Achieving stringent numeric nutrient standards, and other water quality standards, can be costly—yet achieving them can be more costly still. We’re identifying the most cost-effective and forward-thinking upgrades to protect public health and the environment.
To minimize problems with disinfection byproducts, the County plans to implement a new ion exchange process (MIEX) at the Johnston County Water Treatment Plant to reduce total organic carbon levels in the water directed to the chlorinated part of the distribution system.

Johnston County, North Carolina, needs additional drinking water supplies to meet the demands of a growing population, but available sources use a different secondary disinfectant than its system currently does. To accommodate adding the new sources, Hazen and Sawyer studied raw water quality, treatment processes, and the characteristics and performance of the entire distribution system, ultimately designing a solution that achieves regulatory compliance, meets projected demands, and provides safe drinking water.

Johnston County operates a large drinking water distribution system consisting of almost 1,600 miles of pipe. Much of the service area is rural, with scattered demands far from supply sources. The County’s drinking water supply includes several purchased water sources along with water drawn from the Neuse River and treated by a water treatment plant, approximately 10 miles downstream of a large, regional wastewater treatment plant. To control disinfection byproducts, the County currently uses chloramines, as a secondary disinfectant for its entire water supply and distribution system.

Facing continued population growth, the County needs to supplement drinking water supply with additional finished water sources. Additional purchased water supplies are available, but these sources use chlorine as the secondary disinfectant. To prevent mixing disinfectants, which can cause water quality problems, the County plans to split its distribution system into two separate systems—one system that utilizes chlorine as a secondary disinfectant and a second that utilizes chloramines.

Parting the Waters: Regulatory Compliance from a Split Distribution System

By Russell Jones, P.E., Cory Hopkins, P.E., and Meg Roberts, P.E.

Strategies for Stage 2 D/DBP Rule Compliance

Water purveyors can consider many strategies of varying cost in complying with the Stage 2 D/DBP Rule. The MIEX® process, a pretreatment process that utilizes a magnetized ion exchange resin, has been demonstrated to remove between 40 and 90 percent of source water naturally-occurring organic matter from a variety of water supplies, consequently reducing the formation of disinfection by-products upon chlorination.
Secondary sewage treatment has resumed at the Clarksville Wastewater Treatment Plant for the first time since the facility was knocked offline by flooding in May 2010. Clarksville Gas and Water (CGW) officials call it a major milestone in the recovery phase.

Hazen and Sawyer has been assisting CGW with coordination of the flood recovery efforts and designing plant improvements. Initial efforts included oversight of rehabilitation projects and engineering improvements that will coordinate with changes in water supply sources. The split into two separate distribution systems will complicate existing pressure zone boundaries, but careful planning allows water quality and hydraulic problems to be identified and solved proactively, without trial and error adjustments that would adversely affect customers.

Thanks to a variety of experts – water treatment specialists, hydraulic modelers, WTP designers, and construction engineers – the residents of Johnston County will reap the benefits of a cost-effective, regulatory-compliant solution that gives them room to grow and provides safe drinking water to the community.

Nitrification has been a problem in parts of the existing Johnston County chloraminated water system with high water age. The new segregated system will address this by incorporating areas with the highest water age into the chlorinated part of the distribution system.

This plan will require changing the secondary disinfectant for a portion of the water produced at the Johnston County Water Treatment Plant in order to supplement the newly-purchased chlorinated sources and to supply chlorinated water to a larger portion of the distribution system. The County plans to implement a new ion exchange process (MIEX) to reduce total organic carbon levels in the water, in order to minimize DBP formation in the chlorinated section of the water distribution system.

The other part of the split system will continue to distribute finished water from the water treatment plant that is not treated with the MIEX process, and which utilizes chloramines as the secondary disinfectant.

Separate But Equal

Hydraulic modelers studied the impacts of splitting the water distribution system into two disinfectant zones, considering pressures, fire flows, and water age. A Transmission Main Master Plan recommended phased infrastructure and operational improvements that will coordinate with changes in water supply sources. The split into two separate distribution systems will complicate existing pressure zone boundaries, but careful planning allows water quality and hydraulic problems to be identified and solved proactively, without trial and error adjustments that would adversely affect customers.

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Nitrification occurs when bacteria use nitrogen sources, such as ammonia, as an energy source and grow in the distribution piping system. This can cause rapid depletion of chloramine residuals which may subsequently lead to non-compliance with coliform limits; the likelihood of nitrification increases with water age.

