adversely affecting the POTW's operation or for violating any Pretreatment Standard or requirement (in accordance with 40 CFR 403.8(f)(6))." *(EPA 40 CFR 403.3(v)(1)(ii)).*

If noncategorical SIUs discharge to your POTW, you may need to issue an industrial pretreatment permit (IPP), as outlined in the Federal Regulations 40 CFR 403.3(v).

Good Planning Leads to Success

As new businesses enter your municipality, they expect to connect to public utilities, including transportation infrastructure, power, water and wastewater services. Good planning is the key to successful community growth; however, if municipal planning boards are not aware of their utilities' limitations, huge problems can and often do occur.

When I'm out troubleshooting POTWs, my first question to the facility manager focuses on who is connected to the collection system. Does the facility manager have a list of the pollutants and resulting loadings being discharged to the POTW? Most facility managers have a good understanding of who is connected but may not have characterized the wastewater of specific commercial or industrial dischargers. Perhaps the discharger might be a small brewery, distillery or wine producer; these businesses have been popping up across the state in the last few years.

I will also ask the facility manager if the planning board contacts the facility to see if there are any concerns with the wastewater from a new proposed business prior to the board's approval to allow construction and discharge. In the larger communities the answer is always "Yes, of course, we are closely tied to the planning and zoning boards." The bigger problem is that there are fewer, larger POTWs compared to the numerous smaller POTWs found across the state. The smaller POTW facility managers often are not included in the discussion around planning board approvals for new business discharges.

A Case in Point

A few years ago, a POTW manager of a 1.0 million-gallon per day (MGD) treatment facility in central New York was asked by the mayor if the facility had the capacity to take wastewater from a new business that would produce only 20,000 gallons per day of wastewater. The mayor said he could not divulge to the manager who the new business was, as it was top secret! Given the volume information for the new business, and no further information about the nature of the wastewater, the POTW manager told the mayor that an additional 20,000 gallons per day would have a negligible impact on the facility, which still had 500,000 gallons per day of remaining capacity, as well as about 500 pounds per day of BOD loading available.

A few years later, the new business started to discharge to the POTW. Within a few weeks the facility manager observed nearly double the amount of biosolids being produced. Even with all the aeration equipment running, the facility could not achieve dissolved oxygen levels over 0.2 mg/l in the aeration basin. The facility manager was battling poor biomass settling, which necessitated treatment for bacterial filaments on a continuous basis. The facility was over budget, and the mayor wanted to know if the facility manager had lost his mind!

Sound familiar? The new business was a brewery that discharged 6,000 mg/l BOD at 20,000 gallons per day, resulting in a BOD loading of 1,000 pounds per day, or twice the available capacity of the POTW.

This scenario is repeated over and over at many of our smaller POTW facilities. Larger POTWs typically have well-informed staff and programs that effectively manage IPP regulations. For example, this edition of *Clear Waters* contains an excellent article *(see page 33)* on Onondaga County's POTW acceptance of untreated airport deicing fluids with a BOD of up to 40,000 mg/l, which can result in a BOD loading of 60,000 pounds per day. Thank goodness the Onondaga County POTW can handle 140,000 pounds of BOD per day! Because of their staff's expertise and understanding of the IPP regulations, they have been able to manage this very high-strength wastewater and protect the POTW.

A Few Suggestions to Manage Special Waste Streams

Remember, not all wastewaters flow to the POTW through a pipe. Quite often, high-strength wastewaters are being trucked into POTWs. A typical 80,000-gallon tanker truck with 40,000 mg/l of deicing wastewater would load your POTW with 26,688 pounds of BOD. If you were a 1.0 MGD facility … ouch!! Among others, landfill leachate, dairy and other food processing wastewater, and even hydrofracking wastewater all present challenges for POTW managers.

As a POTW manager, you would do well to keep these suggestions in mind when managing for special waste streams.

- Inform your municipal governing body about your POTW facility's capacity. I recommend doing this annually during your budget sessions or if a new SIU is being proposed.
- Attend a planning board meeting and let them know that they need your input in the decision process, so they are aware of how your plant's capacity may be affected by the board's decisions. Otherwise, in the worst-case scenario, the POTW may need to be enlarged to accommodate the new SIUs, which can cost millions. The community will not be happy with the planning department if the board does not foresee the potential impacts of their decisions!
- If you see a new proposed business with a potential for discharge that you feel may affect your facility, call your regional New York State Department of Environmental Conservation (NYSDEC) office to discuss the potential impacts and ask for their help and approval.

- Call other POTW managers, who may deal with similar businesses, and ask how they handled the wastewater, permits, invoice for surcharges and pretreatment requirements.
- Attend a New York Water Environment Association industrial pretreatment meeting and ask questions.
- Update your sewer use law to the NYSDEC model sewer use law that incorporates federal pretreatment language. The USEPA also has a model industrial pretreatment law. Both may be found on the internet.
  - o *https://www.dec.ny.gov/docs/water_pdf/modelseweruselaw.pdf*
  - o *https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww3.epa.gov%2Fnpdes%2Fpubs%2Fpretreatment_model_suo.doc*

Jim Cunningham has been a POTW manager since 1974, with water and wastewater experience throughout the U.S., Europe, Middle East and South America. Jim has received numerous federal and state awards for his work. He was featured in the New York State Conservationist magazine and was a contributor on the New York State Federation of Lake Associations, Inc., publication **Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management** *(Second Edition 2009), produced in cooperation with the New York State Department of Environmental Conservation. He currently serves on the Madison County Board of Supervisors.*

Reference

EPA. 2005. "Title 40, Chapter 1, Subchapter N, Part 403 General Pretreatment Regulations for Existing and New Sources of Pollution, Final Rule." *Code of Federal Regulations, 70 FR 60191.* Oct. 14. *https://www.ecfr.gov/cgi-bin/text-idx?SID=f272fe2f90cf8b872ec8a862e461d5e2&mc=true&node=se40.31.403_13&rgn=div8*

NYWEA
LEADING THE WAY IN WATER QUALITY MANAGEMENT

2020 Upcoming Training Classes & NYWEA Meetings

June 8-10, 2020	**Spring Technical Meeting & Exhibition** The Hyatt Regency Long Island, Hauppauge, NY 11788
June 17, 2020	**Confined Space Awareness** TBD, Allegany or Cattaraugus County
June 22, 2020	**Membrane Bioreactors** Waverly WWTP, 424 Cayuta Avenue, Waverly, NY 14892
June 23, 2020	**Membrane Bioreactors** Brown's Brewing, 417-425 River Street, Troy, NY 12180
June 24, 2020	**Membrane Bioreactors** TBA (Lower Hudson Chapter)
June 25, 2020	**Membrane Bioreactors** Bergen Point WWTP, 600 Bergen Avenue, Babylon, NY 11704
July 14, 2020	**Mathematics for Water and Wastewater Operators** Fredonia Tech Incubator, 214 Central Avenue, Dunkirk, NY 14048
September 23, 2020	**Anaerobic Digestion Operations and Biogas Safety Training** Utica College, 1600 Burrstone Road, Utica, NY 13502
October 20, 2020	**Anaerobic Digestion Operations and Biogas Safety Training** Yonkers Joint WWTP, 1 Fernbrook Street, Yonkers, NY 10705
November 4, 2020	**Mathematics for Water and Wastewater Operators** Wallkill Golf Club, 40 Sands Road, Middletown, NY 10941
November 17, 2020	**Blower Technologies, Selection and Energy Evaluation** TBD, Lockport, NY 14094

Visit nywea.org for more information.

Resource Recovery at NYCDEP: Food Waste Codigestion at Newtown Creek WRRF

by Robert Sharp, Jennifer McDonnell, Mikael Amar, Jane Gajwani and James Ecker

The New York City Department of Environmental Protection (NYCDEP) recently completed "The Newtown Creek Wastewater Resource Recovery Facility (WRRF) Food Waste Codigestion Demonstration Project," which was cofunded by the New York State Energy Research and Development Authority (NYSERDA). The project was a collaboration between the New York City Department of Sanitation (DSNY), NYCDEP, NYSERDA, Waste Management (WM) and Manhattan College.

The project allowed NYCDEP to investigate the costs and benefits of food waste codigestion to address the city's resource conservation and greenhouse gas emissions reduction goals as detailed in Mayor Bill de Blasio's OneNYC initiative *(http://onenyc.cityofnewyork.us/)*. OneNYC 2050: Building a Strong and Fair City ***(Photograph 1)*** outlines how the city plans to tackle the related challenges of population growth, aging infrastructure, increasing inequality and climate change.

The goals of the Newtown Creek WRRF Food Waste Codigestion Demonstration Project included:

1) To demonstrate that source-separated organic (SSO) food waste can be processed into an engineered bioslurry (EBS) that has consistent characteristics with respect to chemical oxygen demand (COD), total solids (TS), volatile solids (VS) and pH so that the risk of upsetting the normal operation of the wastewater anaerobic digestion process is greatly reduced.
2) To demonstrate that the addition of food waste bioslurry to anaerobic digesters can increase biogas production and heating value.
3) To quantify any costs to the WRRF associated with the addition of a bioslurry, i.e., impacts to solids production, dewaterability, nitrogen removal, sludge handling and disposal.
4) To share knowledge and serve as a case study for other wastewater utilities.

Approach

The Newtown Creek facility is home to a complex of eight digesters. When this demonstration project began, the project team recognized that it would not be possible to isolate a single anaerobic digester for testing purposes. Therefore, the project team decided to feed food waste, in the form of EBS ***(Photograph 2)***, to the "Test" group of three operating digesters located on the south side of the plant (Digesters 1, 3 and 4). The four digesters on the north side of the complex (Digesters 5, 6, 7 and 8) were considered the "Control" digesters.

Since the EBS supply had to be sufficient to feed three Test digesters instead of just one, WM was tasked with significantly increasing

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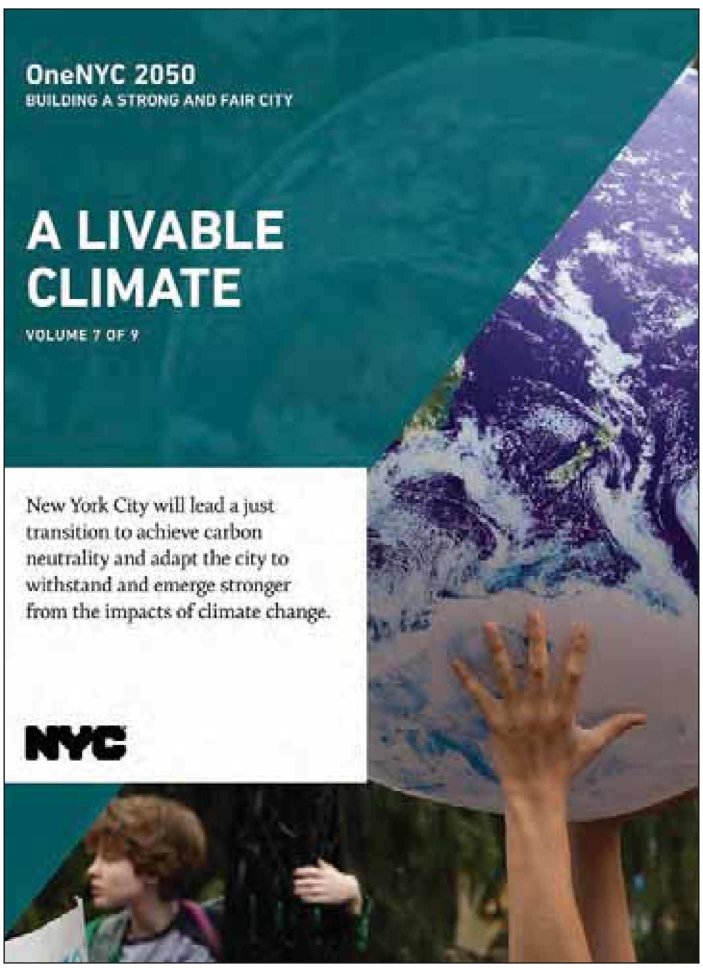

Photograph 1. The cover of Volume 7 of the publication OneNYC 2050.
Credit: New York City Mayor's Office

Photograph 2. A container holds a sample of engineered bioslurry (EBS).
Credit: Waste Management

continued from page 13

Photograph 3. WM needed to significantly increase the quantities of source-separated organic feed waste to provide enough EBS material for three digesters. *Credit: Waste Management*

the quantities of SSO feed stock ***(Photograph 3)*** to achieve a Phase I food waste goal of approximately 12.5% of feed VS in the form EBS.

As WM increased its feedstock, the plant slowly ramped up the EBS addition. Manhattan College and the plant staff sampled and monitored both the Test and Control digesters to ensure the EBS addition was not adversely affecting the digestion process. Phase II included a further ramp-up in EBS addition to achieve an approximate 18.5% level in VS added to the digesters in the form of food waste.

The Phase I and Phase II EBS feed ramp-up phases were prolonged due mostly to difficulty with obtaining adequate volumes of food waste feed stock. The steady-state testing periods in each phase were started after the EBS feed to the digesters had been at or near target levels ***(Table 1)*** for at least one solids retention time (SRT), or about 35 days. The steady-state testing phases were carried out over approximately two months.

Table 1. EBS feed VS target levels and schedule for steady-state sampling and testing periods for Phases I and II of the demonstration project.

Phase	EBS Feed VS Target Levels	Sampling Period
Phase I	12.5%	Jan. 1, 2018 to March 1, 2018
Phase II	18.5%	Feb. 1, 2019 to April 4, 2019

Throughout the ramp-up feeding to achieve the Phase I and Phase II EBS feed goals, and during the critical steady-state operations of each phase, the digesters were monitored to evaluate the overall impact and potential operational issues associated with the EBS addition. The evaluation included:

- Characterization of flows, TS, VS, pH and nutrient content of the digester feed, including both thickened waste-activated sludge (TWAS) and EBS.
- Overall biogas quality and production, including flow, methane (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S), and siloxane content.
- Digester health and performance, including TS, VS, volatile solids reduction (VSr), alkalinity (Alk), pH, volatile acids (VAs), and soluble chemical oxygen demand (sCOD) concentrations.
- Digestate quality, including flow rates, nutrient (nitrogen and phosphorus) concentrations, and any observable changes in the dewaterability and/or chemical demand for dewatering the digestate.

Influent Sludge Flows and Loads

There was a great deal of variability in TWAS feed to all digesters due to the daily operation of the thickening centrifuges and the inherent variability associated with grab sampling. On average, the Test digesters received approximately 50% more VS from TWAS, and the TWAS feed had greater variability. The fact that there were only three Test digesters and that they were also receiving EBS feed reduced the SRT of the Test digesters by about 25% compared to the Control digesters. The daily variability in VS loading from TWAS presented significant challenges with calculating the impact that EBS addition had on biogas production.

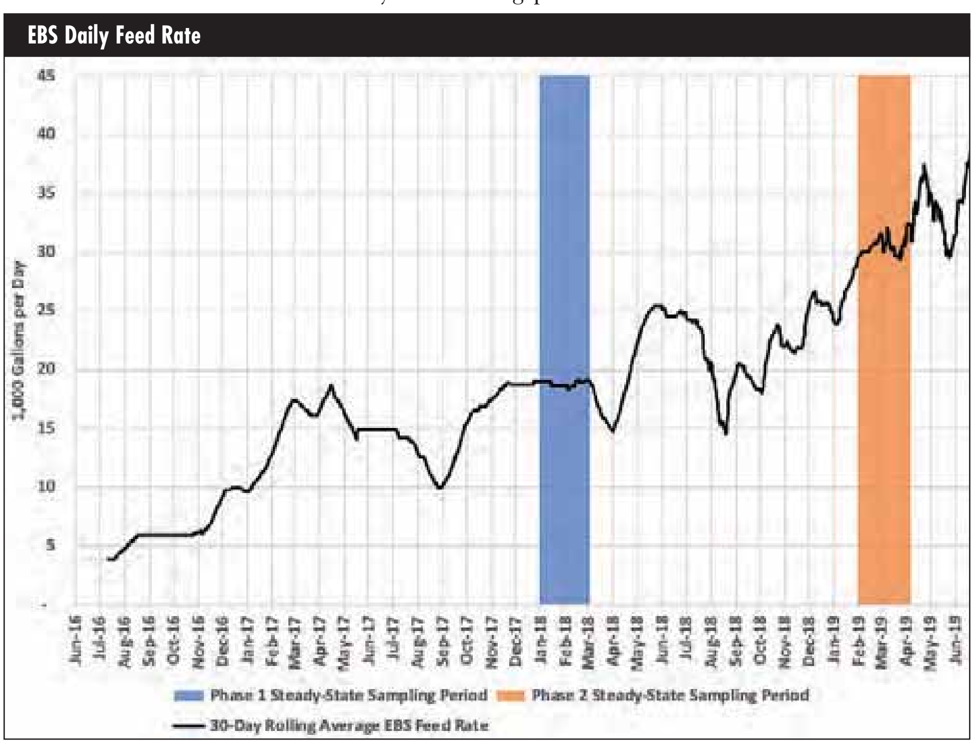

Figure 1. The EBS daily feed rate from June 2016 through June 2019. *Credit: NYCDEP*

EBS and TWAS Feed Loads and Characterization

EBS addition to the Test digesters was carefully monitored throughout the study to ensure the additional organic loading did not impact digester health. It was assumed that the added EBS was equally distributed to each of the Test digesters (1, 3 and 4) throughout the study. The target percent EBS VS feed in Phase I was 12.5% and for Phase II it was 18.5%.

