

City of Oneida WWTP: *Turning a Compliance Situation into a Sustainability Program*

by Mark R. Greene and Daniel Ramer

In 2001, the City of Oneida, New York signed a consent order with the New York State Department of Environmental Conservation (DEC) to resolve noncompliance issues with its State Pollution Discharge Elimination System (SPDES) Permit. Faced with this consent order and the results of a NYSERDA (New York State Energy Research and Development Authority) energy audit, the City of Oneida developed a strategy for sustainability. Elements of the strategy include improving treatment performance to reach compliance, developing partnerships with the neighboring Town of Verona and the Oneida Indian Nation, and capturing the energy production value of a high-strength waste from a large dairy products packaging facility. The ultimate goal of the sustainability program is to allow the wastewater treatment plant (WWTP) to become energy self-sufficient while operating within permit limits.

Oneida's Setting and History

Oneida is located in Central New York, very near the actual geographic center of the state. The City is contained within the farthest eastern portion of the Great Lakes drainage basin, and has occupied a four square mile urban area for well over 125 years. Besides a rich European settler's tradition, the area was also the home of the Oneida Indians of the Iroquois Confederacy for hundreds of years prior to the arrival of the Europeans. During the revolutionary war, the settlers and the Oneidas fought side by side in creating the new nation. The location of the City was a result of a geographic sandwich created by the hills to the south and the existence of swamps and shallow Oneida Lake to the north. Oneida sits on fairly dry and flat land in between these two difficult to traverse areas. As a result of this geographic juxtaposition and the Oneida's existing trade routes, Europeans and Oneidas settled the area.

During the industrialization of the early United States in the 19th century, these trade routes were expanded. With the construction of the railroad and Erie Canal, which passed through this area, the City became an even more active transportation center. As early as the 1840's, Oneida had a population near 10,000. The receiving waters of this human settlement flow down Oneida Creek. The Oneida Creek drainage basin is 110 square miles, with approximately 90 percent of the drainage basin upstream of the City. The high hills and clay soils create a drainage system that carries large amounts of sediment and has very slow groundwater seepage. The basin is prone to flooding due to the large amounts of snow that fall throughout the entire Oswego River drainage basin and, therefore, flooding and drainage problems need to be managed.

As with many cities in the Northeast that share this type of historical development, all drainage was sent downstream to Oneida Creek through a series of natural and manmade conveyance systems. Small canals and mill races fed canal water to and provided transportation for the factories. The settlers came and so did their wastewater, which was also sent downstream. Swampy areas were drained and filled to provide more area for population growth. Eventually, Oneida Creek became eutrophic and other health problems related to this fouling ensued. In 1960, a chemical precipitation and primary treatment system was constructed on the site where the direct pumping system had been in operation. This system was expanded to include secondary treatment as part of the EPA Construction Grants Program initiative in 1982.

Treatment Plant

The Oneida treatment plant consists of the headworks, preliminary and primary treatment works, which have been online since 1962. The 1982 upgrade added a primary effluent pumping station to feed a two-stage activated sludge secondary process, which included clarification after each stage, and a chlorine contact system for disinfection. Due to the influence of wet weather on the collection system, treatment plant and creek, primary and secondary bypasses were included along with an effluent pumping system to lift the water out of the plant during high creek flow and high creek level conditions. Biosolids from the primary and secondary processes are thickened via a dissolved air floatation thickener and stabilized in an anaerobic digester. The biosolids are then dewatered in a belt filter press and trucked to the Madison County landfill. Biogas from solids digestion is used in a dual fuel cogeneration system to generate electricity, which offsets some of the utility power usage and hot water to heat the digesters.

In 1997, the Oneida Indian Nation funded the engineering and construction of a reclaimed water system to treat further a portion of the plant effluent as irrigation water for the newly constructed golf courses at the Turning Stone Casino and Resort that first opened in 1993. The reclaimed water system consists of pumps to convey chlorine contact tank effluent to an Aqua-Aerobic AquaDisk filter, an additional chlorination system. Another set of pumps conveyed the filtered effluent four miles to the Nation's golf course ponds. Recently, the golf courses were expanded to play host to a PGA tournament event in the fall of 2007. The reclaimed water is also used as cooling water for the cogeneration and cooling tower facilities operated at the Turning Stone Resort.

