

VOLUME 48 NUMBER 4 | ISSN 1077-3002 WINTER 2014



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Reclaimed water for cooling & process water systems

Mercury—an old problem with new implications

Striking a balance in pretreatment

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On the cover: Industrial pretreatment systems are installed at a wide range of facilities including research and development laboratories, hospitals, schools, electroplating, semiconductor manufacturing, and pharmaceutical production.



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

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

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

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BECOME A NEWEA MEMBER TODAY

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President's message

It is hard to believe that my

presidency is nearing its end. It has been an amazing year, and I have developed an even greater appreciation for all the work of the NEWEA staff and of all the volunteers that make our association the leader it is today. It is a fascinating time to be involved in our industry. The issues we deal with are complex, but thanks to our hard work more and more people are recognizing the value of water. Our outreach is ever more important as we advocate for sound environmental stewardship.

As president, I have attended a busy schedule of state association meetings and specialty seminars. The effort and commitment of those who plan and coordinate the programs is tremendous. These events support the essential initiatives and enhance the professionalism of our industry. We all must recognize that an important part of our effort as environmental stewards goes beyond the front door of our offices and plants. We need to positively engage the public, and NEWEA will continue to help its members have the materials and information to be advocates for clean water in our communities. Every seminar I attended emphasized, as part of its program, the importance of the information and how we can convey that to the target audience.

The newly designed NEWEA website will enhance the experience for those who use it, whether they be our general membership, committee members, or the public seeking information about clean water. We all recognize that social media has a real impact on information sharing today, and NEWEA members will see an increased effort by the association to engage people through those means. We also have bolstered long-established programs such as our legislative advocacy, primarily supported by the government affairs committee. The bottom line is that NEWEA has positioned itself to help you, who labor in the interest of the water environment industry, in using and sharing important information.



One of my planned initiatives during my presidency was to enhance the value of NEWEA to rank and file operations and maintenance personnel. One task called for a page on NEWEA's website devoted to O&M interests and serving as a clearinghouse for activities in New England. The envisioned page would carry information from available O&M training to recognition of facility workers in each state. The operator page is now under development, and it promises to become an important part of our website. Another planned program was the intrastate operator exchange to complement NEWEA's interstate operator exchange, which has been a successful and appreciated program. The proposed intrastate program will encourage operators to visit wastewater treatment plants in their own states and enable them to receive training contact hours for those visits. The plan is to pilot a program in Maine and, with its success, expand promotion of it in the other New England states, with NEWEA seeking approval for training credits with each state's certifving agencies.

NEWEA's leadership has long recognized the importance of collaborating with other associations that have interests common to ours. During the past year, issues around stormwater have brought NEWEA, the New England Water Works Association, The newly designed NEWEA website will enhance the experience for those who use it, whether users are our general membership, committee members, or the public seeking information about clean water.

and the New England chapter of the American Public Works Association together once again. Although this collaboration is still in its early stages, much has been accomplished. This effort will provide an information exchange depot and advocate for sound environmental policy as we implement our programs to meet the emerging stormwater permits.

Finally, I have presided over NEWEA during a busy year of transition. Elizabeth Cutone retired after 24 years as our executive director. Her leadership of our association is one reason we are in a preeminent position and receive great respect among member associations of WEF. Mary Barry, our new executive director, has hit the ground running, and I am confident she will continue to guide our association toward strengthening and enhancing NEWEA's wellrespected position in our industry.

I count it as a rare privilege to have been the president of NEWEA and to have enjoyed meeting and working with so many dedicated volunteers. It has been a great experience, and I say without hesitation that association involvement is eminently rewarding; whatever level of involvement you elect to give to NEWEA, you will almost certainly get much more in return. Thank you, all, again for affording me this opportunity to serve and to receive, and I look forward to seeing you all at the annual conference in January.



GOT DISPOSABLE WIPE CLOGS ?

From the Editor

n my last editorial, I spoke of the importance of our industry aligning itself as a water resources community, focusing on energy reduction and sustainability. The first article in this quarter's *Journal* highlights a project that speaks to managing water resources on-site by using portions of treated influent and stormwater as supply for industrial process water, while the second article moves the discussion further to triple bottom line reuse of wastewater for power plant water supply.

I was struck by the way the first three articles all emphasize the critical importance of a savvy operator for

these sometimes complex facilities. An effectively run facility requires constant communication with production line staff to share operational changes with treatment plant operators prior to the result of the changes reaching the plant. Without proactive communication potential treatment upsets may arise, resulting in permit violations that can have negative financial and environmental impacts.

Johnson Controls chose a design-build process to construct an integrated facility with the goal of treating wastewater and contaminated stormwater at the lead-acid battery-recycling center in Florence, S.C. The design-build approach helped fast-track the project to get the facility up and running. The

innovative design delivered on the "company's commitment to manage and minimize its environmental impact and improve its competitive position." The facility was designed to meet the commitment of zero stormwater discharge to the Great Pee Dee River. The resulting project won three awards—2013 National Design-Build Award, 2013 Excellence in Environmental Engineering Grand Prize, and 2013 W. Wesley Eckenfelder Industrial Waste Management Medal.

Continuing on the sustainability idea, the second article presents three case studies on the use of municipal wastewater effluent as reclaimed water for operations at power plants. Power facilities continue to require large quantities of water for cooling operations, and it is critical to continue to use municipal wastewater effluent where possible. One of the largest values of recycled water is the embodied energy reclaimed from the water cycle. The third article presents the difficulty in cleaning up legacy mercury in healthcare facilities. Even though mercury is rarely used in the healthcare industry these days, some facilities no longer using mercury are finding quantities in the effluent, which exceed local discharge standards. One major reason for this is that mercury has the ability to bioaccumulate in the plumbing and collection systems, and the article describes a facility installed at a major Boston hospital to meet the new mercury standards in Massachusetts. Interestingly, the material safety data sheets (MSDS) for some chemicals have not caught up to the low level of mercury discharge limits,



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which can pose a problem for industrial pretreatment systems. If mercury makes up less than 0.1 percent of a compound, it is not captured in the MSDS. Since mercury can bioaccumulate, the lower levels can add to the legacy mercury resulting in discharges in exceedance of the state standard. For Massachusetts and the Massachusetts Water Resources Authority the current standard is 1 PPB.

The fourth article highlights the importance of striking a balance among performance, safety, and sustainability, and further drives home the importance of communication between those creating the wastewater discharge and those who must treat it.

Our final article explores the five major factors affecting the design and operation of coagulation and flocculation as it

relates to industrial treatment. Read about the impacts of wastewater particle size, treatment chemistries (matching the right coagulant for the specific pH range) mixing (type and intensity), solids recycle, and testing. It becomes clear, based on the article, that wastewaters are complex and ion interactions affect the final treatment chemistry, creating the need for thorough testing prior to design of facilities.

In this issue's NEBRA Highlights, Ned Beecher provides current insight on Ebola exposure to water resource and biosolids practitioners.

Special thanks to Guest Editor Michael Sullivan and our newest committee member, Matt Hross, for soliciting and reviewing the information-packed feature articles.

Helen Gordon Journal Committee Chair and Editor



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EPA PROVIDES TECHNICAL ASSISTANCE TO FIVE COMMUNITIES FOR INTEGRATED PLANNING OF STORMWATER AND WASTEWATER PROJECTS

Robert Daguillard, EPA News Release

EPA is providing \$335,000 in technical assistance to five communities to help them develop integrated plans for wastewater and stormwater management. Integrated planning lets communities sequence projects so they can start those with the highest priority first. Historically, EPA, states, and municipalities have focused on meeting each Clean Water Act requirement separately, an approach that may have constrained communities from addressing the most serious water issues first. This technical assistance will help recipients meet Clean Water Act requirements for water management cost-effectively and in an environmentally beneficial wav.

"EPA is committed to helping communities meet their requirements and goals for water projects that benefit public health, the environment, and the local economy," says EPA Administrator Gina McCarthy. "Integrated planning provides the important flexibility that cities and towns need to address water challenges in an efficient and effective manner."

In June 2012, EPA issued a framework promoting an integrated planning approach after working closely with state authorities, local governments, water utilities, and environmental groups. In May 2014, 28 communities responded to EPA's request for letters of interest for technical assistance. EPA made its decision after evaluating the letters' consideration of several factors, including human health and water quality challenges, innovative approaches, community and national impacts, and commitment to integrated planning.

The communities selected are:

- Burlington, Vt. The city of Burlington proposed to evaluate its financial capability to fund an integrated stormwater and wastewater program; develop criteria for prioritizing community wastewater and stormwater needs based on social, economic, and environmental factors; develop a list of example projects that rank highly based on these criteria; and evaluate innovative methods of pollutant reduction.
- Durham, N.H. The town of Durham and the University of New Hampshire proposed to evaluate opportunities to consolidate wastewater and stormwater resources, develop a wastewater and stormwater funding strategy,

and develop a toolkit for tracking pollutant load contributions and reductions from wastewater and stormwater. • Santa Maria, Calif. The city of Santa Maria proposed to develop an asset management approach to prioritize investments, identify innovative approaches such as green infrastructure, and identify environmental and

- public health benefits. • Springfield, Mo. The city of Springfield, Greene County, and City Utilities of Springfield proposed to develop a decision analysis tool to prioritize investments. The tool will identify, characterize, and evaluate key pollutants and sources of water pollution.
- Onondaga County, N.Y. The Onondaga County department of water environment protection proposed to outline a process to engage stakeholders and identify, evaluate, and select stormwater and wastewater projects. These five projects will provide examples of how communities can develop integrated plans to address Clean Water Act permits. The projects will also provide useful information and transferable tools for other communities interested in integrated planning.
- More information is available at water.epa.gov/polwaste/ npdes/stormwater/Integrated-Municipal-Stormwaterand-Wastewater-Plans.cfm.

DRAFT STORM SEWER GENERAL PERMIT FOR SMALL MASSACHUSETTS **MUNICIPALITIES**

David Deegan, EPA News Release

EPA is releasing for public comment a draft general permit for small "Municipal Separate Storm Sewer Systems" (MS4) in Massachusetts. The new permits, when finalized, will update efforts in up to 260 municipalities, better protecting rivers, streams, ponds, lakes, and wetlands across Massachusetts.

EPA previously released draft general permits for small MS4s in Massachusetts in North Coastal watersheds in 2010 and in the Interstate, Merrimack, and South Coastal watersheds in 2011. In response to many of the public comments submitted previously and the availability of new technical and census information, EPA has revised the two general permits into one document and is now releasing the revised draft general permits for public input. EPA has also modified the newly proposed draft permit in response to public comments seeking more clarity, guidance, and flexibility in meeting permit requirements.

Regulated MS4s include traditional cities and towns, state and federally owned facilities such as universities and military bases, and state transportations agencies. The general permits will apply to all MS4s in an urbanized area as defined by the 2010 census. The previous permit applied to MS4s located in an urbanized area based on the 2000 census.

Two hundred and sixty municipalities are in urbanized areas as defined in the 2010 census, of which 17 are potentially eligible for waivers from the permitting requirements. Waiver eligibility is based on the population within the urbanized area (less than 1,000) and the municipality's potential to contribute pollutants to an interconnected MS4 or an impaired water. EPA expects to receive completed waiver requests soon, and will review and respond to them. EPA will release an individual permit for Massachusetts Department of Transportation's (MassDOT's) highway division later this year. Other MassDOT divisions are eligible for the general permit.

The draft general permits require regulated small MS4s to develop, implement, and enforce a "stormwater management program" to control pollutants to the maximum extent practicable, protect water quality, and satisfy appropriate requirements of the Clean Water Act. The draft permit requires implementation of six minimum control measures, which include illicit discharge detection and elimination, public education and outreach, public participation, management of construction site runoff, management of runoff from new development and redevelopment, and good housekeeping in municipal operations. The draft permit also includes requirements that address waste load allocations associated with approved total maximum daily loads (TMDLs) for bacteria, phosphorus, and nitrogen, and requirements that address discharges to impaired waters without an approved TMDL.

The requirements contained in this draft permit build on the requirements of the previous general permit issued in 2003. The draft permit identifies four target audiences for public education, details specific procedures to locate and remove illicit connections, encourages low-impact development, and identifies practices to address nutrients, bacteria, chloride, sediment, metals, and oil and grease. EPA has provided a suggested format for the notice of intent information that can be submitted electronically, and will provide templates for the stormwater management program and the annual reports.

EPA has estimated the costs of implementing the minimum control measures but does not have sufficient information to reasonably estimate those associated with achievement of water quality-based limitations. Actual municipality costs will vary depending on a number of factors, including population (1,000 to 150,000), resources, infrastructure (number of catch basins, road miles), size of the urbanized area, and work completed during the previous permit term. As drafted, EPA estimates the cost of implementing the six minimum control measures to be between \$78,000 and \$829,000 per year averaged over the permit term.

To help commence protection of these coastal waters, EPA also announced grant funding of \$728,559 to the Massachusetts Office of Coastal Zone Management (CZM) (Buzzards Bay National Estuary Program) to fund six subawards in the Buzzard's Bay watershed and \$723,869 to the host agency for the Narragansett Bay Estuary Program—the New England Interstate Water Pollution Control Commission EPA received more than 500 comments on the draft permits (NEIWPCC)—to fund six sub-awards in the Narragansett first issued in 2010 and 2011, and has modified the current draft Bay watershed. A list of these projects can be found on the permit in response to many of the submitted comments. Some websites for the Buzzards Bay and Narragansett Bay Estuary changes include: programs (see end of this article for website links).

- Additional time for completion of required tasks
- Opportunities for optimizing activities such as catch basin cleaning rather that mandating a set frequency
- Reduction in the required frequency of street sweeping
- Reduced costs of monitoring by allowing use of field test kits
- Provisions to address approved TMDLs
- Clarification of requirements for discharges to impaired waters

The notice of availability of the general permit was published in the Federal Register on September 30, 2014. The public comment period is 90 days, ending on December 29, 2014. A public hearing was held on November 19, 2014, in Leominster. EPA also hosted a series of public meetings. including one on October 28 in Haverhill, to explain the permit requirements and answer questions. Other public information meetings have been scheduled. The draft general permit, a fact sheet, and information on public meetings and the public hearing can be found at epa.gov/region1/npdes/ stormwater/MS4 MA.html.

EPA APPLAUDS CREATION OF SOUTHEAST NEW ENGLAND COASTAL WATERSHED RESTORATION PROGRAM

David Deegan, EPA News Release

On October 15, 2014, EPA joined state and local dignitaries to formally launch the Southeast New England Coastal Watershed Restoration Program. The new program will promote a broad ecosystem approach to protecting and restoring the coastal watersheds of southeast New England (coastal areas from Westerly, R.I., to Chatham, Mass., including all waters of Rhode Island, southern Cape Cod, Narragansett Bay, and Buzzards Bay). The program, consisting of government and non-government organizations, is working collaboratively and innovatively to maintain and improve water quality and habitat conditions within these coastal watersheds.

In collaboration with a range of stakeholders, the program will develop and promote innovations in restoration and protection, develop new, more efficient technologies, and apply new policies to these new approaches. A critical element of this program will be to prepare for climate change impacts and highlight the need to build resilience into all decision-making. Partners include key federal and state resource agencies, local organizations, and the two local national estuary programs in Narragansett Bay, R.I., and Buzzards Bay, Mass.

In addition, EPA has allocated \$500,000 in technical assistance funds to develop preliminary stormwater best management practice (BMP) designs in Barnstable and Chatham, Mass. The two Cape Cod communities will help develop and pilot designs, including an innovative stormwater BMP that will tie into existing infrastructure and treat stormwater for both pathogens and nitrogen. Based on technical feasibility and total cost, one of these communities will be selected to construct the BMP. The goal is to develop a stormwater BMP that can be shared with other New England communities.

The program will work with stakeholders to develop an overall planning framework and action agenda that builds on and complements the planning and implementation capacities of the numerous entities engaged in this area. By integrating habitat, water quality, and physical processes as parts of a complete whole, the Southeast New England Coastal Watershed Restoration Program will serve as an ecosystem framework for thinking and acting regionally. The goal is to collaborate to share best practices, maximize resources and opportunities, and build local program capacity to sustain this unique approach over the long-term.

For more information, see the Southeastern New England Coastal Watershed Restoration Program at epa.gov/region1/ snecwrp.

For lists of projects funded by EPA, go to:

- Buzzards Bay Program's website: restore.buzzardsbay.org/ restoration-funding.html
- Narragansett Bay Estuary Program's website: nbep.org/ index.html

THREE RHODE ISLAND GRADUATE STUDENTS AWARDED EPA GRANTS FOR **ENVIRONMENTAL RESEARCH PROJECTS**

David Deegan, EPA News Release

Three graduate research students in Rhode Island will receive fellowship grants to assist with their research projects, under EPA's Science to Achieve Results (STAR) program. The students include two from Brown University and one from the University of Rhode Island.

The funded projects are among approximately \$8.6 million being awarded nationally to 105 graduate students. The 105 STAR fellows will receive a maximum funding of \$42,000 for one year (for master's students) or \$84,000 for up to two years (for doctoral students). In addition to the students selected from R.I. schools, nine students were also selected from other New England universities or institutes for STAR fellowships, including from Boston University, Harvard University, Woods Hole Oceanographic Institution, and Yale University.

"EPA is very pleased to provide modest investments in the future of our next generation of scientists and engineers who will help us find cost-effective, sustainable solutions to environmental problems," says Curt Spalding, regional administrator of EPA's New England office. "New England has always been a leader in developing and employing forward-thinking responses to environmental concerns. These students are the next generation of that proud tradition."

The research projects supported by the EPA STAR fellows funding at Brown University are, "Carbon Nanomaterials as

Environmental Sorbents: Friend or Foe?" (\$84,000 grant), and "Spartina Alterniflora in a Changing Climate: Implications of Rising Temperatures for Salt Marsh Persistence" (\$84,000 grant).

The research project supported by the EPA STAR fellows funding at the University of Rhode Island is, "Impacts of Elevated CO2 and Nutrients on Marine Communities and Trophic Interactions" (\$84,000 grant).

Federal agencies have prioritized supporting science, technology, engineering and mathematics (STEM) through education initiatives unique to their agency's mission, vision, and resources. EPA recognizes the need for a commitment to STEM disciplines, especially in environmental areas, and has supported this effort through the STAR and Greater Research Opportunities Fellowship programs.

Graduate students involved in critical and cutting-edge environmental science and research opportunities have benefitted from the STAR fellowship program for almost two decades. Since the program's inception in 1995, it has awarded fellowships to 1,884 students, totaling approximately \$65 million in funding, demonstrating EPA's commitment to supporting students interested in environmental science.

VERMONT STUDENT TEAM WINS GRANT FOR ENVIRONMENTAL PROJECT

David Deegan, EPA News Release

A student team from Norwich University in Northfield, Vt., is among five teams in New England chosen by EPA to receive up to \$15,000 to pursue projects that deliver sustainable, alternative methods of addressing environmental challenges. The team at Norwich University won the funding for a project to re-design pervious, or permeable, concrete to harvest and filter storm water runoff contaminated by organics, nutrients, and metals, and convert it to meet drinking water quality standards. The project is called "Pervious Concrete Filters for Sustainable Water Resources Management."

In addition to Norwich University, four other New England schools—Bridgewater State University, University of Massachusetts-Lowell, Worcester Polytech Institute, and the University of Connecticut—were among 42 colleges nationwide that had teams selected for EPA's annual People, Prosperity and the Planet (P3) student design competition. Since 2004, the P3 Program has provided funding to student teams in all 50 states and Puerto Rico, committing more than \$10 million to cutting-edge, sustainable projects designed by university students. Projects this year include sustainable alternatives to reduce traffic congestion, extension of the growing season for farmers by heating greenhouses with biomass, and environmentally friendly flame retardants.

Funding for the P3 projects is divided into two phases. In the first phase, student teams submit a proposal for a project, and if they are selected, they compete with other Phase I winners at the National Sustainable Design Expo in Washington, D.C. At the Expo, teams compete for Phase II funding of up to \$75,000.