During the study there were some issues with stratification of the EBS in the receiving and storage tank at Newtown Creek, as well as issues with the EBS feed pumps, especially during Phase II testing. In general, however, the percent TS and VS fraction of the EBS delivered to the Test digesters were consistent throughout the study at approximately 12% total solids and 90% volatile fraction. The TWAS percent total solids averaged 5.6% but varied significantly, and the volatile fraction averaged 83% throughout the study ***(Figure 1)***.

Solids Retention Time (SRT)

The SRT for each digester was more than the typical 15- to 20-day SRT required for most mesophilic digesters. The SRT for the Control digesters averaged approximately 44 days and for the Test digesters averaged 34 days. The reduced SRT for the Test digesters was due to increased TWAS loading, since there were only three Test digesters operating on the South battery and four Control digesters operating on the North battery. The long SRTs of all the digesters impacted both gas quality and specific gas production and resulted in a relatively high solids destruction, which in turn reduced total solids leaving the facility.

Digester Health

The addition of EBS did not appear to have any significant impact on the health of the digestion process. All the Newtown Creek digesters were significantly organically underloaded and operated at a low VA content and a low VA/Alk ratio ranging between 0.02 and 0.03. This low VA/Alk ratio is due to the prolonged SRT, which results in low VA content and a relatively high alkalinity. However, the pH of all digesters was adequate, and the high alkalinity suggests the digesters were healthy and stable. The addition of EBS did not affect foaming potential and in fact may have slightly reduced stable foam potential. Overall, the results show that the addition of up to 20% EBS VS did not adversely impact the digestion process.

Photograph 4. The Varick CORe recycling facility houses the processing equipment that produces the EBS for the demonstration project.
Credit: Waste Management

Photograph 5. An operator monitors control room operations in the Varick CORe recycling facility. *Credit: Waste Management*

Digestate Quality

In general, it is expected that the addition of food waste will increase the nitrogen loads in the dewatering centrate by the volumetric fraction of food waste added to the digesters. The addition of EBS as 12.5% and 18.5% of the total feed VS content had no significant impact on the concentration of ammonia in the digested sludge but may have resulted in a slight increase in dissolved phosphorus. NYCDEP will monitor the digesters for struvite formation and consider optimizing ferric chloride addition or installing dispersant polymer if struvite accumulation increases.

At the levels of EBS addition tested, it does not appear that the EBS significantly contributes to the total nitrogen, total phosphorus, and total potassium found in the biosolids.

The addition of EBS did not have an impact on the amount of inerts found in the Test digestates compared to the Control. The low level of inerts (less than 0.5% of TS/dry weight) is one indication of the WM CORe process efficiency ***(Photographs 4** and **5)*** in

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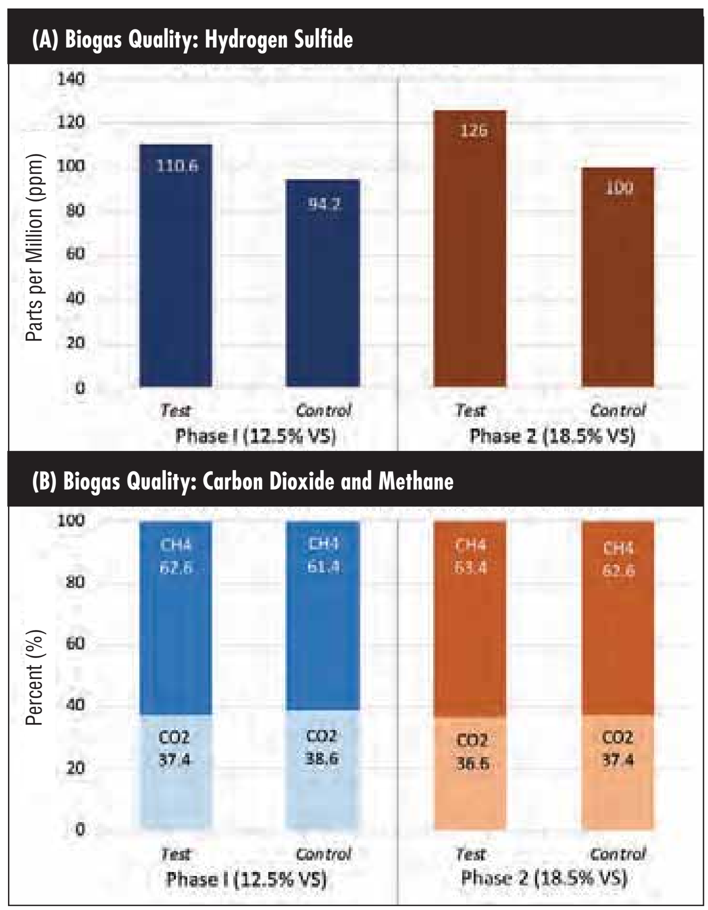

Figure 2. Average biogas quality for the Test and Control digesters during Phase I and Phase II for (A) concentration of hydrogen sulfide (ppm) and (B) percent carbon dioxide (CO_2) and methane (CH_4).
Credit: NYCDEP

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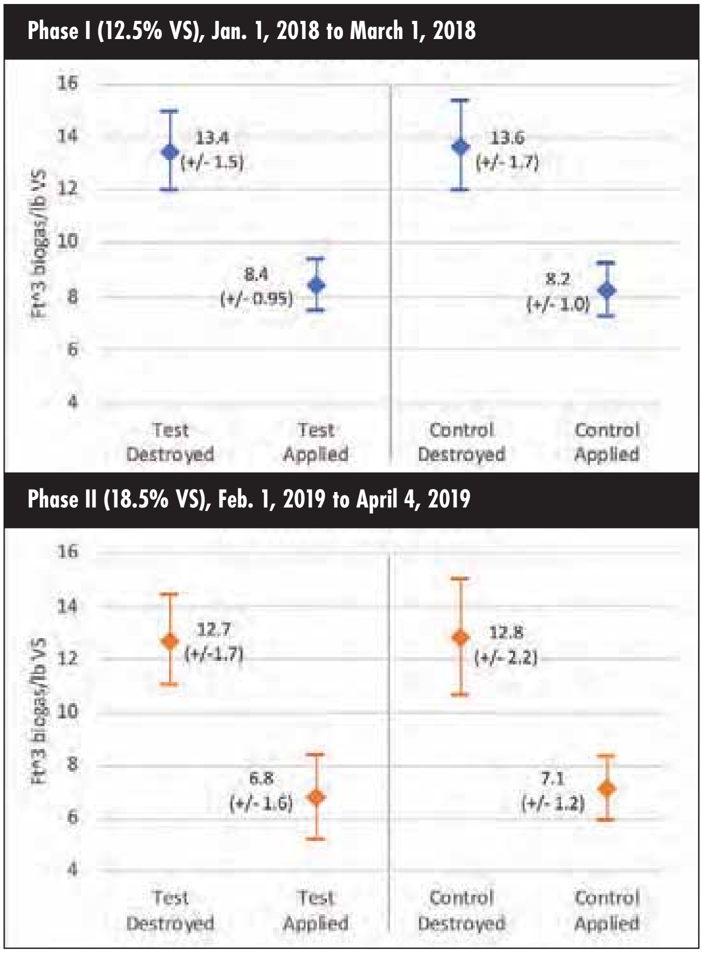

Figure 3. Average specific biogas production, in cubic feet of biogas per pound of VS, using daily data for Phases I and II. *Credit: NYCDEP*

generating a consistent, high-quality product. However, since the accumulation of inerts is considered a significant issue in codigestion facilities, it would be prudent for any wastewater utility to carry-out periodic inert testing to track any effect food waste may have on the accumulation of inert solids in the digesters as the levels of EBS are increased.

Biogas Production and Quality

The high variability in TWAS also resulted in high variability in daily biogas production. However, on average, the biogas production was consistent for each digester.

The addition of EBS to the Newtown Creek digesters increased both the total production of biogas as well as the methane content of the biogas. ***Figure 2*** shows the average biogas quality for the Test and Control digesters during Phases I and II. Using a weighted average on VS added and VSr, it was estimated that the methane content of biogas produced by EBS alone averaged 68%, while the TWAS produced biogas averaging 61.4%. The Test digesters had a slightly higher biogas hydrogen sulfide level, but EBS has no apparent impact on total siloxanes. Both the Test and Control digesters had relatively low levels of both hydrogen sulfide and siloxanes during both phases of the study.

The specific biogas production was calculated using gas production and VS destruction for both Phase I and Phase II of the study. ***Figure 3*** shows that the Test digesters produced essentially the same amount of biogas per pound of VS destroyed in the process. However, it should be noted that the EBS VS are significantly more biodegradable than the TWAS VS.

Dewaterability and Polymer Demand

The addition of EBS appeared to improve dewaterability by both increasing total solids and decreasing polymer demand. The general consensus has been that food waste codigestion can improve the dewaterability of digested sludge, but the extent of improvement depends on type of food waste, degree of food waste addition (percent VS addition), and operating characteristics of the digesters such as temperature, SRT, chemical addition, and others.

EBS Contribution to Biogas and Sludge Production

Using a weighted-average approach, an estimation of the EBS contribution to the biogas production was determined as shown in ***Table 2***. The addition of EBS at 12.5% of the total feed volatile solids accounted for 16.5% of the biogas energy produced. The addition of 18.5% EBS VS accounted for 24% of the biogas energy produced. The impact on biogas energy is due to the higher level of biodegradability of the EBS volatile solids (90%) and the increased methane content of the biogas produced from EBS.

Table 2. Estimated contribution of EBS on biogas production quantity and quality.

		Phase I (12.5% EBS VS)			Phase II (18.5% EBS VS)		
Parameter	**Unit**	**Total**	**EBS**	**WAS**	**Total**	**EBS**	**WAS**
VS Load	%	100	12.5	86.75	100	18.5	81.5
VSr	%	58.3	70.7	56.4	65.1	78.8	62
Avg. Biogas Production	1,000 ft^3/d	362	53.9	308.1	347	77.7	269
Biogas Composition	% CH_4	62.6	69.5	61.4	63.4	67	62.6
Spec. Energy Production	kilowatt-hour/ ft^3gas	0.176	0.196	0.173	0.178	0.188	0.176

Note: Percent VS Load is based on average flow and average percent total VS of both EBS and Test feeds.

The study also estimated EBS addition's impact on sludge production by calculating the residual solids using results-based estimated VS destruction. Although the EBS does increase TS leaving the process, due to its high volatile fraction and increased biodegradability, it produces about 35% less biosolids compared to the TWAS.

Food Waste Biomethane Production and Specific Methane Production Assays

A food-waste biomethane-potential test was carried out, with results showing that EBS addition increases total methane content of the biogas based on both VS applied, or specific-methane production (SMP) and VS destroyed, or biomethane production (BMP). The test only measured methane production and does not account for effects associated with prolonged SRT of more than 15 days, which would likely affect total gas production as well as methane fraction in the biogas. The results also suggest that efficient food-waste codigestion requires acclimated biomass, as unacclimated digestate was not as effective at producing biogas. Generally, the BMP assay helps to confirm the findings in the study that indicate that EBS addition increases the methane content of the biogas.

Metagenomic Analysis

The metagenomic analysis was somewhat inconclusive as it did

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not show a significant difference in the bacteria or archaeal communities in Test and Control digestates. It is likely that the unique operational characteristics of the Newtown Creek WRRF (i.e., diverse food-waste organics, very long SRT, no primary sludge) impacted the microbial diversity and may not allow expected variations in bacterial and archaeal communities to be retained. In addition, since the food waste never exceeded 18.5% of the added VS in this study, the level of food waste addition may not have been large enough to have significantly shifted the bacterial populations in the process.

Operational Lessons Learned

The primary operational lessons learned during this study were on EBS storage, mixing and pumping, as well as digester operations during a non-EBS induced foaming event. Along with feed stock availability, challenges with mixing the 12% to 14% solid EBS and maintenance requirements on the EBS feed pumps had some effect on project operations; however, there were no adverse consequences on plant operations, health or safety as a result. Although these pumping and storage tank mixing issues were infrequent, they did illustrate the importance of storage tank mixing to keep EBS solids in suspension and reduce accumulation of heavy solids in the storage tank and formation of a mat layer on the top of the tank.

Also, although EBS addition did not appear to affect digester foaming, when a foaming sludge is transferred from the main plant to the digesters, one remedy is to drop the levels of the digesters to protect the asset and avoid additional maintenance and potential health and safety issues. Lowering the digester levels can affect digester mixing, which in turn can influence digestion efficiency. As a result of the study, Newtown Creek is pursuing other foaming mitigation strategies including defoamant addition, which could be applied in lieu of dropping the digester level.

Cost Impact Modeling

NYCDEP's assessment of the costs associated with codigestion, using a detailed process model, illuminated that the largest impact, about 75%, was attributable to the solids that were not converted to biogas during digestion and passed through as biosolids. Additional costs such as increased chemical demand from down- and side-stream operations (polymer, ferric chloride, glycerol), energy costs for processing, as well as costs for transport and labor, were all modeled. However, these estimated costs accounted for a comparatively insignificant financial impact to WRRF operations and were not empirically measured as part of the study.

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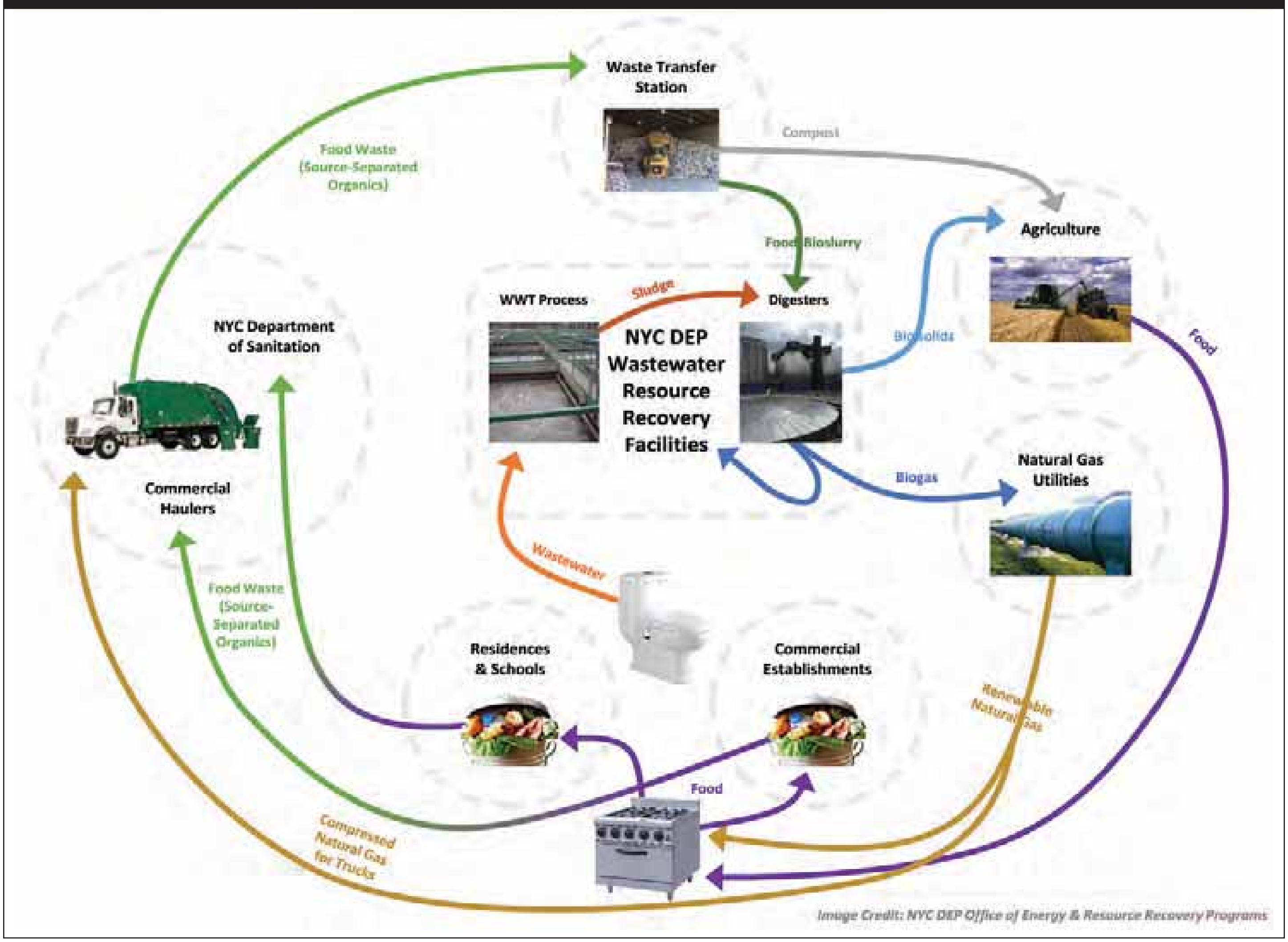
Circular Economy of Organics



As wastewater treatment plants transition to wastewater resource recovery facilities, their position in the circular economy becomes clear. In loops of resource inputs and outputs, WRRFs play a central role in recovery and reuse. Food waste co-digestion is one loop illustrated in this graphic.

Credit: Mikael Amar

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In Conclusion

This full-scale research study clearly demonstrates the potentially significant benefits from large-scale codigestion of a single, consistent product created from source-separated food waste organics, such as EBS. There were no negative impacts to digester health and management, yet there were significant positive benefits with respect to an increase in biogas production, biogas quality and biosolids dewatering.

However, it should be noted that the specific results recorded in this study have some limitations with respect to an exact application to other WRRFs considering codigestion. Specifically, the Newtown Creek WRRF is atypical in its design. There is no primary sludge, as it is a contact stabilization plant, and its operation includes an extremely long digester SRT. In addition, the relatively low EBS addition of 18.5% of total VS load, coupled with a highly variable TWAS quality and flow quality during this study period made data synthesis challenging.