This cooperative relationship between the City and the Oneida Indian Nation has helped further several important infrastructure projects in the region. The casino and golf resort built in the neighboring town has helped develop sewer and water systems for the Town of Verona where the City provides the resources and infrastructure to support these systems. The fostering of this relationship, even during a contentious land claim battle, has been vital and will continue to play a major role in the future. In 2005, the City, the Town of Verona, and the Nation signed a 30-year agreement for sewer services.

Noncompliance History

Instances of noncompliance coupled with poor water quality reports compiled by the NYSDEC for Oneida Creek led to a series of consent orders starting in 1983 to the present. During the planning of the upgraded secondary facility, the City identified combined sewer connections then separated and upgraded significant portions of the collection system. In addition, one consent order required the City of Oneida to remove other sources of infiltration through a series of collection system upgrades, which were made during the late 1980s and throughout the 1990s. In response to these early consent orders, the City spent nearly \$3 million to repair and replace miles of sanitary sewer main and upgrade existing pumping stations.

The results of the inflow and infiltration (I/I) campaign were mixed. Although the City eliminated sources of inflow and disconnected sanitary and storm cross connections, the treatment plant still exceeded effluent settleable solids and flow limits on a regular basis during wet weather periods. These violations and serious managerial problems were cited in a consent order issued in 1993. This required

the City to perform a Comprehensive Performance Evaluation (CPE) and then create a Composite Correction Program (CCP) in accordance with EPA guidance on Retrofitting POTWs (publicly owned treatment works). Several unit processes were identified as creating performance limitations. Many of these were associated with process decision making rather than actual equipment problems. The main equipment problems were associated with maintenance. The one bottleneck that needed correction was the upgrade of the solids handling system. This led to the installation of a new belt filter press, digested sludge pumps and a polymer addition system. During this upgrade, an existing cogeneration engine was removed and updated.

The other significant finding of the 1993 CPE was that discharges from two dairy processing plants were causing high loadings and slug loadings of five-day biochemical oxygen demand (BOD₅). One of the dairies closed shortly after the completion of the CPE/CCP. The other dairy is still in operation. The remaining dairy was issued a new Industrial User Permit that required the milk processing plant to install equalization and spill control systems. The dairy also instituted the use of a "pig tank" to segregate high-strength waste from normal process wastewater. The segregated waste was then trucked off site for land application on local farm land.

Implementation of the capital improvement projects at the treatment plant, pretreatment program elements with the dairy, and retrofit of the defunct cogeneration system began a new wave of sustainability improvements at the plant. Unfortunately, the improvements made between 1995 and 2000 were insufficient to control wet weather excursions and prevent the occasional permit violation. The permit exceedances consisted mostly of high flows, high chlorine residual, and high effluent settleable solids. Once again, in 2001, the

City was facing another consent order with fines and penalties. The action plan contained in this consent order required the City to perform another CPE, create another CCP, and pay \$2,500 of a \$30,000 penalty with the remainder suspended pending completion of the required reports.

The City and its consultants worked with the DEC to focus the 2001 CPE/CCP on developing a path forward that acknowledged the previous improvements. Specifically focused on were the results of a previous NYSERDA FlexTech study. It recommended modifying the treatment process so the plant could better control solids flux to the clarifiers and sludge age, while maintaining the ability to nitrify. This modification was expected to allow the WWTP to increase flow without subsequent violations for poor second stage settleability, which would mean that the plant could handle increased flow due to wet weather events. The plan was to perform the CPE/CCP and include a demonstration program as part of the CCP. As summarized later, the demonstration showed improved ability to keep solids out of the final effluent, and plans were created to make these process changes permanent.

The 2001 consent order was terminated with a new one in 2005. The successes of the 2001 CPE/CCP were incorporated into the 2005 compliance schedule. The 2005 consent order carried a fine of \$5,000, an environmental benefit project (worth \$10,000), a schedule for interim permit limits including staged increases in flow, and a schedule of projects. The schedule of projects included full-scale implementation of the innovative process modification, installation of new aeration equipment, and construction of a new preliminary/primary treatment system.