For more information go to:

- 2014 P3 Phase I Projects: epa.gov/ncer/2014P3grantees
- EPA's People, Prosperity and the Planet (P3) Program: epa.gov/ ncer/p3

WATER QUALITY IMPROVES IN LONG ISLAND SOUND

John Martin, EPA Region 2, EPA News Release For the second summer in a row, concentrations of dissolved oxygen in Long Island Sound were higher than the long-term average, indicating improved water quality and ecological conditions for organisms. In recent years, Connecticut and New York State have worked with EPA to implement a nitrogen pollution reduction plan to improve the Sound's dissolved oxygen levels and protect aquatic animals and public health. Much of the improvement in water quality is attributable to wastewater treatment facility upgrades and other measures that reduce nitrogen pollution to the Sound.

"The work New York, Connecticut, local governments, and EPA have done to build and upgrade sewage treatment plants has significantly reduced the nitrogen going into Long Island Sound," says Judith A. Enck, EPA Region

2 administrator. "We need to make financial investments in sewage treatment plants, and work to reduce pollution from septic systems and fertilizers, which also degrade water quality in Long Island Sound."

"We hope the trend of improved dissolved oxygen levels in Long Island Sound continues, adds Curt Spalding, regional administrator of the EPA's New England office. "Investments in clean water are essential to a healthier ecosystem, which also contributes to more resilient and economically vibrant communities."

In 2000, Connecticut and New York State developed a plan that contains a TMDL to reduce the daily discharges of nitrogen by more than 58 percent from levels discharged in the early 1990s. Connecticut has reached its nitrogen reduction target for wastewater treatment facilities, and New York is expected to reach its target by 2017. In 2013, Connecticut and New York wastewater treatment facilities in the Long Island Sound basin discharged 35 million fewer pounds of nitrogen compared to the amount discharged annually in the early 1990s.

In 2013, the area of hypoxia was the third smallest since 1987. But in 2012, the area experienced one of the most severe years on record. While there is a general trend of improvement over the last decade, the difference between conditions in 2014 and 2012 highlights the high variability in hypoxia caused by factors such as temperature, wind, and precipitation.

The water quality information discussed above comes from samples collected and analyzed by the Connecticut Department of Energy and Environmental Protection's Long Island Sound water quality monitoring program, the University of Connecticut's Long Island Sound Integrated Coastal Observing System, and the Interstate Environmental Commission's Long Island Sound water quality monitoring program. The Long Island Sound Study provides funding support for each of these programs. To see a chart with the year-by-year measurement of the hypoxic area of the Sound since 1987, visit longislandsoundstudy.net/indicator/area-of-hypoxia.



LONG ISLAND SOUND STUDY

LOCAL GOVERNMENT ADVISORY **COMMITTEE WEIGHS IN ON PROPOSED** WATER RULE

David Deegan, EPA News Release

EPA's local government advisory committee (LGAC) met in Worcester, Mass., to provide input on EPA's proposed rule clarifying Clean Water Act jurisdiction.

The public meeting let local officials and stakeholders express concerns and ideas to LGAC's Protecting America's Waters work group, which will work with the full committee to develop formal recommendations to EPA.

EPA Administrator Gina McCarthy has charged the LGAC to give advice and recommendations on important issues affecting the jurisdictions of locally elected and appointed officials. Previously, LGAC has made formal recommendations to EPA on issues from climate change resiliency and air quality to worker protection standards.

EPA's proposed rule clarifies protection for streams and wetlands. The proposed definitions of waters will apply to all Clean Water Act programs. The proposed rule, released on March 25, 2014, is of interest to local officials who are often in charge of implementing Clean Water Act provisions in municipalities and other jurisdictions. Because of the scope of the proposed rule, the public comment period was extended by an additional 90 days to October 20, 2014.

LGAC provides advice and recommendations that help EPA develop a stronger partnership with local governments, as well as building state and local capacity to deliver environmental services and programs. Its goal is to provide citizens with more efficient and effective environmental protection at community, state, and federal levels.

More information:

- EPA's proposed Waters of the U.S. rule: epa.gov/uswaters
- EPA's local government advisory committee: epa.gov/ocir/ scas_lgac/lgac_index.htm



FEATURE

Stormwater and industrial wastewater treatment integral to Johnson Controls environmentally friendly battery recycling center

PAUL SINISGALLI, P.E., CDM SMITH, CAMBRIDGE, MA JO ELLEN TRUEBLOOD, CDM SMITH, COLUMBIA, SC TIM LAFOND, JOHNSON CONTROLS, FLORENCE, SC

ABSTRACT | Johnson Controls' state-of-the-art lead-acid battery recycling center in Florence, S.C., recycles 132,000 metric tons per year, or the equivalent of more than 14 million automotive batteries. Management of industrial wastewater and potentially contaminated stormwater was integral to ensuring this facility had minimal environmental impacts on the community. Plant water is managed through two, co-located liquid treatment systems that collect and treat industrial process wastewater and the site's contaminated stormwater runoff. An intelligent design and well-orchestrated design-build delivery approach for an integrated facility addressed several project challenges, including an aggressive schedule—the facility was online within 10 months—a difficult geology, variable wastewater properties and a strict budget. With long-term reliability in mind, the flexible design allows treatment capacity to be easily expanded to 105,000 gallons per day (397,500 liters per day) if it is needed to meet future demand. Since going online, the facility has consistently met effluent permit limits and has been highly praised by Johnson Controls and the local control authority during inspections. This paper will address several key design, operational, and staffing elements critical to successful plant operations on a highly variable waste stream (at times significantly different from the design for influent wastewater) as well as operational challenges and the response to those challenges.

KEYWORDS | Industrial process wastewater, lined impoundment, pretreatment, clarification, multi-media filtration, stormwater, water reuse



OVERVIEW

The Johnson Controls lead-acid battery recycling center in Florence is essential to the company's commitment to manage and minimize its environmental impact and improve its competitive position. The recycling center's dual treatment system collects and treats its industrial process wastewater and the site's stormwater runoff. To meet permit limits for safe discharge, the wastewater treatment system treats the center's process effluent with chemical pretreatment and pH adjustment, clarification, and sand filtration. A portion of the treated effluent is reused onsite, with excess discharged to the publicly owned treatment works. The advanced system provides a flexible approach to treating a variable wastewater using an equalization (EQ) storage tank to first store wastewater where it may be tested, allowing the operators to adjust pre-treatment chemicals for treatment optimization.

To accommodate the site's complex hydrology, the facility's foundation and 105,000-gallon (397,500-liter) wastewater EQ tank can withstand potentially extreme settlements from a seasonally high groundwater table, extensive clay deposits and perched groundwater. Contaminated stormwater is settled in a lined impoundment, treated by multi-media filtration and used as the primary make-up source for the site's air pollution control scrubbers. Additionally, the impoundment's underdrain system prevents liner floatation by reclaiming seasonal high groundwater for treatment and reuse water throughout the facility. The design-build team provided startup services, operator training, and an operations and maintenance manual, and is providing the facility's supervising operator.

COMMITMENT TO WATER REUSE

The integrated treatment system collects and treats the center's industrial process wastewater and the site's stormwater runoff, protecting the environment, providing for water reuse, and reducing dependence on municipal and groundwater supplies. To protect the scenic Great Pee Dee River, Johnson Controls



Stormwater is collected and stored in a 2.3-milliongallon (8.7-million-liter) high-density polyethylene-lined impoundment, with an underdrain system that prevents floating of the liner by reclaiming and pumping seasonal high groundwater into the impoundment



A stormwater and industrial wastewater treatment system supports Johnson Controls' lead-acid battery recycling

made a commitment that the recycling center would not discharge stormwater. The stormwater treatment system—built to contain a 100-year storm event—meets the unique zero discharge requirement by collecting stormwater from factory roofs, scrubber pads, and pavement. Stormwater from the roofs goes to a 2.3-million-gallon (8.7-million-liter) high-density polyethylene-lined lined impoundment for treatment and reuse, while stormwater from clean pavement and other areas goes to unlined ponds for groundwater recharge.

PROJECT AWARDS

- 2013 National Design-Build Award from the Design-Build Institute of America in the Water/Wastewater Category
- 2013 Excellence in Environmental Engineering Grand Prize Award from the American Academy of Environmental Engineers and Scientists (AAEES) in the
- 2013 W. Wesley Eckenfelder Industrial Waste Management Medal from AAEES

Approximately 23,000 gallons per day (gpd) [87,000 liters per day (Lpd)]—30 to 40 percent of influent flow—of treated wastewater effluent is reused for wheel washing, facility cleaning, and toilets—daily displacing 6,000 gallons (22,700 liters) of municipal potable water and 17,000 gallons (64,350 liters) of groundwater from the onsite well field. An additional 35,600 gpd (134,760 Lpd) of stormwater is treated and reclaimed, primarily for scrubber makeup water that is subsequently discharged to and treated by the industrial wastewater treatment system. The impounded water is treated—on demand—for debris and potential lead contamination with basket strainers and multimedia sand filtration. This reclaimed stormwater surpasses groundwater quality and reduces spray nozzle maintenance.

STORMWATER SYSTEM DESCRIPTION

The stormwater from the process building roof drains and scrubber system containment berms is captured in the in-ground lined impoundment, with



Impounded water is treated on demand for debris and potential lead contamination with basket strainers and multimedia filtration, and used as scrubber make-up water. Treated water surpasses existing groundwater quality and reduces spray nozzle maintenance.

flow occurring by gravity. The lined impoundment bottom is keyed into a clay layer with a peripheral and side slope underdrain system. The underdrain system is pumped as required by a submersible pump to maintain equalized local groundwater level and water level in the lined impoundment.

Roof drainage can contain accumulated lead particles from smelting that have settled on the roof areas. This collected water is pumped from the lined impoundment to the wastewater treatment plant (WWTP) for processing in a dedicated treatment multi-media system and is reused in the site air pollution control scrubbers or can be sent to the municipal wastewater treatment plant if the main facility is shut down and the lined impoundment is full (rare occurrence). Pumps can operate at up to 180 gallons per minute (gpm) (681 liters per minute (Lpm)). The plant sends from 30,000 to 50,000 gallons (113,560 to 189,270 liters) of water to the scrubbers daily. Of this, less than 30,000 gpd (113,560 Lpd) is returned to the process wastes.

Treatment consists of pumping through basket strainers and then two pressure filters (sand, anthracite and garnet), removing most particulates and thereby preventing fouling of scrubber spray nozzles. Filtered water is stored in a 2,000-gallon (7,570-liter) tank from which it is pumped to the scrubbers in the manufacturing building. If there is insufficient stormwater to meet scrubber demand, well water is added to the 2,000-gallon (7,570-liter) tank.

WASTEWATER TREATMENT SYSTEM DESCRIPTION

The wastewater treatment system is installed in a 60-foot-wide by 100-foot-long (18.3-meters-wide by 30.5-meters-long) building, with 18-foot (5.5-meter) clear interior space. The system is designed for and will normally operate at up to 150 gpm (570 Lpm),

allowing treatment of up to 72,000 gallons (272,550 liters) per 8 hours of operation. Current flows consist of an average of 63,300 gpd (239,600 Lpd) of process-related flows with a maximum day flow of 85,800 gpd (324,790 Lpd). On average day conditions, an estimated 52,200 gpd (197,600 Lpd) is discharged to the publicly owned treatment works (POTW) following pretreatment up to 92,300 gpd (349,390 Lpd) on maximum day assuming no reuse. The primary contaminants of concern in the wastewater are lead, zinc, iron, and antimony.

System components

Process wastewaters are conveyed to the WWTP by a gravity sewer discharging to an underground pump station (large manhole). The wastewater is pumped to a rotary screen mounted on an outside platform at approximately 18 feet (5.5 meters) above grade to allow gravity drainage to the above-ground 105,000-gallon (397,500-liter) EQ tank. The pumps are rail mounted to facilitate retrieval for maintenance. The rotary screen removes debris upstream of the EQ tank obviating the need to install a bar rack in a deep wet well. The EQ storage tank allows plant operators to test wastewater influent and adjust pre-treatment chemicals for treatment optimization. The EQ tank volume is mixed using a pulse air mixing system.

The treatment system accommodates up to 5,000 gpd (18,930 Lpd) of dilute electrolyte (high TDS, low pH) in case the evaporators in the manufacturing building cannot process all dilute electrolyte wastes generated. Dilute electrolyte is considered the only source of strong acid (sulfuric acid)-bearing wastewater to the WWTP. This acidic waste is pumped directly from the battery break facility to a 10,000-gallon (37,850-liter) storage tank outside the WWTP. From the storage tank, the dilute electrolyte is pumped at a metered rate directly to the treatment train. Feeding this material into the WWTP at a controlled rate saves money on expensive off-site treatment and reduces the amount of waste manifested off-site for treatment and disposal. Dilute electrolyte is normally received only intermittently during an evaporator shut-down or an unexpected large inventory of dilute electrolyte waste.

Chemical addition to the treatment train occurs in five sequential tanks, each with an agitator:

- **1. Ferric salt addition**, along with any dilute acid electrolyte.
- 2. pH adjustment stage 1 for "coarse" control. One of the sodium hydroxide metering pumps feeding this tank is large enough to accommodate the extra demand from electrolyte. This tank has both mechanical agitation and the option for air mixing if a ferrous salt is substituted for ferric. The operators can "seed" this tank with sludge from the sludge holding tank to improve solids contact and floc growth.



To meet permit limits for safe discharge, the wastewater treatment system treats the recycling center's process effluent with chemical pretreatment, clarification, and multi-media filtration: 1. Dilute electrolyte, 2. pH adjustment, 3. Clarifier, 4. Multi-media filtration

- **3. pH adjustment stage 2**, for "fine" control. This tank offers the option for air mixing. A sulfur chemical can also be added to this tank if required to enhance metals precipitation.
- **4. Rapid mix tank** to disperse a high molecular weight anionic flocculation polymer. This tank, part of the plate clarifier package, has a retention time of less than 1 minute at design flow.
- **5. Slow mix flocculation tank**. This tank is part of the plate clarifier package.

The plate clarifier has two air-operated plastic double diaphragm sludge pumps, one for sludge wasting to a holding/decant tank and one for sludge recycle to the stage 1 pH adjustment tank. The clarifier is mounted in a "cellar" to allow gravity flow from the ferric addition tank through the other chemical addition tanks and into the clarifier. The clarifier is followed by an effluent/filter feed tank and three multi-media filters, of which two filters are normally in service while the third is in back wash or standby mode. Back wash includes both air scour and water steps.

A filtrate tank and pump supplies back wash water to both the process wastewater and stormwater dual media filters. The storage tank also supplies the water to a separate reuse duplex pump station. A filtrate pump station with duplex pumps and variable speed motors supplies reuse water to hoses, truck wash, and other components. Pressure transducers on the pump discharge modulate pump speed to provide constant head at variable flow rates for an intermittent and variable demand.

A sludge treatment system includes a holding tank with decant nozzles, two air-operated metal doublediaphragm sludge pumps, and a recessed plate filter press with gasketed plates for cloth mounts. The press frame, initially supplied with sufficient plates for 20 cubic feet (0.6 cubic meters), provides maximum volume of 25 cubic feet (0.71 cubic meters) of sludge cake capacity per press cycle. This allowed completion of a sludge batch approximately once per week during the initial year of operation. The filter press is mounted on a platform with sufficient height to insert and remove low-profile roll-off containers underneath. Sludge is recirculated to the smelter facility for metals reclamation.



The sludge treatment system includes a holding tank with decant nozzles, two air-operated metal double-diaphragm sludge pumps, and a recessed plate filter press (shown in foreground)

Support equipment includes:

- A positive displacement blower with a noisereducing enclosure to supply 6 to 8 psig (0.4 to 0.6 bar) air to the multi-media filter air scour steps, and if necessary, to the pH adjustment tanks for iron oxidation.
- An air compressor with a 120-gallon (454-liter) tank, drier and noise-reducing enclosure to supply 100 psig (7 bar) air to the air-operated sludge pumps, filter press and EQ tank pulse air mixing system, as well as instrument air.
- Chemical storage tanks each with a 6,000 gallon (22,710 liter) capacity and metering pumps for ferric solution and sodium hydroxide, each with dedicated secondary containment.
- A batch dilution system for the emulsion form of anionic polymer and associated metering pumps.
- A metering pump, drawing from a drum or tote to feed the sulfur chemical.

PROJECT DELIVERY

The project was delivered through a design-build approach, accelerating implementation of the separate wastewater treatment facility, and allowing it to be designed, constructed, and online within 10 months—prior to the battery recycling center startup. Three-dimensional digital modeling gave Johnson Controls the opportunity to be involved throughout the design process, allowing for simplified coordination checking and ease of construction for the mechanical subcontractor.



3D modeling allowed Johnson Controls to be involved throughout the design process



Construction was accelerated by installing all equipment, such as these two-stage pH adjustment tanks, after pouring the building's slab and erecting the steel framing, but prior to affixing the building panels

design review, the project team identified several necessary technical elements, not included in the original scope, which were subsequently assigned to the team and successfully incorporated into the design and procurement to

At the 30-percent

and procurement to meet the aggressive construction schedule. Scope changes during design included:

- Simplifying the stormwater impoundment system as a value engineering item
- Adding a raw wastewater pump station to accommodate the division by Johnson Controls of overall project scope among project constructors
- Adding a concentrated waste management system to allow for more economical management of some liquid wastes
- Increasing the capacity of the stormwater reuse system to reflect changes in the air pollution scrubber system water demands

Speeding implementation was a carefully coordinated construction schedule that called for all major equipment to be installed directly after building slab completion and framing erection and prior to wall panel installation. Additionally, schedule coordination allowed the various building trades to complete their work in a small footprint while avoiding conflicts.

OPERATIONAL CHALLENGES

Many operational challenges arose during design and construction. One challenge was the significant change in influent characteristics. It was realized that the battery recycling facility needed to recirculate water to a higher degree than originally anticipated. By wasting some of this flow, the individual units would perform better. This meant, however, that the wastewater strength increased, and operators had to rely more heavily on a sulfur-based chemical that would remove lead at lower pH values instead of using the normal metals precipitation process. Changes in influent flow included:

Design-build enabled the treatment facility to be installed and online

prior to the recycling center's startup

- Increase in volume of flow. Originally the facility was permitted to take up to 100,000 gallons (378,540 liters) per day as a daily max and a monthly average of 70,000 gallons (264,980 liters). This has been increased to 150,000 gallons (567,810 liters) max day and 100,000 gallons (378,540 liters) average day, respectively.
- Higher than 10 ppm lead (design basis). Up to 25 ppm lead could be treated if it was sent through slowly. To do this, the dilute electrolyte tank was used to also accept high lead wastes. Up to 10,000 gallons (37,850 liters) of this waste is collected in that tank and slowly introduced into the feed train.
- High salt content. TDS values in the range of 60 to 150 thousand parts per million were destroying the floc. Testing determined that if this water was sent very slowly, and dilution water was added, it could be handled in short intervals.

Another challenge was high (or low) pH water being sent to the wet well in error. Thus, acid (or caustic) waste, once released, had to be pumped to the EQ tank. It was decided during construction not to include pH adjustment in the EQ tank. The facility is rethinking this approach, possibly adding chemical feeds for adjusting wastewater pH sooner.

It is suspected that the unexpected low pH and high TDS caused some bolts to break loose in the EQ tank aeration (mixing) system. A couple of the aerators are floating on top of the water instead of bolted to the bottom. This will require a plant shutdown or bringing in a temporary storage tank to use while repairs are made. The facility is deciding which approach is preferred.

Additional challenges included the following:

- Anthracite was being lost from one of the multimedia filters. Changing the backwash procedure to allow air scouring with water eliminated this loss.
- The air release valve burp on the multimedia filters and part of the backwash cycle were spilling on the floor. The technicians had to

squeegee spillage into the drain. This has since been piped to the drain trough which drains to a sump and is pumped back to the EQ tank.

• The facility was asked to take some refinery waste slurry for a few months. The lead content was more than 300 ppm. It was determined that if it was filtered, the filtrate would pose no problem for pretreatment. Therefore, the supervising operator suggested pumping this material into the sludge holding tank and running it through the filter press (J-Press). That allowed the lead-containing solids to be dewatered and then taken to the furnace for lead reclamation. Approximately fifty 500-gallon (1,890-liter) totes were processed in this manner.

