

Horizons

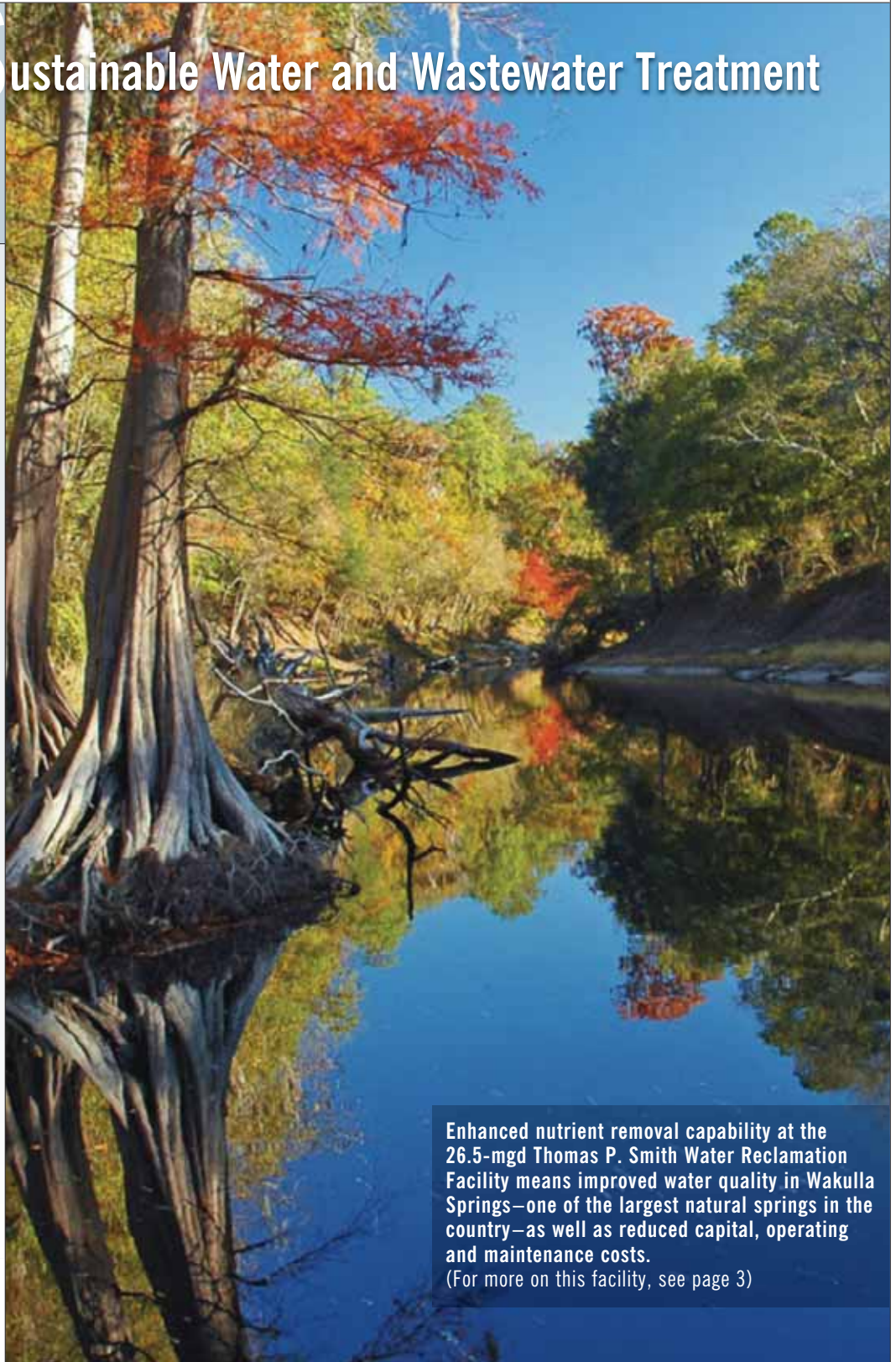
Engineering Excellence in Meeting Environmental Challenges

Sustainable Water and Wastewater Treatment

Fall - Winter 2009

Inside

- 2 ■ Delivering Fast-Track LEED Design and Construction
- 3 ■ Managing Costs with the Right Dewatering Technology
- 4 ■ Alternative Project Delivery in the Dominican Republic
- 6 ■ Sustainable Water and Wastewater Treatment
- 9 ■ The Rewards of Smart Digester Gas Management
- 11 ■ Award-Winning Water Reuse Projects



Enhanced nutrient removal capability at the 26.5-mgd Thomas P. Smith Water Reclamation Facility means improved water quality in Wakulla Springs—one of the largest natural springs in the country—as well as reduced capital, operating and maintenance costs.

(For more on this facility, see page 3)

Delivering Fast-Track, LEED Certified Design and Construction of the Champaign County Water Treatment Facility: Haste Need Not Make Waste

by Mark Bishop, P.E., BCCE, Vice President

Demand for water in Champaign County, Illinois, has been steadily growing, and a new water treatment facility was needed to ensure adequate system capacity and continued reliability. With an eye towards the sustainable delivery of safe drinking water for years to come, Hazen and Sawyer worked with the Illinois-American Water Company to create a new facility that was delivering high-quality drinking water within 21 months of project commencement.