NYCDEP is continuing to collaborate with the DSNY and the Mayor's Office of Sustainability to recover more food scraps from New York City residents, schools, institutions and commercial establishments to increase the volume of material diverted to codigestion.

In addition, through a partnership with National Grid to export biogas beyond the WRRF's demand to the natural gas pipeline, the cleaned and treated biogas will be of equivalent quality to conventionally derived natural gas, but its consumption in stationary combustion applications results in roughly 99.5% lower carbon emissions in comparison, due to its biogenic nature. As a result, if all 592,200 dekatherms of renewable energy produced at the site were to be used to displace conventional natural gas, a total of 31,490 metric tons of carbon dioxide equivalent per year would be reduced.

Overall, the results of this demonstration project serve as a strong guide and add to the growing body of research related to this powerful local option for managing urban organic food waste streams and producing renewable biogas. As a testament to this fact, the partnership between DSNY, WM and NYCDEP has resulted in the diversion of over 97,000 tons of food scraps since the full-scale project started in 2015.

The authors would like to acknowledge the many contributors to this successful effort including:

- NYCDEP Deputy Commissioner Pamela Elardo
- Newtown Creek WRRF staff
  - o Shri Sewgobind, Facility Manager
  - o Zainool Ali, Plant Chief
  - o Sudeep Deb, Process Engineer
- NYC Department of Citywide Administrative Services, NYC Mayor's Office of Sustainability
- NYSERDA
- Manhattan College graduate research assistants
  - o Jeff Conte
  - o Allen Fok
  - o Jeff Liebowitz
  - o Eduardo Torres
  - o Arijit Ghosh
- Waste Management staff
  - o Jim Van Woert
  - o Dan Hagen
  - o Mariush Zmiejko
  - o Brendan Kuhn
  - o Darryll Persad
  - o Dr. Robert Hickey
- Columbia University
  - o Kartik Chandran

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Sidestream Deammonification: Yesterday, Today and Tomorrow, and Lessons Learned from the Field

by Paula Sanjines and Tim Constantine

The deammonification process offers an innovative method for biological removal of ammonia nitrogen from wastewater by using the anaerobic ammonium oxidating (anammox) bacteria, which have a unique metabolic ability to combine ammonium nitrogen and nitrite to form nitrogen gas. The discovery of deammonification, or partial nitritation/anammox (PN/A), has spurred many technological advances and has led to increased efficiency in wastewater treatment.

The deammonification process consists of two steps *(Strous and Heijnen et al 1998)* to remove ammonia-nitrogen from wastewater:

1. Partial nitritation. Ammonia-oxidizing bacteria (AOB) such as *Nitrosomonas* convert half of the ammonia to nitrite (NO_2-) under aerobic conditions.
2. Deammonification. Anammox bacteria oxidize the remaining ammonia using the nitrite produced in the first step to form nitrogen gas and a small quantity of nitrate under anoxic conditions.

Compared to conventional nitrification and denitrification, where the ammonia is converted to nitrate under aerobic conditions and then to nitrogen gas under anoxic conditions, the deammonification process can reduce oxygen demand by over 60% and also eliminate the need for organic carbon for denitrification *(Van Loosdrecht and Salem 2006)*. ***Figure 1*** compares the deammonification process to the conventional nitrification/denitrification process.

History of Deammonification

As early as the 1930s, the process that would later be identified as deammonification was observed in nature. In 1977, E. Broda published a paper postulating that microorganisms that carry out the deammonification process should exist, based on thermodynamic calculations of suitable electron donors and acceptors *(Broda 1977)*.

It was not until a decade later that the reaction would be observed in an anoxic denitrifying pilot reactor and the term “anammox” was coined to describe it. The discovery was presented in 1990 at the Fifth European Congress on Biotechnology *(Van de Graaf et al 1990)*. This sparked a wave of research, including at the University of Delft in the Netherlands, which in 1999 led to the identification of the anammox bacteria as Planctomycetes *(Strous and Fuerst et al 1999)*.

The potential benefits of applying this new process to wastewater treatment were apparent, but it took several more years of research and pilot work to develop a reactor configuration and control scheme that would result in effective ammonia removal from wastewater using the deammonification pathway. Some of the challenges in implementing the process are due to the slow growth rate of the anammox bacteria, with a doubling time of 10 to 12 days at 30 degrees Celsius, and their sensitivity to environmental conditions such as temperature and nitrite concentration *(Strous and Heijnen et al 1998)*. Anammox bacteria are easily outcompeted by other organisms in the mixed liquor. For example, nitrite-oxidizing bacteria (NOB) such as *Nitrobacter,* can deplete the nitrite under aerobic conditions by oxidizing it to nitrate. Similarly, under anoxic conditions and with organic carbon present, heterotrophic organisms can outcompete anammox for nitrite through denitritation to nitrogen gas. Therefore, a successful application of the deammonification process needs to provide an environment that promotes the slow-growing anammox bacteria and allows adequate AOB activity while also suppressing or out-selecting NOBs and heterotrophs *(Lackner et al 2014)*.

The first applications of the deammonification process in wastewater treatment were for treating the waste or reject stream resulting from the dewatering of anaerobically digested sludge, also referred to as a sidestream. The digestion process releases high quantities of ammonia-nitrogen and the sidestream contains ammonia in concentrations that range from 500 to 2,000 milligrams per liter (mg/L) and sometimes higher *(Lackner et al 2014)*. Use of innovative technologies for sludge conditioning before digestion, such as thermal hydrolysis, can further increase the ammonia released during the digestion process resulting in sidestream concentrations of up to 3,000 mg/L *(Bowden et al 2015)*. This highly concentrated sidestream is often recycled to the front of the wastewater treatment plant for treatment in the mainstream biological process. The ammonia loading in the sidestream can contribute 15% to 20% of the total influent loading to the mainstream reactor. For facilities that import sludge from other plants for digestion, the sidestream loading contribution can be as high as 40%.

As wastewater treatment facilities face stricter nutrient limits in their effluent and look for ways to reduce energy and chemical consumption, treating this sidestream prior to introduction to the mainstream process has been a recommended strategy for increasing system capacity, improving reliability, and achieving efficiency in terms of chemical and electricity usage.

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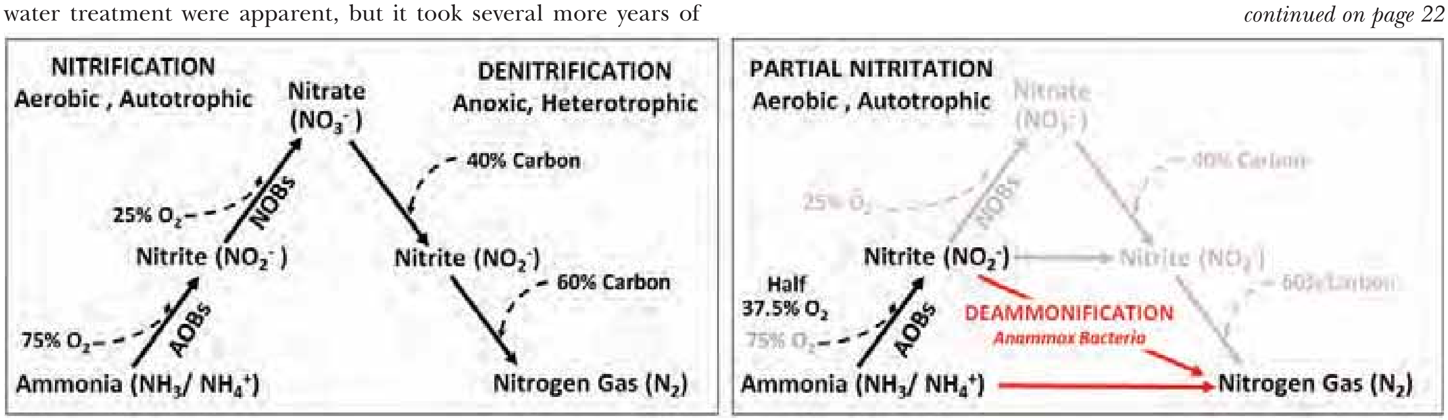

Figure 1. Comparison of oxygen and carbon requirements for nitrification/denitrification and partial-nitritation/deammonification. *Credit: Jacobs*

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Sidestream treatment is a well-suited application of the deammonification process for the following reasons:

- High concentration of ammonia in the sidestream creates high concentration of free ammonia in the reactor, which is inhibitory for NOBs.
- Low carbon concentration, with chemical oxygen demand to nitrogen ratio (COD:N) usually below 1, suppresses heterotroph activity and reduces oxygen demand.
- High temperature in the reactor, usually greater than 30 degrees Celsius, increases the AOB growth rate and the dissolved oxygen (DO) affinity. This allows AOBs to effectively nitrify ammonia at lower DO concentrations *(Blackburne et al 2008)*, which in turn reduces the available oxygen for NOBs to oxidize nitrite. The higher temperature also increases the anammox growth rate and activity.

The first full-scale installation to use the deammonification process for sidestream treatment was a facility in Rotterdam, Netherlands, which implemented a two-stage system in 2002 in which the nitritation and deammonification steps occur in separate reactors. A facility in Strass, Austria, converted their one-stage sequencing batch reactor (SBR) to a deammonification system by introducing seed anammox bacteria in 2004. Following these first installations, adoption of this new technology has been swift, with over 100 installations currently worldwide, including those for both municipal and industrial uses.

"The deammonification process for sidestream treatment was first used in the early 2000s."

Deammonification is currently the most widely used method for treating dewatering sidestreams. Other processes that have been used include:

- Biological treatment processes that rely on conventional nitrification and denitrification, for example, the AT3 process implemented at New York City Department of Environmental Protection's (NYCDEP's) 26th Ward Wastewater Treatment Plant.
- Nitritation and denitritation, for example, the SHARON process used NYCDEP's Wards Island Wastewater Treatment Plant. SHARON is an acronym for "Single reactor system for High-activity Ammonium Removal Over Nitrite."

Some physiochemical processes have been used, such as air stripping and acid absorption, ion exchange and recovery, and breakpoint chlorination. But these processes usually have high chemical and energy costs that make them less economically favorable than biological processes.

Sidestream Deammonification Today

As interest in the deammonification process has continued to surge, several reactor configurations have been developed to provide optimal conditions for anammox growth and activity.

In order to increase the population of the slower-growing anammox bacteria, some systems take advantage of their tendency to naturally form granules, defined as greater than 250 micrometers, which can be physically separated from the rest of the biomass in order to provide a longer solids retention time (SRT) for the anammox compared to other organisms. Other systems use media on which biofilms grow or a combination of biofilm growing on granules. ***Table 1*** lists several types of proprietary processes currently in the market.

Table 1. Sidestream deammonification processes and vendors in North America.

Process Name	Vendor	No. of Full-Scale Municipal Installations Worldwide	First Full-Scale Municipal Installation
AnammoPAQ	**Ovivo**	**25+**	**2002**
	Uses granular sludge with AOBs forming a biofilm over anammox granules. Continuous process, in custom-made reactors greater than 16 feet deep, uses high upflow velocity and DO control to create ideal conditions.		
DEMON	**World Water Works**	**30+**	**2004**
	Most installations use SBRs and hydrocyclones to retain anammox granules. Some installations use a continuously fed reactor with a clarification zone and rotating drum screens for anammox retention. Process uses pH measurement in the reactor to control aerobic/anoxic cycles.		
Cleargreen	**Suez-Degremont**	**2 (several pilots)**	**2015**
	Operates in an SBR with aerobic/anoxic cycles and high overflow rate. This process does not use a cyclone or screen for anammox retention.		
ANITA Mox	**Veolia**	**10+**	**2011**
	Uses carrier media with large protective surface area on which a biofilm is formed by anammox bacteria and AOBs. The system operates as a continuously fed Moving Bed Biofilm Reactor (MBBR) with continuous aeration.		

The processes listed on ***Table 1*** often achieve ammonia removal rates of 90% and total nitrogen removal rates of 80% or better. The design loading rates of the systems range from 0.7 to 2.0 kilograms of nitrogen per cubic meter per day (kg N/m^3/day) and achieve energy efficiency of 1.0 to 1.8 kilowatt-hour per kilogram of nitrogen removed *(Lackner et al 2014)*. By comparison, removal of ammonia nitrogen in the mainstream process using the conventional nitrification/denitrification process uses approximately 6.5 kilowatt-hour per kilogram of nitrogen removed *(Wett 2007)*. The energy use includes aeration, pumping and mixing.

Deammonification Tomorrow

As the use of deammonification in the sidestream treatment processes continues to grow with more installations and experience, the industry is moving toward the next frontier: using the deammonification process to increase the efficiency of nitrogen removal in the mainstream. However, full-scale implementation of mainstream deammonification has proved to be challenging due to difficulty in providing the conditions that promote anammox growth and activity. Some of the challenges include:

- Water temperatures are usually less than 20 degrees Celsius in temperate climates, resulting in slower growth of anammox.
- Influent ammonia concentration of usually less than 40 mg/L are too low to create inhibitory conditions for NOBs.
- SRT control for anammox over NOBs is challenging.
- High carbon concentrations in the influent, usually greater than 250 mg/L COD, create competition from heterotrophs under anoxic conditions.

The main benefit of mainstream deammonification is the potential to remove the ammonia nitrogen in the influent using less oxygen and without the use of organic carbon. However, as long as there is substantial excess organic carbon in the influent, the aeration savings will not be realized because the excess carbon not oxidized using nitrite or nitrate will consume oxygen in the aerobic step *(Daigger 2014)*. In addition, excess carbon favors the activity of heterotrophs that out-compete the anammox bacteria for available nitrite. Therefore, enhanced carbon removal in the primary treatment process is a critical component of promoting nitrogen removal via deammonification and achieving reduced aeration demand. When redirected to anaerobic digestion, the removed carbon can result in greater biogas production and contribute to the facility's energy self-sufficiency. Some strategies currently being used to substantially increase carbon redirection compared to conventional primary treatment include:

- Chemically enhanced primary treatment (CEPT) uses chemicals such as ferric chloride, alum and/or polymer to increase the carbon capture in the primary clarifiers or settling tanks.
- A-stage treatment uses a high-rate, activated sludge reactor that removes carbon in an aerobic environment followed by a settling step. The clarified effluent then enters the B-stage for further treatment.
- Biologically enhanced dissolved air flotation (DAF) primary treatment removes carbon aerobically.

Many facilities and research institutions have worked to implement mainstream deammonification at the lab, pilot and full-scale levels. Only a few facilities have successfully demonstrated mainstream deammonification at full-scale. These include facilities in Strass, Austria; Changi, Singapore; and Xi'an, China.

Some of the methods currently being used to achieve mainstream deammonification include secondary treatment with seeding and retention, tertiary deammonification with partial nitration, tertiary deammonification MBBR and secondary treatment without seeding. These methods are detailed further in the following sections.

Secondary Treatment with Seeding and Retention

This method seeds anammox organisms grown in a suspended-growth sidestream system, such as the DEMON ***(Table 1)***, to the mainstream and retains the anammox granules in the mainstream using hydrocyclones or sieves. Transient anoxia, characterized as periods of high DO concentration followed by anoxic conditions, is used to suppress NOB activity and promote deammonification.

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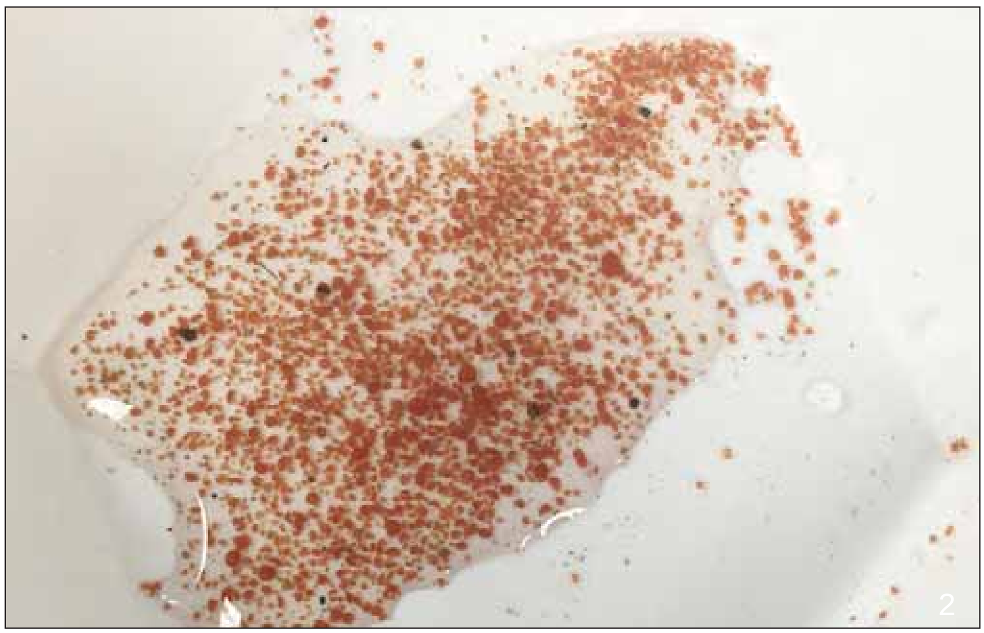

Clockwise: Photograph 1. Sidestream hydrocyclones at AlexRenew Water Resource Recovery Facility, Alexandria, Virginia; Photograph 2. Anammox granules at AlexRenew Water Resource Recovery Facility; Photograph 3. Sidestream reactor at Guelph Wastewater Treatment Plant; Photograph 4. Sidestream hydrocyclones at Guelph Wastewater Treatment Plant, Guelph, Ontario, Canada. *Credit: Jacobs*

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Tertiary Deammonification with Partial Nitritation

This method uses two stages of treatment. In the first stage aeration is controlled to achieve equal concentrations of nitrite and ammonia, then in the second stage deammonification occurs. There are settling steps in-between the stages allowing the SRT for each stage to be controlled separately. This method also uses seeding from a suspended growth sidestream system and sieves or hydrocyclones to retain the anammox granules.