The design-build team provided startup services, operator training, and an O&M manual to help ensure the quality operation and compliance of the highly efficient system. A supervising operator from the team was provided for the treatment facilities through September 2013 start-up. Johnson Controls has since decided to continue with an outside supervisor at the site for continuity and quality control.

The wastewater treatment facility has been in compliance since the recycling center's startup, even surpassing performance requirements when it successfully treated components well above design parameters during testing and commissioning. Operational highlights, in addition to the challenges that were overcome as described above, include the following:

- The entire process worked exceptionally well for what it was designed to treat. The lead was precipitated out at the optimum pH value and was returned to the main facility for removal as cake in the furnaces.
- The treatment system allows the ability to recycle the water back to the EQ tank if it doesn't meet certain criteria, a capability not many pretreatment systems provide. Providing this capability allows further treatment to ensure permit compliance before discharge.
- The technicians hired to operate the pretreatment plant were easy to train and learned the process in a short time. Although training is regularly refreshed, and these personnel also remain open to new suggestions; their willingness to learn is commendable.

SUMMARY

Johnson Controls' battery recycling center is an important advancement in the company's commitment to manage and minimize its impact on the environment and strengthen its competitiveness. Essential to the center is an integrated stormwater and wastewater treatment and recycling system that employs modern controls to protect the public and the environment from exposure to contaminants



Implemented through a design-build approach, the facility treats process wastewater, generated by the recycling facility, to meet permit limits for safe discharge to the city's sewer system and ultimately the publicly owned treatment works. The facility also collects stormwater, from roofs and other nonroofed areas, in an impoundment for treatment and reuse, ensuring zero liquid discharge. Collectively, the system allows Johnson Controls to protect the environment, benefit from water reuse and reduce its dependence on municipal supplies.

ABOUT THE AUTHORS

- Paul Sinisgalli, a vice president with CDM Smith, was project manager for the pretreatment facility project described in this paper. Mr. Sinisgalli has 40 years of experience in facility engineering, industrial wastewater treatment plant design, industrial process water treatment systems, and hazardous waste remediation. He has designed industrial wastewater treatment systems, process buildings and associated utilities, cooling towers, RCRA waste tank farms, and hazardous waste incineration facilities.
- Jo E. Trueblood, an operations specialist at CDM Smith, was the senior supervising operator for Johnson Controls' pretreatment facility project.
 Ms. Trueblood has 25 years of experience in the water, wastewater, and industrial waste field. She is licensed at the highest level for water treatment, water distribution, biological wastewater, physical/chemical wastewater and voluntary wastewater collection.
- Timothy Lafond is the executive director of environmental engineering and risk management for Johnson Controls, Inc., power solutions division. Since joining the firm in 1995, Mr. Lafond has provided leadership in all areas of worldwide environmental compliance and manufacturing facilities engineering support. Mr. Lafond was awarded the W. Wesley Eckenfelder, Jr. medal by the American Academy of Environmental Engineers and Scientists for the design of the battery recycling facility's stormwater and wastewater treatment systems described in this paper.

Startup services, operator training, and an O&M manual were provided by the design-build team to aid in the quality operation of the highly efficient system



The power plant triple bottom line reclaimed water for cooling water and process water systems

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ABSTRACT | The reclamation of treated municipal wastewater for power plant cooling water systems is an important sustainability principle due to stresses being placed on aquatic habitat, potable water systems and consumptive use. This is in fact a triple bottom line advantage since reclaimed water that is recycled for power production is the definitive example of the energy-water nexus. This paper presents three case studies for reclaimed municipal wastewater for power plant cooling and process water systems.

KEYWORDS | Reclaimed wastewater, municipal secondary effluent, water quality, cooling towers, process water, biological treatment, filtration, disinfection, biological aerated filters, cloth disk filters, sustainability



A modern 920-MW combined cycle natural gas-fired power plant

INTRODUCTION

Our nation's thirst for power is growing much faster than our thirst for water. This change has occurred since around 1980 when changes in water use peaked at approximately 440 billion gallons per day (1.67 trillion liters per day). Figure 1, Electricity Production and Consumption 1949-2009 (EIA 2011), and Figure 2, United States Water Use 1950-2005 (USGS 2005), depict this relationship and contrast power generation from thermal electric power plants with total consumptive water use. Water use has dropped due to conservation, irrigation, reduced industrial activity, and reclamation. In many regions the power industry uses up to 80 percent of the surface water withdrawal. This practice is not sustainable and, in fact, increases the conflict among water needs. The interest in the use of reclaimed water from a municipal wastewater treatment plant (WWTP) for power plant cooling water, boiler feed, and other consumptive uses is a growing practice, and new treatment systems continue to be designed and constructed. Advanced wastewater treatment, including nutrient, suspended solids, and biochemical oxygen demand removal, disinfection, and adjustment of feed water characteristics, is normally required to meet the water-quality objectives for the power infrastructure.

WATER QUALITY AND DESIGN CHALLENGES

Developing the design criteria to meet water-quality requirements for cooling water systems is a complex and sensitive decision process due to the balance of site location-specific needs, including: cooling tower materials, raw water quality, finished water quality, National Pollutant Discharge Elimination System (NPDES) regulations, air permits, and other environmental factors. The U.S. Department of Energy's (DOE's) National Energy Technology Laboratory (NETL) determined that alternative sources of water for use at power plants, which included reclaimed water, are an innovative source of cooling water for electric-generating facilities (Veil, DOE 2007). Reclaimed water has taken favor because it is an economic and beneficial source substitution for potable water supplies. Water intensity can range between 100 to 480 gallons/MWh (380-1,800 liters/ MWh) for typical natural gas combined cycle plants and fossil fuel plants.

The advantages and challenges for using reclaimed water include:

- Thermoelectric power plants in the U.S. consume 200 billion gallons (757 billion liters) of water per day, approximately half of the nation's total water use (USGS 2005).
- Reclaimed water is often considered a viable candidate for use in power plants, especially for cooling water applications in overstressed watersheds and when secondary or advanced treatment facilities are nearby.
- Water-quality requirements for cooling water applications vary depending on the metallurgy used at the power plant. (Suspended solids, total dissolved solids (TDS), ammonia, and phosphorus are typically key parameters.)

TYPICAL WATER QUALITY REQUIREMENTS FOR COOLING WATER APPLICATIONS

Operation of the cooling tower using secondarily treated wastewater requires treatment to eliminate the threat of some human health concerns due to aerosol drift from the cooling towers. Many states do not have a requirement on this water quality other than that the cooling tower blow-down is required to meet discharge permit requirements and the processes that affect water quality. Some states have more restrictive requirements for disinfection and contact time that are used when guidance is not available from the regulatory agency where the facility resides. The tendency is to use a more restrictive treatment level when faced with a lack of information to obtain a standard of care in the design criteria.

Most often the raw water or secondary effluent is obtained from a municipal WWTP and may require biological treatment for further nitrification, and phosphorus and suspended solids removal. Use of



Electricity production and consumption



U.S. water use 1950–2005

Table 1. Typical requirements for cooling water quality		
Water Quality Parameter	Maximum Allowable Concentration in Reuse Water	Reason for Water-Quality Requirement
Ammonia	<1.0 mg/L NH₃-N	Two of the case studies required low levels of ammonia to guard against stress corrosion cracking copper/zinc alloy heat exchangers, and the third was due to ammonia in the influent fill to the cooling tower.
Chloride	Less than 100 mg/L as Cl (1,000 mg/L as Cl in recirculated water at 10 cycles of concentration)	Typical heat exchangers are constructed of 304SST, which is resistant to only 300 mg/L Cl.
Ortho-Phosphate	0.5 mg/L as P	High ortho-phosphate results in calcium phosphate scaling of heat exchangers.

soluble salts and metal salts can increase TDS and chloride levels, which can adversely affect permitting and/or process requirements. Although waterquality requirements can vary considerably between applications, common requirements include:

- Low ammonia (typically non-detect)
- Low TDS, especially for boiler feed applications
- Chloride less than 150 mg/L
- Low phosphorus (<0.5 mg/L) to limit calcium phosphate scaling in heat exchangers
- Low iron and manganese (<0.5 mg/L)

The advanced treatment of municipal secondary effluent normally includes biological, filtration, and disinfection processes. To control cooling tower water quality operators typically increase the cycles of concentration to vary the reclaimed water quality. Towers lose recirculating water to evaporation and aerosol drift, and through blow-down. This loss affects water quality.

BIOLOGICAL TECHNOLOGIES

The appropriate biological treatment process is a function of the raw water quality and proposed effluent requirements. Obviously, the treatment technology should be flexible and resilient enough to achieve the stated water-quality goals; however, in many cases selection of the appropriate technology has to be tempered and may be challenged by regulatory perceptions, cost factors, and owner preferences. The power industry is typically schedule-driven, such that the time to construct the process and commission the new facility is sometimes a factor. Another factor in the design of water treatment systems for power plants is that piloting is not at all common, whereas in municipal water systems

it is always done. This, of course, conflicts with the need to not over-design processes and increase costs. The following are technologies and approaches for biological treatment processes within power plants' reclaimed water systems:

- Upgrades to biological nutrient removal at the secondary WWTP: These process upgrades are typically due to separate nitrogen or phosphorus removal NPDES permit requirements by the regulatory agency.
- Side-stream biological processes:
- Integrated fixed-film activated sludge (IFAS). IFAS has been used for 20 years on municipal wastewater for nitrification and denitrification, and requires a clarifier. Effluent quality can be consistent but may also be prone to upsets.
- Membrane bioreactor (MBR). An MBR provides biological and filtration treatment in one process within a very small footprint, and has been used in several package reclaimed water systems. Effluent quality is typically consistent and excellent.
- Moving bed biofilm reactor (MBBR). Similar to IFAS, but without return activated sludge (RAS), an MBBR requires a clarifier and may not achieve water quality as high as IFAS or MBR due to flocculation and mixing of RAS.
- Biological aerated filter (BAF). BAFs can achieve a high level of nitrification and denitrification, and they have been used in several power plant reclaimed water systems. However, sloughing of the media may require clarification or filtration as a downstream process to capture total suspended solids carry-over.

The above processes are typically designed as an advanced wastewater treatment process at the power plant's water pretreatment plant site to better control water quality and operations. Supplemental treatment processes at remote locations such as the WWTP may be affected by water-quality changes through the conveyance system, or may be less likely to be controlled at a remote wastewater treatment site than within the power plant. Additionally, the correction of any water-quality issues at a remote site may take more time. For example, this type of problem in off-specification water quality was found at a facility with a supplemental treatment system during a BNR upgrade to the secondary WWTP. The entire 12 miles of reclaimed water conveyance pipeline needed to be flushed and discharged, and the incident required the power plant to be taken offline during necessary process adjustments.

FILTRATION TECHNOLOGIES

Filtration technology is common in power plant reclaimed water systems, and in several states is required by the state's department of environmental protection. It may be that even when regulatory



agencies do not specifically require filtration in their reclaimed water regulations, it is implicitly required due to air permit regulations and public perception. As an example, an East Coast power plant's reclaimed water process was required to include filtration in addition to chlorination to abate the presence of *enterococci* in cooling tower aerosols. The following are typical filtration technologies that have been used:

- Continuous backwash sand filters have been applied for more than 20 years in water reclamation applications. These systems eliminate the need for backwash equalization basins and, in some cases, may allow higher filtration rates.
- Cloth filtration, a relatively new technology, uses porous material such as perforated disks or cloth media as filtration media, with filtration taking place on the surface. Several cloth filtration installations are now in operation. Cloth disk filters have had challenges operating on poor-quality secondary effluents (low solids retention time), and are typically not applicable

Use of reclaimed water for power plant cooling water systems is an important sustainability factor, since for chemical phosphorus removal. stresses are continually being placed on aquatic habitats, potable water systems, and consumptive DISINFECTION uses. Sustainability in water resources requires Reclaimed water for industrial pretreatment that we consider the principles of embodied energy routinely includes disinfection even though it may when making decisions regarding the water cycle. not be required by the regulations. The addition of The value of recycled water includes the embodied disinfection to limit biological re-growth is a primary energy that is reclaimed from the water cycle. concern for equipment. Normally, a contact tank or Figure 3 depicts the principle of sustainability in service water tank is provided to achieve the desired water reuse (Wilson, WEF 2009). This figure depicts contact time for pretreatment, and disinfection is how the cumulative energy at the point of water achieved by sodium hypochlorite or chloramination. reuse shortens the natural water cycle to reduce the

Figure 3. Sustainability principle in reclamation

- Free chlorine disinfection provides a high degree of disinfecting power, and is a proven, costeffective disinfection process used in non-potable reuse applications. Recent concerns (in Arizona, California, and Florida) include trihalomethanes (THM) in NPDES discharges.
- Monochloramine disinfection is used at plants that do not provide full nitrification, and by some that need to meet lower THM limits. However, this increases N-Nitrosodimethylamine (NDMA) concentrations and is a less-powerful disinfectant.
- Preformed monochloramines minimize THM and NDMA formation. Preformed monochloramines have been implemented in at least one power plant reclaimed water system and are being tested at California and Arizona water reclamation plants.

SUSTAINABILITY AND EMBODIED ENERGY IN THE WATER CYCLE

embodied energy through a recycle loop that circumvents and substitutes for the energy intensity of the potable water treatment and distribution system.

The energy value chain associated with the embodied energy in the water recycling process is cumulative and significant. This, in fact, is a triple bottom line advantage since reclaimed water that is recycled for power production is the definitive example of the energy-water nexus.

CASE STUDY 1

East Coast 635-megawatt combined-cycle reclaimed water cooling water system

The case study is a 635-megawatt (MW), including 107 MW of duct firing capacity, combined-cycle, natural gas-fired power plant on the East Coast. The reclaimed water system includes cooling tower make-up water, feed-water to the ultra-filtration (UF) and reverse osmosis (RO) systems, and service water for heat recovery steam generator, evaporative cooler, and fire water system. Figure 4 depicts the major unit processes for the treatment train. The raw-water feed is taken from the WWTP to a pump



station, through a continuous up-flow sand filter and clearwell. Sodium hypochlorite is then added prior to the chlorine contact tank and cooling tower makeup water. The sand filter backwash is directed to the solids dewatering system, and supernatant is returned to the sand filter system.

Filtered water from the sand filter clearwell is directed toward the UF system and then to the service water tank and RO system. Backwash from the UF system is returned to the raw wastewater on its way into the sand filter. Monochloramines are added prior to, and into, the service water tank. The RO permeate is directed to a transfer tank and an ion exchange demineralized water system.

Much water-quality characterization and jar testing were completed prior to finalizing the unit process design for this project. One of the major equipment suppliers had been working closely with the owner and WWTP operator for a few years. Fortunately, this supplier expended significant time and resources to complete additional water analyses to guide the engineer in selecting the best

ble 1. Case Study 1—East Coast 635-MV	V
mbined-cycle raw feed water quality	

Parameter in Raw Feed Secondary Effluent	Avg. Raw Water Concentration*
Flow (gpm) / (Lpm)	6,200/23,500
Alkalinity (Bicarbonate)	60
Ammonia	1.2
Biochemical Oxygen Demand (BOD)	3.1
Chemical Oxygen Demand (COD)	22
Chloride	110
Iron	0.15
MBAS	0.07
рН	6.5-7.7
TDS	624
Total Organic Carbon (TOC)	4.3
TSS	8
Langlier Saturation Index (LSI)	-1.2

*(mg/L or gallons per minute)

unit processes to achieve the required water quality. Since a lot of the wastewater characterization was completed over an extended period, the supplemental water-sampling program was expedited and took only about 30 days to complete.

Discussion of raw water quality and effect on process selection

Since the raw secondary effluent ammonia was only about 1 mg/L NH_3 , and both biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were low, further biological treatment was not needed. Therefore, the initial treatment process for the reclaimed water was determined to be filtration. Several filtration systems were considered for the raw source water, including cloth disk filtration and two types of up-flow sand filters. However, a common type of continuous up-flow sand filter was selected, since it had been shown to provide adequate treatment on similar water quality for the process train followed by chlorine contact basins. The chloride, iron, TSS, and TDS concentrations were low and, therefore, the water was relatively easy to treat and required minimal chemical addition. Table 1 summarizes the raw water quality of the municipal wastewater effluent prior to treatment at the power plant's water pretreatment plant.

Lessons learned

A few design modifications and lessons learned for this relatively simple water-treatment system were required. A strainer was added between the up-flow sand filters and the UF system to capture some solids and colloidal material. Originally this was not included but was added due to the request of the UF manufacturer. This addition was needed since it captured some solids that escaped the sand filters. The UF backwash was routed to the inlet of the up-flow sand filters at a rate of approximately 2 minutes every hour and did not adversely affect water quality. The solids underflow from the sand filter to the equalization tank averaged 0.5 to 1 percent solids. This made pumping solids easy, and allowed the press filtrate to be equalized and blended with the plant outfall.

The process water system for the plant included RO followed by mixed-bed ion exchange to further polish the RO permeate. The ion exchange is regenerated onsite. A cartridge filter precedes the RO system and was included at the request of the manufacturer even though the cartridge filter has a larger passing size than the UF system. The RO reject includes the addition of sodium bisulfite injection. The sodium bisulfite feed is upstream of the RO booster pumps to lower chlorine to acceptable levels for the RO membranes. The remaining chlorine is neutralized by the bisulfite before going to the plant outfall.

The plant waste is not combined into a single neutralization tank, since pH adjustment is separated to the extent possible from chlorine neutralization. This reduces the size of the pH neutralization tank and system.

The plant has a large demineralized watertreatment system that is needed due to large variations in demand, since the power plant is designed to operate on natural gas as well as fuel oil. When the plant runs on fuel oil, the demineralized water system demand increases significantly for nitrogen oxide control.

Design criteria

The design criteria for the up-flow sand filters are shown in Table 2.

The existing up-flow sand filters are achieving effluent TSS in the 3 to 7 mg/L range, and are operating effectively for the downstream UF system and the chlorine contact basin.

CASE STUDY 2

East Coast 735-MW combined cycle

This case study is for a 735-MW, new 2-on-1 combined-cycle (2x1 CC) power plant with two heat recovery steam generators and one

plant



Figure 5. East Coast 735-MW combined-cycle water pretreatment plant

Table 2. Up-flow sand filter design criteria					
Parameter	Value	Notes			
Peak Flow, mgd	8.9	Peak flow 8.9 mgd (33.7 mLd); average flow 6.6 mgd (25 mLd)			
Peak Influent TSS, mg/L	20	Expected loading rate from municipal secondary effluent process			
Average Influent TSS, mg/L	10	Expected loading rate from municipal secondary effluent process			
Average Effluent TSS, mg/L	5				
Peak Hydraulic Loading Rate, gpm/ft2 (Lpm/m2)	4.75 (194)	With 24 units in service (one in standby)			
Number of Units	24 +1	50 sf/unit (4.65 sm/unit)			

steam turbine. The gas turbines use duct firing and evaporative coolers on their air inlets to increase power output. The cooling tower is used to cool the condenser cooling water. The supply to the power plant for all but potable uses will be secondarytreated wastewater from a local municipal WWTP. Figure 5 depicts the process flow diagram. The plant water uses include cooling tower makeup, demineralized water treatment for boiler makeup, blending with service water for evaporative coolers, and service water.

Discussion of raw water quality and effect on process selection

Significant differences exist between the raw water quality of Case Study 1 and that of this facility. The most significant is the amount of ammonia that needs to be oxidized from an average of 15.6 mg/L to < 1 mg/L. Additionally, further reduction in biochemical oxygen demand, chemical oxygen demand, and TSS is necessary to achieve the desired water quality for the cooling tower makeup. Table 3 depicts the raw secondary effluent quality for Case Study 2.