Illinois American Water Company's Bradley Avenue Water Treatment Facility is a new 15-mgd water treatment plant, expandable to 20 mgd as demand grows, to serve the people of Champaign and Urbana, Illinois, for decades to come. Hazen and Sawyer provided preliminary engineering, permitting, and final design for this design/build project. The new plant was constructed 7.5 miles west of downtown Champaign on a "greenfield" site.

Hazen and Sawyer's design of the Bradley Avenue Water Treatment Facility project included new raw water supply wells, treatment facilities (including lime softening clarifiers, recarbonation basins, filters, clearwells, distributive pumps, chemical feed facilities) and residuals handling facilities, standby power generation, and administrative facilities.

Hazen and Sawyer, River City Construction, and Illinois-American Water Company designed and built the plant with careful attention to energy efficiency, sustainability and environmental impacts. Green and sustainable aspects of the facility included:

- Over 46% of the materials used for construction were locally sourced to lower transportation and energy costs.
- Complete recycle or reuse of waste streams have lowered raw water pumping costs and conserve water.

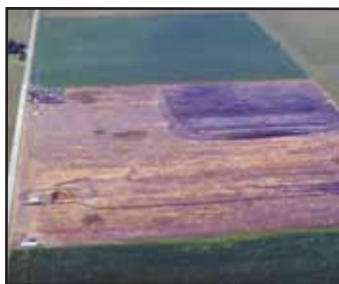


The porous pavement used in construction allows for gradual infiltration of stormwater through the soil, providing some natural water quality treatment and groundwater recharge.

- 68% of the construction waste was diverted or recycled locally to minimize waste hauling energy and disposal impacts.
- 33% of construction materials were from recycled sources.
- Variable speed pump drives optimize operational control and energy use.
- A raw water sidestream is used for geothermal heating and cooling of administration areas.
- Reduced "heat island" by using reflective roofing and pavement.
- Water efficient fixtures specified throughout the facility.
- Optimized building energy performance.
- "Dark Sky" lighting provided to minimize visual impacts at night.
- Native plants used for landscaping to minimize the site irrigation needs – reducing both energy and water consumption.
- Utilized low-emitting adhesives, sealants, paints, and flooring system.

Native habitat is being maintained on the undeveloped portions of the site to serve as a local wildlife sanctuary. Stormwater runoff was minimized through the use of porous pavement, and stormwater retention areas were designed for water quality control.

August 2007



October 2007



March 2008



February 2009



A new plant is born:
The rapid rise of the Bradley Avenue Water Treatment Facility in Champaign County, Illinois.

The commitment to sustainable design guided the design and construction. At the preliminary design meeting, it was established that the project would have a goal of certification using the LEED Green Building Rating System. At completion of construction, the final reviews were completed and the project met its goal of being LEED Certified.

A Grand Opening Celebration was held in June 2009, with approximately 600 people attending the event. The project was delivered on time and on schedule. ▴

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria. For more information on LEED Certification, visit the U.S. Green Building Council website at: www.usgbc.org or contact William Russell, AIA, LEED AP at wrussell@hazenandsawyer.com

Managing Capital and Operating Costs with the Right Dewatering Technology: Lessons from the City of Tallahassee's Water Reclamation Facility

By C. Michael Bullard, P.E., Senior Associate

As part of a 2007 Improvements Project, Hazen and Sawyer helped the City of Tallahassee select the most advantageous dewatering technology for the Thomas P. Smith Water Reclamation Facility – minimizing capital, operating and maintenance costs while producing the most marketable biosolids product possible.

Increasingly, biosolids generators are seeking treatment and processing alternatives that have better pathogen reduction than conventional stabilization technologies (e.g., aerobic and/or anaerobic digestion, or liquid lime treatment) and result in a “Class A” biosolids product with significantly lower pathogen density. Biosolids generators also prefer to generate a product with other characteristics, such as increased dryness and product stability, that differentiate it from the liquid and dewatered cake associated with most conventional “Class B” treatment technologies. Biosolids treatment by thermal drying is thus being viewed as a viable alternative, since it results in a product with both the reduced pathogen densities associated with Class A biosolids and a differentiated product that can be marketed to a variety of outlets.

During the thermal drying process, dewatered biosolids are exposed to a heat source, and the remaining internally and externally bound water is evaporated by either conduction or convection. Thermal drying unit processes are typically rated by



The City of Tallahassee pilot tested the high solids centrifuge unit shown above, housed in a trailer.

evaporative capacity (i.e., mass of water evaporated per unit time), and the dry solids throughput becomes a function of the dewatered cake solids content in the feed and the final product solids content. Dewatering unit processes are typically rated by dry solids throughput capacity; however, all dewatered cake is not created equal. Even with the same feedstock, different dewatering unit processes will produce dewatered cake with varying solids



Aerial view of the 26.5-mgd Thomas P. Smith Water Reclamation Facility in Tallahassee, Florida.

content, which then requires varying amounts of thermal drying. Therefore, the design and operation of the thermal drying unit process and the dewatering unit process must be considered as a matched pair.