Tertiary Deammonification MBBR

This method is similar to tertiary deammonification with partial nitritation but uses attached-growth media in an MBBR as the tertiary step. Seeded media from an attached growth sidestream reactor, such as the ANITA Mox ***(Table 1)***, is brought into the MBBR to seed the process.

Secondary Treatment without Seeding

Several facilities are attempting to grow the anammox bacteria in the mainstream without bringing in seed from a sidestream reactor using various techniques including granular sludge, suspended-growth and attached-growth systems.

Sidestream Deammonification Startup and Operation Lessons Learned

As the number of sidestream deammonification installations has grown, increased experience in the operation of these systems has been accumulated. Some of the issues that full-scale installations have encountered include influent quality control, temperature control, and monitoring of the reactor biology to prevent upsets *(Lackner et al 2014)*.

Two facilities that recently underwent startup and initial operations are located in Alexandria, Virginia, and Guelph, Ontario, Canada, both of which started up in 2015 ***(Photographs 1, 2, 3*** and ***4)***. Both facilities use the DEMON process ***(Table 1)*** in an SBR reactor and use hydrocyclones for anammox granule retention. Some of the lessons learned from the startup and initial operations at the two facilities are detailed in the following sections.

Lessons Learned: Startup

Seeding. When the system is first initiated, the reactor is usually seeded with mixed liquor from another facility to accelerate the startup period. The seed sludge usually comes in totes or shipping containers. Provisions for unloading the seed sludge and introducing it to the system should be considered.

Heating. Startup during the winter can be challenging if the reactor temperature drops below 25 degrees Celsius. Provisions for heating up the reactor, either with temporary immersion heaters or by adding hot water to the influent, can help accelerate the startup period in cold climates *(Houweling et al 2016)*.

Lessons Learned: Influent Quality

Excess Polymer. When the dewatering process uses polymer to improve solids capture, some excess polymer can be carried onto the dewatering sidestream. This polymer can coat the anammox granules and reduce their activity as well as trap nitrogen gas, which then causes the granules to float. For SBR-type reactors where the effluent is removed via a decant cycle, floating granules can result in excessive anammox bacteria loss *(Yin 2018)*.

Excess Solids. High total suspended solids concentration in the centrate can also be detrimental to the process as it can bring unwanted organisms, inhibitory substances, and additional inert solids into the process. A pre-settling step ahead of the sidestream treatment reactor is recommended to remove excess solids from the sidestream *(Lackner et al 2014* and *Yin 2018)*.

Excess Trash. Poor capture in the influent screening system at the Alexandria facility has led to excess trash and debris in the sidestream reactor. The sludge process grinds the trash and debris so that by the time it reaches the sidestream it is in small particles. However, these fibrous particles tend to recluster, causing issues by clogging pumps and heat exchangers as well as affecting instrumentation *(Yin 2018)*.

Lessons Learned: Process Monitoring

Instrumentation. pH and DO measurement in the system are important for process control. Nitrite, nitrate and ammonia are also valuable monitoring parameters. Reliable instrumentation is key to adequate system control and therefore instrumentation technicians are needed to clean and calibrate instrumentation frequently *(Lackner et al 2014)*.

Nitrite Inhibition. Anammox bacteria are inhibited at nitrite concentrations higher than 10 mg/L *(Wett 2007)*. Therefore, close monitoring of the nitrite concentration is necessary, particularly during startup or during recovery from an upset. If the AOB activity is higher than the anammox activity, the nitrite can be produced at a faster rate than the anammox can process it. This causes accumulation and high nitrite concentrations.

Free Ammonia Inhibition. Free ammonia concentration above 2 mg/L is considered beneficial for the process because it causes NOB inhibition. However, as the free ammonia concentration increases above 10 mg/L, it can also start to inhibit the AOBs *(Lackner et al 2014)*. Free ammonia concentration is a result of a combination of factors, including the total ammonia concentration, pH, and the temperature of the reactor. Therefore, having control algorithms that stop or reduce the feed to the reactor when the pH or total ammonia is above the target level helps reduce the risk of free ammonia inhibition.

High DO. Inhibition of AOBs can result in high DO concentrations in the reactor, which in turn reduce anammox activity. The combined effect can result in an increase of ammonia concentration and rising pH that can then cause further AOB inhibition *(Lackner et al 2014)*. DO monitoring and aeration control is also an important parameter for the process.

Reactor Temperature. Elevated temperatures can result in reduced anammox activity. During the summer months the temperature of the reactor contents can increase due to the exothermic nature of the nitritation reaction and the heat introduced by the compressed air. The reactor temperature should be monitored and cooling provisions, such as heat exchangers or cooling water, provided to maintain a maximum reactor temperature of 35 degrees Celsius *(Yin 2018)*.

Lessons Learned: Micronutrient Deficiency

Micronutrients can become deficient in the reactor and may need to be added to achieve successful activity and growth of bacteria *(Grady et al 2011)*. The micronutrients can be purchased from a vendor or made in-house. They typically include a mix of zinc, manganese, nickel, molybdenum, cobalt and copper *(Yin 2018)*.

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Lessons Learned: Seed Harvesting

Seed harvesting may be implemented for bioaugmentation of mainstream reactor or for seeding other facilities. When planning for the future, facilities should consider possible implementation of mainstream deammonification if feasible or serving as seed provider for other facilities.

Conclusions

The use of deammonification for sidestream treatment is a proven technology that has been successfully deployed in many facilities and locations around the world. As additional operational experience is gained, systems are becoming more robust and easier to operate. The process requires well-trained staff who understand the biology and are ready to take appropriate action to maintain effective treatment levels and reliable operation.

The next frontier of using deammonification in the mainstream has proven more challenging than the sidestream application but continued research and pilot studies are shedding light on possible pathways for implementation.

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Nassau County Bay Park Wastewater Treatment Plant

Nassau County's 70-million-gallon-per-day Bay Park Sewage Treatment Plant (Bay Park STP) suffered heavy damage during Hurricane Sandy in 2012. As part of the reconstruction efforts, the Nassau County Department of Public Works decided to incorporate elements that would increase the nitrogen removal capacity of the plant in anticipation of stricter future effluent limits. Sidestream deammonification is one of the technologies included that will reduce the nitrogen loading to the mainstream process by approximately 13%. The design of the new system is complete, and the contractor was issued notice-to-proceed in December 2019.

The sidestream treatment system at the Bay Park STP will consist of two DEMON sidestream deammonification SBRs with rotary drum screens for anammox granule retention. The system is sized to treat up to 3,700 pounds of ammonia nitrogen per day and achieve 70% total nitrogen removal efficiency. The estimated completion time-frame of the project is December 2021.

Sidestream deammonification pilot at Nassau County's Bay Park Sewage Treatment Plant. *Credit: World Water Works*

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Accepting High-Strength Waste in Rome, New York: The Development of a Vision and the Influences That Shaped It

by Richard J. Kenealy

I have been working in the water resource recovery industry for over 30 years and feel that it is both an important and an extremely rewarding field. We get to take a negative (wastewater) and make it a positive (clean water). What could be better than that?

Obviously, it is not as simple as that statement implies. It takes immense infrastructure, a huge monetary commitment, enormous amounts of equipment, governmental assurance, public backing and a dedicated workforce along with industry support. We all have read about the need for upgrades and repairs to our aging infrastructure, which is very important, but I want to focus on the workforce and industry support aspect and how it has affected and shaped me in this industry and my vision for the future of water resource recovery in Rome, New York.

The Importance of Early Mentorship

We all need mentors in our life and career, and I have been fortunate to have had many. I started in this industry back in the early to mid-1980s and met many people along the way who influenced my career path and my passion for this livelihood.

I had a love of numbers and thought I might do well in the accounting field. But I was diverted away from my accounting career path when I decided to work for the City of Rome Wastewater Treatment Plant. My opportunity presented itself when the Chief Operator at the time, Richard Gifford, decided to give me a chance and hired me as a laborer. He was the first mentor I had in the field and was involved in the construction of the original secondary plant in the mid-1970s. Early on, he recognized my potential and gave me computer jobs and accounting duties, which were rare opportunities for a laborer. Those opportunities provided me an inside view of the backbone of facility operations and really started me viewing my work as a career path rather than "just a job".

The City of Rome Wastewater Treatment Plant, which I would call my career home of over three decades, is a 4A-rated facility with a design treatment capacity of 12 million gallons per day (MGD) that discharges into the Mohawk River. The original plant, which was the first in the Mohawk Valley, was built in the mid-1930s ***(Photograph 1)*** and was primary treatment only. After a few minor upgrades, the plant went through its first major upgrade in the mid-1970s, when it went from a primary treatment process to a secondary treatment process. We expanded treatment capacity from 9 MGD to 12 MGD in 1976. There have been several upgrades throughout the years following, which have included headworks, pump stations, aeration, final clarifiers, concrete, and most recently UV disinfection and solids handling. Each of these upgrades was backed by administrations that saw the value in putting money into the facility ***(Photographs 2*** and ***3)***.

As I worked my way up from a laborer to operations, I very closely watched an Operator that really knew his way around process control. His name was Bill Baynes and he was extremely knowledgeable, not only about wastewater treatment, but also about life in general. One thing he taught me was that being intelligent did not mean that you knew everything. Rather, it meant you knew your limitations and were willing to go learn what you didn't already know.

After Richard Gifford's retirement, Bill took over as Chief Operator and I continued to watch and learn. While Bill was Chief Operator, he had several ideas that were developed and implemented to keep our facility moving in the right direction. As Bill kept the plant relevant and upgraded, I started having my own ideas and vision for this facility. One major project that was instituted during Bill's tenure was an aeration system upgrade in 2009. This project was an energy performance contract and this concept was unique to us. What I felt was distinctive about this project was that it took benefits, like energy savings and revenue generation, to help pay for needed infrastructure upgrades. I liked the concept and logged that idea in the old think bank.

Bill held the Chief Operator position for about 16 years. Upon his retirement in 2012 he recommended me as his replacement.

The Spirit of Cooperation

Early in my tenure as Chief Operator, I met another influential individual that really lit a fire in me and helped shape my vision:

Photograph 1. A view of the original plant with discharge going directly to the Barge Canal seen on the right side of the photo. *Credit: Hendricks, 1937*

Photograph 2. Newly constructed UV Building (front left) and upgraded Solids Handling Building (back left). *Credit: Richard Kenealy*

George Bevington. I went to an Energy Specialty Conference in Albany, New York, and attended a session given by George on the Gloversville/Johnstown Wastewater Treatment Plant where they were treating high-strength dairy waste and producing electricity. The proverbial lightbulb went off in my head! I wanted for the City of Rome and my facility the same thing that was going on in Gloversville/Johnstown. To say I was excited would be an understatement. The conference was in November 2012 and by January 2013, I was on the phone with George talking about the Rome facility's potential. I had not met him before and hadn't even talked to him at the conference, but as soon as George answered the phone, I could tell he was almost as excited about the idea as I was.

With the New York Section American Water Works Association, the New York Water Environment Association (NYWEA) co-sponsored that pivotal Energy Specialty Conference in 2012, and it was the influence of this organization that was one of the final pieces that helped define me as an operator and as a professional. NYWEA's influence in the clean water industry is unmatched and it is due to the people that make up the entire organization, from the executive office to the volunteers. It was Patricia Cerro-Reehil, executive director of NYWEA, who was very influential to me in my career and in the industry. She is the ideal leader for this organization and possesses an infectious attitude that inspires you to be a better professional, to get involved and to make a difference.

This is where my participation with NYWEA really took off. I started with a position on the Central Chapter board of directors, which gave me my first look at the support this organization provides on a local level, which I then followed up with my participation on the state level. As I worked with George on developing Rome's future project, he suggested I apply to the Utility Operations and Maintenance Committee. Shortly after I joined that committee George nominated me to assist him in approving the renewal training credits (RTCs) for Operators. It was at that moment the hook was set, and they were reeling me in. During a tour of the Buffalo Sewer Authority, I was then encouraged by Robbie Gaiek to put in my application to the Utility Executives Committee.

After getting my feet wet in these great committees, I was then approached by Patricia to accompany some other remarkable people in NYWEA to Washington, D.C., for the National Water Policy Fly-In. Again, I couldn't say no. To be able to join Patricia, Geoff Baldwin, Mike Garland, Steve Fangmann and others on this very crucial trip was invaluable to me. The more I got involved with these committees and with NYWEA, the more outstanding people I met and learned from. It also widened my network of knowledgeable and influential people in the industry.

What is amazing about this industry is the spirit of cooperation and the willingness of everyone to assist and offer invaluable advice. There is no hiding of information, people are just truly motivated to help. I likened it to the "Phone A Friend" on *Who Wants to Be a Millionaire,* but in this game, I had unlimited calls. It ranged from calls to Dan Rourke, Tim Murphy and Chretien Voerg to the east all the way to Mike Garland and Joe Feigl to the west. Each one was as willing as the next to support and offer guidance.

High-Strength Waste-to-Energy Vision

So how does all this fit into the theme of this *Clear Waters* issue regarding special waste streams? My vision was, and is, to help my facility become more environmentally friendly and to update aged infrastructure in the most economical way. I felt I could duplicate the success of our 2009 aeration project by developing a project that could generate more revenue and save energy while upgrading infrastructure. The idea came to mind after attending that presentation in Albany in November 2012. I thought the concept was a sure thing and would be an easy sell, but it wound up testing my plan and my resolve.

As we moved forward with the idea of bringing in high-strength waste and creating our own electricity, we ran into multiple challenges, obstacles and bumps in the road. Everyone involved had his or her own concerns and ideas of whether it was a good concept. I came back from Albany that November 2012 and hit the ground running, but the running turned to a slow-paced walk. What slowed me down were changes in city administration over the span of six years, including different mayors, three different Department of Public Works (DPW) commissioners, several different common councilors, a few different consultants, and a couple of different engineering companies. Just when I thought the puzzle pieces fit together perfectly, a piece would change, and the puzzle needed to be rebuilt.

I could have easily decided to shelve the idea, leave it for another Chief Operator, or forget it all together. But I didn't give up on the idea or my vision and that was mainly because of the support and backing I had from

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Photograph 3. Secondary process with aeration upgrade from mechanical aeration to fine bubble diffuser shown in the middle of the far back. *Credit: Richard Kenealy*

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Photograph 4. Thickener tank retrofitted to a high strength receiving station. *Credit: Richard Kenealy*

the influences and mentors in my career. I stayed with it and all the right puzzle pieces were finally assembled. In place now are a mayor and DPW commissioner that embraced my vision and have become champions of the project, a Common Council that continually votes in legislation to foster the project, an engineering company with the personnel to make this a successful endeavor, several funding agencies that see the value in a facility attempting to become more resilient, and an awesome workforce at the facility.

This idea took many shapes and forms throughout its development, but the primary focus was high-strength dairy waste. New York state is becoming a leader in the dairy industry, especially in the production of Greek yogurt, and there is a need for outlets for the waste that is produced. I had done a lot of legwork on my own, calling industries and visiting businesses that were potential high-strength or organic waste producers. We would get occasional calls to accept waste on a trial basis and usually we accepted as it gave us a chance to see how our facility handled the treatment of those wastes.

Chobani Waste Finds a Purpose

I eventually got a call from an individual at Chobani, stating they were looking to find some additional facilities to handle their waste, primarily as a backup plan. The individual told me he had called George Bevington to see if he could take waste at Gloversville/Johnstown plant, but since George was no longer there, he suggested they give me a call. After initial talks and the discussion of our facility being their backup, it quickly turned into our facility accepting Chobani waste on an interim basis, and eventually daily thereafter. This was what I had been looking for and the city administration was on board with the arrangement.

We felt we could process a few loads a day and ease ourselves into the high-strength waste treatment business. This meant we would have to do some modifications to our facility, since we wanted to make their offloading of their high-strength waste from trucks as seamless as possible. I did not want this waste to be discharged at the headworks of the facility, since this waste was perfect feedstock for our anaerobic digesters and there was no sense in adding more water to it. We repurposed one of our extra thickener tanks that had been mothballed and transformed it into a receiving station for Chobani (***Photograph 4***). This included paving the area, constructing a new offload area with drain, hoses and connections for quick hook-up, and a new ultrasonic level indicator. This was done with facility and city labor for less than a $40,000 investment.

We had opened a new revenue stream and saw immediate increase in gas production; it actually tripled! As we built baseline data to show the energy potential of this high-strength waste, we cultivated a great relationship with Chobani, and gained confidence from the city administration and the Common Council. The puzzle pieces had finally come together, and my vision had become a reality. We will be breaking ground this year on a project that includes upgrading our current anaerobic digestion complex, installing a new receiving station and holding tank, and installing combined heat and power equipment.

Lessons Learned

I wanted to tell this story as it illustrates how important it is to not only attend educational events, but to also network and create relationships with other environmental professionals in the industry. It was the mentors early in my career that believed in me and planted the seeds that would lay the foundation for me. And it was the chance meeting seven years ago that sparked a vision and it was the support along the way that kept it moving to the finish line.

Richard J. Kenealy is a Water Pollution Control Chief Operator with the City of Rome Wastewater Treatment Plant and may be reached at rkenealy@romecitygov.com.