Table 3. Case Study 2 East Coast 735-MW combined-cycle raw feed water quality					
Parameter in Raw Feed Secondary Effluent	Average Raw Water Concentration*	Case Study 2 Biological Treatment and Filtration Compared to Case Study 1 Filtration Only			
Flow (gpm) / (Lpm)	3,250/12,300	Flow range from minimum of 2,000 to 5,000 gpm (7,500 to 19,000 Lpm)			
Alkalinity (Bicarbonate)	180	Better pH buffer than Case Study 1			
Ammonia	15.6	Biological pretreatment required to reduce NH₃ concentration to <1.0 mg/L			
Biochemical Oxygen Demand (BOD)	36	Biological pretreatment required to reduce BOD concentration to <5.0 mg/L			
Chemical Oxygen Demand (COD)	56	COD/BOD ratio indicative of biodegradable organics, beneficial for biofiltration pretreatment			
Chloride	201	Higher chloride to require a close look at materials of construction for cooling water condenser			
Iron	0.33	Iron moderately high, indicative of some corrosion and pretreatment for iron removal			
MBAS	0.42	Higher foaming potential, biofiltration pretreatment likely to reduce			
рН	6.8-7.1	Typical pH			
TDS	655	Typical TDS			
Total Organic Carbon (TOC)	16	Additional pretreatment required to reduce TOC concentration to <5.0 mg/L			
TSS	11.3	TSS higher than in Case Study 1 and further filtration required			
Langlier Saturation Index (LSI)	-0.8	Gray water somewhat corrosive to carbon steel			

*(mg/L or gallons per minute)

Equalization was provided to temper the possibility for ultra-low secondary plant flows and to enable taking a unit process offline for maintenance. It also provides contact time for iron and manganese oxidation with permanganate. The equalization basin was used to establish and initiate the gravity hydraulic grade line for the pretreatment plant. Sodium bisulfite is added to dechlorinate the water prior to the biological system. Several biological systems were evaluated, including MBR, MBBR, and

IFAS. However, the BAF was chosen due to previous experience with the technology, simplicity of operation, and the number of pretreatment plants that use it for nitrification.

The process flow diagram changed configurations in at least two significant ways during design:

- Originally, the diagram included plate settlers and phosphorus removal followed by the BAF; however, concerns about process loading, sloughing of biomass, and TSS carry-over required a unit process change.
- The second version of the diagram had the BAF ahead of the plate settlers. However, following much process discussion, and because of changes that effectively eliminated the requirement for phosphorus removal and the addition of filtration to temper any aerosol drift, the downstream process was changed to cloth disk filters.

The BAF was selected for flexibility, redundancy, the ability to completely nitrify, and efficient carbonaceous BOD removal. Cloth disk filters were chosen for filtration and polishing of TSS to meet plant discharge limits. Since metal salts would not be added for phosphorus removal, cloth disk filters could be used. Breakpoint chlorination was included in the unlikely event that ammonia breakthrough occurs after the BAF. Sodium hypochlorite was included to convert remaining ammonia, meet other oxidant demands, disinfect for fecal coliforms, and establish a free-chlorine residual for downstream biological growth control. The BAF backwash is equalized and blended into the BAF effluent to minimize solids treatment. Similarly, the disk filter backwash is equalized, underflow is sent to a plate settler, and the supernatant is sent at an equalized rate to the disk filter influent. Chemicals used in the treatment process include potassium permanganate (KMnO4) for iron and manganese oxidation, sodium bisulfite (Na₂SO₄) for dechlorination, polymers for plate settler on disk filter backwash treatment, ferric sulfate (FeSO4) for plate settler on disk filter backwash treatment), caustic soda (NaOH) and/or sodium carbonate for pH and alkalinity adjustment, and sodium hypochlorite (NaOCl) for breakpoint chlorination and disinfection. The TSS limit for the plant discharge outfall is 60 mg/L.

Lessons learned

Several lessons learned came from this case study. The first is that process selection that includes biological treatment and filtration is significantly more complex and costly than filtration alone. Raw water quality is the difference that can increase the water pretreatment cost by \$5 million to \$10 million. Additionally, the elimination of phosphorus removal drove the change to cloth disk filtration. However, if phosphorus removal had remained as a design requirement, the plate settlers would have been

Table 4. Required effluent performance criteria for BAF				Table 6. BAF and cloth disk filter design criteria		
aily Average Less than 2.5 mg/L NH3-N			BAF Design Criteria			
			Filter Cells	8		
30-Day (monthly) Running Average Less than 1.0 mg/L NH ₃ -N			Cell Size	304 ft ² (28 m ²)		
					Depth	11.48 ft (3.5 m)
Table 5. Flow and influent loadir	ng desig	in crit	eria for BAF		Hydraulic Peak (N-1)	2.86 gpm/sf (117 Lpm/sm)
Parameter	Peak [Day	Average Day	Monthly Average	Hydraulic Maximum (N)	2.17 gpm/sf (88 Lpm/sm)
Ammonia I oad (lb/dav)/ (kg/dav)	1.532/6	696	729/331	729/331	CBOD (Loading Rate)	30 lbs/1,000 ft ³ (482 kg/m ³)
	202 ~	d	170 mgd	725 mgd	TSS (Loading Rate)	45 lbs/ 1,000 ft ³ (722 kg/m ³)
low (mgd)	(11.43 n	2 mga 4.70 mgc 3 mLd) (17.79 mLc		(27.82 mLd)	NH ³ -N (Loading Rate)	55 lbs/1,000 ft ³ (883 kg/m ³)
oH (S.U.)	7.0		7.4	7.6	Sludge Generation	1332 lbs/d (605 kg/d)
Alkalinity (mg/L caCO₃)	139		194	244	Backwash Wastewater (Max Month)	261,046 gallons/day (988,059 L/day)
Temperature (deg C)	12		20	25	Air (Process/cell)	154 scfm (4.4 scmm)
ΓSS (mg/L)	10.0)	12.4	20.5	Air (Backwash/cell)	200 scfm (5.7 scmm)
CBOD (mg/L)	3.1		7.6	13.7	Cloth Disk Filter Desig	n Criteria
Ammonia Nitrogen (mg/L)	12	12 18.6		25	Number of Units	two duty, one standby
				Peak Day Loading (gpm/sf) (N-1)	4.65 (190 Lpm/sm)	
hosen for polishing of TSS. Supplemental alkalinity was included to protect the process from a concurrent peak				Peak Instantaneous Loading (gpm/sf) (N-1)	4.88 (200 Lpm/sm)	
ow and peak ammonia loading condition. The number of AF cells was increased by the manufacturer from six to				Filtering Area/Unit	548	
the construction of the manufacturer from bix to						

Table 4. Required effluent perfo	rmance crite	Table 6. BAF and cloth disk filter design criteria			
Daily Average Less than 2.5 mg/L NH2-N			BAF Design Criteria		
				Filter Cells	8
30-Day (monthly) Running Averag	ge Less t	han 1.0 mg/L	NH₃-N	Cell Size	304 ft ² (28 m ²)
		Depth	11.48 ft (3.5 m)		
Table 5. Flow and influent loadir	ng design cri	teria for BAF		Hydraulic Peak (N-1)	2.86 gpm/sf (117 Lpm/sm)
Parameter	Peak Day	Average Day	Monthly Average	Hydraulic Maximum (N)	2.17 gpm/sf (88 Lpm/sm)
Ammonia Load (lb/day)/ (kg/day)	1532/696	729/331	729/331	CBOD (Loading Rate)	30 lbs/1,000 ft ³ (482 kg/m ³)
Flow (mad)	2.02 mgd	470 mgd	729/331	TSS (Loading Rate)	45 lbs/ 1,000 ft ³ (722 kg/m ³)
Flow (mga)	(11.43 mLd)	4.70 mga (17.79 mLd)	(27.82 mLd)	NH ³ -N (Loading Rate)	55 lbs/1,000 ft ³ (883 kg/m ³)
рН (S.U.)	7.0	7.4	7.6	Sludge Generation	1332 lbs/d (605 kg/d)
Alkalinity (mg/L caCO ₃)	139	139 194		Backwash Wastewater (Max Month)	261,046 gallons/day (988,059 L/day)
Temperature (deg C)	12	20	25	Air (Process/cell)	154 scfm (4.4 scmm)
TSS (mg/L)	10.0	12.4	20.5	Air (Backwash/cell)	200 scfm (5.7 scmm)
CBOD (mg/L)	3.1	7.6	13.7	Cloth Disk Filter Design Criteria	
Ammonia Nitrogen (mg/L)	12	18.6	25	Number of Units	two duty, one standby
		Peak Day Loading (gpm/sf) (N-1)	4.65 (190 Lpm/sm)		
chosen for polishing of TSS. Supplemental alkalinity was ncluded to protect the process from a concurrent peak				Peak Instantaneous Loading (gpm/sf) (N-1)	4.88 (200 Lpm/sm)
low and peak ammonia loading condition. The number of 3AF cells was increased by the manufacturer from six to				Filtering Area/Unit	548

eight to allow standby filter cells to be brought in and out of service and the cells to be backwashed out of sequence to optimize effluent ammonia.

Design criteria

The effluent performance and flow and influent loading criteria for the BAF are shown in Tables 4 and 5. The manufacturer determined the basis of design for the size of the filter cells for the BAF. The specification was prepared to allow two BAF manufacturers and three cloth disk filter manufacturers to propose on a qualificationsbased selection. Table 6 shows the basis of design information for the BAF and cloth disk filters.

The water pretreatment plant is under construction, and equipment for the BAF and cloth disk filters are being procured. Based on recent experience with BAFs and water pretreatment plant water quality from another power plant with a BAF, we anticipate achieving the effluent goals.

CASE STUDY 3

Central Mountain coal-fired power plant

The case study is a 717-MW low-sulfur, coal-fired power plant in the central U.S. The reclaimed water system includes cooling tower make-up water and feed water to the plant service water system. Figure 6 depicts the major unit processes for the treatment train. The raw water feed is taken from the secondary WWTP to a pump station.

Discussion of raw water quality and effect on process selection

Raw water is taken from a WWTP approximately one-half mile away from the power plant. The raw-water ammonia is variable and can range from 10 to 20 mg/L. This has been shown to affect the performance of the BAF but not significantly enough to cause a plant

Media Rating (microns) 10

upset. Unit processes include BAF, rapid mix, flocculation, sedimentation, gravity filters, chlorine contact, and a service-water storage tank prior to the cooling towers and plant process water systems.

Water-quality discussion

The raw water quality between Case Studies 2 and 3 are similar in that ammonia concentrations are significantly higher than that in Case Study 1, since the amount of ammonia that needs to be oxidized ranges from an average of 15.8 mg/L to < 1 mg/L. The original primary ammonia removal was from breakpoint chlorination, which required excessive chemical usage, and corroded equipment and structural components. The BAF was installed



Figure 6. 717-MW low-sulfur coal-fired power plant with reclaimed water pretreatment plant



Figure 7. Case Study 3 BAF ammonia concentrations with reclaimed water pretreatment plant



Figure 8. Case Study 3 filter effluent turbidity in reclaimed water pretreatment plant

to reduce chemical costs and corrosion. Additionally, the BAF aeration improved source-water treatability, further reduced BOD, and removed ammonia effectively. The gravity filters reduced TSS and provided operational flexibility for the desired water quality for the cooling tower makeup. Table 7 depicts the raw secondary effluent quality for Case Study 3.

Design criteria

The required effluent performance, flow, and influent loading criteria for the BAF for Case Study 3 are shown in Tables 8 and 9.

Lesson learned

The lesson learned from this case study is that the operational problems and cost of breakpoint chlorination are greater than the capital cost of the BAF construction. Breakpoint chlorination required excessive chemical use, and the BAF significantly reduced sodium hypochlorite chemical costs.

SUMMARY

Numerous reclaimed water systems are in use for cooling water makeup and process water at power plants. The power industry uses a significant amount of water for cooling water. In some regions the demand can approach 80 percent of the surface water withdrawal. This practice is not sustainable and, in fact, increases the conflict among water needs. Use of reclaimed water from municipal WWTPs for power plant cooling water, boiler feed, and other consumptive uses is sustainable and a growing practice. Engineers should consider several important design issues in selecting the appropriate treatment process, as outlined in this paper, and should evaluate the efficiency of biological, filtration, and disinfection processes, as needed to achieve the desired water quality.

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Table 7. 717-MW low-sulfur coal water pretreatment raw feed water quality					
Parameter in Raw Feed Secondary Effluent	Average Raw Water Concentration*				
Flow (gpm)/(Lpm)	10,200 (38,600)				
Alkalinity (Bicarbonate)	158				
Ammonia	15.8				
Biochemical Oxygen Demand (BOD)	16				
Chemical Oxygen Demand (COD)	-				
Chloride	160				
Iron	-				
MBAS	-				
рН	6.6				
TDS	-				
Total Organic Carbon (TOC)	-				
TSS	12				
Langlier Saturation Index (LSI)	-				

*(mg/L or gallons per minute)

Table 8. BAF and cloth disk filter design criteria				
BAF Criteria Description				
Filter Cells	7			
Cell Size	704 ft² (65 m²)			
Depth	9.8 ft (3.0 m)			
Hydraulic Peak (N-1)	3.79 gpm/sf (154 Lpm/sm)			
Hydraulic Maximum (N)	2.47 gpm/sf (101 Lpm/sm)			
CBOD Loading Rate	30 lbs/1,000 ft ³ (482 kg/m ³)			
TSS Loading Rate	45 lbs/ 1,000 ft ³ (722 kg/m ³)			
NH₃-N Loading Rate	54 lbs/1,000 ft ³ (867 kg/m ³)			
Sludge Generation	1,732 lbs/d (787 kg/d)			
Backwash Wastewater Max Month	285,050 gallons/day (1,078,900 L/d)			
Air Process/cell	300 scfm (8.5 scmm)			
Air Backwash/cell	400 scfm (11.3 scmm)			

Table 9. Required effluent performance criteria for biological aeratedfilter

Daily Average	Less than 2.0 mg/L NH ₃ -N
30-Day (monthly) Running Average	Less than 1.0 mg/L NH ₃ -N



Mercury—an old problem with new implications

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ABSTRACT | Although the use of elemental mercury is rare in modern healthcare facilities, environmental agencies have increased the regulatory enforcement against healthcare institutions for mercury discharges. Many times, mercury can be contained in wastewater discharged from research and clinical laboratories to the sewer. In Massachusetts, the Department of Environmental Protection (MassDEP) and the Massachusetts Water Resources Authority (MWRA) prohibit the discharge of mercury to the sewer system, and enforce this prohibition with an effluent limitation of 1 part per billion (PPB) from regulated industries and institutions.

A major hospital in Boston recently installed a mercury removal system at one of its clinical and research buildings. Successfully treating laboratory wastewater to meet such stringent effluent limits relied on selecting a treatment method that could remove the predominant species of mercury in the effluent. Treatability and pilot testing were crucial in pursuing the most applicable and cost-effective options, as research has substantiated that mercury is an unpredictable element that readily changes species.

KEYWORDS | Mercury removal, hospital wastewater, equilibrium testing, column testing, pilot testing, industrial wastewater pretreatment system (IWPS), ion exchange (IX), granular activated carbon (GAC)



INTRODUCTION

Many major hospitals, especially research-based institutions, continue to experience the effects of historical mercury use. Even with the reduction or elimination of mercury from present-day products, mercury and mercurycontaining compounds continue to be in collection systems and piping within older hospital buildings from past use and practices. This situation is often referred to as "legacy mercury."

Testing of various laboratory products has shown that some current reagents and compounds commonly used in laboratories still contain mercury in trace amounts. However, because the mercury makes up less than 0.1 percent of the compound, manufacturers are not required to include it on material safety data sheets (MSDS).

Even at low concentrations, mercury can pose a significant challenge to permitted wastewater discharges because of one of its unique features: its ability to bioaccumulate. This means when organisms, from single cell to humans, consume mercury in small amounts over time, the level of mercury within the organism increases.

The ability of mercury to bioaccumulate also answers the following question: If mercury is no longer used at hospitals, how do elevated levels continue appearing in a facility's wastewater?

Bioaccumulation in a wastewater collection and conveyance system occurs as biological growth in the piping and collection system components (e.g., traps, sumps, transfer tanks) absorbs trace amounts of mercury from the wastewater. This accumulation can occur over decades in which these organisms continue to ingest mercury and concentrate the pollutant throughout the collection system. When this bioaccumulation is disrupted by surges in wastewater flow, construction, or exposure to certain solvents, these mercury-containing organisms can become dislodged from the collection system walls and be discharged as a concentrated slug into the wastewater sewer system.

For the large number of older research hospitals in the metro-Boston area with old piping infrastructure, mercury contamination in wastewater is a significant concern. Since publicly owned treatment works (POTW) are not designed to remove mercury, mercury removal must occur upstream at the individually permitted facilities. In Massachusetts, MassDEP and MWRA prohibit the discharge of mercury to the sewer system, and enforce this prohibition with an effluent limitation of 1 PPB from regulated industries and institutions.

The following paper discusses the reduction in legacy mercury within the collection system at a Boston hospital and the elimination of new sources of mercury from entering the building piping system (source reduction). The paper also discusses the outcome of these efforts and the steps performed to design and install an end-of-pipe wastewater treatment system to remove any remaining mercury.

BACKGROUND

In the hierarchy of pollution prevention techniques, reduction or elimination of a pollutant prior to it entering a waste stream is desired and typically less expensive than treatment afterwards. Based on this, the hospital conducted several steps to reduce mercury levels within the hospital before pursuing end-of-pipe treatment. Steps included lab inspections, investigations into chemical usage and disposal, and cleaning of the piping and collections systems.

Laboratory investigations for the presence and use of mercury were the first efforts in identifying possible sources of mercury. The investigations included testing for the presence of mercury in common laboratory materials, a review of chemical handling and disposal procedures, and internal pipe mapping (to establish low points or dead spots). The investigations attempted to identify specific sources of mercury, so that it could be replaced and/ or collected for disposal. Additionally, if a laboratory wastewater was identified as a source of mercury, the wastewater from that location could be segregated to reduce the overall volume of wastewater requiring further treatment.



The second suspected source of mercury was the biological growth within the collection system and piping. The hospital worked diligently to remove biological growth from the pipe surfaces using pressure washing and chlorine dosing. By removing biological growth containing mercury, and subsequently eliminating slug discharges of growth and future bioaccumulation of trace mercury, it was anticipated that a treatment system would not be required.

Pipe cleaning occurred using a pressure washer with a long hose and specialized spray nozzles. The hose was inserted upstream of areas of concern (risers, low spots, and piping connections) that were identified during camera inspections. After the pressure washer was engaged, the hose was slowly pushed down the pipe with the natural flow of the water. The spray nozzles initially forced water back upstream, causing the spray nozzle to be pulled downstream. This dislodged the biological growth in a controlled manner and prevented clogging of downstream piping. During pressure washing, all solids dislodged from the piping were collected at the temporary treatment system just upstream of the final pH neutralization system. Sampling was conducted throughout pipe cleaning to verify this.

Chlorine cleaning was performed manually by adding small amounts of mercury-free bleach to laboratory sinks on a pre-determined schedule. The chlorine was flushed through the collection system risers, where, in theory, it would kill and dislodge mercury-laden biological growth from pipe walls, allowing it to be collected downstream.

Analytical testing of the wastewater was conducted after initial source investigation (laboratory investigation) and reduction (pressure washing and chlorine cleaning) was completed. Composite samples (24-hour samples using automatic sampling device) were collected at the end of the collection system, but prior to wastewater treatment, to determine the level of mercury contamination still Figure 1. Power washing of collection system



system process flow diagram

present. MWRA requires permit holders to demonstrate a return to compliance (i.e., effluent limit of less than 1 PPB) in two phases. The first phase requires daily effluent samples for 10 consecutive days; the second phase requires one weekly sample for eight consecutive weeks. The hospital's initial source reduction and pipe cleaning showed promise during the 10-consecutive-day monitoring period, as the mercury concentration remained below the limit of 1 PPB.

Note that during weekly testing, the days were alternated to ensure samples represented the wastewater during all operating conditions (i.e., first week—tested on Monday; second week—tested on Tuesday; third week—tested on Wednesday).

However, during the weekly testing, the mercury concentrations exceeded the 1 PPB limit on four of the first 10 weekly samples. When elevated mercury levels were detected, collection system cleaning was repeated. Follow-up compliance testing conducted after additional pipe cleaning indicated that mercury was still present in the system at levels greater than 1 PPB.

Since it was not possible to identify a specific source of mercury (i.e. a specific chemical or laboratory) and cleaning could not eliminate the mercury from the collection system, the hospital turned to end-of-pipe treatment as the remaining option for compliance with MWRA limits.