Thermal energy consumption in the drying unit process is directly related to both the water content of the dewatered residuals to be treated and the dry solids mass throughput. Excess water content in the dewatered cake, in addition to requiring additional evaporative capacity, also results in significant operating costs for

fuel consumption (e.g., natural gas, fuel oil, etc.). Selecting the right dewatering technology can thus have significant lifecycle cost implications that should also be considered when designing a dewatering and thermal drying facility. Operators should carefully examine system functionality as well as capital and operating costs when designing systems where the dewatering technology is coupled with downstream thermal drying.

The City of Tallahassee is currently designing facilities to provide enhanced nutrient removal capability at the 26.5-mgd Thomas P. Smith Water Reclamation Facility. These upgraded facilities will include significant modifications in the liquid treatment train and the residuals unit treatment processes. As part of this work, Hazen and Sawyer evaluated the existing dewatering unit process, and analyzed the thermal dryer evaporative capacity requirements for both rotary screw press and high solids centrifuge dewatering technology. We developed solids loading rates for the digestion, dewatering and thermal drying unit treatment processes using the *BioWin*[™] process simulation model and historical influent wastewater characteristics. Hazen and Sawyer also considered capital, operating and maintenance costs of the two alternatives.

The high solids centrifuge dewatering alternative selected will save the City almost \$10 million net present cost (2008 dollars), with reduced footprint, improved energy efficiency, and a more marketable biosolids product. ▴

Alternative Project Delivery Meets Increased Drinking Water Demand in the Dominican Republic

By Fernando B. Chiriboga, P.E., Latin America Operations Manager

In the Dominican Republic, competing uses of water for irrigation, water supply, and hydropower generation have resulted in water shortages in several urban and newly-constructed tourist areas. To provide safe drinking water to the urban service areas of La Romana, San Cristobal, and San Francisco de Macoris, the National Institute of Water and Sewage of the Dominican Republic (INAPA) retained the Biwater/Sinercon Consortium for the Design-Build delivery of three 23-mgd Water Treatment Plants and associated infrastructure. In turn, Biwater U.S.A. retained Hazen and Sawyer to provide engineering design and construction management services for the project.

The Dominican Republic is a beautiful country that is home to many rivers, lakes, streams, and waterfalls. An expanding



San Cristobal Water Treatment Plant.

tourism industry has fueled rapid growth in the country's GDP for the last thirty years, in turn spurring rapid development. Sustaining this growth, and protecting the public health, has required the Dominican Republic to develop additional water treatment infrastructure.

For this project, more than \$180 million in loans were secured from the U.S. Export-Import Bank for the national government of the Dominican Republic by the Design-Build Team. Meeting and complying with strict environmental and water quality crite-

ria as established by the World Health Organization and other international agencies was a loan requirement, as was having the majority of the materials and services be of U.S. origin.

The project consisted of building three water treatment plants (The Mata Larga Plant, La Romana Plant and the San Cristobal Plant), each of which is rated at 1 m³/s (23 mgd) capacity. Other supporting infrastructure development included nine water storage tanks, seven pump stations with capacities of up to 24 mgd, and 80 miles of ductile iron raw water and transmission mains, ranging in size from 8 to 42 inches in diameter.

In order to meet the 24-month fast-track schedule to have facilities designed, constructed and placed on-line, Hazen and Sawyer issued owner-furnished specifications and assisted during the equipment/materials purchasing process during the initial design phase. The design team concurrently prepared more than 2,000 drawings according to priorities established in the field, to stay ahead of the construction and meet the project schedule. Civil works were designed and constructed first, pending the delivery of U.S. equipment and materials.

Two of the water treatment plants obtain raw water from reservoirs serving hydroelectric dams. River water from the Rio Chavon is pumped to the third plant (La Romana). During the rainy season, river water turbidity can approach 1,000 NTU. Hazen and Sawyer conducted field treatability studies to confirm unit process parameters and chemical dosages at all plants.

The basic unit processes are similar at all three plants and include pre-aeration through a triple cascade works, flash mixing of ALUM and polymer, flocculation, sedimentation utilizing settling tubes to enhance performance, dual media filtration (anthracite and sand), filter media cleaning using air scour followed by backwash water, chlorination, and on-site storage to meet distribution system water demands.

Providing safe and adequate drinking water to the growing population in urban and rural areas throughout Latin America will likely remain a growing challenge for some time. Leveraging our international expertise in design and construction management, Hazen and Sawyer provided proven fast-track design engi-

neering and construction management services to improve the quality, reliability and delivery of safe drinking water to three urban areas in the Dominican Republic. As global populations increase and environmental challenges mount, the need for the kind of practical and innovative engineering solutions seen in this project will surely expand. ▀



San Cristobal balance tank and chlorine contact tank.



Hatillo water storage tank.



San Cristobal filter basin.

The World Bank has earmarked more than \$100 billion to help developing nations improve their infrastructures and boost their economies. Poor farming practices, unregulated industrialization, and urban poverty have negatively affected Latin America's water resources, where most wastewater still flows untreated into rivers, lakes, and canals.