Onondaga County Department of Water Environment Protection's Acceptance of Untreated Airport Deicing Fluids

by Tim O'Dell and Danielle Hurley

Onondaga County Department of Water Environment Protection (WEP) owns and operates six publicly owned treatment works (POTWs). The National Pretreatment Program requires that WEP regulate the discharges to our treatment works from nondomestic dischargers. The mission of WEP's Industrial Pretreatment Program is to regulate wastewater discharges from nondomestic (e.g., commercial or industrial) users that contain constituents that have the potential to:

- Endanger the public or any worker's safety.
- Interfere with or upset the wastewater treatment process.
- Pass through the treatment plant to the environment.
- Limit the options available for biosolids disposal.

Industrial discharges vary greatly in their composition depending on the industry. Metal finishing, pharmaceutical, food/beverage, laundry service and site/groundwater remediation are examples of different waste streams permitted and discharged into the collection systems and treated at WEP treatment plants. WEP's Metropolitan Syracuse Wastewater Treatment Plant (Metro) treats an average of 65.6 million gallons of wastewater per day, with a design capacity of 80 million gallons per day calculated as a 12-month rolling average. The plant receives discharges from 44 permitted industrial sewer users ***(Photograph 1)***.

Photograph 1. The Metropolitan Syracuse Wastewater Treatment Plant (Metro). *Credit: OCDWEP*

Industrial wastewater discharge permits are issued to industries that are either subject to federal regulations or industries that could potentially cause a hazard to the public, to wastewater treatment plant employees or to the receiving collection system/POTW. Applicable federal and WEP discharge limits are outlined in each industrial wastewater discharge permit. Permitted industries are monitored to ensure they are meeting their permit requirements. Permitted industries perform self-monitoring and submit reports to WEP as part of their permit requirements. In addition, WEP performs regular unannounced sampling and inspections of the permitted industries.

All users of the collection system pay a sanitary unit charge for the wastewater that they discharge annually to the sanitary sewer. Some industrial dischargers are subject to pay an industrial wastewater surcharge for the acceptance and treatment of high-strength waste. One of the parameters assessed for industrial wastewater surcharge is five-day biochemical oxygen demand (BOD_5) which measures the organic strength of wastewater by determining the amount of oxygen consumed by bacteria from the decomposition of organic matter in a wastewater sample over a five-day period. Industrial wastewater surcharge for BOD_5 is billed if the industrial user's average annual concentration is above 300 milligrams per liter (mg/L).

Deicing Fluid Waste Stream

The Syracuse Hancock International Airport (SHIA) began discharging treated deicing wastewater to the sanitary sewer in the late 1990s and became a permitted industrial user in 2010. During winter months SHIA utilizes propylene glycol as a deicing agent on the airplanes, which contains BOD_5 concentrations of 1,000,000 mg/L when undiluted. The actual concentration in the wastewater varies significantly due to dilution with rainwater and snow melt.

Odor Complaints Initiate Process Review

Before 2009, the propylene glycol was collected and stored in four 2-million-gallon lagoons ***(Photograph 2)***. When temperatures rose to about 50°F in the spring, SHIA would add a microbe seed and nutrient to aid in aerobic digestion of the glycol within the lagoons. In late summer and early fall, when the BOD_5 concentrations had been reduced below 5,000 mg/L, WEP would process discharge requests from SHIA to allow the lagoons to be discharged to the sanitary sewer and were billed at a sewer use rate of $10 per 1,000 gallons. If the BOD_5 results were above 5,000 mg/L, industrial wastewater surcharge calculations for high-strength waste streams were utilized for cost-recovery billing purposes.

The propylene glycol utilized for deicing emits a strong, onion-like odor that becomes more pronounced with age and aerobic digestion. This odor was the cause of numerous complaints from a nearby neighborhood during the spring and summer months. Due

Photograph 2. Aerial image of the Syracuse Hancock International Airport original treatment lagoons.
Credit: New York State GIS Clearinghouse orthoimagery 2018

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to these odors, the New York State Department of Environmental Conservation (NYSDEC) required SHIA to explore alternatives for their deicing wastewater. In an attempt to mitigate the odor issue, SHIA approached WEP in 2008 to examine the feasibility of accepting untreated deicing wastewater as it is collected, instead of storing it throughout the winter to be treated in the warmer months for late summer/early fall discharge.

Untreated Deicing Wastewater Pilot Study

In 2009, WEP worked with SHIA and their contracted engineers from C&S Companies to perform a pilot study that examined the discharge of untreated deicing wastewater to the sanitary sewer and Metro. Discharges were closely monitored and coordinated with WEP treatment plant operators, as well as the sewer and pump station maintenance personnel.

BOD_5 concentrations of untreated deicing wastewater ranged from 4,000 mg/L up to 40,000 mg/L. Occasional odor issues were experienced at the first downstream neighbor and the first receiving pump station. The pilot study lasted the entire 2009 deicing year, during which time about 6 million gallons of untreated deicing wastewater was discharged and treated at Metro.

As a result of the pilot testing, SHIA was issued an industrial wastewater discharge permit. It was determined that aeration of the discharging lagoon would produce a more homogenous mix of the wastewater, which would prevent slugs of high BOD_5 from entering the collection system. A daily load limit of 10,000 pounds per day (lbs/day) of BOD_5 was established. From a cost-recovery front, SHIA was then invoiced quarterly for industrial wastewater surcharge costs associated with treating the high BOD_5 waste stream.

Photograph 3. The 24-hour composite sampler collects samples of SHIA's wastewater for BOD_5 analyses. *Credit: OCDWEP*

Industrial Wastewater Permit Compliance

Concentrations of BOD_5 in SHIA's wastewater vary significantly based on deicing needs associated with temperature, weather and dilution from precipitation. To maintain compliance with the established 10,000 lbs/day of BOD_5 limit, SHIA was required to begin discharging at a rate of 25 gallons per minute while utilizing a 24-hour composite sampler ***(Photograph 3)*** for the collection of samples for BOD_5 analysis. Each BOD_5 analysis takes five days to complete. Upon receipt of the BOD_5 results, the flow rate could be adjusted such that lagoon discharge could be accelerated while maintaining compliance with the established load limit. All discharges continued to be closely coordinated with sewer and pump station maintenance and operations staff for each discharge start, flow rate increase or discharge termination. SHIA has maintained compliance with the daily load limit for every year they have been permitted.

Upgrading to Covered Tank Storage

Due to continued odor complaints in early spring, combined with solids buildup and deteriorating lagoon liners, SHIA contracted with Arcadis in 2017 to evaluate lagoon alternatives. Covered tank storage was selected as the best approach. The upgrade from the lagoons ***(Photograph 4)*** to covered storage tanks ***(Photograph 5)*** would drastically reduce SHIA's storage capacity by 6,000,000 gallons during construction, requiring a shift from batch discharges to continuous discharge to the sanitary sewer. This raised two questions:

- How would a continuous discharge be monitored for BOD_5 when the analyses take five days to complete?
- Does the Metro plant have the design capacity to accept an increased BOD_5 load from SHIA during construction of the covered storage tanks?

SHIA, in working with C&S Companies in 2018, established a

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Photograph 4. The treatment lagoons were drained before construction of the deicing fluid storage tanks. *Credit: OCDWEP*

Photograph 5. The new deicing fluid storage tanks at the airport were completed in 2019. *Credit: OCDWEP*

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Photograph 6. The new storage tanks are adjacent to the discharging lagoon at the airport. *Credit: OCDWEP*

relationship between BOD_5 and chemical oxygen demand (COD). COD analysis can be conducted in hours whereas BOD_5 analysis takes at least five days to complete. The SHIA BOD_5 concentrations were consistently about half that of the COD concentrations. This meant that COD results, with a faster sample turn-around time, could be used as a surrogate to estimate BOD_5 levels in the discharge.

WEP evaluated Metro's BOD_5 loading from 2015 through 2017. It was determined that Metro received an average monthly BOD_5 loading of 60,000 lbs/day during that period, which was less than half of the 140,000 lbs/day design capacity. Therefore, to facilitate SHIA's covered tank construction, WEP was able to accept the continuous deicing tank discharges by increasing SHIA's daily load limit to 15,000 lbs/day. And by allowing COD results to be used to estimate BOD_5 loading, expedited discharges were now possible.

Construction of the two 3-million-gallon storage tanks was completed in the fall of 2019 ***(Photograph 6)***. There were no problems experienced in the conveyance system, receiving pump stations or Metro wastewater treatment plant during the construction, and SHIA has continued to meet their permit limits for BOD_5.

This case study shows how municipalities can work with industrial sewer users to best serve the community. The new waste acceptance protocol for SHIA's deicing waste continues to protect the public and the environment by providing the necessary treatment at the Metro facility, while reducing the odor impact the SHIA treatment facility was having on the surrounding community. Treatment costs are recovered through WEP's industrial wastewater surcharge program, which bills industries with wastewater strength above that of a domestic user. SHIA's installation of covered tanks also reduces the amount of dilution of deicing agent from precipitation, which in turn reduces the amount of stormwater needing to be treated.

About WEP

WEP's mission is to responsibly improve the water environments in our community. The acceptance of SHIA's airplane deicing fluid is a fitting example of WEP achieving its mission. With proper planning, research, and collaboration, WEP was capable of treating the high-strength waste stream of deicing fluid from our local airport.

WEP works to achieve its mission in a variety of ways, including efforts led by County Executive Ryan McMahon such as:

- Working with towns and villages toward consolidating our collections systems for the purpose of reducing inflow and infiltration to our treatment facilities.
- Upgrading equipment in our treatment plants to improve energy efficiency.
- Employing green infrastructure solutions through our Save the Rain program, in combination with gray infrastructure to reduce combined sewer overflows.
- Engaging in public education to reduce the disposal of fats, oils and grease into the sewer system through WEP's Cease the Grease campaign.

The No. 1 priority of WEP's pretreatment program is protecting the public, POTW workers, the receiving conveyance/POTW and the environment. However, WEP's pretreatment program also serves to assist and educate the public and private sector with their respective discharge needs.

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Aerial photo of a Florida trash landfill. *Credit: istockphoto.com/Felix Mizioznikov*

Municipal Solid Waste Landfill Leachate Characteristics, Collection, Treatment and Co-Treatment with Municipal Wastewater

by Lisa Oberreiter

Originally published in New Jersey Water Environment Association publication "New Jersey Effluents" (Volume 52, No. 3). Reprinted with permission.

Introduction

The Resource Conservation and Recovery Act (RCRA) was passed by Congress and signed into law by President Gerald Ford in 1976. It is an amendment to the Solid Waste Disposal Act of 1965 providing solid waste control in the United States. Regulations were put in place requiring municipal solid waste landfills to have a leachate collection system and all new landfills to have a liner meeting the specifications of 40 CFR 258 Subpart D *(1991)*. This amendment would minimize impacts on the groundwater and nearby surface waters from future contamination by landfill leachate. These new requirements also control the disposal of hazardous and nonhazardous waste *(40 CFR 258, 1991)*. This limited the introduction of additional contaminants to the landfill leachate of municipal solid waste landfills moving forward.

Solid waste collection, management and disposal practices are interconnected to ambient water quality and wastewater treatment. Stormwater comes into contact with collection bins, canisters and trucks, allowing potential contaminants to leach from these surfaces into the water. In some areas, stormwater carries garbage, oils, and particulates from the streets when it rains. These contaminants may flow through a storm sewer into local receiving waters. The importance of the proper handling of garbage and recycling can decrease the chances of foreign materials polluting ambient waters. In New Jersey, stormwater management plans are compiled on a municipal level to alleviate the potential of nonpoint pollution to local waterways. N.J.A.C 7:8-3.7 requires "… prevention or minimization of the exposure of pollutants to stormwater; and control of floatables …" *(2016)*.

In other areas, stormwater collection systems are combined with sanitary systems. Solids, inorganics and grit are removed from wastewater systems during pretreatment and then disposed in a landfill. The protection of public health and the environment does not stop at the landfill. Rainwater, runoff and moisture content of the disposed municipal solid waste (MSW) concentrates contaminants as the water moves through the landfill. This liquid must be contained, monitored, removed and treated prior to discharge back into the environment *(40 CFR 258, 1991)*.

Leachate Characteristics

Leachate is formed as water percolates through waste layers of a landfill that are in various stages of degradation *(Kjeldsen et al. 2002, Brennan et al. 2017, Miao et al. 2019)*. Waste type, hydrology, moisture content, temperature and age of a landfill contribute to the decomposition rate and ultimate leachate composition *(Brennan et al. 2017)*. Precipitation and seasonal weather variations contribute to the volume of leachate collected as well as its potency. This must be considered when selecting a site for a landfill and designing collection and treatment systems *(Tchobanoglous and Kreith 2002, Renou et al. 2008, Tsarpali et al. 2012)*. The leachate is then captured in the collection system.

A typical collection system consists of a liner, collection area, and a removal and holding system, all dependent on the geology of the site *(Tchobanoglous and Kreith 2002)*. The leachate must be pumped out of the collection system and treated before discharge to the environment, either on-site or sent to a water resource recovery facility (WRRF). Tchobanoglous and Kreith's *(2002)* statement, "a landfill must not cause or contribute to violations of any applicable state water quality standard; violate any applicable toxic effluent standard or prohibition under Sec. 307 of the Clean Water Act…" clearly outlines the necessity of landfill leachate treatment.

A cost-benefit analysis must be done to determine if the volume of leachate would justify treating leachate on-site and discharging to groundwater or local waterway or if it should be transported to a WRRF. Leachate is a challenging liquid waste stream. Due to the nature of landfills and varying stages of decomposition, leachate is toxic to the environment *(Renou et al. 2008)*. It is high in biochemical oxygen demand (BOD), chemical oxygen demand (COD) and ammonia. Nitrogen, chlorides, metals and xenobiotic organic compounds are also present though at lower concentrations. Studies found occasional metal precipitation from landfill material but values resulting from leachate analysis were less than 1% of the total concentration present in the waste *(Kjeldsen et al. 2002)*. Xenobiotic organic compounds include aromatic and halogenated hydrocarbons, and nonpolar organic compounds, some of which are priority pollutants like benzene, toluene and 1,2-dichlorobenzene *(Kjeldsen et al. 2002, 40 CFR 423 Appendix A 1982)*.

When discharging to a WRRF for co-treatment, a number of authors recommend that leachate be less than or equal to 10% of plant influent volume to ensure toxic shock to the biological system does not occur *(Diamadopoulos et al. 1997, Renou et al. 2008, Brennen et al. 2017)*. Bioassay testing is widely used to evaluate toxicity of effluent discharges to receiving waters. For example, it has been used to determine leachate toxicity in fresh and saltwater from high ammonia concentrations and oxygen demand *(Tsarpali et al. 2012)*. COD and BOD are both indicative of the amount of oxygen required to stabilize organic matter in wastewater. Each measures

Water draining from a trash truck may carry contaminants into the storm drains. *Credit: istockphoto.com/Valentyn Semenov*

the amount of dissolved oxygen (DO) used by organisms degrading the organic matter present *(Metcalf and Eddy 2014)*. Dissolved and suspended solids are also contributors to oxygen requirements in leachate treatment. Leachate must be treated before discharge into the environment due to these characteristics.

Landfills can be broken down into four phases of decomposition: aerobic, acetogenic (anaerobic acetate generation), methanogenic (anaerobic methane generation), and stabilization *(Renou et al. 2008)*. Little research has been done on the stabilization stage because most landfills have not been closed long enough to evaluate *(Kjeldsen et al. 2002)*. In addition to the four phases of decomposition within a landfill, landfill age can be broken down into three ranges: young (less than 5 years old), medium (5-10 years old), and mature (greater than 10 years old) *(Renou et al. 2008, Brennan et al. 2017, Miao et al. 2019)*. Both designations will indicate what strength leachate is to be expected. Young leachate contains more dissolved organics and therefore a higher oxygen demand. Older leachate is more highly concentrated with ammonia and nitrogen *(Brennan et al. 2017)*. Over time, landfill cells will contain a mixture of both old and new wastes. This should be taken into consideration when determining a leachate treatment method.

Long-term composition of leachate from closed landfills is only theorized. More data collection is required as additional landfills come of age. There are few closed, inactive landfills entering late stages of development where air intrusion and its affects can be measured, and theory backed with scientific evidence *(Kjeldsen et al. 2002)*. Most studies refer to the age or active stage of a landfill when evaluating leachate constituents and toxicity *(Brennan et al. 2017, Kjeldsen et al. 2002, Mahommad-pajooh et al. 2017, Miao et al. 2019)*.

Leachate Collection

A leachate collection system consists of sloped terraces and a piping system on top of the landfill liner. Storage capacity and head pressure are indicative of slope grading. Landfill size, waste types and estimated leachate volume based on geographic location and waste types must be considered in the design *(Tchobanoglous and*

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Leachate collected from below the landfill is pumped into a holding lagoon. *Credit: istockphoto.com/1amgreen*

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Kreith 2002). Modeling can be done in conjunction with the landfill design phase, as well as used during landfill operation, as a tool to determine drainage flow, accumulation rates and ponding. Clogs can be simulated at varying leachate volumes to determine if design changes are required to decrease effect of a partial clog on the system. Collection system capacity, drain configuration and liner pore size can all contribute to clogging of the collection system *(Rowe and Yu 2012, Stibinger 2017)*.

Temperature, moisture content, head pressure on the liner, and leachate recirculation rate can be monitored to obtain necessary data for optimization of landfill operations. Depending on landfill size, the drainage channels may be interconnected to a larger system *(Tchobanoglous and Kreith 2002)*. The leachate collected goes to a sewer or holding tank, depending on design and treatment. Holding tanks are sized to store a few days equivalent of volume during highest precipitation rate based on local historical values *(Tchobanoglous and Kreith 2002)*.