MATERIALS AND METHODS

After efforts to eliminate mercury at the source were exhausted, the hospital turned to an end-of-pipe treatment solution. Analytical data and additional samples upstream of the pH neutralization system were used to establish a baseline to assess wastewater treatment options.

For each sample, the total and dissolved mercury concentrations were analyzed, along with the total suspended solids (TSS) concentration. The total and dissolved mercury results were used to determine the state in which the mercury was present, which typically indicates the species, such as elemental mercury, insoluble mercury compounds, or soluble or dissolved mercury compounds. Each species of mercury (elemental, particulate, or dissolved) must be treated differently, so knowledge of its state was important. Thus the project focused on determining whether the mercury was dissolved or particulate, rather than on specific compounds present. The TSS data were used to correlate particulate mercury concentrations with suspended solids data. Because of the affinity of mercury to bond with biological solids, when solids are present, mercury will likely have a tendency to accumulate within them.

The amount of suspended solids present in the waste stream also is important to know when sizing particulate filtration systems.

Based on sampling and treatability testing, three treatment technologies were investigated: particulate filtration, granular activated carbon (GAC) adsorption, and ion exchange (IX). The following section discusses the investigation in identifying effective and economical treatment for each technology.

TEMPORARY WASTEWATER TREATMENT SYSTEM TESTING

Initial testing indicated that the levels of suspended solids in the wastewater would likely require future treatment to include pretreatment for particulate filtration. A plan was developed to install a temporary particulate filtration system to treat the entire wastewater flow. This would provide a full-scale pilot plant for filtration, and allow the hospital to improve its effluent quality and operate within MWRA compliance limits while the proposed system was being designed and eventually installed. The temporary treatment system could treat all of the wastewater produced at the facility [12,000 to 20,000 gallons per day (gpd)/45,000 to 75,000 liters per day (Lpd)] and comprised equalization tanks, particulate filtration vessels, and GAC media vessels.

The temporary treatment system provided valuable information and allowed the hospital to comply during the design process, while allowing the most effective media to be determined and the gathering of necessary information to scale-up to final design.

EQUILIBRIUM TESTING

Based on data that indicated the presence of dissolved mercury in the wastewater, ion exchange resin technologies were investigated in two stages equilibrium testing followed by column testing.

Equilibrium testing was conducted similarly to jar testing, in which six beakers were filled with 1 liter (0.26 gallons) of wastewater and placed on a sixpaddle, gang-style stirrer unit. After the six beakers were filled with wastewater, varying small quantities of ion exchange resins were added (1 mL, 2 mL, 3 mL, 5 mL, 10 mL, and 25 mL of resin) to each sample. Then, each wastewater and resin solution was mixed for 30 minutes. After the mixing cycle, the resin was allowed to settle so the remaining wastewater could be decanted from the top of each beaker. This decanted wastewater was analyzed for total and dissolved mercury.

Because of fairly low influent concentrations (1-3 PPB), the wastewater was spiked with a pre-made solution of mercuric nitrate to a point where the total mercury concentration was increased to 19.6 mg/liter [parts per million (PPM)] and a dissolved mercury concentration of 12.5 mg/liter (PPM). The spike solution served to increase the mercury concentration to where the maximum mercury capacity (breakthrough point) of each resin could be determined.

Careful consideration was taken when decanting the test solutions to prevent IX resin beads, which contained mercury, from contaminating the samples. This contamination would increase mercury concentration and lower the observed mercury removal of the resin.

During equilibrium testing, six IX resins from multiple manufacturers were tested.

COLUMN TESTING

The second stage of treatability testing included column testing for the ion exchange resins and the two GAC media. This included selection of three of the best-performing resins from equilibrium testing and two types of GAC media.

The first stage of equilibrium testing provided qualitative measurements when comparing the effectiveness of ion exchange resins. Column testing provided detailed operational performance information. This performance information was used to scale-up and determine the size of the equipment, material costs, and performance for a full-scale treatment system.

The small-scale columns simulated operation of full-scale treatment vessels. The units were custommade to maintain the same surface loading rate and retention time of full-scale columns. In addition, the GAC media was crushed into smaller particles as part of the rapid small-scale testing method, which exposed more surface area for adsorption of the mercury (Cooney, 161).

The flow rate through each column was regulated using an adjustable rotameter with a ball valve on the effluent side of the treatment column. The operating parameters of the columns are shown in Table 1.

On the temporary treatment system, a tee fitting and ball valve after the particulate bag filters diverted post-filtration facility wastewater to the column testing apparatus. A chemical metering pump and a wye fitting were used to spike the pre-filtered incoming wastewater. By taking the wastewater from the temporary treatment system, this allowed the small-scale treatability system to be subject to the varying conditions of the wastewater generated at the facility and testing of

Table 1. Pilot system operating parameters					
Parameter (Per Column)	GAC Columns (2 Columns)	IX Columns (3 Columns)			
Flow rate (gph)/(Lph)	0.5/1.9	0.5/1.9			
Length (ft)/(m)	3.0/0.9	1.0/0.3			
Diameter (in)/(cm)	1.0/2.54	1.0/2.54			
Surface Loading Rate (gpm/ft²)/(Lpm/m²)	1.5/61.1[1]	1.5/61.1[2]			
Column Loading Rate (gpd/ft³)/(Lpd/m³)	0.2/26.7[3]	0.5/66.8[4]			

Notes:

1. The maximum recommended surface loading rate is 4 gpm/ft² (163 lpm/m²) (manufacturer's guidance).

2. The maximum recommended surface loading rate is

2 gpm/ft² (81.5 lpm/m²) (manufacturer's guidance).

3. The maximum recommended column loading rate is

4 gpm/ft³ (163 lpm/m²) (manufacturer's guidance).

4. The maximum recommended column loading rate is

2 gpm/ft³ (81.5 lpm/m²) (manufacturer's guidance).

the effectiveness of the desired treatment scheme particulate filtration followed by IX and/or GAC treatment.

Column testing was closely monitored over 10 days, with the apparatus operating approximately 8 hours per day. During operation, flow rates were closely monitored and samples were taken at six locations, including one influent wastewater sample prior to the columns (after the spike solution was added) and one effluent wastewater sample after each of the five individual columns.



Table 2. Temporary syst summary	Table 3 testing-	
Sampling Location	Name	
Influent Wastewater	1.1	Resin 1
Post Bag Filter Vessels	ND	Resin 2
Final Effluent	ND	Resin 3
(POSLGAC VESSEIS)		Resin 4

Notes

1. The GAC media material used in the temporary system was GAC 1 water purification carbon, which was also one of two GAC media investigated in the column testing phase

2. ND = Not detected (i.e. below detection limit, 0.5 PPB).

uilibrium Sin Sults*	Table 4. testing— capacity	Table 4. Column testing—resin/media capacity results*			
Capacity	Name	Capacity			
0.51	Resin 2	0.0036/0.058			
0.62	Resin 3	0.0028/.045			
0.53	Resin 5	0.0045/0.072			
0.41	GAC 1	0.0008/0.013			
0.59	GAC 2	0.0033/0.053			
0.37	*(Ib total Hg	removed/ft ³ of			

estimation of resin/media quantity required				
Estimated Quantity of Media Needed*				
51.3				
64.7				
45.3				
1,110				
222				

Table 5. Column testing—

*(ft³) per year (@ 3 ppb & 20,000 gpd)

During the first 4 days of column testing, samples were collected at 2-hour intervals and then each of those was manually composited in equal proportions by the analytical laboratory to represent that day's treated effluent.

able 3. Eq

esting—re apacity re

Resin 5

Resin 6

(mg Dissolved Hg

removed/mL of resin-

from 20 mL resin test)

For the following 6 days, the frequency of sampling was increased just prior to the expected breakthrough of mercury in the pilot columns. The column breakthrough point was the main factor investigated in this phase. During this phase, samples were collected at 1-hour intervals. An equal portion of each hourly sample was manually composited by the analytical laboratory to represent a daily composite, and the remaining portion of each hourly sample was saved for additional analysis if needed. The composites were used to estimate the day that breakthrough may have occurred, in turn reducing the total amount of analysis required. When a daily composite indicated that breakthrough may have occurred for a particular media, the laboratory was instructed to analyze a portion of the hourly samples for that media to gather additional analytical points along the breakthrough curve to pinpoint when breakthrough occurred.

During the 2 weeks of pilot testing and investigation, samples were also taken at three locations within the temporary system: influent to the system, after the second bag filter, and after the second GAC vessel. During treatability testing, samples were taken once per hour and, for the purpose described above, manually composited into daily samples. In each instance, the samples were analyzed for total and dissolved mercury, and TSS.

RESULTS

Temporary Wastewater Treatment System Testing

The temporary wastewater treatment system was effective at removing the detectable amounts of mercury discharged into its collection tanks. The

combination of step-down bag filtration shown in Figure 2 (i.e., 50-micron filters followed by 25-micron filters) and two GAC vessels in series reduced trace amounts of mercury to below discharge limits, as shown in Table 2.

The results showed that a large portion of the mercury in the wastewater was in particulate form, which could be removed by the bag filters. As the incoming wastewater had low mercury concentrations, it was unclear from the temporary system whether dissolved mercury was removed using the GAC vessels.

EQUILIBRIUM TESTING

Equilibrium testing was valuable in identifying the best performing resins from the initial group of six selected. During equilibrium testing, the resin capacity of each resin was determined to be as follows in Table 3.

From this test, the three best-performing resins —Resin 2, Resin 3, and Resin 5—were selected for column testing.

COLUMN TESTING

Based on the equilibrium testing, column testing determined the ability of each media to remove mercury under typical design conditions. First, the capacity to remove mercury was found, and then the quantity of material required to treat the wastewater annually was determined, presented in Table 4 and Table 5.

The best-performing ion exchange resin was Resin 5, and the best-performing GAC media was GAC 1. Since the GAC media cost is a fraction of the ion exchange resin cost, and maintenance and operation of GAC are much less than the ion exchange, the most effective and economical treatment technology was GAC media adsorption using GAC 1 activated carbon.



Similar experiments have been performed for other major hospitals and had varying results. The most effective GAC and IX media vary by location and wastewater characteristics. Because of this variation, small-scale testing needs to occur case by case to determine the best treatment techniques for the specific application.

FINAL DESIGN

The treatability system was scaled up to a final design based on existing pH system operational logs (flows and pH), data collected during baseline sampling, and information collected during the temporary and pilot-scale systems operation. The full-scale wastewater treatment system includes one collection and preliminary pH neutralization tank, two equalization tanks (piped together to act as one large tank), two parallel trains of two filtration vessels each, two GAC media vessels operated in series, and a final pH neutralization tank also used as a backwash tank for the carbon vessels.

The collection and preliminary pH neutralization tank is used to consolidate the incoming risers feeding the wastewater treatment system and to roughly neutralize the wastewater, which protects downstream equipment. This tank is constantly filled and overflows via gravity into the two equalization tanks. The equalization tanks are piped together to act as one tank; however, they have been configured so that they can be operated independently of each other if maintenance or future system expansion is required. The wastewater pH introduced to the equalization tanks was typically between 6 and 8 standard units (s.u.), with some peak levels approaching 10 s.u. To accommodate fluctuations in flow common in a laboratory setting and to provide for future expansion, the tank was oversized to have a retention time of 1.2 hours.

The levels in the equalization tanks are continuously monitored and when the tanks reach approximately 60 percent, the treatment cycle is activated

in a batch treatment mode. The equalization tanks were sized to provide headspace, allowing the level to rise above the 60-percent capacity during peak flow periods [30 gallons per minute (gpm), 114 liters per minute (Lpm)], while still allowing the system to operate at 20 gpm (76 Lpm). This design was based on historical flow logs that showed the peak flow to be 29 gpm (110 Lpm) with an average flow rate of 12.5 gpm (47 Lpm).

From the equalization tanks, the wastewater is pumped through the treatment system using a parallel set of centrifugal pumps. The pumps have a rated capacity of 45 gpm at 55 feet of head (170 Lpm at 16.8 meters of head) and are equipped with variable frequency drives (VFD) on a flowmeter control so that the flow can be maintained at 20 gpm (76 Lpm) regardless of pressure loss in the downstream operations.

The filtration system design was based on the temporary treatment system noted above in which the first stage of filtration contains bag filters with a pore size of 50 microns (um), and the second stage of filtration contains filters with a pore size of 25 um. Each filtration vessel (four in total) contains six bag filters. The vessels were designed for a much larger flow rate to maintain a reasonable filter change-out frequency (one housing per week) and to compensate for biological growth observed during the temporary system operation. This was an important design consideration, since the biological growth in hospital wastewater tends to "blind" filters rather quickly, potentially leading to maintenance headaches.

The filtration trains are installed in parallel with one train operating at a given time. The system automatically changes the active filtration train to the stand-by filtration train when the pressure drop across one or more of the filtration vessels exceeds 10 psi (69 kPa). This was an important design consideration as the bag filters must operate within a pressure differential less than 15 psi (100 kPa),



Figure 5. GAC vessel configuration and piping triggers automated valves to direct flow to the other train.

Operators are notified through the building automation system when the filter train has been switched, prompting the operator to change the filters as soon as possible. The system will not automatically divert back to the other train until the filters are changed and the operator acknowledges the filter differential pressure alarm at the control panel.

which, if exceeded,

could cause a filter bag

to rupture resulting in

the potential release of

accumulated mercury

from the bag filter. The

alternation between

trains occurs using a

pressure differential

pressure differential

is exceeded and then

when the desired

switch, which engages

Following filtration, two 1,000-pound (455-kg) GAC media vessels are operated in series. The series configuration will allow media in the first vessel to be completely used before it needs to be changed without adversely affecting the system's treatment capabilities.

An extensive piping assembly is included with the GAC media vessels to assist with operation and maintenance. The GAC media vessels are connected, so each vessel can operate independently or in reverse order. If one of the media vessels requires maintenance, backwashing, or media change out, the other unit can be operated by opening and closing a series of manual valves. The vessels can also operate in reverse order to ensure that the media in both vessels can be completely used.

The GAC media vessels also feature a manually activated backwashing system. As mentioned previously, a main source of mercury concentration is the biological growth present in the wastewater. GAC media provides a bed for the biological growth to accumulate and reproduce. This layer can build up such that passing wastewater through the unit is difficult. In this case, a backwash pump can be engaged to backwash treated wastewater through the GAC media vessels. Backwash water is directed to a single bag filter vessel and discharged back to the treatment system headworks. This allows for the biological growth that was backwashed off the GAC to be captured by a dedicated filter. The remaining backwash water can be reprocessed through the system. GAC vessel size was determined by the amount of media needed over a year and the desired frequency of media change out. Since changing the media is laborious, it was not desired to occur more than twice per year. Based on using two 1,000-pound

(455-kg) vessels, the estimated maximum change out frequency was two times per year per vessel.

Wastewater treated by filtration and GAC adsorption is then discharged to the final pH neutralization tank prior to the wastewater entering the sewer system. The final neutralization system has been designed using a series of diversion valves to automatically direct out-of-spec pH wastewater to a pit in the floor which transfers the out-of-spec wastewater to the headworks for reprocessing.

ADDITIONAL DESIGN CONSIDERATIONS

Because the nature and characteristics of laboratory wastewater can change over time, several additional design features were included to allow for future system modifications. For example, additional connections in the form of blank flanges and piping connections were provided for the possibility of adding ultraviolet disinfection to the equalization tanks to keep biological growth to a minimum. Chemical injection ports were added to the final pH neutralization tank to allow for future addition of chlorine to the final tank for biological growth control. Piping connections and stubs were provided after the GAC vessels to allow IX vessels to be added should the wastewater characteristics change and additional dissolved mercury removal capability be required. 🔇

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Industrial wastewater pretreatment striking a balance among performance, safety and sustainability

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ABSTRACT | One of the primary objectives of industrial pretreatment is to remove the constituents that will not be treated at the municipal treatment plant. Sometimes this is as simple as pH neutralization, but can be as complex as treatment for heavy metals. Treatment processes typically require chemical addition, and this article will focus on best practices for selection of treatment chemicals to mitigate toxicity, improve treatment performance, and provide other sustainability benefits. It will include a discussion on understanding the implications of sampling new chemicals in the treatment process, as well as a brief discussion on the Toxics Use Reduction Act (TURA) and other regulatory requirements targeted at identifying opportunities to reduce wastes and usage of potentially harmful chemicals. Ultimately, this article is intended to help an industrial operator strike a balance among obtaining adequate treatment, optimizing chemical use, minimizing toxic chemicals, and meeting permit.

KEYWORDS | Wastewater, industrial treatment, pretreatment, chemical use, toxic, sustainability, health, safety, performance, TURA



Industrial wastewater pretreatment is the first step to a longer process of treating wastewater to prepare it for discharge to the groundwater, rivers, or other water bodies. Pretreatment targets constituents that are specific to the industrial facility and that will not be treated at the municipal treatment plant. This can be as simple as pH neutralization or as complex as treatment for heavy metals. Industrial pretreatment systems can be located at a wide range of industries, including research and development laboratories, hospitals, schools, electroplating, semiconductor manufacturing, pharmaceutical production, and facilities handling discharges that could contain chemical residuals. Treatment processes typically require chemical addition, and selection of these chemicals traditionally focuses on which chemical is best for the particular treatment. Today, other considerations are necessary when selecting treatment chemicals, such as reducing toxicity and other safety risks for operators, assessing impacts on mechanical equipment, and understanding the impacts on energy use and sustainability.

The primary objective for pretreatment is obviously compliance in meeting permit limits. The effluent leaving the pretreatment facility is an operator's final product, and several factors can affect the quality of this final product particularly when a new process, chemical, or equipment modification is introduced. The key to successful industrial wastewater treatment is



understanding the ingredients (influent) and the final product (effluent). This helps to formulate the steps in between. To better understand the influent, wastewater operators should spend time with the production line operators, laboratory staff, researchers, or any of the front-end users to understand their day-to-day procedures. This will allow a wastewater operator to understand what is coming to the treatment system, how frequently it is being discharged, which decisions are being made on the floor, and how these decisions can affect the wastewater influent. It also lets the wastewater operator understand the pressures and restrictions that these team members are dealing with. This may also be a great time for a wastewater operator to identify potential waste reduction opportunities right at the source.

Point source reduction is one of the first options for improving wastewater pretreatment from a sustainability and a treatment perspective. A wastewater operator should work with production staff or lab technicians to determine whether any contaminants can be removed from the production line or laboratory procedure. Other considerations include whether there can be recovery by adding process solutions back through the line or by using evaporation. For example, reducing drag-ins, dragouts, changes in rinsing configurations, and drain boards are all options that should be considered in a production line.

Beyond point source reduction, another key step to successful pretreatment is understanding any changes in the upstream process. It is on the floor, either production, laboratory, or hospital, where the changes happen, and these changes can dramatically affect the influent for the wastewater operator. One way to control these changes is to implement a strict protocol for introducing new chemicals. This should be implemented across the entire facility—both on

the floor and for use in the treatment plant. A safety data sheet should be reviewed and approved by an appropriate person or team before any new chemical comes into the building. A bench test of the product should be conducted to make sure it works as advertised, and the waste byproduct should be accumulated and the effects on pretreatment evaluated on scale with discharges and its effects. Reporting hazardous materials is not a new concept, and it may be becoming the standard operating procedure in most industries now. However, caution is needed when a vendor gives a gallon or two of "new" product to an engineer and says, "Try a little of this, it works great." Sometimes these little favors can wreak havoc not only on a production line, but more importantly on a wastewater treatment system. In addition to the impacts on the system, chemical tracking is critical to initiatives such as the Toxics Use Reduction Act (TURA) in Massachusetts. which was enacted in 1989.