Applying New Tools and Integrated Approaches for Sustainable Water and Wastewater Treatment

By Sandeep Mehrotra, P.E., Vice President

As public concern over greenhouse gas emissions grows and new regulations appear likely from the local to the federal level, Hazen and Sawyer has focused on helping our clients meet their targets for improved environmental performance. Through our technical leadership, we integrate sustainable solutions into our planning and design services that meet the triple bottom line of social, environmental, and financial drivers. We provide innovative, cost-effective, energy-efficient solutions to environmental challenges while carefully considering risk and liability. Success in this arena involves mastering new tools, as we broaden the considerations that influence material selections and facility design alternatives.

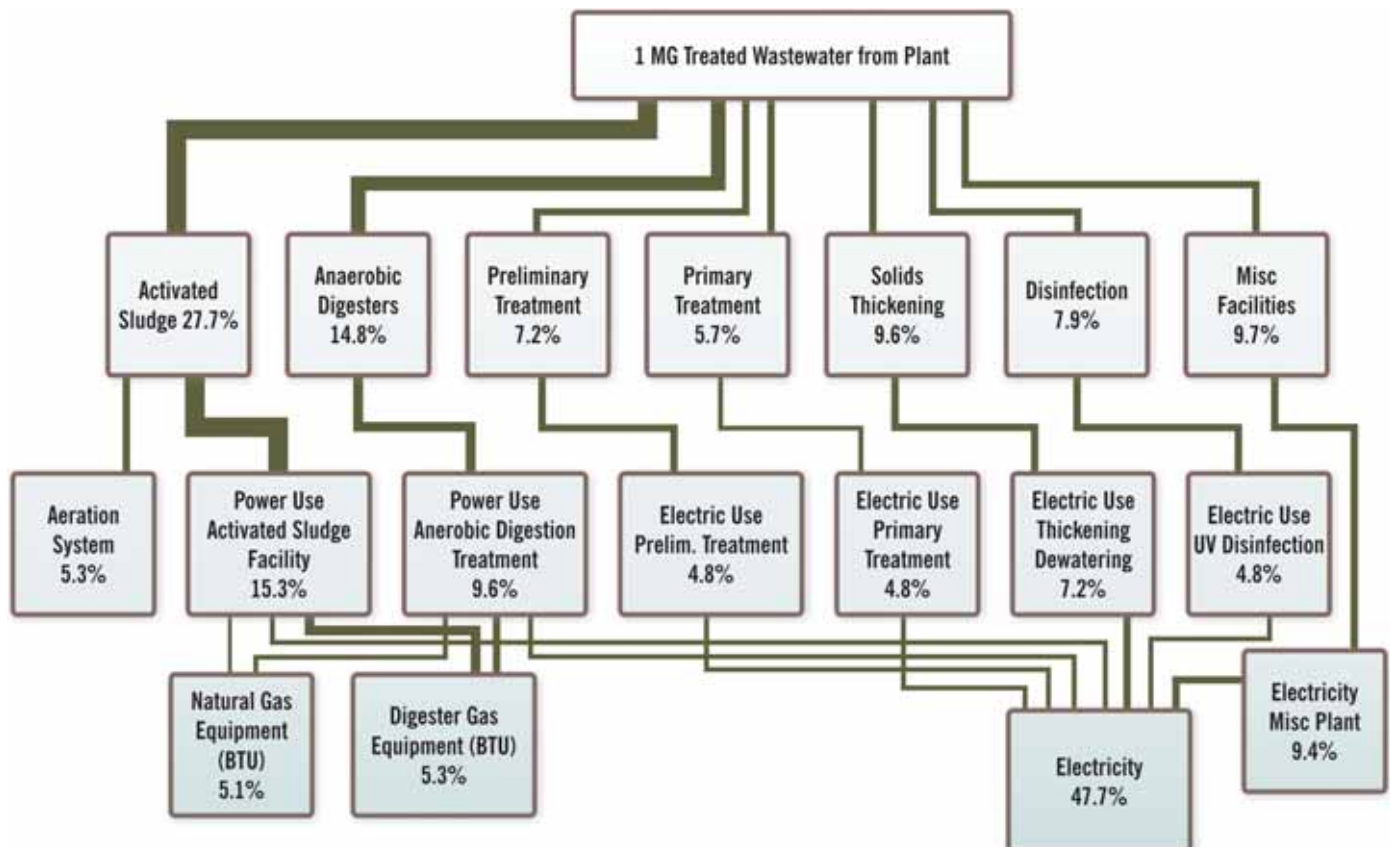
To help clients make the best possible forward-thinking decisions in this climate, we have developed customized metrics and tools, such as Life Cycle Analysis (LCA) and Carbon Footprinting, which enable facility owners and operators to better assess the sustainability of their operations.



Life Cycle Analysis

Pioneering the application of LCA to the North American water and wastewater industries, Hazen and Sawyer has built models and templates customized to the types of systems our clients employ, enabling expedient and cost-effective quantification and comparison of environmental impacts of different treatment processes and products.