Leachate volumes should directly correlate with rainfall. If drifts are seen in the data over time, clogging is likely to blame. Biological buildup and precipitates are common causes of clogs *(Rowe and Yu 2012)*. Defects in the liner or piping systems can also contribute to build up and blockages. Compaction and material failures are less likely but can be to blame as well *(Stibinger 2017)*. Overall, collection system performance is expected to degrade over time due to decreases in the porosity and hydraulic efficiency of the drainage layer. Minimizing overloads to the system may extend the efficiency of the drainage layer *(Rowe and Yu 2012, Stibinger 2017)*.

In its design, a high-density polyethylene leak detection system is placed below the liner to ensure any leaks are caught if the system becomes compromised. The extra protection system allows time for the leak to be addressed without any discharge to ground water having occurred as a result *(40 CFR 258)*. A ground water monitoring system is required at each facility to monitor water quality and identify any changes over time. Monitoring wells both up and down gradient of the landfill must be accessible and used for sampling to fulfill regulatory requirements *(40 CFR 258)*. Any contamination from a breached landfill operation that is leaching toward a groundwater system can be identified, and corrective action taken.

Leachate production continues long after a landfill stops receiving waste. The collection and treatment of such is paramount throughout the life of the landfill. Leachate, as with any wastewater, must be treated to meet water quality standards of the receiving water. In each U.S. case, the water quality limitations will be found in the facility pollutant discharge elimination system permit.

Leachate Treatment Options: Physical/Chemical

Leachate recirculation can be used to manage leachate accumulation and reduce organic content (*Tchobanoglous and Kreith 2002)*. However, it does not eliminate the need to treat leachate altogether. While recirculation increases the rate of gas production in the landfill, if too much moisture is present, gas production will decrease. Excessive moisture content is detrimental to decomposition and landfill equilibrium. A recirculation balance must be found to protect the landfill from being overloaded to the point where decomposition is impacted *(Rowe and Yu 2012)*.

Leachate evaporation ponds are another option for leachate management. There must be adequate space for the ponds and an appropriate liner is required. Evaporation ponds offer limited storage based on the slow rate of evaporation. The use of evaporation ponds is generally weather dependent for siting applicable locations (e.g., arid regions). Forced evaporation using landfill gas is a promising solution. Electricity and solar power could be used to speed up evaporation but at a higher cost *(Zhao et al. 2017)*.

Using landfill gas for leachate evaporation decreases contribution to global warming by way of methane release into the atmosphere. A study by Zhao et al. *(2017)* evaluates partnering with a nearby incineration plant. The landfill gas would promote combustion in the incineration plant and the resulting waste heat would be used for leachate evaporation. A study of the economic benefit concluded that more information is required on crystallization and off gases in this case *(Zhao et al. 2017)*. The idea of enhancing the evaporation process has potential and could be a suitable option for a facility with the capability of gas extraction and use.

Air stripping is another method for ammonia removal. Volatile organic compounds are also removed by this process. As a result, air pollution control measures are required. Sulfuric acid is the most frequently used compound in air stripping *(Renou et al. 2008, Metcalf and Eddy 2014)*. Ammonium must be converted to ammonia by increasing the leachates' pH. High pH must be maintained. The leachate then passes through a packed media tower or stripping column. Ammonia is removed from the liquid phase into the gas phase. The off gas must then pass through a scrubber to remove any contaminants transferred to the air before release to the atmosphere. Though effective, air stripping for ammonia removal can be costly if the process is not optimized *(Ata et al. 2017)*. Chemicals must be purchased to maintain high pH levels and maintenance requirements are intensive due to calcium carbonate scaling *(Renou et al. 2008, Metcalf and Eddy 2014)*.

Leachate Treatment Options: Biological

High-strength waste treatments can treat dissolved organics and high concentrations of ammonia. Biological leachate treatment methods include activated sludge, nitrification-denitrification, sequencing batch reactors (SBR), anaerobic processes and co-treatment with wastewater *(Tchobanoglous and Kreith 2002, Renou et al. 2008)*.

Treating a high-strength waste to meet water quality standards for surface discharge or ground injection is no simple task. Many facilities choose to transport leachate to WRRFs for treatment *(Brennan et al. 2017)*. Publicly owned WRRFs are typically designed for treatment of sanitary wastewater and some percentage of industrial wastewater depending on the location of the facility. High-strength wastes from industrial or landfill processes were not necessarily accounted for in large volumes *(Metcalf and Eddy 2014)*. The microbiological population required to treat sanitary wastewater varies from that for leachate. The two can both be treated but less efficiently for some parameters of concern, such as nitrogen *(Brennan et al. 2017)*.

National Pollutant Discharge Elimination System (NPDES) Pretreatment Standards require the identification of industrial users (IU) within a treatment plant's service area. The IUs are required to meet local limits determined by evaluation of legacy pollutants, treatment processes at the WRRF, and water quality limitations of the receiving water. Pretreatment standards have decreased the impact of industrial waste flows on WRRFs and the environment *(40 CFR 403 1995)*. The primary goal of leachate treatment is to decrease or remove toxicity from the waste stream prior to discharge. Pretreatment of leachate is preferred before discharge to a domestic WRRF. Such pretreatment decreases the

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oxygen demand in a treatment plant and thus decreases operating costs *(Brennan et al. 2017)*.

Like leachate, sanitary wastewater contains BOD, COD, total suspended solids (TSS), total dissolved solids (TDS) and ammonia, but at lower concentrations ***(Table 1)***.

Table 1. Comparison of typical wastewater concentrations and landfill leachate concentrations of selected parameters.

Compound	Wastewater 100 gal/capita/day	Landfill Leachate
BOD (mg/L)	200	25,000
COD (mg/L)	508	80,000
TSS/TDS (mg/L)	195	not available
Ammonia (mg/L)	560	3,000
Source Citation	*(Metcalf and Eddy 2014)*	*(Renou et al. 2008, Brennan et al. 2017)*

Co-treatment of leachate and sanitary wastewater has not been widely studied on a full scale. A recent study by Brennan and others *(2017)* evaluates leachate loadings to WRRFs and their effects on the treatment processes at four volumetric loading rates from 0% to 10% landfill leachate to mixed liquor suspended solids (MLSS). The study monitored effects of leachate in full scale at the WRRF. The option to alter the sludge age for experimentation purposes was not available. Drip-feed and slug loading were also evaluated. BOD, COD, and ammonia removals remained over 85%. Total nitrogen remained below 30% removal and nitrogen mass loadings were increased.

Ammonia (NH_4+-N) must be largely removed from wastewater prior to discharge. The NH_4+-N range found in domestic wastewater is between 25 and 45 mg/L *(Metcalf and Eddy 2014)*. Conventional nitrification-denitrification converts NH_4+-N to nitrite (NO_2), then NO_2 to nitrate (NO_3). NH_4+-N oxidizing bacteria oxidize ammonia to NO_2. Then nitrite oxidizing bacteria oxidize NO_2 to NO_3. Oxygen is required for the conversion of NH_4+-N to NO_3. This is the nitrification process. Denitrification occurs in an anoxic stage, without free DO *(Metcalf and Eddy 2014, Miao et al. 2019)*. The organic material found in wastewater acts as electron donors and NO_3 is denitrified to nitrogen gas *(Miao et al. 2019)*. If there is not enough of a carbon source in the influent stream, then an additional source must be added. This adds to the cost and energy consumption of treatment.

Activated Sludge Treatment Limitations with Leachate

Co-treatment of leachate with sanitary wastewater is challenging if conventional activated sludge treatment is used. The common methods of treating leachate are various forms of nitrification processes which require anoxic or anaerobic stages of treatment. Activated sludge systems oxygenate the mixed liquor throughout the water column. Oxygenation can be lessened to decrease DO in the lower portion of a tank, but it would mean altering treatment of sanitary wastewater, controlling solids deposition in the tank, and changing the microorganism population and reacclimating them to different conditions. Additionally, if leachate is not received in a steady stream it will be difficult to maintain an optimal biological system to efficiently co-treat the waste streams *(Brennan et al. 2017)*. Converting a WRRF secondary treatment system to better treat leachate is feasible but a cost benefit analysis must be performed to determine the best course of action is to take.

Activated sludge is a waste stabilization process utilizing the presence of oxygen. Microorganisms break down organic matter in wastewater by oxidation to biomass, carbon dioxide and water *(Metcalf and Eddy 2014)*. The MLSS is the mixture of wastewater influent, biomass, microorganisms, and oxygen being kept in suspension. The MLSS is mixed mechanically via surface aerators and lower mixing impellors or diffusors *(Metcalf and Eddy 2014)*. To complete the biological treatment of the MLSS, the suspended solids, including microorganisms and biomass, must be removed. The resulting solids are referred to as activated sludge. This separation

Modern landfill construction design includes leachate capture systems, which protect local groundwater. *istockphoto.com/gece33* is done by gravity and minimal machinery to save time and money on maintenance and energy requirements *(Metcalf and Eddy 2014)*. An attached-growth system is an alternative to suspended-growth activated sludge. Nitrification inhibition is minimal due to bacteria growth rates, no sludge settling is required, and it is less sensitive to high-strength waste *(Renou et al. 2008, Metcalf and Eddy 2014)*.

It is important to note that the presence of DO and sludge settleability are necessary for successful biological treatment. Leachate and some industrial discharges are toxic to the activated sludge system due to increased oxygen demand and decreased sludge settleability *(Renou et al. 2008)*. Limitations must be made to the volume of ammonia and nutrient-rich loadings introduced into the system at one time as microorganisms need a chance to acclimate to the characteristics of a new waste stream. Slug flows of leachate will have adverse effects on the treatment. The activated sludge process successfully removes BOD and some nitrogen and phosphorus. Sludge retention time (SRT) for co-treatment with leachate may be longer than that required of domestic wastewater due to the higher strength waste *(Renou et al. 2008)*. Also, more oxygen must be introduced to the MLSS to keep up with the demand required to degrade ammonia and nitrogen.

Anaerobic treatment methods are also successfully used. However, specific parameters such as temperature and pH must be maintained to optimize the treatment system. Anaerobic digestion does not have the flexibility to treat varying influents. Digestion is limited to batch reactions and requires longer SRTs for proper treatment *(Metcalf and Eddy 2014)*.

Sequencing Batch Reactors Limitations with Leachate

A study by Diamadopoulos and others *(1997)* examined the removal of ammonia and nitrogen from mixed leachate and wastewater using an SBR. The concentrations of BOD, COD, NH_4+-N and NO_3 in the influent flow, including 10% leachate, were approximately double that of the initial wastewater concentrations alone. An SBR was selected for its multifunctionality *(Diamadopoulos et al. 1997)*. Biological contact treatment occurs within the same reactor as gravity settling and effluent decantation. Oxygen demand will decrease with reaction time. The SBR sequence can be adjusted for that depending on the strength of the SBR influent flow *(Renou et al. 2008, Metcalf and Eddy 2014)*.

Effluent BOD and COD concentrations were between 6 to 10 mg/l and 170 to 200 mg/L respectively, resulting in up to 98% BOD removal. However, overall nitrogen percent removal was between 35% to 50% in each trial, regardless of extended aeration time *(Diamadopoulos et al. 1997)*. To achieve a higher percent removal for overall nitrogen, Diamadopoulos and others *(1997)* trialed an anoxic phase after aeration. They added an external carbon source to meet the minimum recommended carbon to nitrogen ratio for denitrification. The bench scale reactor showed significant improvement in nitrogen percent removal to over 60%. However, the BOD and COD percent removals suffered as a result, dropping to about 70% *(Diamadopoulos et al. 1997)*. A limitation of SBRs is their capacity. SBRs need to run at lower flow rates than activated sludge systems *(Tchobanoglous and Kreith 2002)*.

Status of the Science of Co-Treatment

Co-treatment of leachate with domestic wastewater has become frequent practice worldwide *(Renou et al. 2008, Ferraz et al. 2016)*. However, research on co-treatment is done mostly on a bench or pilot scale. Analysis of effluent samples from facilities where co-treatment is practical confirm decreased levels of organic matter, ammonia and COD removals *(Ferraz et al. 2016)*. A determination still needs to be made if this is the result of limits of biological treatment or dilution with domestic wastewater. Studies by Ferraz and others *(2016)* and Campos and others *(2014)* investigated this question of treatment and determined that partial degradation of humic acid, acid mostly from decayed plant material, found in leachate does occur in co-treatment with wastewater by suspended aerobic activated sludge treatment *(Von Wandruszka 2000)*.

Smidt and Meissl *(2007)* state that "Every stage of decomposition is characterized by specific metabolic products." Fourier-transform infrared (FT-IR) spectroscopic analysis identifies indicators in waste materials that can be associated with specific metabolic products. Phases of degradation can be seen by the intensity of light bands through FT-IR. FT-IR was used to evaluate oxidation patterns in effluent from pilot reactors *(Smidt and Meissl 2007, Wei et al. 2007, Ferraz et al. 2016)*. Research by Ferraz and others. "confirmed that most of the (leachate) slowly biodegradable organic matter was removed by partial degradation rather than dilution or adsorption of organics in the (activated) sludge" *(2016)*.

Conclusion

Disposal of municipal solid waste in a landfill has become widespread practice. Legislation was passed to control pollution due to landfilling from unregulated wastes and lack of ground and surface water protections. Landfills are now required to have leachate collection systems and partake in groundwater monitoring.

Characterization of leachates around the world have determined that landfill age and rainfall play a significant role in leachate strength. BOD, COD, ammonia and nitrogen are present in leachate at elevated concentrations. Thus, treatment is more demanding as compared to more conventional waste streams. Studies show high ammonia concentrations in both young and old landfill leachates. Physical/chemical treatments such as recirculation, evaporation, and air stripping effectively decrease leachate volume and organic constituents, but further treatment is still required.

Biological treatment with municipal wastewater is a cost-effective practice in leachate management. Storage in the collection system or in tanks until discharge or transport to the WRRF requires minimal action on the part of landfill facility owners. However, caution must be taken when co-treating wastewater and leachate. A constant, low feed rate of leachate into the treatment system is required for successful treatment. Slug loads to a WRRF can cause process upsets resulting in settleability issues, insufficient oxygen availability, and elevated ammonia and nitrogen loadings.

WRRFs that discharge to smaller, more sensitive receiving waters are now being assigned more stringent effluent limits. Over time, it is likely that all U.S. WRRFs will be required to meet lower effluent limits. At that point, co-treatment of leachate with municipal wastewater may no longer be a viable option.

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Havre's Wastewater Woes Solved by Beer

by Rachel Cramer

Several years ago, Havre, Montana, had a problem. Its treated wastewater had too many nutrients. Fixing it was expected to cost millions of dollars. But wastewater workers discovered a cheap, upcycled solution through the magic of chemistry and beer.

Drue Newfield, the superintendent at Havre's Wastewater Treatment Facility, looks out across a series of large outdoor tanks full of something that looks like frothy chocolate milk ***(Photograph 1)***. Every day, this place turns 1.5 million gallons of waste from sinks, showers and toilets into clean water to be released into the Milk River just beyond the line of trees.

Until recently, the facility had issues with phosphorus and nitrogen. The nutrients can cause algae blooms in rivers, which suck up all the oxygen and kill aquatic life.

Newfield says Havre spent over $10 million on upgrades in 2015 in an effort to meet the Environmental Protection Agency's newer, tougher standards.

"Which wasn't enough. That upgraded a lot of the old plant as well that just needed to be fixed," Newfield says.

He says they were going to have to spend tens-of-thousands of dollars each year on a chemical additive and potentially a million dollars on another upgrade.

"That's where the barley came in and was able to do what we didn't get," Newfield says.

Across town at Triple Dog Brewing, owner Michael Garrity walks past his large, shiny fermenters in the back and opens the garage door.

Sitting right outside are seven large buckets full of moist grain leftover from brewing beer.

"It just smells like oatmeal. That's pretty much what it is. Put a little sugar on it, you've got yourself some breakfast," Garrity says ***(Photograph 2)***.

Garrity used to take the spent barley to Havre's compost site. It took a lot of time and was kind of messy.

Three years ago, Newfield asked Garrity if he could take the barley to the wastewater treatment facility.

"Just out of a thought that I had, I took the fermented organics from the brewery and added it, and we saw those bacteria bring our phosphorus levels lower," Newfield says.

Bacteria play a big role removing nitrogen and phosphorus at wastewater treatment facilities. But to be really effective, bacteria need some extra food at the end of the treatment process when they're starving for carbon and volatile fatty acids. Luckily, spent barley has both.

"So, we began to do it over time. We started learning how much to add," Newfield says.

Every morning, one of the operators dumps 16 gallons of spent barley into the water as it heads toward the treatment pools to give the hard-working bacteria a boost. Newfield says they were able to reduce the nitrogen and phosphorus levels and save the town a lot of money: $16,000 annually for a specific chemical treatment and possibly a million dollars on another upgrade ***(Photograph 3)***.

The Environmental Protection Agency gave Havre an honorable mention at the end of last year for its innovative solution.

Paul Driscoll with the Montana Department of Environmental Quality says, to the best of his knowledge, Havre is the only place in Montana using spent barley to treat wastewater. But with the recent award from the Environmental Protection Agency, Newfield says he's been getting more calls from communities both in and out of state interested in the possibility of using brewery waste.

About 300 miles to the south, Bozeman tried something similar last summer with a pilot project at its Water Reclamation Facility.

Coralynn Revis, an engineering consultant and project manager with HDR, looks down at the water as it moves between the different tanks. In some, the water is calm. In others, it bubbles like a Jacuzzi. The facility treats over four times as much wastewater as Havre.

Rather than using spent barley, Revis wanted to find out if the liquid waste from making beer could reduce the facility's nitrogen and phosphorus levels.