TURA has been a successful approach in reducing the use of toxic materials. This environmental program refocuses attention away from treatment of toxic wastes which have already been produced, and toward the elimination or reduction of toxics at the point of production. The TURA regulations (310 CMR 50.00) require that large-quantity toxic users (LQTUs) report annually on their use of toxic materials as well as plan to help uncover any opportunities to reduce their wastes and their usage of potentially harmful chemicals. TURA planning and reporting requirements apply to facilities that meet all three of the following criteria:

- Process or manufacture at least 25,000 pounds (11,000 kilograms) or otherwise use at least 10,000 pounds (4,500 kilograms) of substances regulated under SARA Title III and CERCLA 101 and 102
- Employ 10 or more full-time employees

• Fall within Standard Industrial Classification (SIC) code 10-14; 20-39; 40, 44-49; 50-51; and 72, 73, 75 and 76

Regulations similar to TURA throughout the country are intended to reduce the use of toxic materials. This approach is good from an environmental, health, and safety perspective as well as from a treatment perspective. The less toxic the incoming ingredients/influent, the easier it is to treat wastewater and the less toxic the final product/ effluent is.

In a world driven by cost-effectiveness and production efficiency, the primary focus for some companies is to get the product off the line and out the door. From first-hand experience, removal and replacement of thousands of gallons of chemicals has occurred simply because time did not allow for the proper analysis to confirm if the production baths were truly contaminated. Many savvy engineers have well-tested troubleshooting techniques to identify contamination sources, but many times after exhausting all the in-house tests, the only alternative is to send out for laboratory analysis and wait a few days for results. In some cases, when two sources have been identified as the potential sources of contamination, rather than waiting for the laboratory analysis, the team may be instructed to change them both and send them to wastewater pretreatment. Unfortunately, managers, production line workers, or laboratory researchers sometimes forget that when they flush it down the drain it is still a problem for the company. A pretreatment system is not a magical system that will rid all wastewater of any contaminants. A wastewater facility is designed to target particular constituents in particular doses and frequencies. So when someone orders a discharge to be sent to the wastewater treatment system because he or she does not want to wait for the lab analysis, it is like sending an operator a pile of unknown ingredients and expecting the individual to be able to create the same, compliant product/ effluent as usual. It is critical to let the wastewater operator know about these types of discharges and to work with that individual to characterize the wastewater as well as possible to maximize the potential for adequate treatment.

Once the wastes reach the wastewater treatment system, numerous process options are available. New chemistry, sludge dryers, ion exchange, evaporation, electrowinning, and electrodialysis are a few processes that can reduce or may even eliminate the hazardous discharge completely. As an example, ion exchange can recover the primary metals from rinse waters and they can be polished for reuse out on the lines. The capture columns can be regenerated and the regenerate solution evaporated to make a new bath. Although this is a simplified description, it is an example of how a properly designed, installed and

operated system can transform a waste stream from treatment and discharge to drain into a closed-loop no-discharge system instead.

The wastewater treatment process has many stages where improvements can be made to strike a balance among performance, safety, and sustainability. Key components include understanding the upstream processes, working with the team members who are creating the wastewater discharge, and communicating any changes. For the safety of the production line and laboratory employees, as well as for the well-being and sanity of wastewater treatment operators, identifying all the chemicals being used in the facility is critical, because the impacts and interactions of chemicals are central to every stage of a facility's operations.

ABOUT THE AUTHORS

- Karla King is the director of environmental health and safety services at EBI Consulting and has 12 years of experience in environmental, wastewater, and stormwater engineering. Ms. King has served as the project manager/engineer on several water and wastewater projects, including groundwater discharge permitting, NPDES permitting, drinking water assessments, hydrogeologic reports for groundwater discharges, sewer system evaluation studies, comprehensive wastewater management plans, build-out analyses, operation and maintenance manuals, and the design, upgrade, and construction of several wastewater treatment plants and pump stations. She has also provided stormwater permitting support, including multi-sector general permits, municipal separate storm systems permits, stormwater pollution prevention plans, and spill prevention, control, and countermeasure plans.
- George Bianco is an environmental technician at EBI Consulting and works in the environmental health and safety group. He has more than 30 years in the environmental and precious metal refining business. He has been involved in toxic chemical release reporting (EPCRA and TURA), environmental analysis, audits, monitoring, permitting, equipment installation, toxic use reduction, training and environmental compliance engineering projects. Prior to joining EBI Consulting, Mr. Bianco was the environmental supervisor for a large stamp, plate, and mold manufacturer responsible for federal and state emissions reporting, state and local wastewater permit compliance, wastewater collection and treatment, industrial pretreatment facilities and program design, toxic use reduction planning, solid and hazardous waste disposal.



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Key steps to successful coagulation and flocculation

HUGH TOZER, P.E., Woodard & Curran Inc., Portland, ME

FEATURE

NEWEA

ABSTRACT | Many industrial wastewater treatment plants use coagulation and flocculation to remove phosphorus, heavy metals, and other solids that would not practically settle in conventional clarifiers. The successful design and operation of these systems must consider the wastewater characteristics, treatment chemistries, mixing, solids recycle, and testing.

KEYWORDS | Coagulation, flocculation, precipitation, phosphorus, heavy metals, particle size, pH, mixing, solids recycle, CoMag, HDS, jar tests, pilot tests

> Industrial treatment systems use coagulation and flocculation to remove fine solids that would settle too slowly for conventional clarifiers or be too small for removal by filters. A chemical coagulant destabilizes suspended particles and forms an amorphous floc that helps sweep particles from the solution. The addition of a flocculant aid aggregates the floc particles into solids large enough to be removed by a clarifier or dissolved air flotation.

Of the many factors that affect the design and operation of these systems, five of the most important are wastewater particle sizes, treatment chemistries, mixing, solids recycle, and testing.

WASTEWATER PARTICLE SIZE

Coagulation and flocculation are needed when the wastewater contains small particles that do not settle in a reasonable time. Their high surface area-to-mass ratio contributes to drag, which slows their settling velocities. Figure 1 illustrates the approximate time for discrete particles of different sizes to fall 10 feet (3 meters), a depth typical of many clarifiers. In suspensions of solids, particle interactions would affect the actual settling velocities, but the need for coagulation and flocculation would remain. By contrast, grit and coarse sand settle quickly enough to use simple sedimentation.

Phosphorus removal by ferric chloride addition is an example of a process needing coagulation and flocculation. The treatment produces iron phosphate (FePO4 in the graph) solids, which are approximately 0.4 microns across (Smith. 2007) and would take more than 240 days to settle 10 feet (3 meters). Heavy metals precipitated as sulfides or hydroxides are also small, typically ranging from 2 microns to more than 20 microns (Patterson, 1987). They would take hours to settle in a clarifier without coagulant and flocculation.

TREATMENT CHEMISTRY

A wastewater system must use a coagulant that works at a pH compatible with the rest of the processes. Coagulants are most effective within a specific pH range, and performance degrades outside these limits. In pure water, aluminum-based coagulants operate best between a pH of 6.0 to 7.8, and iron-based coagulants work best from a pH of 7.0 to 9.0. Figure 2 illustrates the iron (III) species present at different pH values. The lowest solubility of the iron hydroxide, the solid associated with sweep floc, is close to a pH of 8.2. Its solubility increases as the pH moves in either direction from this low point.

The colored squares in Figure 2 illustrate the optimal pH values for precipitating cadmium, copper, lead, nickel, and zinc as hydroxide solids (squares shown at different locations on the y-axis for clarity only). The best pH values for precipitating these metals are higher than the optimal pH for iron hydroxide floc formation. Copper, lead, and zinc are close, but the designer might need a different type of coagulant to remove cadmium.

Although ideal curves like those in Figure 2 can help guide the selection of coagulants, wastewaters are complex and ion interactions affect the final treatment chemistry. Most industrial wastewaters contain ions that affect the operating pH for coagulants. Multivalent anions can shift the optimal pH toward acid. Black, Rice, and Bartow in 1933 evaluated the impact of sulfate on the rate of floc formation using aluminum coagulation (AWWA, 1971). Without sulfate, the fastest coagulation occurred in a narrow band around a pH of 7.2. Sulfate additions broadened the acceptable pH range. With as little as 125 mg/L

Packham observed a different effect with ortho-

The operating pH changes the surface charge of sulfate, the rate of floc formation was equally good the particulates and coagulant, with the point of for pH values from 5.0 to 7.0. zero charge (PZC) being the pH at which the net surface charge is zero (Kosmulski, 2009a, 2009b). phosphate additions (AWWA, 1971). The optimal pH For example, iron phosphate precipitate has a PZC for turbidity removal shifted from 7.2 to as low as of approximately 3.0. Its surface charge is positive 5.0 with progressively higher orthophosphate addibelow a pH of 3.0 and negative above 3.0. Other tions, but the shape of the solubility curve did not solids in wastewater, such as aluminum phosphate, substantially change. many metal sulfides, clays, and oil droplets, also Researchers have observed similar phenomena have negative charges at a higher pH. By contrast, with the precipitation of phosphorus and metals. The iron hydroxide has a PZC value of approximately pH for optimal precipitation can vary with the waste-8.5 (Montgomery, 1985). It has a positive surface water characteristics and even with the alkali used charge below 8.5. Surrounded by positively charged for pH adjustment. Smith (2007) found that phoscoagulant particles, the negatively charged iron phate could be reduced to very low concentrations phosphate precipitates can approach each other and for pH from 3.5 to 8.5 if other conditions (e.g., mixing) coalesce into larger, fragile particles. The addition of were optimal. In another study, researchers tested a negatively charged anionic flocculant aid (polymer) different alkalis for chromium precipitation from can bring these solids together into floc large tannery wastewater. The best performance using enough to settle. However, excess anionic polymer sodium hydroxide was at a pH of 9.2; it was a pH of can reverse the charge neutralization, resulting in 9.0 with hydrated lime, 8.5 with sodium carbonate, turbid effluent. The operator can perform jar tests to and 7.8 with ammonium hydroxide (EPA, 1977). identify the appropriate polymer dose.



The impact of pH and ions on precipitation and coagulation indicates the need for thorough testing to determine the correct treatment chemistry for a particular wastewater. The tests must evaluate the best conditions for coagulation and precipitation.

In addition to sweep floc formation, coagulation depends on charge neutralization (WEF, 2006). Surface charges cause colloidal and fine suspended particles to repel each other, helping to keep the solids in suspension. The coagulant neutralizes the charge, allowing the solids to coalesce.

of different sizes using

Stokes' Law





COAGULANTS AND FLOCCULANT AIDS

Table 1 lists some common coagulants and their properties, including the change in alkalinity and the approximate mass of solids formed for a 1 mg/L addition of coagulant (dry weight basis, DW).

Coagulants such as alum consume alkalinity (negative value in table) when they undergo hydrolysis (see equation). The addition of 1 mg/L of filter alum (DW) uses 0.5 mg/L CaCO³ alkalinity and produces approximately 0.26 mg/L Al(OH)₃ solids. The wastewater system may need to add an alkali such as sodium hydroxide if the coagulant drops the pH outside the desired range.

The first reaction is:

 $Al_2(SO_4)_3 \cdot 14.3H_2O + 3Ca(HCO_3)_2 \leftrightarrow 3CaSO_4 + 2AL(OH)^3 + 6CO_2 + 14.3H^2O$

In practice, the hydrolysis continues beyond this first reaction, forming large amorphous molecules, such as $[Al_8(OH)_{20}]^4$ +. These molecules create the gelatinous floc that sweeps fine particles from solution.

In addition to iron and aluminum salts, manufacturers produce a number of proprietary cationic, anionic, and nonionic polyelectrolytes that may be appropriate for some industrial wastewaters. Some function better at the alkaline pH used to precipitate some heavy metals. Though polyelectrolytes cost more, their dose is typically lower and they often produce less sludge.

A thorough evaluation of polyelectrolyte coagulant and flocculant aids should include toxicity tests if they are part of the permit. Some cationic polyelectrolytes have exhibited toxicity, particularly to Ceriodaphnia Dubia (Fort & Stover, 1992 and 1995; Rowland, 2000). Toxicity has also been observed with anionic polyelectrolytes in an emulsion. The emulsifying agents, rather than the polyelectrolyte, appeared to be the cause of the toxicity.

MIXING

Mixing type and intensity affect the performance of precipitation, coagulation, and flocculation processes. Smith evaluated mixing intensities for coagulant addition from G of 2 sec⁻¹ to 425 sec⁻¹ and found that the most intense mixing improved phosphorus removals. "Instantaneous phosphate removal is more efficient when metal-hydroxides are being formed under high G conditions, providing ample opportunity for contact between ferric and phosphate ions, and the flocs produced have a higher surface area." (Smith 2007).

The designer needs to consider the wastewater flow and chemical feed systems when selecting the type of mixer for coagulant addition. A tank with an axial flow mixer provides superior control of mixing energy, irrespective of the flows. Static inline mixers should be limited to plants with steady wastewater and chemical flows. Because the mixing intensity in a static mixer rises and falls with the flow, a mixer that works well at average flows, and does not impart excessive headloss at maximum flows, may not provide enough shear at low flows. A static mixer also provides longitudinal mixing. If the chemical arrives in pulses, typical of many metering pumps, the coagulant will not be well distributed in the

wastewater. This is particularly a problem in phosphorus removal systems where the coagulant is used for both precipitation and coagulation.

Mixing in the flocculation tank is more gentle (G = 10 to 75 sec⁻¹) than in coagulation. If hydrofoil mixers are used, the polymer can be added at the impeller to improve dispersal of the chemical.

SOLIDS RECYCLE

Some treatment processes return or recycle some of the settled solids to the coagulation tank. An example is CoMag, which has used a variety of coagulants to

Polyaluminum 10 chloride L = liquid; S = solidremove phosphorus, heavy metals, oil, and solids. Another example is high-density solids (HDS),

Table 1. Coagular

Name

Alum

Lime

Sodium

aluminate

Ferric chloride

Ferrous sulfate

which uses lime to treat mining wastewaters. In both cases, the return solids increase the mass of floc available to sweep fine particulates from the water without having to increase the coagulant dose. In the case of HDS, the return solids provide more time to dissolve the lime. Systems that return solids typically use less coagulant, in some cases reducing the dose by over half. However, there are limits to the benefits of solids recycle. Floc particles become more crystalline as they age, making them less effective in removing solids (Smith, 2007).

TESTING

The successful design and operation of coagulation and flocculation processes requires thorough testing. Jar tests are an effective tool for screening different chemistries. The manufacturers of the Phipps and Bird gang stirrer provide guidance on the test procedures (phippsbird.com/jar.html), and several textbooks outline the tests (Hudson, 1981). Key steps to remember include:

- 1. Collect fresh, representative samples
- 2. Prepare fresh diluted reagents
- 3. Systematically evaluate variables
- (e.g., reaction times, pH, doses)
- 4. Document all results
- 5. Remember that the jar test results are only an approximation of full-scale operations

Pilot testing is recommended for most industrial wastewaters because of their complex nature. A pilot test will provide a better understanding of reaction times, solids generation, and treatment performance with a larger sample of water, and it may identify issues not observed in a jar test (e.g., scale formation).

| KEY STEPS TO SUCCESSFUL COAGULATION AND FLOCCULATION |

ants and their properties								
Typical Form	Formula	Specific Gravity (g/cc)	рН @ 1%	Δ Alkalinity as CaCO ³ (mg/L)	TSS Increase (mg/L)			
48.9% L	Al ₂ (SO ₄) ₃ ·14.3 H ₂ O	1.33	3 to 4	- 0.50	+ 0.26			
93% S	Ca(OH) ₂		12	+ 1.35	+ 1.35			
38.5% L	FeCl ₃	1.35	3 to 4	- 1.85	+ 0.66			
98% S	Fe ₂ SO ₄ ·7H ₂ O		3 to 4	- 0.36	+ 0.32			
38% L	Na ² Al ² O ⁴	1.48	11 to 12	+ 0.61	+ 0.95			
10.5% L Al ₂ O ₃	Al²(OH)³Cl³ (typical)	1.26	3 +/-	Negligible	+ 0.16			

ABOUT THE AUTHOR

• Hugh Tozer is a senior vice president with Woodard & Curran. He manages the industrial wastewater group. He has a bachelor of arts in chemistry and a master of science in civil engineering.

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Ebola and Biosolids

Many sectors in the U. S. and Canada have been improving protocols and preparations regarding the potential for an Ebola outbreak. There have been only a few cases of Ebola documented in the U. S., and most have been successfully treated. However, precautions are appropriate, given the severity of the illness caused by the Ebola virus.

The wastewater management profession has taken Ebola seriously and is working with the Centers for Disease Control (CDC) and others to understand and address any risks to wastewater management professionals. In early November,

Some wastewater treatment facilities have worked with local hospitals to ensure that any bodily fluids from known Ebola patients will be disinfected prior to discharge to the sewer system

WEF conducted a webinar on the topic, which can be viewed via the WEF website. At press time, various organizations involved in wastewater treatment were expressing concerns about unknowns regarding such questions as how long the Ebola virus can remain viable in various environmental media and whether there may be some risk of it being transmitted to wastewater workers. CDC officials do not think it likely and have stressed that even some people living with Ebola victims do not become infected; Ebola is transmitted by close, direct contact with bodily fluids of an infected person who is displaying symptoms. In early November, CDC released guidance recommending careful use of personal protective equipment for protecting wastewater workers. Some water resource recovery facility managers are recommending increased attention and more thorough use of personal protective equipment (PPE), especially by those working with collection systems and pump stations. And some wastewater treatment facilities have worked with local hospitals to ensure that any bodily fluids from known Ebola patients will be disinfected prior to discharge to the sewer system.

What about potential risks to those involved in biosolids management? The research is not completely clear. However, it is likely that risks to workers via biosolids, which have been treated, are lower than those in collection systems and wastewater treatment processes. According to CDC, the Ebola virus likely behaves similarly to other envelope viruses; they are some of the most susceptible to being killed in the wastewater and solids treatment processes, and they do not survive long in typical environmental conditions. CDC considers the risk of transmission of similar envelope viruses via wastewater to be low. Class A biosolids have gone through treatments that inactivate or remove such viruses and other pathogens, making them safe for public use. Class B biosolids, on the other hand, may contain reduced levels of viable pathogens, and there are long-standing recommendations to take appropriate measures to reduce risks to workers and others exposed to Class B biosolids. See the 2002 CDC guidance for controlling risks to biosolids workers at: cdc.gov/niosh/docs/2002-149/pdfs/2002-149.pdf. It stresses common-sense precautions such as avoiding any inadvertent ingestion of biosolids (e.g. via eating or smoking during work), regular hand-washing, and use of PPE.

Monitor the latest Ebola information at cdc.gov/ vhf/Ebola, including the interim Ebola guidance for wastewater professionals.

Biosolids Court Cases Around the Nation

In the first week of November, the state of Washington Appeals Court overturned a ban on the use of Class B biosolids that had been imposed by Wahkiakum County. This case has been closely watched by those involved in biosolids management around the continent. The Northwest Biosolids Management Association (NBMA) closely tracked the case. It reported:

"Following the oral argument held July 1, 2014, the Court Slaughter told the National Law Journal. was tasked with determining whether the County's Class In New England, where local political power lies more B biosolids and septage ban irreconcilably conflicted with with municipalities than counties, numerous municipal ordinances ban or severely restrict biosolids land applicathe state law The Court's published opinion outlines their comprehensive review of both sides, with resounding tion—especially in New Hampshire. A long precedent for support to uphold the duty assigned to Ecology by the local control exists in this region. In addition, legislatures legislature to safely manage and regulate biosolids in the have not been as clear, perhaps, in their intent to require State....The Court also highlighted state Supreme Court that biosolids be recycled when possible. However, some cases that support their decision to uphold the current state solid waste management laws and plans, such as [state] biosolids regulatory framework. Ecology and the Vermont's, do set clear goals for recycling biosolids, amici supporting them were adamant about the effect indicating some legislative intent. It is uncertain whether one ban could have in other counties across the state or not such goals and related statements would provide and nation. The Court agreed, stating that 'if local governenough basis for a case arguing that the state biosolids ments have the power to ban land application of biosolids, management program preempts a local ban. Those land application of biosolids could be banned throughout affected by local bans have generally declined spending the state, clearly thwarting the legislature's purpose of the money and time required to challenge a local ban. recycling biosolids through land application rather than Meanwhile, the ongoing Kern County litigation in landfill disposal or incineration. The County's ordinance Southern California, where the county has banned importhwarts the express purpose of the legislature and, thus, is tation and land application of biosolids (Class A and Class irreconcilable with state law and unconstitutional." B), also involves state preemption arguments. However,

The Wahkiakum County ordinance banned land application of Class B biosolids while allowing Class A biosolids use and landfill disposal of either one. It was passed by the county in 2011 over concerns about surface water quality and traces of heavy metals and chemicals in biosolids (concerns that apply to Class A biosolids as well). The Washington department of ecology (DOE) sued the county, and a Cowlitz County judge upheld the ordinance. DOE appealed last winter, and the November judgment was the result.