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See related links

www.hazenandsawyer.com

- Revised Total Coliform Rule: A Utility Briefing
- Hydraulic Models Shed Light on Water Age
Meeting the New Numeric Standards: Research to Link Sources, Effects, and Controls

By Damann Anderson, P.E.

Numeric standards for discharged levels of nitrogen and phosphorus in areas such as Florida will require that many utilities change the way they treat and/or dispose of wastewater effluent. Opinions vary greatly as to the capital costs involved: U.S. EPA has estimated likely annual costs of meeting numeric standards in Florida’s waterways as being in the neighborhood of $180 million, while the Florida Stormwater Association has estimated those costs in the billions.

Each estimate stems from a unique assumption of exactly how the standards will be met, and there are many viable alternatives: upgrading treatment facilities to advanced wastewater treatment, reverse osmosis, and the use of brine contactors; effluent disposal via deep wells; and the identification of reuse opportunities, to name a few.

Identifying the most cost-effective way to meet new numeric standards requires a better understanding than we currently have of the linkages between nutrient sources, their predicted and measured adverse effects in receiving waters, and the costs and benefits of source controls, process changes, or removal technologies needed to address them. Under a contract recently awarded to us by the Water Environment Research Foundation, Hazen and Sawyer is at work developing a framework for understanding these linkages.

Our goal for this project, titled “Linking Receiving Water Impacts to Sources and to Water Quality Management Decisions: Using Nutrients as an Initial Case Study,” is to develop a technically-defensible and robust framework for the assessment of the linkage between nutrient sources (point sources and non-point sources) and water body responses, and how this linkage is influenced by source controls.

The framework developed will build on knowledge gained from current successful management programs and will outline the key components and linkages, identify what is known, what might be missing, and describe the best method for gathering any essential missing data and information to implement successful nutrient source controls. This approach would then be applied to the evaluation of nitrogen impacts to Florida waters, providing a timely and thorough evaluation of these issues using Florida case studies for an initial demonstration of the framework. Subsequently, the developed approach could become a “best practice” for establishing successful nutrient source controls that could help other areas facing a similar situation.

Nitrogen: One of the earth’s most abundant elements, it is essential for both plant and animal life. However, as a result of human activities, there has been a tremendous increase in the amount of reactive nitrogen available in the global environment over the past 50 years.

Nitrogen can enter a receiving waterbody through atmospheric deposition, nonpoint source discharge, or point source discharge pathways. However, these two ultimate sources of nutrients. The key culturally-derived nitrogen sources are combustion of fossil fuels, fertilizer and animal waste, and human and industrial waste.

See related links

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Technologies Available to Meet Numeric Nutrient Criteria and their Associated Impacts

Florida’s Numeric Nutrient Criteria & the Potential Importance of Dissolved Organic Nitrogen

Horizons Winter 2010
LID City: Low Impact Urban Development

By Sandeep Mehrotra, P.E.

LID seeks to maintain the functional ecosystem relationships between the atmosphere, land, and water by retaining and reusing stormwater where it falls. Controlling stormwater at its source is typically the most cost-effective management solution, as it reduces overall dependence on the sewers and increased wet weather capacity at wastewater treatment plants – each of which are costly to build, expand, and maintain.

LID also typically improves the aesthetics and ecology of a developed area, adding trees, shrubs, and flowers to swales and enhanced tree pits – areas that might otherwise just be gray. By putting nature to work, LID also represents the most sustainable stormwater solution, as the maintenance investment is minimal once the system is established.

LID allows natural processes such as infiltration, soil storage, filtration, evaporation, and vegetative uptake to provide the necessary quantity and quality control of stormwater runoff, restoring the natural flow regimes that channel stormwater gradually back into our natural water bodies, streams, and river systems.

Fortunately, nature provides a guidebook for us in how to most efficiently and effectively mimic the water cycle. The current industry term for relying on natural processes to channel and treat water is Low Impact Development or LID.

Vegetation conservation helps preserve the natural ecological processes and water balance of the area, reducing runoff and maintaining the natural flow paths.

Porous pavement captures stormwater and allows it to percolate into the ground or a catch basin.

In our developed, sparsely-permeable environment, LID stands as the most attractive solution for the cost-effective management of stormwater. A well-designed LID integrated stormwater management system will minimize runoff volume, maximize the treatment capabilities of the landscape, be easy to maintain, and create a more appealing environment for everyone.

Bioswales/Rain Gardens add to the aesthetics of the property as well as provide for a hydrologically rough landscape that lengthens flow paths, increases time of concentration, and promotes infiltration.

Enhanced tree pits and infiltration swales absorb and often detain stormwater for an extended period of time, creating a self-sustaining ecology.