LCA can be used to provide a big picture view of a project, exploring the “cradle-to-grave” impacts that can result from constructing and operating a treatment plant or other facility, including disposal of its waste products. Examining the inputs and outputs from the process under consideration, LCA uses peer-reviewed industry and academic data to convert these components into a range of environmental impacts, such as global warming, ozone depletion, aquatic ecotoxicity, and waterbody eutrophication, among others. The scope of the LCA assessment extends beyond the physical boundaries of a facility, by including emissions generated in raw materials production and transport, assembly, construction, operation, and waste generation and disposal.

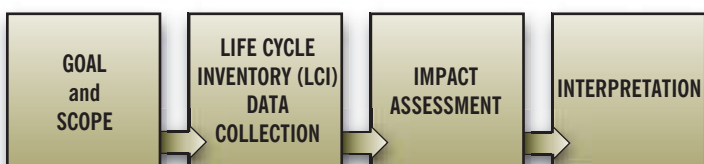


This simplified Impact Network illustrates the dominant process impacts on the carbon footprint of one million gallons of treated wastewater. While not all of the impacts are depicted, you can see that the most dominant stem from electricity or other power used in the treatment of wastewater. In our experience, these operating impacts far overshadow those associated with construction of the treatment plant.

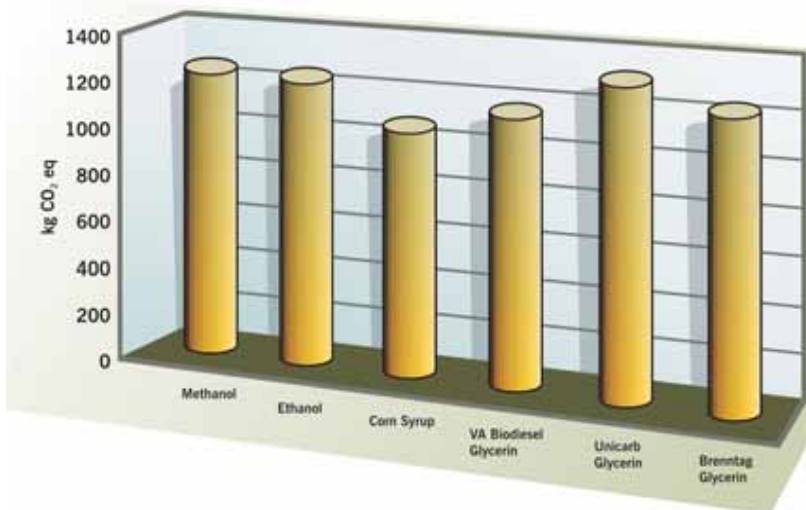


We have developed customized modules for our core business areas (water and wastewater), using *SimaPro*, the market-leading LCA software. These customized modules afford us the ability to easily configure the model to fit a particular client's needs and economically conduct screening-level studies of a client's operations, ultimately providing guidance as to measures for reducing environmental footprints.

LCA is typically conducted in four phases:



For the 20-mgd South Durham Water Reclamation Facility in North Carolina, Hazen and Sawyer employed LCA to conduct an evaluation of alternative sources for supplemental carbon addition. For years, methanol has been the supplemental carbon source of choice for the plant's denitrification process, primarily due to availability and costs. However, recent supply interruptions



and volatility in price led to an evaluation of various sources of supplemental carbon, in lieu of methanol. The LCA evaluation compared and contrasted the various environmental and economic impacts associated with each of these products, and identified the net change in the plant's overall carbon footprint, as shown in the graphic above.

The LCA also generated an "impact network" for the water reclamation facility, which is useful for identifying "hotspots" in

the process train. As the figure on page 6 shows, the activated sludge process is one of the most impact-intensive processes within the facility. We can further infer that, within the activated sludge process, electricity usage is the largest contributor to the process' associated carbon footprint. In fact, when considering the entire treatment plant operation, the electricity usage is the most dominating contributing factor to the overall carbon footprint. Specific component analyses such as these enable us to identify key focus areas that would most benefit from the development of cost-effective and environmentally sound options.

Other LCA evaluations conducted by Hazen and Sawyer have examined the impacts of biosolids management at a wastewater treatment plant, as well as the operation of water treatment plants. We will also be using customized LCA models to evaluate the impacts of climate change mitigation measures for the New York City Department of Environmental Protection, who seeks to determine effects of climate change on the City's water and wastewater infrastructure.

Project engineers from different Hazen and Sawyer offices regularly meet to review and share *SimaPro* expertise and the LCA modules we've developed for various water and wastewater treatment processes. These periodic training and feedback sessions allow us to share local expertise and specific project application experience while keeping our experts up to date with the latest advances in the use of this powerful sustainability tool.