According to the *National Law Journal*, "James Slaughter, a principal at Washington's Beveridge & Diamond who represented several amicus groups in the case,... said the ruling provides an additional precedent in a long line of preemption challenges across the country over the use of biosolids. 'The litigation is not frequent, because it [biosolids recycling] is largely a very successful practice. It benefits all communities that generate sewage sludge and it provides farmers with a bulk organic fertilizer they like.... However, there have been a number of states where these clashes have arisen, and the trend is very much in favor of preemption of local biosolids bans."

According to several media accounts, Wahkiakum County plans to appeal to the Washington Supreme Court. A TDN Online article quoted Daniel Bigelow, attorney for the county, as saying, "What we're talking about here is how much additional regulation local government can put on something that's already been regulated by the state. The general idea behind county government is that for

local issues—and the local ecology is particularly a local issue—there should be local people making local laws. We feel this is legitimately one of those, but the state doesn't think so."

"The Superior Court's decision was based on the fact that the state legislature expressly stated that 'to the maximum extent possible, biosolids should be used," Slaughter told the *National Law Journal*.

Meanwhile, the ongoing Kern County litigation in Southern California, where the county has banned importation and land application of biosolids (Class A and Class B), also involves state preemption arguments. However, so far, the California courts have not addressed the substantive issues of the case. But that will change next year, as the city of Los Angeles, Responsible Biosolids Management Inc., and others (the plaintiffs) have asked the Superior Court, County of Tulare, to permanently end any possible enforcement of the Kern County ban known as Measure E. Court battles over Measure E have been ongoing since shortly after Measure E—a voter referendum—passed on June 6, 2006. To date, Measure E has not been enforced, because of a preliminary injunction obtained by the plaintiffs.

The plaintiff's current brief begins, "The time has come to issue a permanent injunction against Kern County Measure E, a discriminatory local voter initiative that bans a critical recycling practice, land application of biosolids. The Court of Appeal resolved the merits of this action in February 2013 when it affirmed this court's rulings that Measure E was likely preempted and exceeded the county's police powers. Five federal and state trial and appellate judges agree that Measure E is illegal and



the plaintiffs ask that this court apply its prior analysis -ratified by the Court of Appeal-to issue a permanent injunction."

In the summer of 2014, the state Supreme Court dismissed the case, stating that the plaintiffs (city of Los Angeles and others) had not filed their original state court action in a timely fashion. This was Kern County's only victory to date. However, the Supreme Court did not address any substantive issues. This means that the arguments previously put forth in earlier stages of this case by the Tulare County Superior Court and the Appeal Court have not been superseded by the state Supreme Court. Therefore, the plaintiffs are hopeful that the same arguments will prevail in the future, resulting in a permanent injunction against Measure E. A hearing in Tulare County Superior Court is scheduled for January 15, 2015. The plaintiffs and other biosolids management professionals hope that this will be the last step in defeating the Kern County ban.

Meanwhile, a Pennsylvania court battle over biosolids use also continues. Next year, the Pennsylvania Supreme Court will hear that case, Gilbert v. Synagro, and will likely address questions about whether or not the state's Right to Farm law applies to biosolids land application. As noted in a press release from Beveridge & Diamond, the law firm employed in these various biosolids cases, many other states have Right to Farm laws, so the Pennsylvania case is also of great interest to biosolids management programs nationwide.

The Pennsylvania Supreme Court has addressed biosolids issues before-in a case that involved state preemption of a local ordinance. In November 2003, it found that a New Jersey biosolids management company, Hydropress, had standing in filing suit against a township because of the township's restrictive biosolids ordinance and local biosolids tax. The state Supreme Court found that two sections of the local ordinance were preempted by state laws and regulations, and ordered the township not to enforce them. However, the court said the remaining provisions could be enforced. The opinion, however, was held by barely a majority of the court and was accompanied by two minority opinions. One justice felt that Hydropress did not have standing in the case and that the case should have been dismissed without any consideration of the substantive issues. Three justices (including the chief justice), however, felt that the lower courts were correct in annulling the local ordinance in its entirety, stating that those courts "correctly recognized that the pervasive state regulation in this specialized area, embodied in and authorized by the Solid Waste Management Act ... indicates clear legislative intention to preempt the field from local regulation." These three justices supporting Hydropress in that case continue on the court today, which means they have some knowledge and acceptance of the appropriateness of biosolids recycling to soils.

NEBRA continues to track these landmark biosolids legal battles. Biosolids recycling has generally fared well in the legal courts, if not always in the courts of public opinion.

The North East Residuals and **Biosolids Conference**



The North East Residuals and Biosolids Conference, co-sponsored by the NEWEA residuals committee and NEBRA, was held in South Portland, Maine, on October 22 and 23. It began with tours of the biosolids management system at the Lewiston-Auburn, Maine Water Pollution Control Authority (LAWPCA), which includes a new anaerobic digestion (AD) facility (the first municipal digesters in Maine!) and solids composting.

The afternoon of that first day, the focus was on AD, co-digestion, energy generation, and key new information

on related issues such as fats, oils, grease (FOG), odor management, optimization of the feeding of outside wastes, and rapid volume expansion. The discussions continued into the evening with networking in the exhibit area and more networking at an Irish pub in downtown Portland.

October 23 included a full day of presentations on bigpicture decision-making and planning, biosolids land application, environmental management systems, harvesting of nutrients, and energy-neutral water resource recovery facilities—all timely topics. Mac Richardson, LAWPCA superintendent, gave the keynote address, a retrospective on 25 years of advancing biosolids management. The day ended with updates on regulatory developments in five states and provinces.

All residuals conference presentations are available on the NEBRA website (click to the Annual Conference page under Resources and Links) and on the NEWEA website.





(top) Mac Richardson, LAWPCA superintendent, leads conference tour. (bottom) Travis Peaslee, LAWPCA assistant superintendent, showed conference attendees the new anaerobic digestion and combined heat and power systems.

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NEWEA

WEF delegate report

The Operations Challenge competition was fierce and once again was a highlight of the WEFTEC week. Forty-two teams slugged it out for bragging rights as the best operators in the industry. All three NEWEA teams performed well and made us proud. One New England team, Force Maine (shown), received impressive hardware for winning the process control event for Division II.



WEFTEC 2014 was held in New Orleans, with more than 22,000 water quality professionals in attendance. NEWEA was well represented throughout the convention by our leadership, members, and Operations Challenge teams. Saturday began with all the WEF delegates and NEWEA Executive Director Mary Barry participating in

day-long training sessions and committee meetings. It is important for NEWEA members to understand the responsibilities of our WEF delegates, and since it has been awhile since these have been emphasized, here is a short update on what we do.

The House of Delegates (HOD) is the deliberative and representational body of WEF. It advises the WEF board of trustees on strategic direction and public policy development, and has authority to elect and remove trustees and officers to the extent provided for in the WEF constitution and bylaws. The HOD:

- Advises the board on strategic direction and on policies and initiatives of the Federation
- Reviews the budget report from the board and provides comments to the board on its consistency with the strategic plan and other initiatives
- Confirms nominations from the president of members to serve as trustees on the board
- Elects the officers of the federation, except the executive director
- May remove trustees and/or officers in the manner provided by WEF constitution and bylaws

DELEGATE RESPONSIBILITIES

Delegates are required to be members in good standing of WEF, and one or more delegates are to be appointed or elected by each member association (MA). Delegates at large are to be nominated and confirmed in accordance with the WEF constitution & bylaws.

- NEWEA delegates:
- Represent the interests of NEWEA

- Are WEF's direct liaison to NEWEA
- Provide for timely two-way communication and transfer of information between HOD and NEWEA
- Work with NEWEA's executive committee to bring forward issues of importance to NEWEA
- Participate in one or more WEF committees, with choices based on the qualifications or interests of the delegate and/or the specific needs of NEWEA
- Attend WEFTEC annually and participate in HOD meetings, including the House Orientation, discussion sessions, and two HOD business meetings
- Participate in one WEF MA exchange meeting (WEFMAX) annually at a location and date convenient for the delegate subject to the needs of NEWEA
- Participate in the NEWEA annual conferences and as voting members in NEWEA executive committee meetings, and assist in coordinating the WEF representative's participation in the NEWEA annual conference
- Participate in one or more work groups, with choices based on the qualifications or interests of the delegate and/or the specific needs of NEWEA

Howard Carter is serving on the MA leadership development work group. This group, chaired by Delegate-at-Large Jennifer Lachmayr, will build on the developed guidance documents and PowerPoint presentations from the 2013-14 work group and continue the mission of addressing leadership training needs for the MAs. The work group will complete the series of PowerPoint presentations on membership recruitment and retention, produce and conduct webcasts, collect and evaluate feedback on the training, and determine if additional training is needed. The training materials may be used in peer-to-peer training sessions at future WEFTEC leadership days, WEFMAX meetings, MA leadership retreats and MA planning sessions. The relevance will



not be limited to individual leadership development but will include MA sustainability and the training needs of MA boards and executive committees.

Mr. Carter is also a member of the HOD steering committee. The committee reviews and prioritizes information from committees and work groups, develops and summarizes the information, and advises and directs the speaker of the house and HOD. It also advises the board of trustees on strategic direction and public policy development.

Michael Wilson is on the MA financial sustainability committee, which is looking into helping MAs to plan for more robust financial goals. He is working with a subcommittee to develop board expense policies that will be shared with the committee in support of the financial challenges some MAs are addressing. NEWEA has an excellent financial model and is sharing its experience with the MA financial sustainability committee. Mr. Wilson has also taken on the vice chair position for the HOD nominating committee. The nominating committee is identifying future leaders within HOD and is responsible for soliciting and reviewing applications for next year's HOD leadership. Mr. Wilson has also begun to use the WEFCOM website for communications with other delegates. He is working with the NEWEA most outstanding MA ad-hoc task force to prepare an award submission to WEF recommending NEWEA for that award at next year's WEFTEC.

In October, Dan Bisson began his first of a 3-year term as a WEF delegate. He has been nominated to serve as chair of the HOD nominations committee and will lead the placement of the next leaders of the WEF HOD. Mr. Bisson was also asked to serve on the value of water coalition task force. This task force is a water industry collaboration among national associations, engineering and construction firms, and private water companies and technology and service providers. These groups have come together to create a stronger, more united voice across the sector and to improve public awareness about the value of water. For details, visit: thevalueofwater. org. The task force serves as a sounding board to

WEF leadership and assists Linda Kelly (WEF's senior director of development and strategic alliances) in providing feedback to and garnering support for the value of water coalition's Water Works! campaign.

WEFTEC Highlights: Monday's NEWEA luncheon again proved a big success, with a packed house offering members an opportunity to network and catch up with old friends. President Bradley Moore provided an overview of the latest NEWEA activities. He was followed by WEF delegates who shared WEF HOD plans for the upcoming year. During the luncheon, old friend George Vercelli was integrated into the Select Society of Sanitary Sludge Shovelers. Although he recently located to Winnipeg, Mr. Vercelli has been an active NEWEA member for more than 25 years, and he recently became the WEF membership committee chair.

In closing, we thank two outgoing NEWEA WEF delegates, Phyllis Arnold Rand and Jennifer Kelly Lachmayr, for their extensive efforts. Ms. Lachmayr has been elected as a WEF delegate-at-large, expanding NEWEA's influence in HOD. We also congratulate and welcome our newest delegates, Messrs. Bisson and Wilson. Based on the many successful meetings and interactions with WEF leadership, staff and other MAs, NEWEA is well represented as one of the premier MAs in WEF.

MEMBERSHIP SERIES—NOV. 6 AND DEC. 4

A successful webcast membership series was conducted in November and early December with topics from the membership recruitment and retention guidebook. The first webcast was on November 6 and focused on "Chapter 3—Burnout." The two presenters were Paul Pinault, WEF delegate from Florida Water Environment Association, and Jamie Eichenberger, speakerelect of HOD. The second webcast was on December 4 and focused on "Chapter 4—Operator Engagement/Professionalism." The two presenters for this webcast were David Briggs, WEF delegate from Texas WEA, and Todd Boling, WEF delegate from Nebraska WEA. Both webcasts are available for viewing at: wef. org/Members/page_ma_detail.aspx?id=6442451557.

NEWEA delegation poses with award winners from the Narragansett Bay Commission and the NEWEA public education committee



SYSTEMS>GO **NEWEA 2015 Annual Conference & Exhibit**

Preview

January 25–28, 2015 • Boston Marriott Copley Place, Boston, MA

e have some exciting additions to the Annual Conference the biggest and best wastewater forum in New England. NEWEA President Brad Moore will preside over this year's conference featuring expanded technical sessions, two days of poster sessions, exhibitors, and the Awards Ceremony.

The technical program will include 33 sessions that span all areas of expertise in the water quality and resources profession. Topics are wide-ranging and will include emerging issues, practical applications, specific project experience, and lessons learned. New this year are sessions focused on selected "Hot Topics."

New this year-

Two Graduate Level Technical Sessions in addition to our Student **Poster Competition**

Conference Events SUNDAY, JANUARY 25

Registration - 4th Floor.. .. Noon-4:00 PM **MONDAY, JANUARY 26** Registration – 4th Floor... ...7:00 AM-6:00 PM

Technical Sessions 1–6	.8:30–10:30 AM
Technical Sessions 7–12	.2:00–4:30 PM
Exhibits	.10:30 AM-6:30 PM
Opening Session	. 11:00 AM
Exhibit Hall Reception	.4:30–6:30 PM
TUESDAY, JANUARY 27	

Registration – 4th Floor	7:00 AM-6:00 PM
Exhibits	8:00 AM-6:30 PM
Technical Sessions 13–18	9:00 –11:30 AM
Technical Sessions 19–24	1:30–4:00 PM
Exhibit Hall Reception	4:00-6:00 PM

WEDNESDAY, JANUARY 28

Exhibits. . 8:00 AM-1:00 PM Awards Presentation & Gavel Passing ...11:00 AM Technical Sessions 31–33.....1:00–3:00 PM

Hot Topics

- Advances in Process Monitoring and Control
- Emerging Technologies
- Funding Stormwater Management
- Infrastructure Resiliency
- Revolutionizing Training and Learning How to Learn
- Sustainable Nutrient Removal

Event Hotel

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

SINGLE-\$199.00 DOUBLE-\$219.00

Conference Registration

Register online/download a complete conference program at newea.org Phone: 781-939-0908 Early registration before January 9

Conference Exhibitors

ACF Environmental/Fabco Industries	F.W. Webb Co
ADS Environmental Services	Fay, Spofford
Advanced Drainage Systems, Inc.	Flottweg Sep
AP/M CentriPipe	Flow Assessn
Aqua Solutions, Inc.	FlowWorks, Ir
Aquagen Infrastructure Systems, Inc.	Flygt Product
Asahi/America	Ford Hall Cor
Associated Electro-Mechanics Inc.	G.L. Lyons As
Atlantic Fluid Technology	Gabriel Nova
BAU/HOPKINS	Geomembrar
BDP Industries	Green Mount
Bilfinger Airvac Water Technologies	Hach Compa
Biosec Enviro., Inc.	Hamilton Ken
BISCO Pump Systems	Hanna Instrur
Blake Equipment Co.	Hayes Pump,
Brentwood Industries, Inc.	Hazen and Sa
Burt Process Equipment	HOBAS Pipe
Cabot Norit Activated Carbon	Holland Com
Carl Lueders & Company	Infrastructure
Carlsen Systems, LLC	Innovyze, Inc.
Casella Organics	Inovair
Coyne Chemical Environmental Svcs.	J&R Sales and
CUES	Kemira
David F. Sullivan & Associates, Inc.	Maltz Sales C
DN Tanks	Martinez Cou
Duperon Corp.	Mechanical S
Duke's Root Control, Inc.	National Filter
Eastern Pipe Service, LLC	New England
Engineered Treatment Systems, LLC	Equipment
Environmental Dynamics, Inc.	Oakson
Environmental Operating Solutions, Inc.	Pavers by Ide
Evoqua	Perma-Liner l
F.R. Mahony & Associates, Inc.	PRIMEX Cont

Webb Co. – Process Controls Div.	Pump Systems Inc.
Spofford & Thorndike	R.H. White Construction Co., Inc.
tweg Separation Technologies, Inc.	Resource Management, Inc.
v Assessment Services	RITEC Environmental
vWorks, Inc.	Rockwell Automation
t Products – A Xylem Brand	Russell Resources, Inc.
d Hall Company	Schulz Group, A Timken Brand
Lyons Associates	SDE, Inc.
riel Novac & Associates, Ltd.	SNF Polydyne, Inc.
membrane Technologies Inc. (GTI)	Statewide Aquastore, Inc.
en Mountain Pipeline Services	Synagro North East, LLC
h Company	SyTech, Inc.
nilton Kent LLC	Technology Sales Associates Inc.
na Instruments	The MAHER Corporation
es Pump, Inc.	Trumbull Industries
en and Sawyer	United Concrete Products Inc.
BAS Pipe USA	USA Blue Book
and Company	Vari-Tech, LLC
structure Technologies	Vogelsang
ovyze, Inc.	Walker Wellington, LLC
air	Wastecorp Pumps LLC
Sales and Service, Inc.	Water & Waste Equipment, Inc.
nira	WESCOR Associates, Inc.
z Sales Company	Westech
tinez Couch & Associates LLC	WhiteWater, Inc.
chanical Solutions, Inc.	Winters Instruments
onal Filter Media	Woodard & Curran
v England Environmental	Yeomans Chicago Corporation
ipment	as of 10/28/14

ers by Ideal na-Liner Industries, LLC **MEX** Controls

2014 Award Recipients

NEWEA

Alfred E. Peloquin, CT	Brian Armet
Alfred E. Peloquin, MA	James Barsanti
Alfred E. Peloquin, ME	Travis Peaslee
Alfred E. Peloquin, NH	Harry Stewart
Alfred E. Peloquin, RI	Janine Burke
Alfred E. Peloquin, VT	Robert Fischer
Asset Management	City of Dover, NH
Biosolids Management	John Donovan
Clair N. Sawyer	Edward Rushbrook
Committee Service	David Press
E. Sherman Chase	Aubrey Strause
Elizabeth Cutone	
Executive Leadership	Sidney Holbrook
Energy Management	
Achiovomont Voolia Wator	Dumouth MA MM/TD
Achievenient	FIYITIOUUT, IVIA VVVI F
James Courchaine Collection Systems	John Sullivan, Jr.
James Courchaine Collection Systems Operator Safety	John Sullivan, Jr. Donald Dubiel
James Courchaine Collection Systems Operator Safety Operator, CT	John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr.
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA	John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME	John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Janiel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Janiel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI Operator, VT	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Janiel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Linkevin McLaughlin
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI Operator, VT Past President Plaque & Pin	John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Kevin McLaughlin Michael Bonomo
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, RI Operator, VT Past President Plaque & Pin Public Educator	John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Kevin McLaughlin Michael Bonomo Markey Fish
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI Operator, VT Past President Plaque & Pin Public Educator SJWP - CT	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Kevin McLaughlin Michael Bonomo Michael Bonomo Michael Bonomo
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI Operator, VT Past President Plaque & Pin Public Educator SJWP - CT SJWP - ME	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Kevin McLaughlin Michael Bonomo Michael Bonomo Michael Oei Mary Butler
James Courchaine Collection Systems Operator Safety Operator, CT Operator, MA Operator, ME Operator, NH Operator, RI Operator, VT Past President Plaque & Pin Public Educator SJWP - CT SJWP - ME SJWP - NH	John Sullivan, Jr. John Sullivan, Jr. Donald Dubiel Daniel Sullivan, Jr. Linda Schick Michael Tibbetts Kenneth Noyes Shawn Murphy Kevin McLaughlin Michael Bonomo Michael Bonomo Michael Bonomo Michael Bonomo

Wastewater Utility	City of Montpelier Water Resource
	Recovery Facility, Montpelier, VT
Young Professionals	Dustin Price

WEF (presented at WEFTEC)

Operations Challenge	Force Maine
Operator Ingenuity	Michael Carle
Public Education	NEWEA
Water Quality	
Improvement	Narragansett Bay Commission
VVLI I EIIOVVS	James Crook
WEF Fellows	James Crook John Hart

WEF—MA Awards

Arthur Sidney Bedell	Steven Freedman
George W. Burke, JrWin	nipesaukee River Basin WWTP
Lab Analyst Excellence	Mary Jersey
William D. Hatfield	Stephen Sloan
Quarter Century Operator	Gregory Thulen
Quarter Century Operator	Mario Leclerc
Quarter Century Operator	Michael Bisi
Quarter Century Operator	Phyllis Arnold Rand
Quarter Century Operator	Timothy Baker
WEF Life Membership	James Pappas
WEF Life Membership	Joseph Shepherd
WEF Life Membership	Roger Janson
WEF Life Membership	Russell Adams
WEF Life Membership	Steven Freedman
WEF Service/WEF Delegate	Jennifer Lachmayr



It's prime time.