Green roofs are capable of absorbing and retaining large amounts of stormwater; they also absorb air and noise pollution and provide rooftop cooling.

Blue roofs are non-vegetated source controls that detain stormwater and provide sustainability benefits such as rooftop cooling.

Rain barrels connect directly to a gutter downspout and detain stormwater that can then be used for irrigation or other purposes.

Bioswales/Rain Gardens add to the aesthetics of the property as well as provide for a hydrologically rough landscape that lengthens flow paths, increases time of concentration, and promotes infiltration.
Aeration Systems Test Results: Key Findings for Process Optimization

By Diego Rosso, Ph.D., D.Ch.Eng., Paul Pitt, Ph.D., P.E., Ron Taylor, P.E., and Jim Cramer, P.E.

Many of the fine-pore diffusers typically employed for aeration in municipal wastewater treatment decline in performance over time, with consequent increases in process energy usage and operating costs. Hazen and Sawyer’s Applied Research Group sponsored a study by the University of California, Irvine, that extensively tested 17 membrane diffusers from five different manufacturers to measure oxygen transfer efficiency, dynamic wet pressure, and process water effects. We’ve used the test results to develop a dynamic energy model that quantifies decreasing performance over time and can be used for process optimization, producing significant energy conservation and reducing operating costs.

Aerobic biological treatment is the most common process for municipal wastewater treatment plants in developed areas of the world. Since aeration accounts for 45 to 75% of the wastewater process energy, it is typically the primary candidate for energy optimization and improvement efforts.

Due to their lower specific energy requirements, fine-pore diffusers have become the most common aeration technology in municipal wastewater treatment. Among the various types of fine-pore membranes, ceramic discs and polymeric membranes are currently the most common, and therefore the subject of our research.

We performed laboratory and field tests to measure oxygen transfer efficiency, dynamic wet pressure, and process water effects (i.e., alpha factors) and compiled the experimental datasets into a dynamic energy and carbon footprint model that quantifies fine-pore diffuser decrease in performance with increasing time in operation.

Using the model to comparatively analyze the energy usage of different diffuser models, we’ve illustrated a comparative scenario over the lifespan of the diffusers. The resulting data increases our understanding of the factors that affect energy consumption of an aeration system, helping us identify potential strategies for improved energy efficiency.

To further our understanding of the dynamics of diffuser efficiency, and further improve design procedures, Hazen and Sawyer has since extended the scope of this research to include a long-term fouling study performed in real wastewater mixed...
In southeast Florida, the demand for potable water is expected to grow significantly over the next 15 years, primarily due to the expected increase in population served by public water supply utilities. The total population of southeast Florida is expected to grow from 5.4 million in 2005 to 7.1 million in 2025, with Palm Beach, Broward, and Miami-Dade counties experiencing the greatest growth. This area includes the cities of West Palm Beach, Fort Lauderdale, and Miami.

The Regional Water Availability Rule greatly restricts any additional water withdrawals from the existing surficial aquifer, the region’s historical water supply source. Specifically, the Rule prohibits increased water withdrawals from the Lower East Coast Everglades, the North Palm Beach/Loxahatchee River Watershed water bodies, and the District’s regional canals that are hydraulically connected to these water bodies (collectively called the Regional System).

Under the Cascade Effect, the District would release water from the proposed C-51 Reservoir through the existing regional and secondary canal system to recharge the surficial aquifer in Palm Beach and Broward counties.

Design procedures have historically relied on manufacturer’s datasets for efficiency and operating pressure drop, but these datasets have never accounted for performance decline with time in operation. Using one of the most comprehensive independent studies on fine-pore diffusers completed to date, we’ve developed a dynamic energy model that quantifies fine-pore diffuser decrease in performance with increasing time in operation. These modeling results give rise to a new level of process optimization, offering promise of significant energy conservation and operating cost containment for plants using aerobic biological treatment.

These plots show the range of operating performance and pressure requirements for different diffusers – normalized field transfer efficiency (aSOTE/Z, main graph) and pressure drop (DWP, inset) for fine-pore diffusers tested in process water, as function of the operating air flow rate. Regardless of the diffuser model, efficiency decreases and pressure drop increases rapidly with increasing air flow rate. Understanding the variation of these parameters over time is crucial for healthy process operations and for improving design procedures.