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Model for Sustainability

Facing these challenges, the City of Oneida and its consultants formulated a strategy that included developing a sustainable model for meeting the requirements of the latest consent order. Strategic partnerships were identified. Opportunities to improve energy efficiencies were prioritized. The focus of the past four years has been to deal with the noncompliance issues and to develop a sustainable model for the future. Due to the WWTP geographic location and the size of the treatment plant, the City is poised to provide treatment capacity to neighboring towns in need of relief due to failing septic systems. As a result of the City's relationship with the Oneida Indian Nation with its need of increased treatment capacity to support resort development, a willing financial partner emerged.

In the last 15 years, the dairy processing plant has grown from processing 15 million gallons of milk and discharging 1500 pounds of BOD₅ per day, to processing nearly 60 million gallons of milk and discharging nearly 3500 pounds of BOD₅ per day. Therefore, the sustainability web includes several towns, the Oneida Indian Nation, the dairy processing plant, and the City.

At the heart of the sustainability challenge, are the costs of infrastructure, wet weather pressures, extremely high energy costs, regional growth and unrealized potential energy. The story presented here illuminates a path to making the sustainability model a reality. The little 3.75 MGD (million gallons per day) City of Oneida facility has untapped potential energy. Through the development of strategic partnerships and the tapping of this potential energy, it is possible for Oneida to realize its ultimate goal to "get off the grid."

Steps to Sustainability

During the 2001 CPE, eight performance limiting factors were identified and one was addressed immediately. During the phases of upgrading this facility, projects were selected on the basis of priority as identified in the CCP.

Energy Audit: In 2003, the City worked with NYSERDA to utilize a program that reimbursed 50 percent of the cost for conducting an energy audit. The objective was to identify treatment process-related, cost-effective measures that would reduce electrical demand and annual electrical energy consumption, increase biogas production, and maximize in-plant consumption of plant generated electricity. In terms of sustainability, this study was to be used to guide the capital budget prioritization process with respect to a five-year capital spending plan. The audit report was completed in early 2005 and recommended six energy efficiency measures. Many of these measures are being implemented or are completed.

Innovative Process Modification: Using the CCP and the energy audit, the project team created a phased approach to address the long list of potential projects. The first step was to create, then calibrate and validate, a model of the secondary treatment system, which was used to identify potential solutions for the two highest priority

performance limiting factors. The model allowed the team to investigate several different process configurations and recommend the most economical one that met the consent order requirements while incorporating the energy audit recommendations. The modeling results showed that an innovative process for secondary treatment (see Figure 1) could increase the secondary treatment capacity from 2.5 MGD to 6 MGD without adding additional tanks or clarifiers.

The innovation of adding a selector (a zone in an aeration tank) for second stage nitrification allowed higher clarifier overflow rates due to settleability of the nitrifiers. A small bypass of the first stage is necessary to provide sufficient food for the nitrifiers and to improve the ability of the selector to create healthy, good settling nitrifiers. The bypass of the second stage was not allowed by the DEC and, therefore, the plant re-rating was limited to 3.75 MGD.

Full-Scale Demonstration: Two of the performance limiting factors were plant hydraulic loading during wet weather, and secondary treatment process flexibility. Modeling showed that implementing the modified two-stage aeration process could relieve these factors. To measure the effectiveness of this process change, a full-scale demonstration was conducted in one half of the WWTP.

For the full-scale demonstration, one half of the secondary treatment system was operated in the modified aeration mode with the first stage configured in contact-stabilization and the second stage including a biological selector. The full-scale demonstration was conducted over a 10-month period with a focused sampling program conducted over an eight-week period when high influent flows were experienced. Analytical results measured the treatment performance of the modified aeration process and calculations determined unit loading rates for the aeration tanks and associated clarifiers. The results showed that the modified aeration process achieved acceptable performance under loading conditions in excess of the original and the proposed design basis.

The WWTP staff self performed most of the necessary modifications to reconfigure the secondary treatment process in one train of the two-train secondary system.

Phasing of Plant Upgrades: Based on the results of the successful demonstration, the capital projects were addressed in a phased approach.

Phase 1 included immediate upgrades necessary for compliance:

- Phase 1A – Implementation of process modifications to secondary treatment system
 - Phase 1B – Installation of new aeration equipment (blowers and aerators)
 - Phase 1C – Construction of new preliminary and primary treatment
- Phases 1A and 1B are completed. Phase 1C is under construction with startup expected in the second quarter of 2008.