"We have all of these craft breweries. They make all of this high strength waste, which is rich in carbon, which causes trouble and it's what we're treating for coming, into the plant," Revis says.

Bozeman has more breweries than Havre. When they all dump their liquid waste down the drain, the Water Reclamation Facility

Photograph 1. Treatment tanks at the Havre Wastewater Treatment Facility, Jan. 24, 2020.

Credit: Rachel Cramer/Yellowstone Public Radio

Photograph 2. Barley used in brewing beer at the Triple Dog Brewing Company, Havre, Montana, Jan. 24, 2020.

Credit: Rachel Cramer/Yellowstone Public Radio

Photograph 3. Spent barley from the Triple Dog Brewing Company delivered to the Havre wastewater treatment facility.

Credit: Rachel Cramer/Yellowstone Public Radio

has to absorb it all and treat it.

Revis says her team figured out that controlling the flow and feeding it to the bacteria at the end of the treatment process turned a problem into a solution.

During the pilot project, she worked with MAP Brewing to siphon the liquid waste into a separate tank. The city hauled it to the facility.

"We had a tank of brewery waste that we put over there on the ground, and then we ran some little peristaltic pumps up, and then there's a mixer under here," Revis says.

Revis says this method dropped the nitrogen and phosphorus levels, but Bozeman's Water Reclamation Facility stopped using it once the pilot project ended.

"So, the reason it was just a pilot is because it would take some effort to bring it full scale. Being able to go truck and pick up all the brewery waste when you need it and coordinate all that, it would take a full-scale program to be able to do that all the time," Revis says.

Since the facility's nitrogen and phosphorus levels are allowed with its current permit from Montana DEQ, Revis says it would be hard for Bozeman to justify spending public money on developing a new program. The pilot project alone, which was funded by her company HDR, was $10,000. It lasted less than two months.

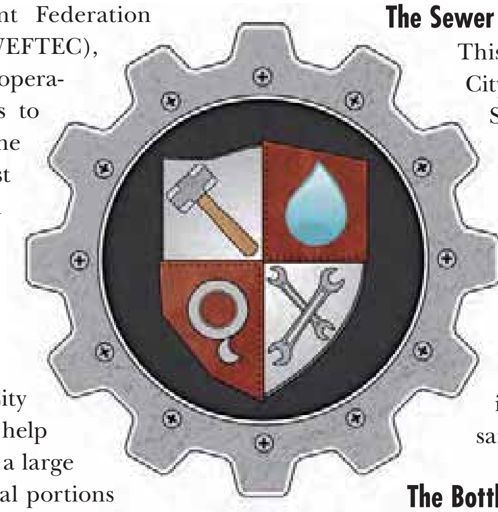
"There are stricter regulations coming. So, in the future that might be a good choice for them," Revis says.

Rachel Cramer is a journalist with Yellowstone Public Radio. The online article may be found at https://www.ypradio.org/post/havres-waste water-woes-solved-beer#stream/0.

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

Seven Entries Earn Awards in the 2019 Operator Ingenuity Contest

Every year at the Water Environment Federation Technical Exhibition and Conference (WEFTEC), the Operator Ingenuity Contest awards operators who find simple, applicable solutions to everyday problems. WEFTEC 2019 hosted the eighth annual Operator Ingenuity Contest awards ceremony on Sept. 25. In 2019, seven new winners joined the ranks of the nearly 50 other fixes that made people's jobs easier and safer.



The Muckraker Award

This award went to Mike Wenner of the City of Napoleon, Ohio, for creating a tool to help solids dry more quickly. Wenner fabricated a large rake using a piece of steel angle with several portions of cut pipe welded to it. The rake gets attached to a front-end loader. The loader can now be used to rake the solids in the drying bed, increasing its surface area and drying it much faster than was previously possible.

The Goody Bag Award

William Paddock of the South Orange County Wastewater Authority in Dana Point, California, received this award for his invention of a fisheye filtration system. After discovering fisheyes (globules of polymer) were blocking his facility's polymer flow switch and ball checks and triggering multiple "low polymer flow" alarms daily, Paddock knew something had to be done. Paddock and his staff decided to create a filter using an old chemical tote. They cut a hole in the tote and fashioned a filter from screen door material. It worked, but the process was labor intensive because they had to frequently clean the filter to maintain flow. After a few iterations, they landed on using a replaceable 600-micron bag filter that it could be replaced easily when full. They also installed a removable filtration platform that could be placed on top of any tote, and a pneumatic double diaphragm pump, which enables them to place the filtration system above the tank. Paddock credits his success to communication with staff: "I went to every single operator and asked, 'what would make this better?' We got some really good ideas."

The Tight Squeegee Award

This award went to Charlotte Water's Johanna McHone, from Charlotte, North Carolina, for inventing a device to peel polymer slime off the polymer age tanks at her facility. Before her invention, she had to use a heated pressure washer to clean the tank sides. This had the risk of splashing scalding hot water or chemicals on the operator. It also consumed a lot of diesel, electricity and water. Her fix was incredibly simple: she fixed a squeegee to a flexible broom handle. The tool just peels the slime off the tank wall.

The Sewer Sailor Award

This award went to James E. Segrest Jr. from the City of Auburn Water Resource Management Sewer Department in Auburn, Alabama. Segrest had a wide diameter sewer main that had to be inspected. The flow in the main was too great for the facility's crawler camera to be feasible. So, instead of sending a human in, Segrest attached a GoPro camera and flashlights to a cooler lid and floated it through the main. He attached the float to a reel of kite string to control its progress. The facility has used the sewer sailor several times.

The Bottle Bump Award

Perhaps the simplest and cleverest of all, this award went to James Petalio of the Rodeo Sanitary District in Rodeo, California, who was dealing with constant chlorine dosing alarms after hours. The alarms triggered the facility's sodium bisulfite metering pump to run at 100% automatically to prevent a chlorine violation. The problem was solved by simply raising reagent bottles of acetate and potassium iodide buffer solution from below the analyzer unit to above it. Removing the need for the reagent dosing pump to overcome the head of lifting it up to the analyzer stabilized the process and eliminated the alarms. This straightforward fix saved the district $1,200 in overtime costs and more than $12,800 per year in sodium bisulfite costs.

The Smooth Move Award

This award went to John Presta and George Pelzowski of the Corbett Creek Water Pollution Control Plant in Whitby, Ontario, Canada, who were dealing with jammed, manual, aluminum channel sluice gates. The aluminum gates had fused to the aluminum channels. Staff often were resorting to cutting out the gate to resolve the problem.

To address this issue, the Corbett Creek team ordered new gates from various suppliers. Their clever twist came in how to install them: they welded side slide tabs to the new gates that let them fit in the original channels perfectly. They also added a rubber stop at the bottom of the gate to help the seal.

The Rag Spear Award

Matt Haggler from the City of Meridian, Idaho, received this award for skewering an irritating problem. The city's 3-million-liter (800,000-gallon) anaerobic digesters hadn't been cleaned in several years and the influent screens weren't working well. This meant wipes, rags, and hair had built up in the tank. The bound-up material had created massive rag flotillas, which soon began to affect digester performance.

Haggler's solution was a 7.6-meter (25-foot) long, 50-millimeter

(2-inch) thick solid steel spear head with collapsible tines. The spear can be attached to a crane and forced into the rag balls. Once stabbed in, the crane pulls the spear back out and the tines unfold. The tines hook into the rag ball like barbs, and the mass of material can be pulled out. The spear has removed rag balls weighing nearly 450 kilograms (1,000 pounds). The spear cost less than a few hundred dollars and has saved the city significant money in down time, and enabled the digesters to work properly.

Apply Now for Operator Ingenuity 2020

Next year's contestants will certainly have big shoes to fill, but if past years are any indication, the ideas will only get more creative and ingenious. If you have a simple fix that has made your job safer, easier or more efficient, submit it for the 2020 contest.

The application period is open now and closes June 5. The contest is open to all. Note that the entry form includes a field for WEF Member ID number; this field is optional. Find full submission details online at *www.weftec.org/ingenuity*.

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A Flint, Michigan, Retrospective

by Matthew L. Sweeney

At 6 a.m. Jan. 2, 2020, an interdisciplinary team of nine Manhattan College students pulled away from campus to embark on a 12-hour trip to Flint, Michigan. L.O.V.E. Flint was the title of the group, which stands for the Lasallian Outreach Volunteer Experience. L.O.V.E. is an eight-week program during which selected students prepare for an on-site week of service in a location, in our case the City of Flint. L.O.V.E. Flint consisted of students studying various fields in engineering, science and the liberal arts. The majority of the group came into the city knowing it primarily for its water crisis, but we would all come to learn that Flint was far more than its flaws.

Upon arrival to our residence, the Firestone Center ***(Photograph 1)***, we were greeted by Mr. Steve Wolbert. Mr. Wolbert is a nonprofit specialist and the person currently in charge of the programming for the Center. Given the shadow of the water crisis, the first item addressed was where to obtain our drinking water. We were directed to fill our canteens at a water cooler that we replaced daily. Although Mr. Wolbert admitted the tap water might be acceptable to consume, he would never trust it again and this was a sentiment shared by many Flint residents. Our first night would be spent settling into our new home for the week, ending with a pasta dinner and a nightly reflection that would become integral to our experience.

Day One

Our first morning we left the house by 8:30 a.m. to travel to a Habitat for Humanity site within city limits ***(Photograph 2***). We were greeted by Don, the carpentry foreman and Santa Claus. Santa Claus was their best volunteer, having logged a record number of hours building houses with Habitat for Humanity. He earned his nickname from the fact that he was a professional Santa for the Christmas season and was in the process of "de-Santafication" when we met him.

I have a background in plumbing, so I have ample experience with construction. But my carpentry skills are entry-level, so this was surely going to be a day of great learning for me. You'd expect that this construction crew would take it easy on us newbies coming in for the day, but no such treatment for us! We were put to work in two different divisions: one team would go to work pulling out temporary supports, while the other team would assist in framing the second level of the affordable housing units being constructed. I was put on the supports detail and truly learned the concept of leverage with my hammer that day!

We gathered for lunch around a burn barrel, which I was told was a leftover from a General Motors strike. As we ate our bagged lunches, I asked one of the apprenticing carpenters what he saw as the benefit of this work for the community. He explained that this neighborhood had seen high crime rates and that by removing the houses affected by urban blight and building new construction, incidents of crime would be reduced.

However, later that day while discussing our work we were enlightened to the unintended consequences of demolition. What happens to the racoons and rodents living in the abandoned homes when these places are destroyed? They spread to neighboring inhabited homes and wreak havoc. This cast our work in a more complicated light.

After work, Mr. Wolbert gave us his tour of Flint. He showed us where he grew up and the vast tracts of the city that had been abandoned. We passed public parks, gardens and even a planetarium. What stood out to us were the beautiful murals that have appeared on the sides of buildings in recent years. Mr. Wolbert showed us where the street had been excavated to replace lead piping.

This city seemed to be a microcosm of the U.S. The infrastructure problem in Flint is one that we are facing across the nation and will have to reckon with for many years into the future.

We were informed that little Flint, Michigan, with a peak population of 200,000 people, has produced more professional athletes than any other city in the U.S. Most recently are athletes such as Kyle Kuzma, power forward for the Los Angeles Lakers, and the current female world middleweight boxing champion Claressa Shields, who trained in the legendary Berston Field House. This athletic legacy extends back over 100 years and is just one example of the pride that the people of Flint have in their city.

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Photograph 1. Our L.O.V.E. Flint travel group at the Firestone Center. Front row (l-r): Peter Parlato, Erin McWilliams, Klenton Sparks, Matthew Sweeney; second row, (l-r): Brianna Remache, Miah Cohall, Jana Clark; third row, (l-r): Meggie Osorio, Michevi Dufflart, Rachel Bowers.

Credit: Steve Wolbert

Photograph 2. Our L.O.V.E. Flint travel group at the Habitat for Humanity site. (L-r): Matthew Sweeney, Meggie Osorio, Jana Clark, Rachel Bowers, Michevi Dufflart, Brianna Remache, Miah Cohall, Erin McWilliams, Peter Parlato.

Credit: Habitat for Humanity


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Day Two

Our second day of activities involved walking neighborhoods and asking residents whether they needed free water bottles. We would soon learn that this was a strange activity to be engaging in. The people of Flint are proud, and few would accept handouts from us strangers. This was the most peculiar activity that we engaged in during our trip and this was reflected in the night's dinner conversation.

Once we wrapped up our walking tours, the mayor of Flint, Sheldon Neeley, invited us to tour City Hall. While in City Hall, there were free city planning pamphlets and some of us leafed through them. What I was struck by was the promotion of green infrastructure and urban gardens.

After our City Hall tour, the mayor joined us for pizza pies at a local restaurant. During dinner, the mayor stressed that he was interested in being the people's advocate. He discontinued the practice of shutting off water to those who couldn't afford to pay their bills and practiced getting out into the neighborhoods and meeting his constituents. The mayor enjoyed our visit so much that he requested future groups who come through the Firestone Center be invited to City Hall.

During the day, we had passed by the City of Flint Water Treatment Plant, the site that started the crisis. Through conversation, we learned that the water crisis was a symptom of the depopulation that has plagued Flint for decades. General Motors built Flint, Michigan, but also tore it down. When the jobs left, so did the people and with them the tax base for the city. When it came down to making budget cuts, the decision was made to switch sources of drinking water. The lack of funding and staffing for the Flint Water Department led to the water crisis the city has found itself in.

At reflection for the night, we shared our discomfort with the day's activities, particularly with the activity of handing out water bottles. We were joined that night by a man named Klenton Sparks. Mr. Sparks grew up in Flint and like many others had returned to help their city in any way possible. What he added to the conversation at that particular reflection was that you may see a homeless person and assume they need your help. However, they may have chosen that lifestyle and you may be offending their dignity by offering them food. If they needed anything, they would come to us. This thought process would continue for us throughout the trip as we stopped to reflect whether we were taking the correct actions.

Day Three

For our third day of activities, we had free time to explore the City of Flint. We took that opportunity to visit the famous Flint Farmers Market and indulged in local specialties. While there, I picked up the local newspaper and came upon a countdown. The countdown was a running tally of the lead pipes that still needed replacement. The City is anticipating that 2020 will be the year service line replacement will be finished.

After our morning in the market, the team further explored the mural scene around downtown Flint. The highlight of the day was when we attended the local Mott Community College basketball game and took part in the long tradition of Flint athletics. The day ended with a beautiful Catholic Mass at a local parish church.

Day Four

Monday was our fourth day of activities. First, we were sent to the Flint Development Center (FDC) to assist in constructing a community water-testing laboratory. The FDC offered services such as

Photograph 3. Our L.O.V.E. Flint travel group at the Sylvester Broome Empowerment Village. Front row, (l-r): Erin McWilliams, Brianna Remache, Miah Cohall, Michevi Dufflart; back row, (l-r): Jana Clark, Rachel Bowers, Meggie Osorio, Peter Parlato, Matthew Sweeney.
Credit: Sylvester Broome Empowerment Village

alternative high school, in which those who didn't receive a diploma could return to receive it, and a day care. The water lab would be another addition to the great services the FDC already provided.

We met another set of seasoned tradesmen in Yusuf the pipefitter and Aaron the carpenter, who accepted us into their crew like those from the Habitat for Humanity site. Once again, two teams were developed: one to pull wire through the ceiling and one to put up drywall. I had bought a "Rocks of Michigan" kit earlier in the trip and had picked up a gypsum specimen, the main component of the drywall I would spend my day installing.

At lunch time, we headed back to the main building in the FDC and ate in the gymnasium. We were entertained by the day care class that was having recess at the same time and saw the future incarnations of Kuzma and Shields. Our education major was especially touched by the fact that these children had a safe space to just be children. Our construction day ended with an expression of gratitude for our work by the executive director of the FDC, none other than Mr. Sparks' sister, Shelly Sparks, who is also a 2005 Greater Flint Afro-American Hall of Fame inductee for basketball!

Our second act for the day was to offer our services at the Sylvester Broome Empowerment Village (SBEV) ***(Photograph 3)***. The SBEV is a place dedicated to instructing the children most affected by the lead crisis in marketable skills such as photography, coding and writing.

Upon entering the SBEV, we passed a large water filtration device called the Water Box and learned that actor Jaden Smith had donated several units to the city. Following this, we were introduced to program director Ms. Linnell McKenney, known fondly as Coach, who is another hall of fame inductee in sports, including the Greater Flint Afro-American Hall of Fame (2002), the Greater Flint Area Hall of Fame (2005), and the Kentucky State University Athletics Hall of Fame (2016).

Coach was impressed by the fact that we had trekked from New York City to little Flint to volunteer our time. She returned to Flint, like Klenton Sparks, to give back to the community that raised her. We weren't expected and so we were given tasks that Coach couldn't find the time to complete, which in this case was assembling a donated gaming room for the children. She didn't think that we would have the time or tools to achieve our task and stressed that

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anything we could get done would be a massive help to her and the SBEV. We decided as a team at that moment that whatever it would take to get it done, we would do it.

I got to work with three others on a pool table while others vacuumed the rooms and assembled an air hockey table. Rather than give up when we realized we didn't have a pair of scissors around, I grabbed some nails and handed them out to cut the packaging straps. We cranked our tunes and set up the entire game room. We were scheduled for two hours but we stayed for three. When Coach returned and saw that we had achieved the unlikely, she beamed with excitement. She walked in and out of the gaming room about three times just repeating "AMAZING." Her happiness made the work worth it, but Coach had another form of compensation in mind. As a token of her gratitude, she gifted us a bag of 700 Tootsie Rolls. To this day, they have not been finished.