New Data Informing Better Design

Regardless of type, model, or manufacturer, the fine-pore diffusers show decreased efficiency and increased pressure drop with increasing air flow rate. Also, multiple diffuser configurations (i.e., increased number of diffusers per unit of tank area) may help mitigate decreased efficiency at elevated air flow rate, as they help distributing the air flow through more and smaller bubbles. Early results on diffuser fouling confirm our expectation that the energy usage of fine-pore diffuser operation tends to rise with increasing time in operation. This pattern provides a significant opportunity for improvement in terms of process optimization and cleaning schedules.

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See related links
- Energy-Savings Benefits of Denitrification
- Clarifier Optimization with Computational Fluid Dynamics Modeling

By Grace Johns, Ph.D.
Most available options for meeting this growing demand are costly and complex, leading several utilities to collaborate on an investigation of the potential to capture storm water currently lost to tide. The goal of capturing storm water would be twofold – first, to reduce the detrimental environmental effects of water drainage on estuarine environments and, second, to provide additional water to “offset” regional water withdrawals.

Hazen and Sawyer, in association with MacVicar, Federico and Lamb, Inc., was retained by the City of Fort Lauderdale to evaluate the construction and use of a new reservoir in the vicinity of the existing L-8 Reservoir. Currently referred to as the C-51 Reservoir, this reservoir would store wet season storm water from the C-51 canal that is currently drained to coastal environments and causes environmental concern in the Lake Worth Lagoon and the Loxahatchee River estuarine area. This stored water would be released as needed by the District to recharge the surficial aquifer in Palm Beach and Broward counties, supplying water to the Regional System so that water utilities could pump additional water from the surficial aquifer while maintaining compliance with the Regional Water Availability Rule.

For comparison purposes, Hazen and Sawyer also evaluated the costs, water supply quantities, and conceptual feasibility of obtaining additional water from two other potential alternative sources. Developing and using the C-51 Reservoir compared favorably to both surface water recharge with reclaimed water and pumping and treating water from the upper Floridan aquifer system, offering a number of significant advantages:

**Cost-Effective Water Supply.** The C-51 Reservoir could provide needed potable water supplies to the Lower East Coast planning area at a competitive cost relative to other alternative water supply projects.

**Help Natural Habitat.** Storing water in the C-51 Reservoir for potable water supply could attenuate degradation of the Lake Worth Lagoon estuarine system by holding excess fresh water. Hydrologic modeling by District staff indicates that the existing L-8 Reservoir will not be sufficient to prevent all excess storm water from being released through the C-51 Canal to the Lake Worth Lagoon. The C-51 Reservoir is expected to double the amount of water storage capacity (over that afforded by the L-8 Reservoir).

**Facilitate Flood Control.** The additional water storage capacity could facilitate the District’s flood control activities.

**Low Energy Requirements.** The C-51 Reservoir conceptual project may result in lower energy requirements relative to other potential alternative water supply projects.

This water supply has the potential to become a valuable alternative water source to many southeast Florida water utilities by offsetting regional system recharge of the surficial aquifer to support existing and expanded wellfield pumpage – a cost-effective, environmentally beneficial method to meet the future growth in southeast Florida water demand. The results of this study are being used to obtain water utility and South Florida Water Management District consensus regarding how best to proceed with developing this water supply source.

Following the earthquake that displaced more than 1.5 million Haitians, Hazen and Sawyer participated in discussions with relief agencies, international banks, and non-governmental agencies to offer engineering services to assist with the reconstruction effort. The Inter-American Development Bank requested Hazen and Sawyer’s services to assist with a $50-million grant program being distributed to the Republic of Haiti called the “Support to the Shelter Sector Response Plan.”

The grant will support the development of a 5,000-unit transitional housing program to accommodate approximately 20,000 displaced people at the 50-hectare Les Orangers site, approximately 12 km from Port-Au-Prince.

Hazen and Sawyer’s site development and seismic specialists performed a site assessment to examine potential environmental factors, such as flood control and drainage issues, seismic concerns, potable water and wastewater issues, and possible impacts to the nearby coastal wetlands.

Hazen and Sawyer’s final report revealed that the Les Orangers site is feasible for development and reviewed options to develop the property, identifying a concept based on an expedited construction schedule and effective site drainage. Hazen and Sawyer is now working with the IDB on the next phase of the program to develop plans and provide housing relief to a portion of the displaced population.
Cutting-edge wastewater treatment
Optimizing clarifier operation with computational fluid dynamics modeling

By Alonso Griborio, Ph.D., P.E., and Paul Pitt, Ph.D., P.E.

PROGRESSIVE ENGINEERING

Full-plant simulators are limited in their ability to simulate accurately the performance of clarifiers, which play a significant role in the wastewater treatment process.

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