Phase 2 includes projects for increased sustainability measures:

- Phase 2A – Upgrade to anaerobic digesters
- Phase 2B – Construction of pretreatment system dedicated to high-strength dairy wastewater
- Phase 2C – Installation of cogeneration equipment

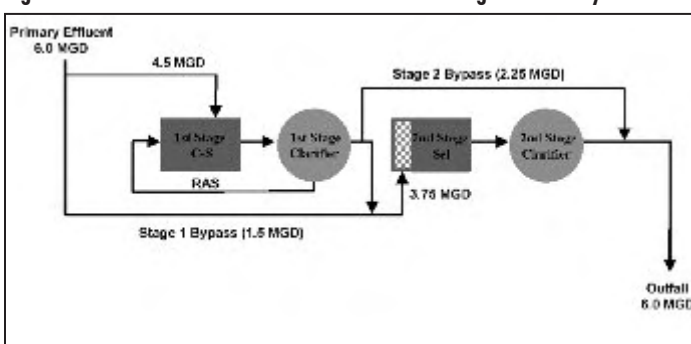
Phase 2 projects are planned, with Phase 2A expected to be completed in 2008 and the schedule for Phases 2B and 2C not defined at the time of this writing.

During every phase, innovation and energy reduction approaches for compliance created an environment for capital improvements that incorporate a "sustainable" decision making process.

Phase 1A – Process Reconfiguration: Upon successful completion of the full-scale demonstration, the City initiated construction of Phase 1A components (see Figure 2). This included installation of the following:

- Baffles in the second stage to create the selector zone

Figure 1 – Innovative Process Modification for Two-Stage Aeration System



As previously mentioned, Phase 1C components are under construction with completion expected soon.

Phase 2A – New Mixing Equipment: The energy audit identified the digester heating and mixing system as a weakness in the solids handling system. A recommendation was to mix the unmixed secondary digester, which is consistent with current best practices for digesters that stabilize secondary waste activated sludge. Another recommendation was to heat the digesters independently from one another. The current configuration supplies hot water to each of three spiral heat exchangers in serial fashion with one pump that gets heated water from the cogeneration system. The Phase 2A project will provide a thermocoupled hot water pump for each of the four digesters feeding a dedicated heat exchanger for that digester. The third recommendation was to redo the mixing system in each digester. The Vaughan Rotamix system, a hydraulic nozzle mixing system, was selected for this application. Plant personnel will clean each digester and then install the new mixing equipment. The Phase 2A projects should be complete by the end of this year.

Phase 2B – Biogas Study: In the second half of 2006, a pilot treatability study was conducted to demonstrate the performance of a wastewater pretreatment technology that could generate biogas from high-strength dairy wastewater. The demonstration program involved four partners: the City of Oneida, O'Brien & Gere, Ecovation, Inc., and a dairy processing corporation. The concept is shown in *Figure 4* and includes:

- Delivering wastewater from the dairy operation to the Oneida WWTP via a dedicated forcemain
- Separating the fat using a DAF (dissolved air floatation)
- Digesting the DAF float with other WWTP biosolids in the

anaerobic digesters

- Treating the DAF supernatant wastewater using Ecovation's proprietary anaerobic technology to convert 90-95 percent of the BOD₅ to biogas
- Sending all the biogas to cogeneration to produce heat and electricity for the WWTP with excess electricity delivered to the power utility grid.

The City would realize reduced operating costs, improved treatment plant performance, and have the ability to accommodate regional residential, commercial and industrial growth and increased service area due to reduced load from the dairy processing corporation. The dairy processing corporation would benefit by eliminating one of its bottlenecks that limits expansion (wastewater treatment), reducing sewer charges, and reducing costs by ending trucking and land application fees for their high-strength wastewater.

The pilot demonstration was conducted at the Oneida WWTP from September 2 - December 5, 2006. The pilot test results showed the high-strength waste and the process wastewater could be effectively treated. The combined amount of biogas will be enough to run a 250 kW generator.

Phase 2C - Conversion: The objective of Phase 2C is to determine the most appropriate technology for the WWTP to use to convert biogas into heat and electricity. The plan is to consider gas engines, microturbines and, possibly, fuel cells for this application. This evaluation will be completed in 2008.