Save Energy Costs and the Environment

In addition to Life Cycle Analysis, there are many other ways to reduce energy costs and improve the environmental profile of a municipal water and wastewater treatment plant. These include:

- Energy efficiency audits – This activity helps identify where most of a water or wastewater treatment plant's energy costs originate (such as the aeration system, for example), and enables utilities to develop a plan for greater efficiency.
- Treatment process optimization – Changes in technologies and processes often represent significant opportunities for energy savings and can forestall major construction projects.
- Renewable energy generation – The digester gas produced by the anaerobic digestion process in a wastewater treatment plant can yield significant economic

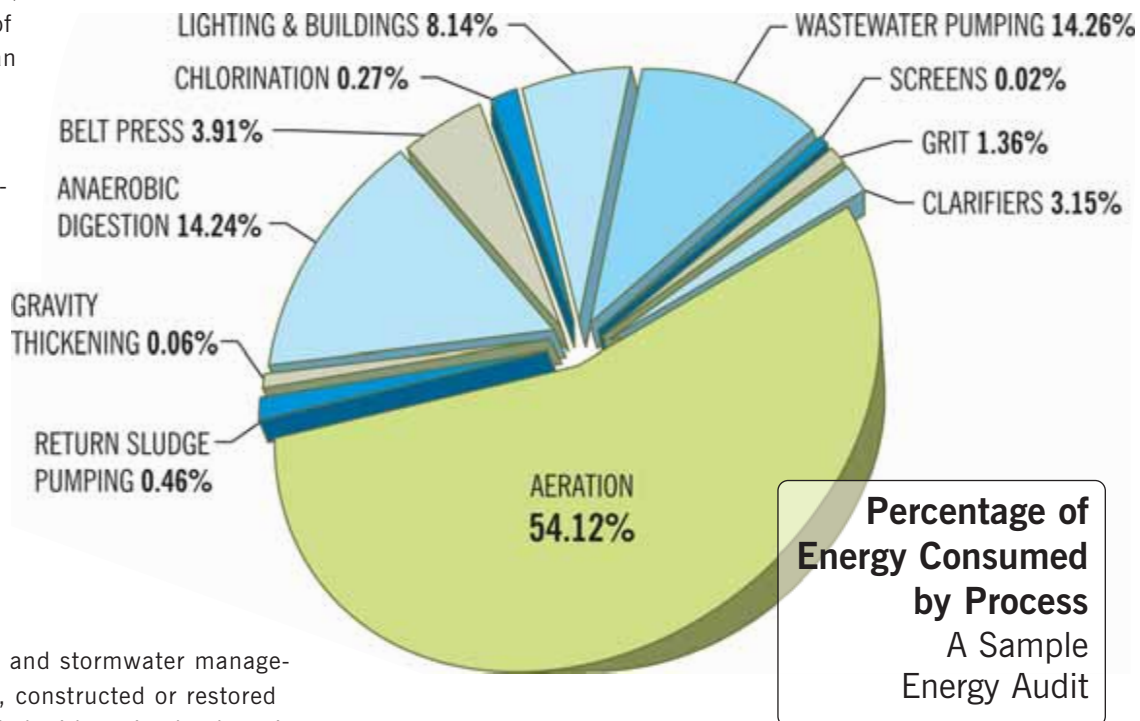
and environmental benefit; this is but one example of how renewable energy can be used.

- Green architecture – Including sustainable features (such as a green roof, chilled beams, reflective windows, recycled materials, etc.) in designing new facilities can reduce energy and water consumption while ensuring occupants a comfortable and functional work environment throughout all seasons.
- Low-impact development and stormwater management – Porous pavement, constructed or restored wetlands bioswales coupled with native landscaping, will reduce both a building footprint and impact on the surrounding environment.
- Beneficial reuse of waste products – Practical applications and markets exist for both treated effluent and biosolids resulting from the treatment process – a sustainable and profitable alternative to disposal.
- Sustainable site selection – Choosing a location for a new facility using criteria that consider environmental factors such as soil erosion, visual impacts, storm runoff, stability of slopes, wetland impacts, and the like, minimizes the facility’s environmental footprint.

The first step we recommend to clients will often be a screening-level environmental footprint study, which can identify areas of operation that could be improved in energy efficiency, resource consumption and cost, reducing the environmental burden. Life Cycle Assessment can be an important tool at this stage of the planning process, providing a snapshot of the networks of materials and energy that generate a facility’s environmental impacts, along with a full accounting of resource consumption from “cradle to grave.” This quantifies defensible metrics that can be compared during alternative development and selection.

The design process can also incorporate these sustainability metrics to evaluate design alternatives, allowing clients to make informed decisions about the impacts of selecting a particular treatment process or type of technology. Our metrics can quantify key indicators such as carbon footprint or energy efficiency, providing precise information about improvements and cost-effectiveness.

Please refer to the articles in this newsletter describing our-



work for the James A. Loughlin, Jr. Wastewater Treatment Plant (page 9) and the Champaign County Water Treatment Facility (page 2) for excellent examples of the practical application of these resource management strategies.

Hazen and Sawyer’s Long-Term Vision

Long before the term “sustainability” was coined, Hazen and Sawyer was pioneering industry leading, client-focused environmental engineering solutions in the fields of water and wastewater. For us, sustainability has always meant the confluence of technical performance with the best combination of environmental, economic and social outcomes. Sustainability is fully integrated into all of the environmental services that we offer, and we are constantly updating our design approaches and associated tools to afford our clients options to reduce their environmental footprint and improve their sustainability in innovative and cost-effective ways.