Join us at the NEWEA 2015 Spring Meeting & Exhibit June 7 – 10, 2015 | Omni Mount Washington Resort, Bretton Woods, New Hampshire **Announcing the call for presentations and papers** Visit the NEWEA website for more information or to submit an abstract









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Specialty conference proceedings

WATERSHED MANAGEMENT AND STORMWATER

Hosted by NEWEA's Watershed Management and Stormwater Committees

October 16, 2014

Mystic Marriott, Groton, Connecticut

Meeting registrants included: 83 attendees and 11 exhibit displays for a total of 94 registrants.

The technical presentations commenced on Thursday with NEWEA Watershed Management Committee Chair Phil Forzley; NEWEA President Brad Moore, and Mark Oefinger, Town Manager, Groton, Connecticut providing the Welcome and Opening Remarks to meeting attendees.

TECHNICAL PRESENTATIONS

Update on Local and Regional Stormwater Issues

• Moderator: Ginny Roach, CDM Smith; Chair. Stormwater Committee Christopher Stone, CT DEEP and Thelma Murphy, EPA Region 1

Stormwater Utilities Panel Discussion

 Moderator: Mike Walsh, CDM Smith with: James Laurila, Northampton, MA; Maria Rose, Newton, MA; Terrance Sullivan, Fall River, MA; Brad Moore, Bangor, ME

Two Concurrent Sessions were held.

CONCURRENT SESSION 1

• Moderator: Aubrey Strause, Fuss & O'Neill

TESTING THE WATERS-TMDLS, MS4s AND FINANCING

Chesapeake Bay Watershed Implementation Plans—Large-Scale Stormwater Infrastructure Retrofit to Achieve TMDL Compliance • S. Ali Abbasi, Prime AE Group, Inc.

MassDOT's Impaired Waters Program— A Case Study of MS4 Compliance Jennifer Doyle-Breen, AECOM

Implementing Stormwater Utilities in Two Southern New England States • James Riordan, ESS Group, Inc.



CREATIVE WAYS TO MEET TMDL REQUIREMENTS

Restoring Impaired Streams to Meet TMDL Requirements and Create Public Amenities

• Kelly Mattfield, Brown and Caldwell Philadelphia Water Department: Cobbs Creek Restoration, Floodplain Wetlands and Green Stormwater Infrastructure Improvements

 Antonio Federici, Dewberry Integrating Oyster Reef and Salt Marsh Restoration to Enhance Estuarine Water Quality, Wellfleet, MA

 Robert Rafferty, Environmental Partners Group

CONCURRENT SESSION 2 • Moderator: Vinta Varghese, CH2M HILL

SIGNS OF THE TIMES-CLIMATE **CHANGE AND INTEGRATED PLANNING**

BWSC Climate Change Impact Assessment and CIP Mitigation/ Adaptation Strategy Development William McMillin, CH2M HILL and Charlie Jewell, BWSC

Integrated Planning and Permitting: Technical, Legal and Financial **Opportunities and Challenges**

- Zach Henderson and Toby Fedder, Woodard & Curran and William Taylor. Pierce Atwood
- City of Seattle Integrated Plan Jeff Herr, Brown and Caldwell

ADVANCES IN GREEN TECHNOLOGIES

Reconstructing Commercial Street with Porous Pavement to Mitigate Stormwater Discharges & Improve Water Quality in Provincetown Harbor

 Jessica Janney and Sandra Tripp, GHD, Inc.

Creating Incentives for Green Infrastructure in Vermont's Stormwater Management Manual

Julie Moore, Stone Environmental, Inc.

Mill River—Amalgamating Green Infrastructure into Existing Construction Projects

• Cindy Baumann, CDM Smith

EXHIBITORS

ACF Environmental Advanced Drainage Systems, Inc. Fay, Spofford & Thorndike Flow Assessment Services LLC GZA GeoEnvironmental. Inc. Hanna Instruments Hydro International Pavers by Ideal StormTrap

SPONSOR

CDM Smith

NORTH EAST RESIDUALS & BIOSOLIDS Keeping Current

Hosted jointly by NEWEA's Residuals Management Committee and the North East Biosolids & Residuals Association (NEBRA).

October 22 & 23, 2014 Portland Marriott at Sable Oaks, South Portland, Maine

A two-day specialty conference, exhibit and tour

Meeting registrants included: 106 attendees and 12 exhibitors for a total of 118 registrants.

The technical presentations commenced on Wednesday, October 22, with NEWEA President Brad Moore and NEWEA Residuals Management Committee Chair Jonathan Keaney providing the Welcome and Opening Remarks to meeting attendees.

In addition to the conference, an optional facility tour to the Lewiston Auburn Water Pollution Control Authority (LAWPCA) was held on Wednesday. A meet and greet reception was also held in the exhibit area on Wednesday.

TECHNICAL PRESENTATIONS Wednesday, October 22

SESSION 1: CO-DIGESTION Moderator: Deborah Mahoney, Hazen and Sawyer

The Power of FOG: Turning a Bad Situation Into a Good One • Melissa Hamkins, Wright-Pierce

Managing Food-Waste-Management Odors

Raymond Porter, Porter Odor Science

Scheduling Optimal Anaerobic Digestion Feeding for Co-digestion Operations

Barbara Wingler, Natural Systems

Full-Scale Case Study of Rapid Volume Expansion of Digester Contents Christopher Muller, Brown and Caldwell

An Anaerobic Digestion System Integrated with Wastewater Treatment in a Public/Private Partnership Facilitates (Nutrient) Resource Recovery Alan Johnson, Quasar Energy Group

Thursday, October 23

Utilities

WELCOME & OPENING REMARKS: • Aubrey Strauss, MEWEA President and Andrew Carpenter, NEBRA President

SESSION 2: GO FOR IT! Moderator: Jason Turgeon, U. S. EPA Region 1

Standing at a Crossroad: Navigating **Biosolids Management Decisions in the** Face of an Uncertain Future -• Matthew Van Horne, Hazen & Sawyer

Treatment Plant Utilities

KEYNOTE

SESSION 3: NUTRIENT CHALLENGES & OPPORTUNITIES Moderator: Elaine Sistare, CDM Smith

Nutrient Harvesting • Eric Spargimino, CDM Smith

Struvite—The Deer Island Experience • Ethan Wenger, Massachusetts Water Resources Authority

SESSION 4:

SESSION 5:

 Lystek BIOFerm



Triple Bottom Line Analysis of Biosolids Management Options: TBL Model Results from the WERF Energy Neutrality Project Andrew Carpenter, Northern Tilth

Ridgewood, New Jersey: An Energy-Positive, Cash-Positive Wastewater

• Eugenio Giraldo, Natural Systems

25 Years in the Biosolids: Challenges, Changes, Chances & Conclusions • Clayton "Mac" Richardson, Lewiston-Auburn Water Pollution Control Authority

Side Stream Nutrient Considerations and

YOU'VE GOT OPTIONS!

 Therma-Flite Crown Disintegrator

RISING TO THE CHALLENGE Moderator: Kenneth Scully, Fay Spofford & Thorndike

Class B Land Application—It's Alive! • Jen McDonnell, Casella Organics

Using a Biosolids Management System to Advance Quality Practices Natalie Sierra, Brown and Caldwell

REGULATION ROUNDTABLE Moderator: Ned Beecher, NEBRA Maine Odor Regulations & Other Recent Developments • Carla Hopkins, Maine DEP

Vermont Biosolids White Paper & **Regulations Development**

 Eamon Twohig, Vermont DEC New Hampshire Biosolids Rulemaking

2015

• Michael Rainey, NH DES

Massachusetts' Organics Ban & the **Biosolids Program** • Gregg Cooper, MassDEP

An Update from Nova Scotia Ashley Hosier, Nova Scotia Environment

EXHIBITORS

Aqua Solutions, Inc. **BIOFerm Energy Systems** Casella Organics David F. Sullivan & Assoc. Lystek International Inc. The MAHER Corporation Resource Management, Inc. Statewide Aquastore, Inc. Technology Sales Associates, Inc. Walker Wellington LLC WeCare Organics LLC

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AECOM Aqua Solutions, Inc. ARCADIS Brown and Caldwell CDM Smith David F. Sullivan & Assoc., Inc. EST Associates, Inc. Hazen and Sawyer, PC Kleinfelder NEFCO RH White Construction Co. Synagro Northeast LLC The MAHER Corporation Tighe & Bond, Inc. Wright-Pierce

SPECIALTY CONFERENCE PROCEEDINGS

MICROCONSTITUENTS: SOURCES, SINKS AND **SUSTAINABILITY**

Hosted by NEWEA's Microconstituents Committee

October 29, 2014 Bentley College, Waltham, Massachusetts The conference had 47 attendees.

The technical presentations commenced on Wednesday with NEWEA Vice President Ray Willis and NEWEA Microconstituents Committee Vice Chair Sandeep Sathyamoorthy providing the Welcome and Opening Remarks to meeting attendees. Three graduate students presented in a special poster session

TECHNICAL PRESENTATIONS

 Moderators: Priscilla Bloomfield, CH2M HILL and Charles Tyler, MWRA

Benchmarking Microconstituent **Biodegradation During Biological** Nutrient Removal

• Wendell Khunjar, Hazen and Sawyer, PC



Evaluating the Role of Nitrification in Pharmaceutical Biodegradation During Wastewater Treatment

• C. Andrew Ramsburg, Tufts University Looking Beyond The Parents—The

Presence and Toxicity of Transformation Products

Mark Benotti, Batelle/Bentley College

Biosolids and Soil—Remarkable Media for Managing Microconstituents • Ned Beecher, NEBRA

Inputs of Contaminants of Emerging Concern into the Cape Cod Aquifer from Onsite and Centralized Wastewater Laurel Schaider, Silent Spring Institute

Assessing Downstream Potential for Attenuation of Microconstituents in River Systems Receiving Moderate Wastewater Inputs

• Allison MacKay, University of Connecticut



SEX and DRUGS—How and When to Sample for Them • Patrick Phillips, USGS

Where the Pipe Ends—Antibiotics and Antibiotic Resistance in the Ambient Environment

• Ferdi Hellweger, Northeastern University

Sustainability and Microconstituent Management—What are the Big

Questions?

• Tim Verslycke, Gradient

STUDENT POSTER PRESENTATIONS

Exploring Beta Blocker Cometabolism by Mixed Culture Biomass Communities from Water Resource Recovery Facilities • Amy Hunter (Presenter), MS Candidate, Civil and Environmental Engineering, Environmental and Water Resources

Group, Tufts University

Application of DNA Stable Isotope Probing to Identify Trace Organic

Contaminant Degrading Microorganisms Catherine Hoar (Presenter), Sandeep Sathyamoorthy, Kartik Chandran, Columbia University

Organic Cation Structure: Effects on Adsorption to Montmorillonite

• William Jolin (Presenter), Environmental Engineering Department, University of Connecticut

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AECOM

ARCADIS Green Mountain Pipeline Services Hazen and Sawyer, PC RH White Construction Co. The MAHER Corporation

SMALL COMMUNITY & PLANT OPERATIONS

Operating Small Community Facilities with Seasonal Flow Variations

Hosted jointly by NEWEA's Small Community and Plant Operations Committees

November 5, 2014 NHDES, Portsmouth, New Hampshire

The conference had 30 attendees.

The technical presentations commenced on with NEWEA President-Elect Matt Formica; NEWEA Small Community Chair Jeff Gregg and Plant Operations Chair Ray Vermette providing the Welcome and Opening Remarks to meeting attendees. An afternoon facility tour to the Durham. NH Wastewater Treatment Plant was offered.



TECHNICAL PRESENTATIONS

It's a Roller Coaster Ride with University of New Hampshire Population

· Daniel Peterson, Superintendent, Durham, NH WWTF

A Coastal Maine Community Strategically Meets the Tenfold Influx of Tourism

- Timothy Haskell, Superintendent York, ME Sewer District
- Dustin Price, Chief Operator, York, ME Sewer District

Managing Growth at a Seasonal Resort

Community in a Protected Watershed David Keith, Chief Administrative Officer, Carrabassett Valley, ME Sanitary District

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Upcoming meetings & events

NEWEA CONGRESSIONAL BREAKFAST

April 14–15, 2015 • Rayburn House Office Building, Washington, DC

The NEWEA Congressional Briefing is the annual hallmark for the Association and its government affairs program. Mark your calendar to join us on April 14-15, 2015.

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

Attending the Briefing will allow:

- senators, representatives and legislative staff
- Substantive discussion of federal clean water legislative initiatives and opportunity to provide feedback related to the impact that these initiatives have on our communities and the water quality industry
- A forum for presentation and discussion of the NEWEA Position statements

AFFILIATED STATE ASSOCIATIONS AND OTHER ASSOCIATIONS

GMWEA STATE HOUSE EVENT January 21 & February 13, 2015 State House cafeteria, Montpelier, VT

MEWEA JOINT ANNUAL MEETING AND TRADESHOW WITH MWUA February 3-4, 2015 Holiday Inn by the Bay Portland, ME

GMWEA LEGISLATIVE LUNCH February 26, 2015 Capitol Plaza, Montpelier, VT

MEWEA/MWUA LEGISLATIVE BREAKFAST February 26, 2015 Augusta, ME

CWPAA LEGISLATIVE BREAKFAST March 2015 Hartford, CT

NHWPCA LEGISLATIVE BREAKFAST March 25, 2015 Holiday Inn, Concord, NH

MEWEA/NHWPCA JOINT SKI DAY March 27, 2015 Sunday River, Newry, ME

NEW ENGLAND WATER WORKS ASSOCIATION SPRING CONFERENCE April 1-2, 2015 Conference, DCU Center, Worcester, MA



Opportunities to meet with

on the Hill. If you plan to attend the briefing, the government

appointments.

Boston, MA

Headquarters In addition to the Briefing



· A forum to provide comments directly to regulatory leaders from EPA's Washington, D.C.

Breakfast, an important part of this day is holding individual meetings with senators and representatives affairs committee will work with you to schedule these individual

MWPCA LEGISLATIVE EVENT March 5, 2015

RI NWPCA LEGISLATIVE EVENT March 19, 2015 Providence, RI

NEWEA ANNUAL CONFERENCE January 25–28, 2015 Boston Marriott Copley Place Hotel, Boston, MA

NEWEA EXECUTIVE COMMITTEE **MEETING WITH ALL CHAIRS** January 25, 2015 Boston Marriott Copley Place Hotel, Boston, MA

NEWEA WATER REUSE & INDUSTRIAL WASTEWATER SEMINAR April, 2015 Windsor Locks, CT

THE NEWEA 2015 SPRING MEETING & EXHIBIT June 7–10, 2015 • Mt. Washington Resort Bretton Woods, NH



The Spring Meeting & Exhibit offers three days of technical sessions, exhibit displays, tours, the Operations Challenge competition and a chance to network with other wastewater professionals in a relaxed setting.

NHWPCA 2015 ANNUAL TRADESHOW April 19, 2015 Executive Court, Manchester, NH

CWPAA 2015 ANNUAL TRADESHOW April 23, 2015 New Life Church, Wallingford, CT

GMWEA SPRING & ANNUAL MEETING May 21, 2015 Killington Grand Hotel, Killington, VT

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





2015 NEWEA Executive Committee*

*Proposed 2015 NEWEA Executive Committee-pending the election vote at the annual business meeting of the membership on January 26, 2015 at the annual technical conference and exhibition

Matthew Formica Wakefield, MA PRESIDENT-ELECT

PRESIDENT

Raymond L. Willis Franklin, MA

VICE PRESIDENT James R. Barsanti Framingham, MA

TREASURER Frank E. Occhipinti Peabody, MA

SECRETARY Gerald C. Potamis Falmouth, MA

PAST PRESIDENT Bradley L. Moore Bangor, ME

COMMUNICATIONS DIRECTOR Jennifer K. Lachmayr Wakefield, MA

MEETING MANAGEMENT DIRECTOR Margaret C. Tabacsko Chelsea, MA

DIRECTORS Priscilla J. Bloomfield Orleans, MA

Peter J. Goodwin Portland, ME

Jonathan E. Kunay Cambridge, MA

Nathan W. Lavallee Milton, VT Virgil J. Lloyd

Manchester, CT

Frederick J. McNeil Manchester, NH

Michael Moreau Raynham, MA

Jay G. Sheehan Cheshire, CT

Michael L. Spring Providence, RI

EXECUTIVE DIRECTOR Mary Barry

WEF DELEGATES Howard F. Carter Saco, ME

Michael J. Wilson Boston, MA

Daniel P. Bisson Manchester, NH

Susan J. Sullivan Lowell, MA

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**NEWEA is a member association of WEF (Water Environ	nment Federation).

Employment Information (see back page for codes)

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

Sponsorship Information

WEF Sponsor name (optional)	Sponsor I.D. Number

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 Professional Wastewater Operations (PWO) Package 	Individuals in the day-to-day operation of wastewater collection, treatment or laboratory facility, or for facilities with a daily flow of < 1 mgd or 40 L/sec.	 WE&T (including Operations Forum) WEF Highlights Online 	\$96	
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2. JOB Code:

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ione			membership level, \$10 of your dues is allocated towards a subscription to the NEWEA Journal.	
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NEWEA/WEF^{}** Membership Codes 2015

To help us serve you better, please complete the following: (choose the one that most closely describes your organization and job function) **NEWEA is a member association of WEF (Water Environment Federation). By joining NEWEA, you also become a member of WEF.

What is the nature of your **ORGANIZATION?**

(circle one only) (ORG)

Municipal/district Water and Wastewater Plants and/or Systems

Municipal/district Wastewater Only Systems and/or Plants

Municipal/district Water Only Systems and/or Plants

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

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

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

Research or Analytical Laboratories

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

Manufacturer of Water/Wastewater Equipment or Products

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

Stormwater (MS4) Program Only

12 Other (please specify)

Optional Items (OPT)

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

Year of birth?

Gender? 1 Female 2 Male

What is your Primary JOB FUNCTION?

(circle one only) (JOB)

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

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

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

5

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

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

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

8 Student

9

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

10

Other

Education level? (ED)

1 High School 2 Technical School 3 Some College 4 Associates Degree 5 Bachelors Degree 6 Masters Degree 7 JD 8 PhD

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

What are your **KEY FOCUS AREAS?**

nole

Federation

(circle all that apply) (FOC)

Collection Systems

Drinking Water

Industrial Water/Wastewater/ **Process Water**

> Л Groundwater

5 Odor/Air Emissions

Land and Soil Systems

Legislation (Policy, Legislation, Regulation)

Public Education/Information

Residuals/Sludge/Biosolids/Solid Waste

10 Stormwater Management/ Floodplain Management/Wet Weather

11 Toxic and Hazardous Material

12 Utility Management and Environmental

> 13 Wastewater

14 Water Reuse and/or Recycle

15

Watershed/Surface Water Systems 16

Water/Wastewater Analysis and Health/ Safety Water Systems

OUNG ONAL

Other

Water quality professionals, with fewer than 5 years working experience and under the age of 35, are eligible to join WEF as an Active Member, while

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