Day Five

Our fifth day of activities was spent at the St. Luke N.E.W. Life Center, where we put together various orders for young families such as a crib, some linens and clothes. The Center is known for its program to retrain those who had left the workforce for an extended period. In addition, the Center runs an industrial sewing center that provides jobs and produces clothing for a popular Midwestern company known as Stormy Kromer. A free eye care clinic has taken root in the Center as well, thanks to a retired optometrist donating his equipment and time to the Center. All around us were incredible people, content with letting their good deeds go unknown.

As we swept the eye care clinic, we struck up a conversation with the secretary and one of the directors of the center. We had gotten into the topic of struggle and the director replied that although Flint has its problems, New York had the tragic events of Sept. 11. We didn't know how to respond. These people were humble to the degree that they didn't want to focus on their troubles but rather express sympathy for ours. This attitude of humility was a constant in all people we met in Flint.

Day Six

Our sixth and final day of activities was spent at the Northridge Academy. At the Academy, we spent a school day tutoring elementary and middle school students. These were children of the age to have been affected by the lead crisis and we were witness to some of the unfortunate effects. At the end of our time at the Academy, one boy expressed that I was his "bestest friend," filling my heart with great joy.

I thanked the teacher for her patience and love in instructing the future generation, and she thanked us for the immense impact we made on the children. Not knowing how else to say goodbye, I told the children to continue with their education as it will take them to great heights. We left truly worried for the future of these children. Would they be able to live healthy and happy lives? These questions still haunt me. I can only pray that the good people we met can continue their mission without losing hope.

A New Perspective

The L.O.V.E. Flint team had come into the city identifying it primarily with the water crisis. We left with a sense of what it meant to be from Flint, Michigan. It's a city with its fair share of problems, no question. However, what the news doesn't show is the beauty of

Sunset over the City of Flint, Michigan.

Credit: istockphoto.com/ Brand Diverse Solutions Steven Barber

the people's hearts and actions. I like to say that I saw the face of God in the people of Flint. They give of themselves to work toward a better future for Flint and its children.

This experience has anchored me firmly in the pursuit of social and environmental justice. It has reaffirmed my commitment to fight for human rights and to uphold human dignity. L.O.V.E. Flint has taught me invaluable wisdom that I shall carry with me for the rest of my days. I implore those wanting to help a community to go and ask them what they need. Listen to their ideas on how they think their problems could be solved. Outside help is appreciated, but can fail if there is no community input.

In addition to the intangible, I picked up some tangible memorabilia during our stay: the most difficult nail for me to remove; a can of Vernor's ginger soda; and a print of a stormwater curb drain. All of these will hang in my office wherever I end up. They will serve as a reminder of the commitment I made to the City of Flint and to people everywhere.

I want to thank my tremendous L.O.V.E. Flint team and the incredible people of the City of Flint for making this experience one that I will always cherish. How will I take the spirit of Flint forward? The city taught me that in order to solve a societal issue, we must first have the foundation of a healthy community. My intention is to dedicate my career to building and sustaining these communities. As I conclude this piece, I ask myself: when can I go back?

Matthew L. Sweeney, Class of 2021, is vice president of the Manhattan College Chapter of the New York Water Environment Association. He is studying civil and environmental engineering at Manhattan College and may be reached at msweeney01@manhattan.edu.

A New Generation of Water Quality Investments

by Matthew Millea

Leading the Nation

New York state leads the nation in its direct investment in drinking water and clean water infrastructure. Hands down, no other state has dedicated the financial and administrative resources, nor moved as quickly, to fund critical water quality projects as New York. In February, Environmental Advocates, an Albany based not-for-profit, issued their report, "Untapped Potential" highlighting that between 2015 and 2018, New York state invested $773 million in grant funding from the state's Water Infrastructure Improvement Act (WIIA) to nearly 500 projects in 57 out of 62 of New York's counties.

And while the overall funding gap for these critical assets remains daunting, we must give credit where it is due. New York state has stepped in to fill a void left by a federal government that long ago severely reduced its investment in critical water infrastructure funding.

At the close of the budget process in March 2015, Governor Andrew Cuomo and the New York State Legislature adopted the first of what would ultimately become a series of historic appropriations to fund water infrastructure investments in New York state. In 2017, building upon $400 million in previous investments, New York state committed an historic $2.5 billion in capital funding for clean and drinking water treatment plant upgrades, collection and distribution system improvements, lead lateral replacement programs and engineering planning grants. This new funding is in addition to resources available from the Clean Water and Drinking Water State Revolving Funds and the Environmental Protection Fund-supported Water Quality Improvement Program.

At a recent budget hearing in Albany, New York State Department of Environmental Conservation (NYSDEC) Commissioner Basil Seggos testified that the state's investments in clean and drinking water infrastructure improvements over the past five years have leveraged more than $11 billion in new construction and system upgrades.

We Have Come a Long Way

The 1977 classic movie *Star Wars* begins with the famous tag line "A long time ago, in a galaxy far, far away …." For many local government officials, 1977 certainly feels like a long time ago and a galaxy far, far away. It was 1977 when a municipality in New York state could apply for a 75% federal and 12.5% state grant to fund the construction or upgrade of their treatment plant and sewer system. Many who worked during this era of federal riches often refer to it as, "the good old days."

These generous grants derived from amendments adopted by Congress in 1972 to the Federal Water Pollution Control Act of 1948, establishing the Clean Water Act (CWA). The Act established standards for sewage treatment and provided billions of dollars in grant funding via a newly created Construction Grants Program, including up to an 85% federal grant for projects deemed to be "innovative or alternative." With the state match of 7.5%, some projects benefited from 92.5% grant funding. The good old days indeed.

Within five years of enactment, Congress had appropriated almost $20 billion to the Construction Grants Program, adding an additional $11.2 billion by 1980. This investment helped to reverse decades of environmental degradation to our waterways and prevented the discharge of innumerable tons of harmful pollutants into our nation's lakes, streams and coastal waterways.

Many communities in New York state benefited from the Construction Grants Program and built state-of-the-art treatment and collection systems. This sizable investment also helped to advance newly enacted protections of public health and the environment without placing an undue burden on local taxpayers, who up to this point had paid very little or nothing at all in local taxes or fees for water treatment services.

Then, due to budget constraints and shifts in federal spending priorities, Congress amended the Clean Water Act in 1987 and transitioned from a grants program to instead capitalizing a new, state-by-state loan program, the Clean Water State Revolving Fund. The New York State Environmental Facilities Corporation (NYSEFC) administers the Clean Water and Drinking Water State Revolving loan funds on behalf of the state. Created in 1997, the Drinking Water State Revolving Fund (DWSRF) is administered by NYSEFC in partnership with the New York State Department of Health.

While some legacy grant funding remained following the 1987 CWA amendments, the shift from providing construction grants to low interest loans dramatically affected the affordability of water-quality investments throughout the nation and slowed local investments in infrastructure upgrades.

By 2006, the federal government was poised to end their funding of capitalization grants for the Clean Water State Revolving Fund (CWSRF) program and greatly reduce their investment in the DWSRF program. The second lowest appropriation approved by Congress for the CWSRF came in 2008, when only $689 million was provided for the CWSRF and $829 million for the DWSRF.

At a time when national needs assessments for clean water and drinking water infrastructure were demonstrating a funding gap of hundreds of billions of dollars, the federal government provided only $1.5 billion in total funding, almost entirely dedicated to capitalizing low interest loans, for our nation's water quality infrastructure needs. The U.S. Environmental Protection Agency estimates that the nation's wastewater treatment facilities alone require approximately $271 billion over the next 20 years to meet the CWA's water quality objectives. A strikingly small investment in comparison to the size of the federal budget and growing need for both drinking and clean water infrastructure investments.

And then, things began to change.

Grants? We Can Get Grants … Really?

While 2008 represented an historic low for federal funding for the CWSRF and DWSRF, the following year Congress adopted, and President Barak Obama signed, the American Recovery and Reinvestment Act (ARRA) in response to the national financial crisis. ARRA provided a sizable appropriation of $4 billion to CWSRF and $2 billion to the DWSRF. Moreover, for the first time in a generation, the federal government authorized states to use CWSRF and DWSRF dollars to provide grants. There was one hitch though: states had only one year to allocate 100% of the money to "shovel ready" projects. Any funds not used by mid-February 2010 had to be returned to the federal government.

Fortunately, New York rose to the challenge and put to use every nickel of the almost $500 million state share provided to the New York via the ARRA.

Given the success of ARRA, Congress continued to allow states to provide modest funding grants from the CWSRF and DWSRF in subsequent federal appropriations. These grants were not, however, a return to the glory days of the Construction Grants Program.

While the investment from the federal stimulus program provided some communities with a significant boost, the overall need for financial assistance for clean water and drinking water improvements continued to grow. Many systems have reached the end of their useful life or have been deemed to be inadequate to address new public health standards or environmental permit requirements. In addition, communities are now facing the financial challenges associated with the treatment of "emerging contaminants" including PFOA and PFOS.

New York's Historic Investment

In April 2015, New York state stepped up to fill this growing funding gap through the adoption of the Water Infrastructure Improvement Act, and its successor, the $2.5 billion Clean Water Infrastructure Act adopted in 2017 and increased to $3 billion in 2019. A sum far greater than that provided on an annual basis from the federal government for the entire 50 states.

Local governments are now eligible for engineering planning grants to help assess their infrastructure needs and develop strategies to repair, replace and modernize their drinking water and clean water infrastructure systems. Communities seeking to use innovative approaches to stormwater management can pursue grants from the Green Innovation Grant Program, and local governments interested in consolidating services with neighboring communities are eligible for funding to assess and advance such an initiative.

New York state is creatively combining resources from the CWSRF and DWSRF programs, the WIIA, and local funding to optimize capital investments and help limit the impact of tax or rate increases. The NYSDEC is also spearheading a pilot program that assists local governments in developing and implementing asset management programs that will aid in long-term maintenance and capital budget planning for future investments.

The return of meaningful grant funding for critical water quality projects is a welcome shift from the 20 years following the demise of the Construction Grants Program. While we are not likely to ever see a return to the generous 90% grants offered in the 1970s and early 80s, local governments do have a unique opportunity in 2020 to benefit from New York's $3 billion plus commitment to addressing their critical water infrastructure needs.

NYSEFC's website is a tremendous resource to research funding options. There are also several grants available through the state's annual Consolidated Funding Application process. Whatever your needs may be, it is likely the state now has resources available to assist your community in moving forward with a solution.

New York state has set an example for the entire nation. It is only through a combination of federal, state and local investment that we will ultimately repair, replace and modernize our critical clean and drinking water infrastructure.

Matthew Millea works for the C&S Companies in Albany, New York, and is the Chair of the New York Water Environment Association's Government Affairs Committee. This article also appears in the New York Conference of Mayors publication titled, The Bulletin, spring 2020 issue.

President Robert Wither.

Continued from page 7

New member Meet ’n Greet breakfast was well attended.

YP Reception attendees, Sara Igielski and Claudia Duran.

YP Reception attendees (l-r), Nicolette Leung, Eliora Camilleri and Liza Faber.

YP Reception attendees.

L-r: Jorge Carvajal, Vijesh Karatt Vellatt, Alex Leu and Jon Pepe.

2020 NYWEA President William J. Nylic III.

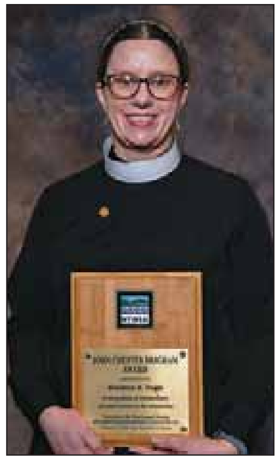
NYCDEP Commissioner Vincent Sapienza, left, receives the WEF Arthur Sidney Bedell Award, presented by WEF President-Elect Jaimie Eichenberger.

(L-r:) Steve Sanders, Christina Chiappetta and Madison Quinn.

Over 80 students participate in the Student Design Competition.

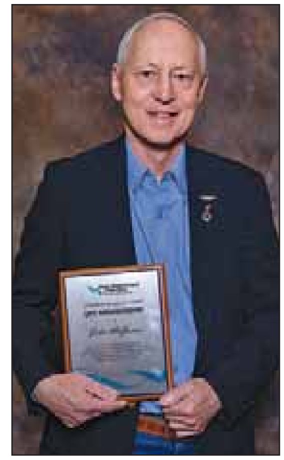
Donna Bee receives the Milton T. Hill Award.

William Grandner receives the Robert D. Hennigan Water Hero Award.



Rosaleen Nogle receives the John Chester Brigham Award.

Salvatore Campisi receives the Collection System Operator Award.

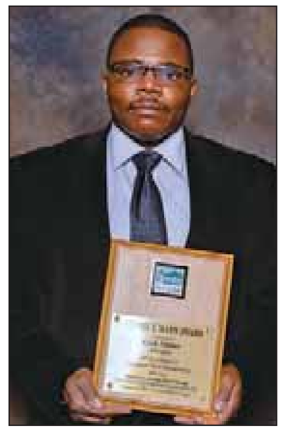


John McGowan receives WEF Life Membership.

John Mancini receives the Linn H. Enslow Memorial Award.

Robert Klosko receives the Laboratory Analyst Award.

Jeffrey Bryant receives the Uhl T. Mann Award.



Kiah Miller receives the Uhl T. Mann Award.

Joseph Massaro is inducted into the Hall of Fame.

SUNY-ESF receives First Place Student Recognition grant.

Clarkson University receives Third Place Student Recognition grant.

President Robert Wither (l), and Executive Director Patricia Cerro-Reehil present Fran Sansalone with John Sansalone's Hall of Fame posthumous recognition.

Manhattan College receives Second Place Student Chapter Recognition grant.

The Lucy Grassano winners (l-r): James Plochocki,Central Chapter; Craig Hurteau, Capital Chapter; Anthony Filer, Genesee Chapter; Joseph Giarraffa, Met Chapter; Michael Cush, Long Island Chapter; and Robert Wither,NYWEA President. Not Pictured: Kevin Maendel, Lower Hudson Chapter; Ryan Miller, Western Chapter.

Operator Quiz Spring 2020 – Activated Sludge

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

1. Which of the following terms refers to a hydraulic condition, typically indicated by billowing solids flowing over the effluent weir, where a portion of the flow through a clarifier experiences a much shorter detention time than the rest of the wastewater in the tank?
   a. Surging.
   b. Short-circuiting.
   c. Overload.
   d. Dispersion.

2. The typical range of suspended solids in domestic influent wastewater is:
   a. 100-300 mg/L.
   b. 400-600 mg/L.
   c. 700-900 mg/L.
   d. 1,000-12,000 mg/L.

3. If mixed liquor is black in color and the level of DO is extremely low, this typically indicates that the mixed liquor is:
   a. Healthy.
   b. Recycling.
   c. Septic.
   d. Reversing.

4. Which of the following is an appropriate location to collect a final effluent sample for a chlorine residual test?
   a. At the chlorine injection point.
   b. At the point where influent enters the plant.
   c. At the downstream end of the chlorine contact tank or just before the point of discharge.
   d. At the downstream end of the aeration tanks.

5. The target DO level in a biological reactor of an efficiently operated activated sludge process should fall within the range of:
   a. 0.0 to 1.0 mg/L.
   b. 2.0 to 3.0 mg/L.
   c. 4.0 to 6.0 mg/L.
   d. 8.0 to 12.0 mg/L.

6. Which of the following types of solids most accurately represent the microorganisms in the activated sludge process?
   a. Total suspended solids.
   b. Mixed liquor suspended solids.
   c. Mixed liquor volatile suspended solids.
   d. Total dissolved solids.

7. What piece of laboratory glassware is used mainly to mix chemicals and measure approximate volumes?
   a. Burette.
   b. Pipette.
   c. Graduated cylinder.
   d. Beaker.

8. What is the maximum recommended holding time for a sample that is to be analyzed for pH?
   a. None, it must be analyzed immediately.
   b. 30 minutes.
   c. 4 hours.
   d. 5 days.

9. Given the following information, calculate the BOD of this sample:
   Initial sample DO = 8.5 mg/L
   Final sample DO = 5.1 mg/L
   Amount of sample used = 9 mL
   Total sample volume = 300 mL
   a. 62 mg/L.
   b. 85 mg/L.
   c. 102 mg/L.
   d. 113 mg/L.

10. The temperature of a drying oven used for TSS analysis must be kept at:
   a. 104 ± 1°F.
   b. 104 ± 1°C.
   c. 180 ± 2°C.
   d. 500 ± 50°C.

Answers on page 62.

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

Spring 2020, Vol. 50, No. 1

Clear Waters

New York Water Environment Association, Inc.

Operator Quiz Spring 2020

Answers from page 61:

1. (b) Short-circuiting.
2. (a) 100-300 mg/L. Suspended solids removal is one of primary process goals for activated sludge treatment. Typically, raw wastewater contains approximately 100-300 mg/L of suspended solids.
3. (c) Septic.
4. (c) At the downstream end of the chlorine contact tank or just before the point of discharge.
5. (b) 2.0 to 3.0 mg/L.
6. (c) Mixed liquor volatile suspended solids.
7. (d) Beaker, they are suitable for mixing chemicals and measuring volumes.
8. (a) None, it must be analyzed immediately.
9. (d) 113 mg/L.

   BOD mg/L = (Initial sample DO mg/L - Final sample DO mg/L) / (amount of sample used, mL/total sample volume, mL)

   = (8.5mg/L – 5.1mg/L) / (9mL/300mL)

   = 3.4mg/L / 0.03

   = 113.3 mg/L
10. (b) 104 ± 1°C. For TSS analysis, samples must be dried to a constant weight at 104 ± 1°C.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