As public and institutional concern over sustainability grows, Hazen and Sawyer remains focused on helping our clients meet their targets for improved environmental performance. Impending climate change legislation will almost certainly limit the greenhouse gas emissions permitted from the water and wastewater industry, making LCA and similar methods a valuable planning and design tool for utilities and the industry.

With more than five decades of experience in environmental design and planning, we are exceptionally positioned to offer our clients valuable and practical sustainability guidance. Our approach to designing water and wastewater treatment facilities integrates efficiency and sustainability from inception to completion, preparing our clients for today’s challenges as well as tomorrow’s. ▀

Reaping the Rewards of Smart Digester Gas Management: Reducing Greenhouse Gas Emissions can be Very Profitable

By C. Michael Bullard, P.E., Senior Associate

Using the appropriate equipment, the Cape Fear Public Utility Authority's (CFPUA) 16-mgd James A. Loughlin, Jr. WWTP can turn digester gas into usable electric power – creating \$2.40 of economic benefit with each dollar of invested capital – while simultaneously preserving the environment.

Of the 16,000 centralized wastewater treatment facilities in the United States, approximately 3,500 utilize anaerobic digestion for residuals stabilization, and only about two percent (~70) of those facilities are utilizing digester gas for onsite electricity production. Increasing public demands for “green energy” and economic and regulatory actions in some regions to enact a required renewable energy portfolio standard are now helping to make these projects increasingly attractive for many facilities. Since waste-to-energy projects can offer both environmental and economic benefits, operators of treatment facilities should evaluate digester gas utilization projects for energy recovery that transcend the current and most common practice of capturing energy for process heating and flaring surplus digester gas.

Hazen and Sawyer performed an evaluation for the CFPUA James A. Loughlin, Jr. WWTP, finding that a full combined heat and power (CHP) system would produce a larger economic benefit than generation of electrical power from digester gas without heat recovery, and a significantly greater benefit than only using digester gas for hot water process heating demands. The CHP system also provides significant reductions in greenhouse gas emissions.

The CFPUA James A. Loughlin, Jr. Wastewater Treatment Plant solids treatment train includes waste activated sludge thickening, primary and secondary residuals stabilization via anaerobic digestion, and digested residuals dewatering. The stabilized residuals meet the requirements for land application as a 40 CFR 503 Class B biosolids product.

We developed a Life Cycle Cost Analysis (LCA) for both energy recovery alternatives for the purpose of determining which option, full CHP or energy generation without heat recovery (non-CHP), would provide the greatest return on investment for CFPUA. The LCA includes an assessment of the following components:

- Facility Capital Cost
- Net Present Operation and Maintenance Costs
- Net Present Value Created

Net present value and benefits were developed for both alternatives, with consideration given to estimating average seasonal heating demands for the anaerobic digestion unit process and the available digester gas production for operation at flows ranging from 10-mgd to 16-mgd. Operating costs and benefits were estimated for both energy recovery system configurations, based on a 20-year uniform annual increase in flow to the CFPUA James A. Loughlin WWTP.



Digester gas storage is provided via gas holder style floating covers and ground level DYSTOR™ membrane gas storage.

Electrical power production capability – the ability to create positive economic value – was shown to be dependent on the energy recovery system operating mode. In the non-CHP system, digester heating demands in the hot water boilers were given first priority, and only surplus gas beyond that required for digester heating was made available for electrical energy production. In the CHP system, all digester gas was assumed to be routed to the energy recovery system, with heat from the internal combustion engine generator (ICEG) recovered and utilized for digester heating, and natural gas (purchased fuel) utilized for supplemental heating in the hot water boilers during cold weather operations.