Think Energy Savings and Regional Capacity

For every project considered in this program, the team was encouraged to think energy saving, life cycle analysis for every decision.

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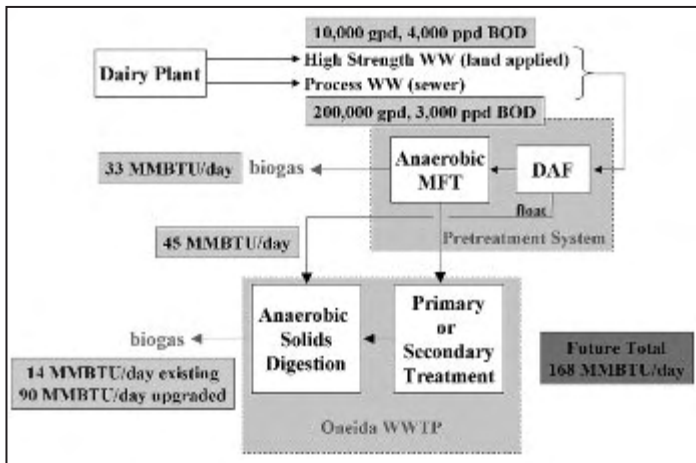
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Figure 4 – Process Flow Schematic for Phase 2B Upgrade



MFT stands for Ecovation’s mobilized film technology.

During the time period between the two consent orders with the completion of the energy audit, the City worked with vendors and the dairy processing facility to address biogas production potential.

The 2001 CPE/CCP process identified hydraulic overloading of the digesters as a performance limiting process. The symptom was very thin primary solids being fed to the blended sludge tanks, which would then be pumped to the digesters. As a result of this hydraulic overload, the digesters were difficult to heat and prone to foaming. This problem was solved without the need for any new equipment simply by feeding the primary solids with the secondary solids to the existing dissolved air flotation thickeners. Upon thickening with the DAF, the solids increased to well over six percent. Digester foaming problems were eliminated within days of this change and digester gas production became more stable as heating demands were more uniform. In addition, secondary process upsets due to the primary solids overload were also eliminated.

The need for regional capacity and the potential energy resource of the dairy processing wastewater has been emphasized throughout. The challenge was finally incorporated into one concept. The idea is to reduce the BOD loading from the dairy on the secondary system by treating the entirety of its waste through a dedicated anaerobic pretreatment system located at the POTW. The dairy would benefit by not having to segregate high-strength waste from normal processing wastewater, thereby saving trucking costs. The City benefits by generating additional biogas for its cogeneration with the potential of generating all of its electricity and heat needs. The region benefits due to the availability of capacity in the secondary treatment system.

The aerobic treatment of dairy waste is not energy efficient, so the anaerobic treatment paradigm makes much more sense. The dairy wastewater discharge has been BOD limited for many years; this new concept would free the dairy from that constraint and would lead to a more sustainable platform for it to stay in the community. The first step in this project was completed in early 2007 when the results of the pilot program validated the specific technology choices and removal efficiencies. A facility plan is being created to identify the best way of delivering the dairy wastewater to the treatment plant so that the facility, or new pretreatment equipment, fits into the footprint of the plant, how much it will cost, how the partnership can obtain funding, and how much money will be potentially saved by the dairy and the City.

Conclusions on the Path Forward

The simplified sustainability goal, to get off the grid, has taken


some baby steps forward. The climate for these projects has never been more favorable. Considering the local utility rates and partnerships developed by the City of Oneida, the potential for moving these projects to completion has never been better. The City could utilize biogas production to generate electricity and heat to satisfy all the plant’s needs. Ultimately, these projects represent a future without utility power. The savings from these improvements will help maintain existing utility rates and help the City add new customers. The savings potential for the dairy also represents a competitive advantage worth millions of dollars to the community.

The following conclusions can be drawn as a result of this program:

- *Energy savings and a greater degree of compliance is being achieved*
- *Public-private partnerships work: Industry-City-Casino-NYSERDA together produce cheaper energy and cut waste disposal costs*
- *Construction is underway, to include new headworks, and primary and preliminary treatment systems*
- *New more stringent WWTP effluent standards are in place*
- *Getting off the grid is possible!*

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