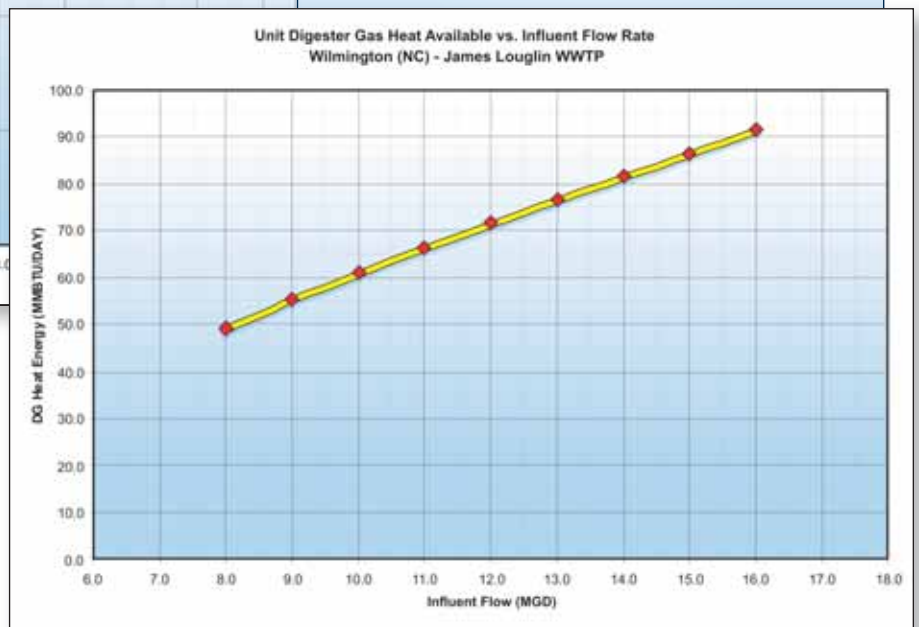
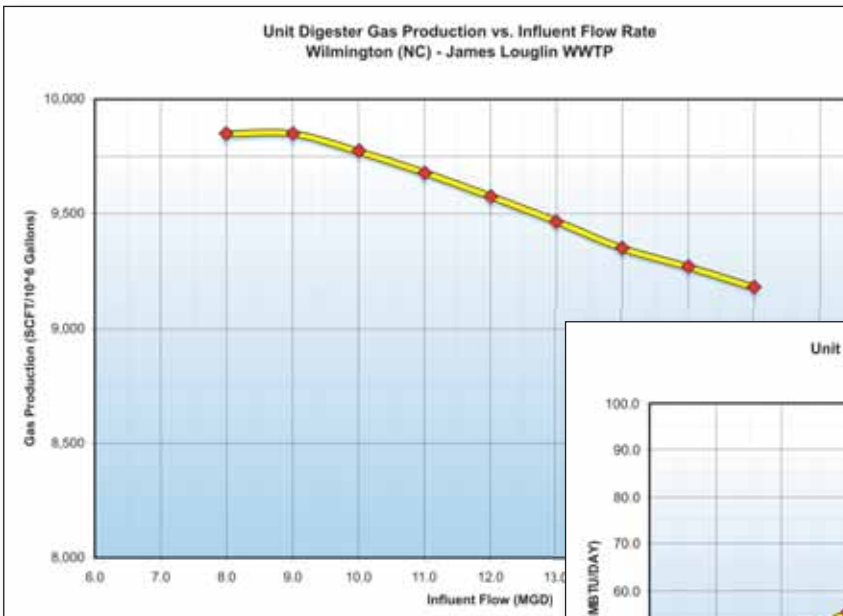
We reached the following conclusions as a result of our analyses:

1. Both process configurations, non-CHP and CHP, would generate positive economic value based on the lifecycle cost assessment and have an internal rate of return greater than the owner’s estimated cost of capital (5.5%).
2. The CHP process configuration offers the greatest rate of return on invested capital between the two energy recovery alternatives. The resultant incremental benefit-to-cost ratio for this marginal expenditure would be approximately 2.40 (i.e., each dollar of invested capital would create \$2.40 of present value).

3. The beneficial utilization of digester gas for electrical power production results in reduced greenhouse gas emissions as a renewable energy power source. Estimated greenhouse gas emissions reductions would range from approximately 890 ton CO₂ equivalents (tCO₂e) per year under current capacity conditions (10 mgd), for a system configured to operate in the non-CHP mode, to approximately 2,670 tCO₂e per year under future operating conditions (16 mgd) in a full combined heat and power configuration.

Based on CFPUA’s experience, Hazen and Sawyer believes significant economic and environmental benefits should be available for medium-sized (10- to 20-mgd) treatment facilities with anaerobic digestion process equipment that are not currently beneficially utilizing digester gas beyond process heating demands. ▴

Estimated unit gas production rates (SCF per million gallons treated) are projected to decrease as plant flow capacity increases, attributed primarily to decreased residence time as residuals flows increase with increasing plant flow. However, as shown below, even as digester unit production rates decrease, there is an overall increase in energy available from digester gas.



Pioneering Sustainable Solutions

OWASA and UNC Win

WaterReuse 2009

Institution of the Year Award

New System Projected to

Reduce Drinking Water Demand by 9%

The system began operation in April 2009. The new reclaimed water system already provides many important benefits to the community and the University of North Carolina/Chapel Hill:

- Enables the Orange Water and Sewer Authority (OWASA) to meet the community's non-drinking water needs in a more cost-effective way, while freeing up the drinking water supply and treatment capacity to meet essential needs.
- Lowers the risk for all customers during water shortages due to droughts or other conditions.
- Helps OWASA defer the need for certain long-term capital improvements by reducing demand for drinking water.

Collier County Wins WaterReuse Award of Merit for 2009

Diversified Potable Water Supply Portfolio will Accommodate Growth

The population of Collier County, Florida, has increased approximately 65% over the past ten years, and this growth, which is projected to continue, has produced tremendous stress on both water and wastewater infrastructure.

In 2005, the County began design and construction of a major expansion to the South Regional Desalination Plant reverse osmosis (RO) facilities, including both a 20-mgd South RO Wellfield and a 12-mgd RO Treatment Expansion. The treatment expansion was placed into operation in 2007, and the wellfield expansion was placed into service in phases, from 2007 through 2009.

For more information on these and other award-winning projects, visit www.hazenandsawyer.com



OWASA / UNC



COLLIER COUNTY



OWASA / UNC



www.hazenandsawyer.com

HAZEN AND SAWYER
Environmental Engineers & Scientists

498 Seventh Avenue
New York, NY 10018